NOAA Technical Memorandum NOS ORCA 90

National Status and Trends Program
for Marine Environmental Quality

Natural and Anthropogenic Events Impacting Florida Bay 1910 - 1994 Time Line

Silver Spring, Maryland
October 1995

US Department of Commerce

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National Ocean Service
Office of Ocean Resources Conservation and Assessment
Coastal Monitoring and Bioeffects Assessment Division

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A. Y. Cantillo, L. Pikula, J. Beattie, E. Collins, K. Hale, and T. Schmidt

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United States Department of Commerce	National Oceanic and Atmospheric Administration	National Ocean Service
Ronald H. Brown Secretary	D. James Baker Under Secretary	W. Stanley Wilson Assistant Administrator

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ACRONYMS AND SYMBOLS

$^o/oo$	Parts per thousand
µm	Micrometers
pM	Pico molar
AAF	Army Air Field
AFB	Air Force Base
AOML	Atlantic Oceanographic and Meteorological Laboratory/ERL/OAR/NOAA
ATC	Air Transport Command
BIS GIS	Bureau of Information Systems Geographic Information System/Florida
BP	Before present time
C-CAP	Coastal Change Analysis Program/NMFS/NOAA
C-MAN	Coastal-Marine Automated Network/NDBC/NOAA
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CGS	Coast and Geodetic Survey
CIE-BBS	Coastal Information Exchange Bulletin Board System/Florida
COE	US Army Corps of Engineers
DDTs	Dichlorophenyltrichloroethane and metabolites
DERM	Departmenrt of Environmental Resource Management/Dade County
EDC	EROS Data Center
EEZ	Exclusive Economic Zone
EMAP-E	Environmental Monitoring and Assessment Program - Estuaries/EPA
ENP	Everglades National Park/NPS
ENSO	El Niño/Southern Oscillation
EOSAT	Earth Observation Satellite
EPA	Environmental Protection Agency
ERL	Environmental Research Laboratories/OAR/NOAA
EROS	Earth Resources Observation Systems
ESA	Endangered Species Act
EVER GIS	ENP GIS System
FDEP	Florida Department of Environmental Protection
FGFWFC	Florida Game and Fresh Water Fish Commission
FGS	Florida Geological Survey
FIFRA	Federal Insecticide, Fungicide and Rodenticide Act
FINDS	Facility Index System/EPA
FIU	Florida International University
FKNMS	Florida Keys National Marine Sanctuary
FMRI	Florida Marine Research Institute
FNAI	Florida Natural Areas Inventory
FWCA	Fish and Wildlife Coordination Act
FWPCA	Federal Clean Water Act
FWS	US Fish and Wildlife Service
GERG	Geochemical and Environmental Research Group/TAMU
GIS	Global Information System
GOES	Geostationary Operational Environmental Satellite
GPS	Global Positioning System
IR	Infrared
MMPA	Marine Mammal Protection Act
MMS	Marine Monitoring Network/ENP
MMS	Minerals Management Service
NALC	North American Landscape Characterization/EPA

NAPP	National Aerial Photography Program
NAS	National Audubon Society
NASA	National Aeronautics and Space Administration
NAWQA	National Water Quality Assessment Program/USGS
NBS	National Biological Survey
NCDC	National Climatic Data Center/NESDIS/NOAA
NDBC	National Data Buoy Center/NWS/NOAA
NESDIS	National Environmental Satellite, Data, and Information Service/NOAA
NGDC	National Geophysical Data Center/NESDIS/NOAA
NHAP	National High Altitude Photography
NMFS	National Marine Fisheries Service/NOAA
NOAA	National Oceanic and Atmospheric Administration
NODC	National Oceanographic Data Center/NESDIS/NOAA
NOS	National Ocean Service/NOAA
NPS	National Park Service
NS&T	National Status and Trends Program/NOS/NOAA
NURP	National Undersea Research Program/OAR/NOAA
NWI	National Wetlands Inventory/FWS
NWS	National Weather Service/NOAA
OAR	Office of Oceanic and Atmospheric Research/NOAA
ONR	Office of Naval Research
PAH	Polycyclic aromatic hydrocarbons
PCBs	Polychlorinated biphenyls
PCS	Permit Compliance System/EPA
QA	Quality assurance
RCRA	Resource Conservation and Recovery Act
REMAP	Everglades Mercury Study/EPA
RF3	Research File 3/EPA
RSMAS	Rosenstiel School of Marine and Atmospheric Science/UM
SEFSC	Southeast Fisheries Science Center/NMFS/NOAA
SFWMD	South Florida Water Management District
TAC	Tactical Air Command
TALARS	Tides Automated Login and Retrieval System/NOS/NOAA
TAMU	Texas A&M University
TFW	Tactical Fighter Wing
TM	Thematic Mapper
TOC	Total organic carbon
TRIS	Toxics Release Inventory System/EPA
TSCA	Toxic Substances Control Act
UM	University of Miami
USGS	United States Geological Survey
WBS	Waterbody System/EPA
WILDOBS	Wildlife Observation Database/FGFWFC

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ABSTRACT

Florida Bay is a coastal lagoon, on average less than 3 m deep, approximately 1,000 square miles in area, located between the South Florida mainland and the Florida Keys. In recent years, adverse environmental changes have been noted in the Bay. Currently, a multi-agency multi-year effort is underway to restore the ecosystem of South Florida, including that of Florida Bay. To assist in determining the Bay's former condition and to catalogue changes, events that may have affected or have occurred in the Bay are described, listed and graphically displayed in a common time scale. The time coverage begins in 1910 with construction activities along the Florida Keys, and in what later became the Everglades National Park. Included are global scale atmospheric, geological and astronomical phenomena such as El Niño events, volcanic eruptions and solar activity that may affect local weather. On local scales, documented are: dieoffs of species such as seagrasses, sponges and fishes; environmental occurrences of algal blooms, coral reef degradation, fishery catch changes and soil subsidence; and human activities such as population increases, and construction. Awareness of the environmental importance of the Bay is documented in legislation affecting environmental regulations nationwide and in the Bay area; and environmental programs and studies performed currently and in the past by Federal, state, municipal, academic and civic organizations.

1. INTRODUCTION

During the past decades, Florida Bay has undergone significant environmental changes. Seagrass dieoffs, algal blooms, shifts in biodiversity, fauna and flora population changes, and other phenomena are being observed with increasing frequency. In an effort to determine the Bay's environmental condition prior to the changes currently observed and to catalogue these changes, events that may have affected or have occurred in the Bay and surrounding areas have been compiled. Included are global scale atmospheric, geological and astronomical phenomena, such as El Niño events, volcanic eruptions and solar activity that may affect local weather. On local scales, documented are: dieoffs of species such as seagrasses, sponges and fishes; environmental occurrences of algal blooms, coral reef degradation, fishery catch changes and soil subsidence; and human activities such as population increases, and construction. Awareness of the environmental importance of the Bay is documented in

* NOAA/Miami Regional Library, Miami, FL.
Δ NOAA/Central Regional Library, Silver Spring, MD.
◊ Rosenstiel School of Marine and Atmospheric Science, University of Miami, Miami, FL.
☆ Everglades National Park Research Center, 40001 State Rd. 9336, Homestead, FL.

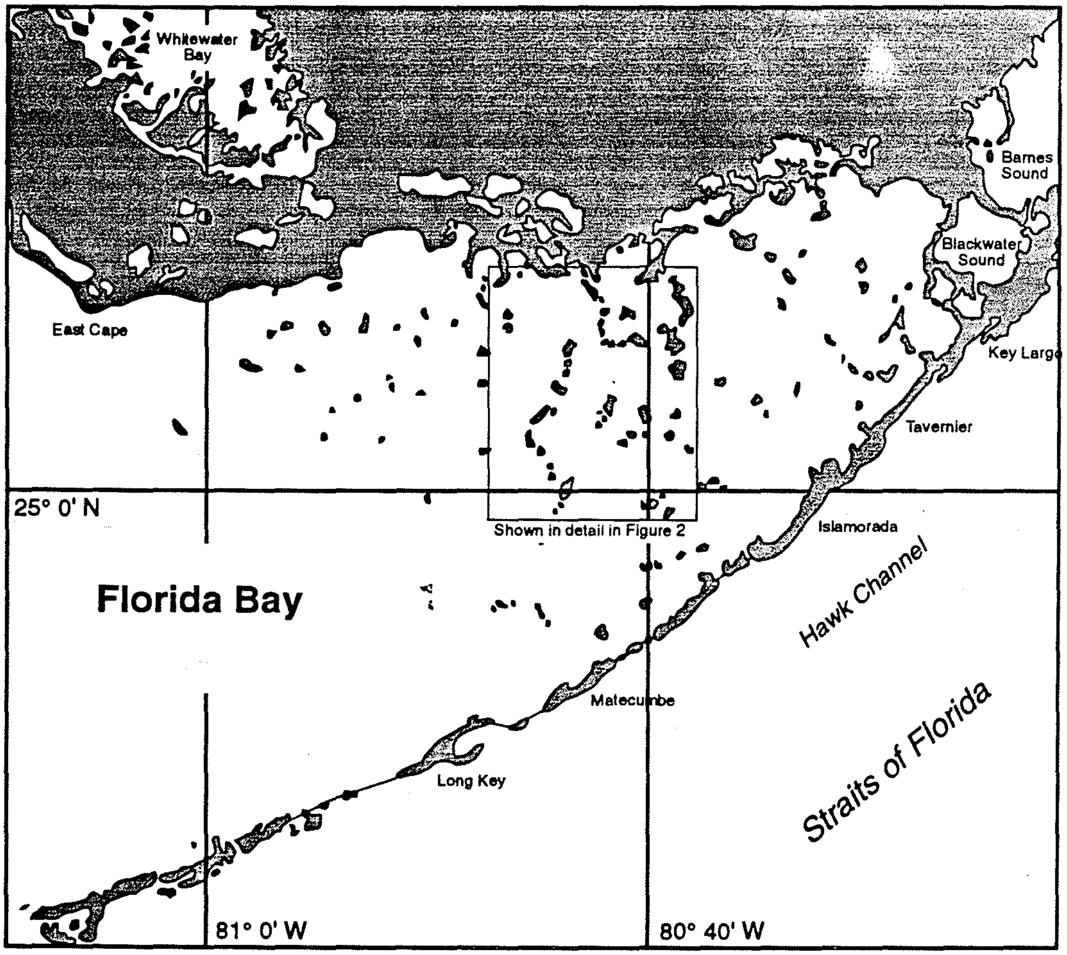

Figure 1. Florida Bay.

legislation affecting environmental regulations nationwide and in the Bay area; and environmental programs and studies performed currently and in the past by Federal, state, municipal, academic and civic organizations.

2. DESCRIPTION OF FLORIDA BAY ECOSYSTEM

Florida Bay is a coastal lagoon, on average less than 3 m deep, approximately 1,000 square miles in area, located between the South Florida mainland and the Florida Keys (Figure 1). Approximately 80% of the Bay is protected as part of the Everglades National Park (ENP), and the rest is under the protection of the National Oceanic and Atmopsheric Administration (NOAA) Florida Keys National Marine Sanctuary. Whitewater Bay, located between the Everglades mainland and Cape Sable, is connected to Florida Bay by the Buttonwood Canal. The Bay is open to the Gulf of Mexico in the southwest. During most years, Florida Bay is a negative estuary where evaporation exceeds freshwater input resulting in a hypersaline (>35‰) environment. Such conditions were observed for 12 of the 17 yrs of recorded data since 1956 examined by Robblee *et al.* (1989). Salinities greater than 50 ‰ have been routinely measured, and maximum levels of approximately 70 ‰ have been observed. Highest salinities occur in the central basins, usually during late spring, and lowest salinity conditions occur in the northeast region, usually during late summer. Seasonal variations of salinity appear to be related to the rainfall conditions in South Florida, where highest rainfall occurs during the summer and early fall. Freshwater drainage into the Bay is limited to runoff from Taylor Slough, from the coastal wetlands south of Shark River Slough, and seepage of groundwater from the mainland (Schomer and Drew, 1982).

Florida Bay opens to the Gulf of Mexico in the southwest. Open water effects on the Bay, however, are dampened by interconnecting mudbanks which cordon the Bay into a series of internal basins or "lakes" (Merriam, 1989) (Figure 2). Major morphological changes in the Bay occur during major storms such as hurricanes. The intense runoff and increased rainfall that accompanies these storms appear to be very significant in maintaining the Florida Bay ecosystem (Meeder and Meeder, 1989; Craighead and Gilbert, 1962; and others). Storms that affect the Bay bottom and coastline occur about once every 3 - 5 yrs, and those that produce extreme freshwater runoff occur once every 6 - 7 yrs.

There are 237 muddy islands with areas smaller than 100 m^2 unevenly distributed in Florida Bay (Enos, 1989). Most of these islands are connected by narrow mudbanks (Merriam and Quinn, 1989). They are most common in the central region of the Bay. In general, these islands are larger in the northeast region adjacent to the mainland than in the rest of the Bay, and the mudbanks are thicker and wider in the western part adjacent to the Gulf of Mexico. These islands are composed of soft carbonate mud accumulated over the Miami Limestone (Pleistocene) bedrock during the sea level rise through the past 5,000 yrs. Florida Bay is a source of biogenic carbonate sediments (Merriam, 1989; Bosence, 1989; and others). The principal habitats of the small islands are associated with red and black mangrove swamps, algal and halophyte marshes, grass "prairies", and hardwood-buttonwood hammocks (Enos, 1989). The islands are dynamic and the habitats are subject to sudden catastrophic alterations. The islands also migrate through erosion on exposed margins and lateral accretion on sheltered margins. Geological stratigraphy of the islands as determined by cores showed no obvious relationship to habitat. The largest keys in Florida Bay are listed in Table 1.

The bottom of the Bay is dominated by seagrasses, especially *Thalassia testudinum* (turtle grass). There is a gradient in seagrass communities from the enclosed northeast region of the Bay to the open western regions (Fourqurean, 1992). The northeast region is dominated by sparse *T. testudinum* with denser cover on localized areas of increased sediment accumulation. The seagrass communities in this region are nutrient limited (Powell *et al.*, 1989a; Lapointe, 1989; and others). Seagrass cover increases towards the west where *T. testudinum* is intermixed with *Halodule wrightii* (shoalgrass) and *Syringodium filiforme* (manatee grass). Large bird colonies in some of the mangrove islands in the northeast Bay increase nutrient availability and therefore seagrass density in the vicinity of the colonies. Since 1987, a major die-off of seagrass and benthic macrophytes has been observed in Florida Bay (Zieman *et al.*, 1988). Anomalies in the recent climate record, including excessively warm waters during the summer and fall of 1986 - 1988 and 1990, and a reduction of tropical storm frequency, may have contributed to the die-off. Recent reports of seagrass die-offs on the Atlantic Ocean side of the Florida Keys between Long and Grassy Key have been reported in the media.

The Florida Bay ecosystem supports a variety of species, some of which are threatened or endangered. Endangered and common species are listed in Table 2.

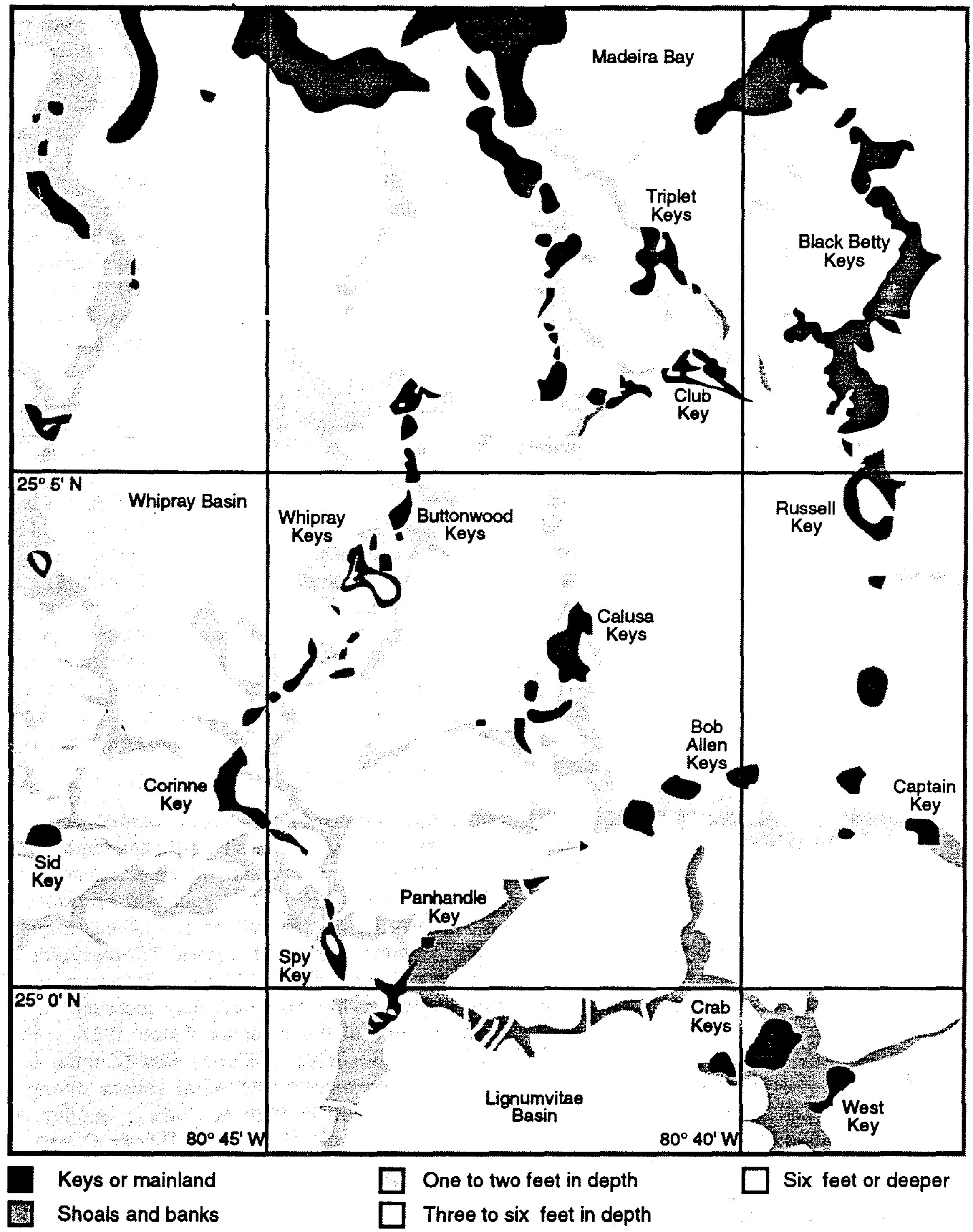

Figure 2. Typical keys, shoals and basins of Florida Bay.

Table 1. Large keys, banks, basins and bays in Florida Bay.

KEYS

Barnes Keys	Cluett Key	Jim Foot Key	Pollock Keys
Big Key	Cocoanut Key	Joe Kemp Key	Porjue Key
Black Betsy Keys	Coon Key	Johnson Key	Rankin Key
Bob Allen Keys	Cormorant Key	Lake Key	Roscoe Key
Bob Keys	Cotton Key	Low Key	Russell Key
Boggy Key	Crane Key	Lower Arsenicker Key	Samphire Keys
Bottle Key	Curlow Key		Sandy Key
Brandely Key	Curry Key	Man of War Key	Shell Key
Brush Keys	Dead Terrapin Key	Manatee Keys	Sid Key
Buchanan Keys	Deer Key	Mangrove Key	Spy Key
Buoy Key	Derelict	Murray Key	Stake Key
Butternut Key	Duck Key	Nest Keys	Swash Keys
Buttonwood Keys	Dunop Keys	Otter Key	Tern Key
Calusa Key	Eagle Key	Oyster Key	Topsy Key
Camp Key	East Bahia Honda Key	Palm Key	Triplet Keys
Captain Key	East Key	Panhandle Keys	Twin Keys
Carinne Key	End Key	Park Key	Umbrella Key
Carl Ross Key	Frank Key	Pass Key	Upper Arsenicker Key
Catfish Key	Gopher Keys	Pelican Keys	West Key
Clive Key	Green Mangrove Key	Peterson Keys	Whaleback Key
Club Keys	Hardup Key	Pigeon Key	Whipray Keys

BANKS

Arsenic Bank	First National Bank	Old Sweat Bank	Schooner Bank
Bamboo Banks	Grassy Key Bank	Oxfoot Bank	Sprigger Bank
Bethel Bank	Horseshoe Bank	Peterson Key Bank	Tripod Bank
Blue Bank	Jewfish Bush Banks	Pontoon Bank	Twin Key Bank
Bullard Bank	John Sawyer Bank	Rabbit Key Basin	Upper Cross Bank
Channel Key Banks	Lignumvitae Key Bank	Rachel Bank	Whipray Basin
Dave Foy Bank	Ninemile Bank	Ramshorn Shoal	
Dildo Key Bank	Old Dan Bank	Red Bay Bank	

BASINS AND BAYS

Alligator Bay	Garfield Bight	Little Madeira Bay	Snake Night
Blackwater Sound	Joe Bay	Long Sound	Sunset Cove
Buttonwood Sound	Little Blackwater Sound	Madeira Bay	Tarpon Basin
Cotton Key Basin		Matecumbe Bight	Terrapin Bay
Cowpens Anchorage	Little Buttonwood Sound	Rankin Bight	Trout Cove
Davis Cove		Santini Bight	

Table 2. Endangered and common species in Florida Bay [List not comprehensive and compiled from various sources including Schmidt (1979). Fish names were checked against Robins *et al.* (1991).]

FLORA	
Macroalgae	
Batophora oerstedii	
Acetabularia crenulata	
Seagrasses	
Thalassia testudinum	Turtle grass
Halodule wrightii	Shoalgrass
Syringodium filiforme	Manatee grass
Mangroves	
Rhizophora mangle	Red mangrove
Laguncularia racemosa	White mangrove
Avicennia germinans	Black mangrove
FAUNA	
Sponges	
Hippiospongia lachne	Sheepswool sponge
Spongia barbara	Yellow sponge
Spongia graminea	Grass sponge
Crustacea	
Penaeus duorarum	Pink shrimp
Penaeus aztecus	Brown shrimp
Penaeus setiferus	White shrimp
Panulirus argus	Spiny lobsters
Menippe mercenaria	Stone crab
Other invertebrates	
Astraea americana	American star shell
Astraea phoebia	Longspined star shell
Cerithium atratum	
Cerithium literatum	Lettered horn shell
Columbella mercatoria	Mottled dove shell
Fasciolaria tulipa	Tulip shell
Leucozonia nassa	Chesnut latirus
Marginella eburneola	
Marginella guttata	
Modulus modulus	Atlantic modulus
Montastraea annularis	
Solenastrea bournoni	
Tegula fasciata	Colorful top shell
Thais deltoidea	Deltoid rock shell
Turbo canaliculatus	Channeled turban
Fish	
Achirus lineatus	Lined sole
Aetobatis narinari	Spotted eagle ray
Ahlia egmontis	Key worm eel
Albula vulpes	Bonefish
Aluterus schoepfi	Orange filefish
Anchoa cubana	Cuban anchovy
Anchoa hepsetus	Striped anchovy
Anchoa mitchilli	Bay anchovy
Anisotremus virginicus	Porkfish
Archosargus probatocephalus	Sheepshead
Archosargus rhomboidalis	Sea bream
Arius felis	Sea catfish
Bagre marinus	Gafftopsail catfish
Bairdiella batabana	Blue croaker
Bairdiella chrysoura	Silver perch
Balistes vetula	Queen triggerfish
Bascanichthys scuticaris	Whip eel
Bathygobius soporator	Frillfin goby
Bothus ocellatus	Eyed flounder
Brevoortia smithi	Yellowfin menhaden
Bryx dunckeri *	Pugnose pipefish
Calamus arctifrons	Grass porgy
Caranx crysos	Blue runner
Caranx hippos	Crevalle jack
Caranx ruber	Bar jack
Carcharhinus limbatus	Blacktip shark
Centropomus undecimalis	Snook
Centropristis striata	Black seabass
Chaetodipterus faber	Atlantic spadefish
Chasmodes saburrae	Florida blenny
Chilomycterus antillarum	Webbed burrfish
Chilomycterus schoepfi	Striped burrfish
Chloroscombrus chrysurus	Atlantic bumper
Chriodorus atherinoides	Hardhead halfbeak
Cosmocampus albirostris	Whitenose pipefish
Cynoscion nebulosus	Spotted seatrout
Cyprinodontvariegatus	Sheepshead minnow
Dasyatis americana	Southern stingray
Diapterus plumieri'	Striped mojarra
Diplectrum formosum	Sand perch
Diplogrammus pauciradiatus Δ	Spotted dragonet
Echeneis neucratoides	Whitefin sharksucker
Elops saurus	Ladyfish
Epinephelus itajara	Jewfish
Epinephelus morio	Red grouper
Epinephelus striatus	Nassau grouper
Equetus acuminatus	High hat
Etropus crossotus	Fringed flounder
Eucinostomus argenteus	Spotfin mojarra
Eucinostomus harengulus	Tidewater mojarra
Eucinostromus argenteus	Spotfin mojarra
Eucinostromus gula	Silver jenny
Floridichthys carpio	Goldspotted killifish
FFundulus confluentus	Marsh killifish
Fundulus grandis	Gulf killifish
Fundulus similis	Longnose killifish
Fundulus chrysotus	Golden topminnow
Gerres cinereus	Yellowfin mojarra
Gobiesox strumosus	Skilletfish
Gobionellus smaragdus	Emerald goby

* Formerly *Syngnathus*. Δ Formerly *Callionymus*.

Table 2. Endangered and common species in Florida Bay. (cont.)

Gobiosoma robustum	Code goby
Haemulon aurolineatum	Tomtate
Haemulon plumieri	White grunt
Haemulon sciurus	Bluestriped grunt
Harengula juguana	Scaled sardine
Hippocampus erectus	Lined seahorse
Hippocampus zosterae	Dwarf seahorse
Hypoplectrus pyella	Barred hamlet
Hyporhamphus unifasciatus	Silverstripe halfbeak
Lachnolaimus maximus	Hogfish
Lactophrys quadricornis	Scrawled cowfish
Lactophrys trigonus	Trunkfish
Lagodon rhomboides	Pinfish
Lobotes surinamensis	Tripletail
Lucania parva	Rainwater killifish
Lutjanus analis	Mutton snapper
Lutjanus apodus	Schoolmaster
Lutjanus griseus	Gray snapper
Lutjanus synagris	Lane snapper
Megalops atlanticus	Tarpon
Megalops cyprinoides	Ox-eye
Membras martinica	Rough silverside
Menidia berylinna	Tidewater silverside
Menticirrhus americanus	Southern kingfish
Menticirrhus littoralis	Gulf kingfish
Microgobius gulosus	Clown goby
Micropogoniasundulatus	Atlantic croaker
Monacanthus ciliatus	Fringed filefish
Monacanthus hispidus	Planehead filefish
Mugil cephalus	Striped mullet
Mugil curema	White mullet
Mugil trichodon	Fantail mullet
Mycteroperca microlepis	Gag grouper
Myrophis punctatus	Speckled worm eel
Negaprion brevirostris	Lemon shark
Nicholsina usta	Emerald parrotfish
Ogcocephalus radiatus	Polka-dot batfish
Oligoplites saurus	Leatherjacker
Ophichthus gomesi	Shrimp eel
Opisthonema oglinum	Atlantic threadherring
Opsanus beta	Gulf toadfish
Orthopristis chrysoptera	Pigfish
Paraclinus marmoratus	Marbled blenny
Paralichthys albigutta	Gulf flounder
Poecilia latipinna	Sailfin molly
Pogonias cromis	Black drum
Pomatomus saltatrix	Bluefish
Prionotus scitulus	Leopard searobin
Prionotus tribulus	Bighead searobin
Pristis pectinata	Smalltooth sawfish
Rachycentron canadum	Cobia
Sciaenops ocellatus	Red drum
Scomberomorus cavalla	King mackerel
Scomberomorus maculatus	Spanish mackerel
Selene vomer	Lookdown
Sparisoma chrysopterum	Redtail parrotfish
Sparisoma viride	Spotlight parrotfish
Spheorides nephelus	Southern puffer
Spheorides spengleri	Bandtail puffer
Sphoeroides nephelus	Southern puffer
Sphyraena barracuda	Great barracuda
Sphyrna tiburo	Bonnethead shark
Strongylura timucu	Timucu
Strongylura marina	Atlantic needlefish
Strongylura notata	Redfin needlefish
Symphurus plagiusa	Blackcheek tonguefish
Syngnathus floridae	Dusky pipefish
Syngnathus louisianae	Chain pipefish
Syngnathus scovelli	Gulf pipefish
Synodus foetens	Inshore lizardfish
Trachinotus carolinus	Florida pompano
Trachinotus falcatus	Permit
Trinectes maculatus	Hogchoker
Tylosurus crocidilus	Houndfish
Birds	
Ajaja ajaja	Roseate spoonbill
Anhinga anhinga	
Ardea herodias	Great blue/white heron
Bubulcus ibis	Cattle egret
Butorides striatus	Green backer heron
Casmerodius albus	Great egret
Columba leucocephala ◊	White-crowned pigeon
Egretta alba	Great egret
Egretta caerulea	Little blue heron
Egretta rufescens	Reddish egret
Egretta thula	Snowy egret
Egretta tricolor	Tricolored heron
Eudocimus albus	White ibis
Ixobrychus exilis	Least bittern
Mycteria americana	Wood stork
Nycticorax nycticorax	Black crowned night heron
Nycticorax violaceous	Yellow crowned night heron
Pandion haliaetus	Osprey
Pelicanus occidentalis	Brown pelican
Phalacrocorax auritus	Double crested cormorant
Reptiles	
Dermochelys coriacea	Leatherback turtle
*Caretta caretta***	Loggerhead turtle
*Chelonia mydas**	Green turtle
*Eretomochelys imbricata**	Hawksbill turtle
*Lepidochelys kempii**	Ridley turtle
Crocodylus acutus *	American crocodile
Mammals	
Pseudorca crassidens	False killer whale
Trichechus manatus *	Manatee
Tursiops truncatus	Bottlenose dolphin

*** Endangered species. ** Threatened species. ◊ Status under review.**

The environment of South Florida has undergone changes since the early part of the century. A typical account of the environment at that time is the one of Simpson (1920).

> "From 1882 till 1886 I made my home on the southwest coast of the State and have lived near Miami since 1902. When I first came to the State, the greater part of Lower Florida was an unbroken wilderness, and during the time I have been here I have quite thoroughly explored the territory described in this volume both as a collector and general naturalist. To-day most of its hammocks are destroyed, the streams are being dredged out and deepened, the Everglades are nearly drained; even the pine forests are being cut down. At the time when I first resided in the State, flamingoes, roseate spoonbills, scarlet ibises, and the beautiful plumed herons were abundant. Deer and otter could be seen at any time and the west coast waters were alive with immense schools of mullet and other fish, while manatee were not rare. The streams and swamps were full of alligators; in fact the wonderful wild fauna of our region filled the land and the waters everywhere. It has seemed to me fitting that some record of this life should be made, in view of the fact that it is so rapidly disappearing - and forever. Already a number of pscies of our animals and plants are exterminated from this the only area in the United States in which they have ever been found."

3. INFORMATION GATHERING METHODS

This document has been compiled using various sources and methods. Searches of electronic databases were performed to obtain listings of published citations concerning Florida Bay (Table 3). The results of the electronic databases were cross checked against the bibliographies prepared by Tabb and Iversen (1971), Schmidt and Davis (1978), Mahadevan *et al.* (1984), and Schmidt (1991). The references listed in citations on Florida Bay were also cross referenced to the current compilation. In addition, information on specific subject areas, such as El Niño events and weather, was obtained from books, journal articles and other published sources without extensive subject coverage. Problems were encountered concerning the indexing used for Florida Bay. If the words "Florida Bay" were not used in the title, key words or text, searching of the databases resulted in a large number of citations on bays in Florida. The Boolean combination of "Everglades" and "coastal" or "marine" did not yield many citations. Also, there is a lag time of several months between publication and entry into electronic databases for some services.

Selected citations on Taylor Slough, Shark River Slough, Buttonwood Canal, Whitewater Bay and the Florida Keys are included since these ecosystems are closely related to Florida Bay. This work, however, is not intended to have a comprehensive coverage of these areas.

An anecdotal and historical chronology of events that affected the marine environment of the Florida Keys from 1714 to the present was prepared by The Nature Conservancy (DeMaria, in press). This time line contains information gathered from recent interviews of approximately 75 individuals with 10 or more years of on-the-water experience in the Keys and Florida Bay. Selected information from this work on Florida Bay was incorporated in this time line.

Table 3. Electronic databases and CD-ROMs searched.

CD ROMs

Aquatic Sciences and Fisheries Abstracts (CD-ROM), 1978 - 1993 (Searched 1/94).
Water Resources Abstracts (CD-ROM).

DATABASES
[Search done 3/28/94. Search strategy: FLORIDA(W)BAY and EVERGLADES(W)COASTAL.]

BIOSIS PREVIEWS (R)	1969-1994/Mar.
Dissertation Abstracts Online	1861-1994/Apr.
GeoArchive	1974-1994/Feb.
GeoRef	1785-1994/Apr.
Enviroline (R)	1970-1994/Feb.
Env. Bib.	1974-1993/Oct.

4. NAVIGATION AND CARTOGRAPHY

An early account of exploration in Florida Bay gives a good description of the navigation difficulties encountered in the area (Simpson, 1920).

> "The waters of the key region are exceedingly shallow, the bottom either being composed of ragged rock or very soft, almost fathomless mud. Navigation chiefly consists of getting aground and getting afloat again. One never makes an extended cruise among the keys without getting 'piled up' as it is called, often several times a day, and strangely enough, this generally seems to occur when the tide is falling. If the boat gets on the rock bottom one is fortunate it is not seriously injured; if it gets fast in the mud there is pretty sure to be an amazing amount of trouble getting afloat. In the former case, everybody must get overboard and try to lift the boat out of the grip of the ragged rock. If the vessel is fast in the mud poles will do little good as they can usually be pushed to full length into the soft marl. The engine is reversed, all must get out, sometimes sinking in to the waist, and lift until they can see stars."

4.1. Charts and maps

A historical account of geographical and ecological knowledge of the Gulf of Mexico and South Florida, including a description of navigation charts produced since the 18th Century, can be found in Galstoff (1954).

4.1.1. NOAA charts

The NOAA charts covering Florida Bay currently available from NOAA are listed in Table 4. The marine Weather Services charts, published by NOAA/National Weather Service (NWS), list NWS radio stations and commercial radio stations that broadcast marine weather information. The Marine Boundary Charts portray the 3 n mi line and the Territorial Sea and Contiguous Zone (12-mi limit) and/or Exclusive Economic Zone (EEZ) (200-mi limit) boundaries in US waters.

Table 4. Currently available NOAA maps and navigation charts covering Florida Bay.

Chart number	Title	Scale
Best coverage of Florida Bay		
11450	Fowey Rocks to American Shoal (includes Loran-C lines of position)	1:180,000
11451	Miami to Marathon and Florida Bay (folio, small craft chart)	1:80,000
11452	Alligator Reef to Sombrero Key (includes Loran-C lines of position)	1:80,000
Partial coverage of Florida Bay		
11013	Straits of Florida and Approaches	1:1,200,000
11420	Havana to Tampa Bay	1:470,940
11431	East Cape to Mormon Key (includes Loran-C lines of position)	1:80,000
11433	Everglades National Park - Whitewater Bay (pocket fold, small craft chart)	1:50,000
11434	Florida Keys - Sombrero Key to Dry Tortugas (includes Loran-C lines of position)	1:180,000
11441	Key West Harbor and approaches	1:30,000
11442	Sombrero Key to Sand Key (includes Loran-C lines of position)	1:80,000
11445	Intercoastal Waterway - Bahia Honda to Key West	1:40,000
11447	Key West Harbor	1:10,000
11448	Intercoastal Waterway - Big Spanish Ch. to Johnson Key	1:40,000
11449	Matecumbe to Bahia Honda	1:40,000
11460	Cape Canaveral to Key West	1:466,940
11462	Fowey Rocks to Alligator Reef	1:80,000
11463	Intercoastal Waterway - Elliot Key to Matecumbe	1:40,000
Bathymetric maps (OCS)		
NG 17-8	Miami	1:250,000
NG 17-11	Key West	
NG 17-10	Dry Tortugas	
Marine Boundary charts		
11431, 11442, 11439, 11434, 11452, 11462, 11439, 11442		
Offshore mineral leasing maps		
1113-A	Not available	1:470,940
Marine Weather Service charts		
MSC-5	Savannah, GA, to Apalachicola Bay, FL	

4.1.2. USGS maps

The US Geological Survey (USGS) National Mapping Program publishes a variety of multipurpose maps to serve all map users. In addition to published maps, basic map data and open-file map byproducts are available (Table 5). These include aerial photographs, satellite images, advance and reproducible map materials, geodetic control data, geographic-names data, status maps, microfilm map copies, and map data in digital form. Listings of these maps are available for each state.

4.2. Coast Pilot

The Coast Pilot books cover navigation regulations, outstanding landmarks, channel and anchorages, peculiarities, dangers, weather, routes, pilotages and port facilities. Coast Pilot no. 4 covers Cape Henry to Key West and No. 5 the Gulf of Mexico, Puerto Rico and the Virgin Islands. These publications are updated annually.

The 1897 and 1901 coast pilot guides, published by the Coast and Geodetic Survey (CGS) (1897 and 1901), have the following description of Florida Bay:

> "Florida Bay is the large, shallow body of water lying between the south coast of the mainland of Florida and the Florida Keys, and extending, in E. and W. direction, from Cape Sable to Barnes Sound. The eastern and greater part of this bay is full of ridges and reefs which show bare, or nearly bare, and there are also a large number of small wooded keys: this part is only navigable for small flat-bottomed craft. The western part is comparatively clear, the depth of water ranging from 7 to 13 feet, and vessels of 7 feet draft, bound to the Gulf of Mexico from the Hawk Channel, can enter the Bay of Florida through Moser Channel instead of passing through Key West Harbor, and thus shorten the distances to Cape Romano and Cape Sable by about 45 to 70 miles respectively: but the passage through Moser Channel requires some local knowledge, as there are no aids to assist a stranger. The bay is only frequented by spongers, and the inhabitants of the keys, who generally use flat-bottomed craft of 3 to 4 feet draft. There are no towns or villages on the shores of the bay."

The 1908 edition of the guide added the following information (Coast and Geodetic Survey, 1908).

> "The bay is only frequented by yachts, spongers, fishermen, and the inhabitants of the keys, who generally use flat-bottomed craft of 3 to 4 feet draft. The post village of Flamingo is on the shore of the bay, about 7 miles east of East Cape."

The 1916 edition of the coast pilot guide contained descriptions of the Bay bottom and water characteristics.

> "The depths are shallow and irregular, and the bottom is mostly coral, with a thin covering of silt in the eastern part. From April to October the waters of the bay are clear and the shoals plainly discernible, but during the winter months the water is milky and the shoals indistinguishable.
>
> "The western part of the bay is comparatively clear, with depths ranging from 7 to 13 feet, and the bottom is covered with loggerhead sponges and small coral heads."

The coast pilot editions also contain descriptions of the status of navigational aids such as light houses and beacons, bridges, the strength and behavior of tide flow through the channels

Table 5. USGS Currently available maps covering Florida Bay (listed west to east, north to south when applicable).

Sectional map series
(1:2,000,000)

12-13, Florida

Primary map series
(7.5 minute, 1:24,000)

Lake Ingraham West
Lake Ingraham East
Flamingo
West Lake
Madeira Bay
Joe Bay
Blackwater Sound
Sandy Key
Clive Key
Pelican Keys
Calusa Keys
Tavernier
Rock Harbor
East Bahia Honda Key NE
Schooner Bank
Buchanan Keys
Upper Matecumbe Key
Plantation Key
East Bahia Honda Key
Bamboo key
Grassy Key
Long key
Lower Matecumbe Key
Seven Mile Bridge
Marathon
Crawl Key

County map series

Dade County
Monroe County

30 x 60 Minute series
(1:100,000 scale)

25801-A1 Cape Sable
25080-A1 Homestead
24801-E1 Key West
24080-E1 Islamorada

1 x 2 Degree series
(1:250,000 scale)

25080-A1, Miami
24080-A2, Key West

National park and monument maps

Everglades National Park

7.5-minute geological survey maps

Table 6. List of aerial overflight data of Everglades National Park/Florida Bay [Data stored at the Everglades Research Center Library].

Date of flight	Scale	Area flown	Film type
5/3-7/40	1:40,000	Everglades National Park area	Black and white
11/28/53	1:20,000	Northwest Florida Bay and east Cape Sable	Black and white
4/26-6/1/64	Unknown	Florida Bay	Unknown
1/27/71	Unknown	Everglades National Park including extreme southeast Florida Bay	Unknown
1/73	Unknown	Florida Bay	Color IR, high altitude U2
12/78	1:7800-10,000	Flamingo and Florida Bay mangroves	CIR
87	Unknown	Florida Bay (exotics)	Color
90	Unknown	Florida Bay?	Unknown
92	Unknown	Florida Bay and Ten Thousand Islands	Color. Post Andrew.

between the Keys, passages through Florida Bay as a short cut to Cape Sable, and places that could afford shelter during severe weather.

4.3. Aerial photography and remote sensing

There have been many aerial overflights of Florida Bay and the Everglades National Park including some shortly before and after World War II. The data recorded during many of these flights has not been processed and the film is stored at Everglades National Park Headquarters. A partial list of overflight compiled from various sources is in Table 6. There are other sources of remote sensing data on the Bay not listed in Table 6 including overflight data stored at the Earth Resources Observation Systems (EROS) Data Center (EDC).* Landsat 4/5 Multispectral Scanner (MSS) data are available from the Earth Observation Satellite (EOSAT) Company under contract agreement to the Government. As of 1990, EOSAT and NOAA reached an agreement that allowed MSS data older than two years to be sold at the EROS Data Center for the cost of reproduction and distribution. Landsat MSS data are archived at EDC as part of the National Satellite Land Remote Sensing Data Archive.

In 1978, several Federal agencies agreed to coordinate their aerial photo acquisition activities. Thus from 1980 through 1986, the Federal Government conducted the National High Altitude Photography (NHAP) Program designed to obtain complete, uniform coverage of the 48 conterminous states over a 5-yr cycle. As part of the NHAP Program, black-and-white and color-infrared aerial photographs were obtained from an altitude of 40,000 ft on 9-in film. The color-infrared photographs, at a scale of 1:58,000, and the black-and-white photographs at a scale of 1:80,000, were centered over the USGS 7.5-min quadrangles. Strict specifications regarding sun angle, cloud cover, minimal haze, stereoscopic coverage, and image inspection were followed. In 1986, the NHAP was renamed the National Aerial Photography Program (NAPP) and specifications were changed to obtain color-infrared photographs only. NAPP photographs are obtained from an altitude of 20,000 ft on 9-in film with a resulting scale of

* EROS Data Center, Customer Services, Sioux Falls, SD 57198. 605 594 6151.

1:40,000. These photographs are centered on quarters of 7.5-min quadrangles. Information about these photographs can be obtained from EDC.

5. ATMOSPHERIC, GEOLOGICAL AND ASTRONOMICAL PHENOMENA

5.1. South Florida climate

South Florida has a tropical climate, with a summer wet season and a dry season from mid fall through late spring (Duever *et al.*, 1994). Average temperatures are warm all year, but occasional freezes, associated with winter cold fronts, occur during the winter months. Thunderstorms are the major source of rainfall. During some years, tropical storms and hurricanes, and cold fronts can contribute significantly to the rainfall. Besides the annual cycle rainfall patterns are associated with a minor bimodal peak during the wet season and a 5- to 6-yr cycle associated with global climate cycles. The long-term trend in total annual precipitation has been essentially constant over the past 100 yrs. Evapotranspiration is lowest during the cool winter months and highest in late spring, after which it declines only slightly during the summer months. Freezes play a large role in controlling the distribution of tropical elements of the fauna and flora of south Florida. In general, they are more severe farther north or inland from the ocean. There is no clear evidence of any change in frequency or severity of freezes over the last 40 yrs. Droughts can significantly alter composition and structure of aquatic animal communities, provide opportunities for germination of wetland vegetation, and set the stage for fire. Individual droughts may affect all of south Florida, but they are frequently restricted only to portions of it.

The most severe drought on record in Florida as of 1961 occurred during the 3-yr period of 1954 - 1956 (Pride and Crooks, 1962). The drought was caused by rainfall deficiencies in amounts ranging from 7 - 11 in during each of the three years. Minimum stream flows recorded at 135 continuous record stations, low-flow measurements at 190 partial record stations, and chemical analyses of water at 133 sites are summarized in Pride and Crooks (1962). Records of streamflow at 13 representative streams and records of stage for 17 representative lakes were compared with average flows or stages. The dissolved solids concentrations in most streams increased as flows declined. Less severe draughts occurred in 1916, 1920, 1926, 1930, 1938, 1942, and 1949-1951. Annual total rainfall for the Florida lower East Coast is shown in Figure 3.

Severe freezes have occurred in Florida in February 1917, January 1928, December 1934, January 1940, February 1947, the winter of 1957-58, December 1962, November 1970, January 1971, January 1977, January 1981, January 1982, December 1983, and January 1985 (Myers, 1986). Especially cold winters were those of 1941-1942, 1957-1958, 1963-1964, 1969-1970, and 1989. The most severe were those of 1957-1958, 1969-1970, and 1989. During these severe periods, the growth pattern of a *Montastrea annularis* specimen were interrupted (Emiliani et al., 1978).

Weather may influence the bioaccumulation of chemicals as changes in temperature and salinity affect biochemical processes. Rainfall is one of the most important ways of mobilizing contaminants in soil and urban areas and may affect the amounts of contaminants that reach coastal and estuarine environments. The effect of global climate changes in tropical marine systems, such as mangroves, seagrass beds, and coral reefs, is being examined by several workers (e.g., Zieman *et al.*, 1989; Cubit, 1992; Davis, 1992; Zieman *et al.*, 1992; Twilley and Chen, 1994; Cubit, 1994; Davis *et al.*, 1994; Winter *et al.*, 1994; Zieman *et al.*, 1994; and others). Seasonal variations in temperature and salinity influence abundance, productivity, and reproduction of macroalgae and seagrass in south Florida (Tabb *et al.*, 1962; Josselyn, 1977; Bach, 1979; Morrison, 1981; Zieman, 1988; Montague and Ley, 1993; and others).

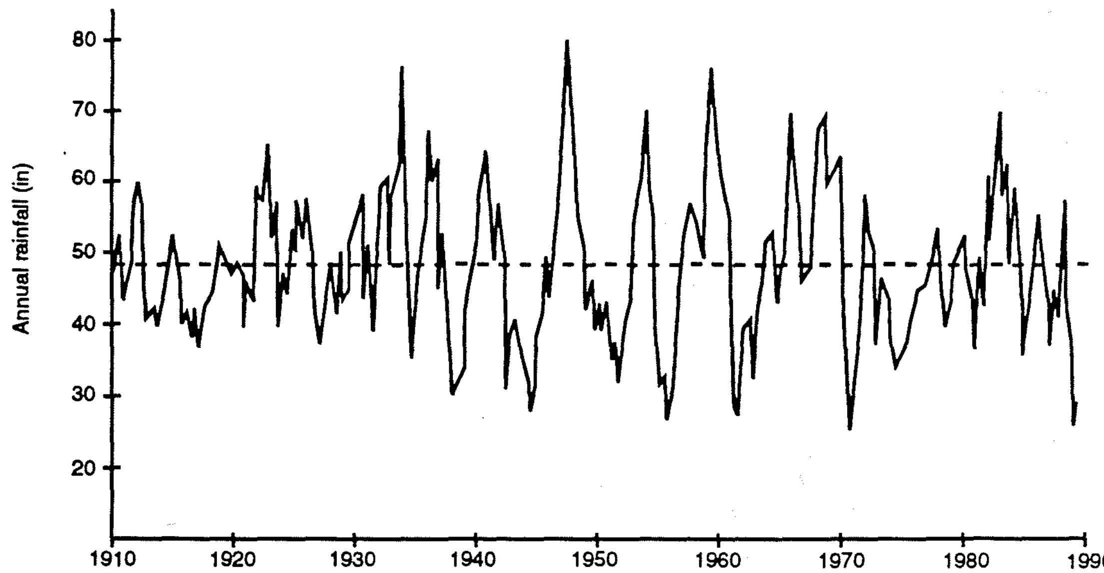

Figure 3. Annual total rainfall for the Florida lower East Coast. Rainfall totals are running averages and are plotted at the first month of the 12-month period. Dashed line is the average rainfall [Redrawn from Hanson and Maul (1991)].

5.1.1. Weather stations

Three NOAA weather stations, located at airports, bracket Florida Bay: Miami, Key West, and Ft. Myers. These stations, however, are not good indicators of weather conditions in the Bay. Other weather stations in the area are located at Homestead Air Force Base, the Everglades National Park Research Center, Flamingo, and at other sites. The station identification, name, location and length of operation of the weather stations reporting data to the NOAA National Climatic Data Center* located south of Lake Okeechobee are listed in Table 7.

5.1.2. Tornadoes

Tornadoes are part of South Florida weather. Although they are not long lived, their effects on land or water can be severe. The NOAA National Severe Storms Forecast Center analyzed 1372 tornadoes that occurred from 1950 to 1992 at or south of 30°N latitude in Florida. Most tornadoes occur singly, and rarely are there more than 3 tornadoes in one day. A threshold of four tornadoes per day is the regional definition of a tornado outbreak. The greater majority of four or more tornado events occur in four hours or less. In addition, tornadoes have to be related to the same synoptic forcing mechanism to be considered part of a tornado outbreak. The yearly distribution of tornado outbreaks from 1950 to 1992 is listed in Table 8. The scarcity of outbreaks prior to 1964 is related to lower population density and the fact that only the most intense tornadoes were reported.

* NOAA/NWS/National Climatic Data Center, 37 Battery Park Ave., Asheville, NC 28801-2733.

Table 7. Weather stations south of Lake Okeechobee listed at the NOAA National Climatic Data Center.

Station number	Division number	Station	Latitude (N)	Longitude (W)	Begin year	End year
611	5	BELLE GLADE EXP STN	26° 40'	80° 38'	1948	1988
611	5	BELLE GLADE EXP STN	26° 39'	80° 38'	1988	Active
616	5	BELLE GLADE HRCN GT 4	26° 42'	80° 43'	1970	Active
845	6	BOCA RATON	26° 22'	80° 7'	1985	Active
1271	5	CANAL POINT GATE 5	26° 52'	80° 38'	1951	1988
1271	5	CANAL POINT GATE 5	26° 52'	80° 38'	1989	Active
1276	5	CANAL POINT USDA	26° 52'	80° 37'	1969	1988
1276	5	CANAL POINT USDA	26° 52'	80° 37'	1988	Active
1654	5	CLEWISTON US ENGINEERS	26° 45'	80° 55'	1951	1989
1654	5	CLEWISTON US ENGINEERS	26° 45'	80° 55'	1989	Active
1795	7	CONCH KEY	24° 47'	80° 53'	1982	Active
1858	6	CORAL SPRINGS	26° 16'	80° 16'	1991	Active
2298	5	DEVILS GARDEN	26° 36'	81° 8'	1974	Active
2850	5	EVERGLADES	25° 51'	81° 23'	1967	1988
2850	5	EVERGLADES	25° 51'	81° 23'	1988	Active
3020	5	FLAMINGO RANGER STN	25° 9'	80° 55'	1964	1988
3020	5	FLAMINGO RANGER STN	25° 9'	80° 55'	1988	Active
3163	6	FORT LAUDERDALE	26° 6'	80° 12'	1982	Active
3180	5	FORT MYERS BEACH 2	26° 27'	81° 56'	1965	Active
3186	5	FORT MYERS FAA/AP	26° 35'	81° 52'	1981	1989
3186	5	FORT MYERS FAA/AP	26° 35'	81° 52'	1989	Active
3909	6	HIALEAH	25° 50'	80° 17'	1951	1988
3909	6	HIALEAH	25° 50'	80° 17'	1988	Active
4091	6	HOMESTEAD EXP STN	25° 30'	80° 30'	1985	1987
4091	6	HOMESTEAD EXP STN	25° 30'	80° 30'	1987	1989
4091	6	HOMESTEAD EXP STN	25° 30'	80° 30'	1989	Active
4095	6	HOMESTEAD GEN AVIATION	25° 30'	80° 33'	1990	Active
4210	5	IMMOKALEE 3 NNW	26° 28'	81° 26'	1970	1988
4210	5	IMMOKALEE 3 NNW	26° 28'	81° 26'	1988	Active
4570	7	KEY WEST WSO AIRPORT	24° 33'	81° 45'	1957	1990
4570	7	KEY WEST WSO AIRPORT	24° 33'	81° 45'	1990	Active
4662	5	LA BELLE	26° 45'	81° 26'	1956	Active
4667	5	LA BELLE	26° 46'	81° 27'	1978	Active
5182	6	LOXAHATCHEE	26° 41'	80° 16'	1980	1988
5184	6	LOXAHATCHEE NWR	26° 30'	80° 13'	1990	Active
5658	6	MIAMI BEACH	25° 47'	80° 8'	1948	1986
5658	6	MIAMI BEACH	25° 47'	80° 8'	1986	Active
5663	6	MIAMI WSCMO AIRPORT	25° 48'	80° 18'	1980	Active
5678	6	MIAMI 12 SSW	25° 39'	80° 18'	1958	1988
5895	5	MOORE HAVEN LOCK 1	26° 50'	81° 5'	1975	1988
5895	5	MOORE HAVEN LOCK 1	26° 50'	81° 5'	1988	Active
6078	5	NAPLES	26° 10'	81° 47'	1984	Active
6323	5	NORTH NEW RIVER CANAL	26° 20'	80° 32'	1951	Active
6406	5	OASIS RANGER STN	25° 51'	81° 2'	1978	1986
6406	5	OASIS RANGER STN	25° 51'	81° 2'	1986	Active

Table 7. Weather stations south of Lake Okeechobee listed at the NOAA National Climatic Data Center (cont.).

Station number	Division number	Station	Latitude (N)	Longitude (W)	Begin year	End year
6657	5	ORTONA LOCK 2	26° 47'	81° 18'	1951	Active
6988	5	PENNSUCO 5 WNW	25° 56'	80° 27'	1968	Active
7020	6	PERRINE 4 W	25° 35'	80° 26'	1989	Active
7200	7	PLANTATION KEY	24° 58'	80° 33'	1962	Active
7254	6	POMPANO BEACH	26° 14'	80° 9'	1948	1988
7254	6	POMPANO BEACH	26° 14'	80° 9'	1988	Active
7293	5	PORT MAYACA S L CANAL	26° 59'	80° 37'	1980	Active
7397	5	PUNTA GORDA 4 ESE	26° 55'	82° 0'	1982	Active
7760	6	ROYAL PALM RANGER STN	25° 23'	80° 36'	1949	1987
7760	6	ROYAL PALM RANGER STN	25° 23'	80° 36'	1987	Active
8780	5	TAMIAMI TRAIL 40 MI BEN	25° 45'	80° 50'	1958	1986
8780	5	TAMIAMI TRAIL 40 MI BEN	25° 45'	80° 50'	1986	Active
8841	7	TAVERNIER	25° 0'	80° 31'	1985	Active
9010	5	TRAIL GLADE RANGES	25° 46'	80° 29'	1982	Active
9525	6	WEST PALM BEACH WSO AP	26° 41'	80° 7'	1977	Active

Table 8. Yearly distribution of tornado outbreaks and outbreak tornadoes, 1950 - 1993 (Hagemeyer and Matney, 1994).

Year	Outbreaks	Tornadoes	Year	Outbreaks	Tornadoes
1950-54	0	0	1975	1	5
1955	1	6	1976-77	0	0
1956	1	4	1978	3	18
1957-63	0	0	1979	3	30
1964	1	9	1980-81	0	0
1965	1	4	1982	1	10
1966	1	4	1983	2	20
1967	0	0	1984	1	4
1968	2	13	1985	0	0
1969	0	0	1986	1	9
1970	2	11	1987-90	0	0
1971	2	12	1991	2	15
1972	2	18	1992	1	9
1973	2	9	1993	2	19
1974	0	0			

5.1.3. Hurricanes

Hurricanes are tropical cyclones with wind speeds of 119 km per hour (74 mph) or higher that occur over the Atlantic Ocean, Caribbean Sea and Gulf of Mexico usually during summer and fall. These storms originate in warm waters in areas of low pressure and with wind circulation counterclockwise around the center. Hurricanes have struck South Florida half of the years during the past century, and the frequency of hurricanes is greater in South Florida than in any other place in the US (Gentry, 1984). The frequency of hurricanes in the Atlantic was below normal from 1894 through 1930, and was especially low from 1911 through 1921. During the 1930s, the frequency increased above normal and remained so through 1982, with the exception of a few years around 1940. In Florida, the frequency was above normal from 1933 - 1938, 1945 - 1952, and 1964 - 1966. Otherwise, frequencies have been slightly below normal. The increase in frequencies in the Atlantic area during the 1930s may be attributed to improved observations. In addition to the variations in frequencies for the Atlantic, there are periods in which the hurricane tracks seem to concentrate on Florida, for example 1945 - 1950. During 1952 - 1957 and 1967, they seemed to shift away from Florida.

Tropical storms passing over or within a radius of approximately 50 mi of Florida Bay from 1910 to 1993 are listed in Table 9. The intensity of the storm on the Saffir/Simpson scale (Table 10) at the time it passed over or closest to the Bay is noted in Table 9.

Meeder and Meeder (1989) described the effects of hurricanes on the Florida Bay ecosystem and contrasted them to the effects of fires in south Florida terrestrial ecosystems. Just as the importance of fires has been recognized in the management of terrestrial ecosystems, the role of hurricanes on coastal and shallow bay communities must also be recognized. Anthropogenic alteration of hurricane runoff quantity and timing, quality of runoff water and tidal exchange rates are possible. Intense periods of rapid runoff appear to be very significant in maintaining the Florida Bay ecosystem. Physical processes associated with hurricanes are: rainfall, storm tides, extreme wind and waves, and outwash. Although predicting the precise effects of any given hurricane is difficult, several observations were made after analysis of storm data since 1971: (1) a total of 95 tropical storms have affected the Florida Bay ecosystem, and 20 of these were considered major storms; (2) nearly 50% of all the storms fell within three general tracts; (3) of 39 storms analyzed since 1916, rainfall from individual storms made up 1.7 to 14% of annual rainfall; (4) storms from different vectors produced different rainfall characteristics; and (5) 11 storms from two vectors produced more than twice as much rain as other storms (averaging 213 mm). From these observations, two generalizations were made: storms that affect the Bay bottom and coastline occur at reasonably predictable intervals of one every 3 - 5 yrs, and storms which produce extreme freshwater runoff occur once every 6 to 7 yrs.

Although Hurricane Andrew was a devastating storm for South Florida, the last major hurricane to significantly impact Florida Bay was Hurricane Donna. An excellent description of the effects of that storm on the Bay was prepared by Craighead and Gilbert (1962) and excerpts of this work are used in this section.

Table 9. Tropical storms passing over or within a radius of approximately 50 mi of Florida Bay from 1910 to 1993 (Neumann *et al.*, 1993) [Storm track data in NOAA (1993) was used to determine storm intensity when it passed over Florida Bay].

Year	Category	Storm name and month of origin	Year	Category	Storm name and month of origin
1916	1	Storm 14, Nov.	1952	☆	Storm 1, Feb.
1919	☆	Storm 2, Sept. (near Bay)	1953	☆	Storm 3, Aug. (near Bay)
1924	3	Storm 7, Oct. (near Bay)	1960	4	Storm 5 (Donna), Aug.
1926	4	Storm 6, Sept.	1960	Δ	Storm 7 (Florence), Sept.
1926 ◊	∇	Storm 7, Sept.	1962 ◊	Δ	Storm 1 (Alma), Aug.
1926 ◊	3	Storm 10, Oct.	1964 ◊	2	Storm 5 (Cleo), Aug.
1928	☆	Storm 2, Aug.	1964 ◊	3	Storm 11 (Isbell), Oct.
1929	3	Storm 2, Oct.	1965	3	Storm 3 (Betsy), Aug.
1932	☆	Storm 3, Aug.	1966	1	Storm 9 (Inez), Sept.
1933 ◊	2	Storm 18, Sept. (near Bay)	1968	Δ	Storm 2 (Brenda), June
1934	☆	Storm 1, May (near Bay)	1968 ◊*	Δ	Storm 4 (Dolly) (near Bay)
1935	4	Storm 2, Aug.	1969 *	Δ	Storm 13 (Jenny), Oct. (near Bay)
1935	1	Storm 6, Oct.			
1936	☆	Storm 1, June	1970	Δ	Storm 7 (Felice), Sept.
1936	☆	Storm 5, July	1970 ◊	∇	Storm 8 (Greta), Sept.
1941	2	Storm 5, Oct. (near Bay)	1972	Δ	Storm 5 (Dawn), Sept.
1945	☆	Storm 7, Sept. (near Bay)	1976 *	☆	Storm 5 (Dottie), Aug.
1945	3	Storm 9, Sept.	1981	☆	Storm 4 (Dennis), Aug.
1947	2	Storm 4, Sept. (near Bay)	1987	1	Storm 7 (Floyd), Oct.
1947	1	Storm 8, Oct.	1991	☆	Storm 6 (Fabian), Oct. (near Bay)
1948	3	Storm 7, Sept. (near Bay)			
1948	3	Storm 8, Oct.	1992	4	Storm 2 (Andrew), Aug. (near Bay)
1950	3	Storm 11 (King), Oct. (near Bay)			
			1993		----
			1994		(Gordon)

* Storm passed between approximately 50 to 100 mi of the Bay. ◊ Storm passed on the Atlantic side of the mainland or the Florida Keys or west of Key West. ☆ Tropical storm. Δ Tropical depression in development stage when it passed over the Bay. ∇ Tropical depression in dissipation stage when it passed over the Bay.

Table 10. Saffir/Simpson hurricane intensity scale (Morgan and Morgan, 1989).

Category	Central pressure (mb)	Central pressure (in)	Wind speed (mph)	Wind speed (km/hr)	Storm surge (ft)	Storm surge (m)	Damage
1	>980	>28.94	74-95	121-154	4-5	1-2	Minimal
2	965-979	28.50-28.91	96-110	155-178	6-8	2-3	Moderate
3	945-964	27.91-28.47	111-130	179-210	9-12	3-4	Extensive
4	920-944	27.17-27.88	131-155	211-250	13-18	4-6	Extreme
5	<920	<27.17	>155	>250	>18	>6	Catastrophic

Hurricane Donna moved slowly through southern Florida, at approximately 14 mph, subjecting the area to damaging winds for nearly 36 hrs. In the Flamingo area, estimated sustained winds were 140 mph with gusts to 180 mph or more. High storm tides in Florida Bay and along the lower Gulf Coast contributed greatly to the damage. Maximum storm tide at Flamingo was 12 ft above the normal high tide. Hurricane damage to the vegetation was generally most severe in the mangrove belt and on the keys in the western portion of Florida Bay. This area, except for a small section from Little Madeira Bay eastward, was within the path of the wall cloud of Donna, where the strongest winds were located. Storm damage lessened inland away from the storm center and wall cloud. However, this was extremely erratic, depending on the eccentricities of the wind, the type and size of vegetation, character of the soil, and other factors.

The 1935 Hurricane virtually demolished the mature mangrove forest along the mainland coast of Florida Bay around Flamingo and Cape Sable. Estimated wind velocities up to 200 mph and a hurricane tide of 11 to 18 ft were reported for this storm. The forest in the Flamingo area was a fine mature stand of red, white and black mangroves, and buttonwood, called the "black forest" by some of the former residents. Trunks of many large dead trees killed in the 1935 storm were still standing when Donna struck. Some living trees, survivors of the 1935 storm, were also present. Most of these survivors were killed, but a small number were recovering at the time of the damage survey by Craighead and Gilbert (1962). These large black mangroves were conspicuous above the broken remains of the second growth forest that developed since the 1935 storm. The most severe damage in the mangrove belt from Hurricane Donna occurred from Madeira Bay westward to Shark River. Between Flamingo and West Lake there are many places where all of the trees over 2 in in diameter were sheared off 6 to 10 ft above the ground.

In general, the severity of damage to Florida Bay keys increased from the eastern half of the Bay westward to Sandy Key. This damage was erratic, but it was chiefly the southeastern portions of these keys where defoliation and breakage was most severe. Coconut palms suffered severely. The large clump on the north end of Buoy Key was torn away. On Clive Key, only seven out of about twenty coconut palms were left standing. Palm Key, before this storm, supported about fifty large cabbage palms. Many of these had survived the 1935 storm but all, except for three of the larger palms, were torn away. Sixty-seven of the younger trees 6 - 10 ft tall survived. Thatch palms fared much better. On Clive Key, some 30 - 40 remained standing. Four were blown down but were expected to continue to grow. Many of the thatch palms in the vicinity of Fan Palm Hammock were flattened by the 1935 hurricane, but nevertheless many of these lived and developed new upright trunks. Measurements and comparisons of the relative length of the flat and upright portion indicated these palms to be over 100 yrs of age. The larger cabbage palmettos on Palm Key are probably about the same age.

Several larger islands in Florida Bay, including Palm, Oyster, Clive, Murray, Man o' War, and Otter Keys, were examined in more detail on foot. These keys were highest on the levee-like rim just inside the mangroves where they support some hardwood trees. The interior was covered by several species of grasses and salt tolerant plants depending on the elevation, becoming more sparse toward the lowest central ground which was a bare marl flat covered with water in the rainy season. The mangrove rims were badly broken, especially on the east and south sides, and the broken trees were carried across and piled up on the north and western fringe. This drift line of debris averaged about 8 ft high. All trees were defoliated except the low shrubs and an occasional clump of trees of the mangrove fringes. Observation in the early 1950s and inquiries from people who knew the keys before and after the 1935 Hurricane indicated that the mangrove fringe on many keys was completely torn away by that storm. The herbaceous and shrubby vegetation was little affected. Exceptions were noted on Man o' War and Oyster Keys where the top soil was washed off on the levee-like rim and the herbaceous plants uprooted. Many of the large key lily *Hymenocallis* bulbs were found hanging in trees with the drift. Hundreds of these were carried to the mainland where they were left along the shore or hanging in the brush.

Hurricane Donna profoundly altered some of the physical features of the area. A deposit of silt varying from a trace to 5 in. was carried over the area inundated by the tidal wave. The deposit was heavier in the denser vegetation near the shore, building up the coastal flats of the mainland and adding to the higher rim characteristic of the Florida Bay keys. This deposit is an important factor in raising the elevation of the land formation of the coastal prairie and hammocks and especially the Florida Bay keys, some of which are 18 to 24 in. higher than the interior land. An appreciable deposit was left in the coastal mangrove areas where 2 to 5 in. elevation is an important factor in the encroachment of other plant species into this type. This deposit is high in nutritive values as indicated by the luxuriant growth that developed on it during the months following the storm. On some exposed keys and coastal hammocks the entire humus deposit and surface soil was removed and the debris carried inward to form a moraine 2-5 ft high where the vegetation acted as a barrier. This will stimulate hammock formation.

Some smaller keys were practically obliterated. Sandy Key was cut in two, and Cape Sable beaches were altered considerably. Inland, practically all the small mangrove creeks and canals were clogged with wind thrown trees. The Bear Lake Canal, formerly 4-6 ft deep, was filled to within 6-12 in of the surface with organic deposit from the mangrove forest and marl from the Bay. This action will hasten the obliteration of those creeks where the currents are not strong enough to prevent further deposits of humus and silt. Many such filled creeks were present in the mangrove belt.

Many of the Florida Bay keys have moats up to 10 ft deep and 50 ft wide on the northeast, east or southeast side directly against the mangrove fringe. Dildo Key is nearly surrounded by such a moat. Craighead and Gilbert (1962) attributed these moats to the action of storm waves beating against the solid wall of mangroves and scouring out the marl down to the Miami oolite bedrock.

Tabb and Jones (1962) studied the mortality of aquatic animals caused by Hurricane Donna. Fish and invertebrates were stranded by retreating salt water which had been driven inland or were killed by mud suffocation or turbulence. Oxygen depletion due to decomposition of organic material caused subsequent mortality. Salinities returned to normal within 6 weeks, but dissolved oxygen concentration remained abnormally low for a longer period. When environmental conditions again became suitable, the stricken areas were recolonized from surrounding regions. Sport fish catches in the area declined immediately after the storm, but recovered within one to several months, depending on the locality. Catch statistics indicate that after the storm juvenile pink shrimp moved from their estuarine nursery grounds into deeper water about 60 mi offshore, where they were caught by the fishery. There is no evidence that the aquatic fauna of the area suffered any permanent damage.

Hurricane Andrew passed over Homestead August 24, 1992. Andrew was a relatively dry hurricane, with strongest sustained winds of 144 mph. The hurricane passed directly over Biscayne Bay and had little effect on Florida Bay. The effects of this storm on Biscayne Bay and the northern Florida Keys have been described in several works (Blair *et al.*, 1994; Bohnsack *et al.*, 1994a; O'Brien *et al.*, 1994; Meier and Porter, 1994; Meeder *et al.*, 1994; Milton *et al.*, 1994; Pimm *et al.*, 1994; Smith *et al.*, 1994; Tilmant *et al.*, 1994; and others)

Table 11. El Niño years from 1910 to 1993 (Quinn *et al.,* 1987).

Event no.	Year	Strength	Event no.	Year	Strength
21	1911-12	S	32	1951	W/M
22	1914	M+	33	1953	M+
23	1917	S	34	1957-58	S
24	1918-19	W/M	35	1965	M+
25	1923	M	36	1972-73	S
26	1925-26	VS	37	1976	M
27	1930-31	W/M	38	1982-83	VS
28	1932	S	39	1987	M
29	1939	M+		91-92	*
30	1940-41	S		92-93	*
31	1943	M+		94-95	*

W/M - Nearly moderate. M+ - Nearly strong. S - Strong. VS - Very strong.
* Personal communication. J. Bell, NOAA/NWS/National Meteorological Center Climate Analysis Center, Camp Springs, MD.

5.2. El Niño events

The El Niño/Southern Oscillation (ENSO) is the largest single source of interannual climatic variability on a global scale and its effects are wide ranging (Diaz and Markgraf, 1992). The Southern Oscillation is a large scale sea level pressure "seesaw" across the tropical Pacific Ocean. The anomalous oceanic and atmospheric conditions that occur periodically along the upwelling zone of the Equatorial Pacific along the coast of Ecuador and Peru is known as El Niño and is a manifestation of coupled ocean-atmosphere processes. The warm phase of this coupling is known as El Niño and the cold phase as La Niña. Winter *et al.* (1994) found a very good correspondence between low $d^{13}C$ values (indicative of cloud cover) in a core taken from a specimen of *Montastrea annularis* and strong El Niño events indicating that the Caribbean is sensitive to ENSO activity. Various efforts have been made to determine El Niño and La Niña years using various data sets and techniques. Several of these efforts are discussed in Diaz and Markgraf (eds.) (1992). Those determined by Quinn *et al.* (1987) are listed in Table 11. During the past centuries, El Niño events tend to repeat over periods of 3 - 4 or 7 - 8 yrs (Quinn *et al.*, 1987; Brier *et al.*, 1989; and others).

Wilson (1989) compared onsets of El Niño events and major volcanic activity and found that 40-60% of El Niño events are preceded within one or two years by major volcanic eruptions in the tropics, while 70-80% are preceded within one or two years by major eruptions somewhere in the world. A number of El Niño events, however, cannot be directly linked with any major volcanic eruption that preceded them within three years. Major, tropical volcanic activity can inject large quantities of aerosols into the stratosphere and can account for about 70% of El Niño events. Wilson (1989) also compared onsets of El Niño events to specific phases of the solar/geomagnetic cycles and found that nearly two thirds of El Niño events had their onsets when the annual sunspot number was below 54 (the average annual sunspot number for the interval 1848 to 1987).

Hanson and Maul (1991) identified rainfall anomalies associated with major El Niño events in the climate record of the seven climatic divisions of Florida. Only El Niño events that were strong enough to persist over two successive years were examined in this study. Therefore only "moderate" and "strong" events as defined by Quinn *et al.* (1987) were used. An additional requirement was that the year prior to the two-year event must be a non-El Niño year. The two-year events that met this criteria were: 1911-12, 1917-18, 1925-26, 1930-31, 1939-40, 1957-58, 1972-73, and 1982-83. The most significant anomalies were: below normal rainfall over the State during winter (December, January and February) and spring (March, April and May) of the year prior to an El Niño event; and above normal rainfall over the State during the winter and spring of the second year of an El Niño event. The largest rainfall anomalies occurred in the southern climatic divisions of Florida (the Everglades and southeast coast, lower east coast, and the Keys).

5.3. Volcanic eruptions

As early as 1913, the effect of volcanic eruptions on global climate was recognized, and the levels of solar radiation after a volcanic eruption measured (Abbot and Fowle, 1913). Scattering of sunlight by volcanic aerosols can change the Earth's albedo or reflectivity, thereby causing climatic changes (Wilson, 1989). It has been shown that direct volcanic injection of material into the stratospheric aerosol layer occasionally takes place, and historically, effects such as poor harvests due to cool summers related to volcanic activity have been documented (Newell and Deepak, 1982; Friend, 1991; Rampino, 1991a and 1991b; Robock, 1991; and others). Recently, atmospheric chemical and radioactive effects have been examined. The eruption of Mt. Pinatubo in June 1991 produced a stratospheric aerosol cloud which was observed at altitudes between 18 - 28 km (Kinnison *et al.*, 1992). Although the latitudinal distribution of Pinatubo aerosol was initially equatorial, some of the material seemed to reach northern mid-latitudes, primarily in the lower stratosphere. Aerosol optical thickness was consistently observed to be twice the expected background values in a zone about 40° wide straddling the equator. This increased aerosol burden produced a strong cooling effect immediately after the eruption and the effect increased through September 1991 (Minnis *et al.*, 1993). The observed correlation of stratospheric plumes with climatic effects indicates that those plumes nearest the Equator have the largest impact on surface temperatures (Jakorsky, 1986). Injection of debris into the stratosphere is more important in determining the effect on climate than the volcanic explosivity of the eruption or the actual height reached within the stratosphere. Volcanic eruptions observed to reach the stratosphere since 1883 are listed in Table 12 (Jakorsky, 1986).

5.4. Solar cycles

Sunspots are dark (cool) areas on the Sun's surface that interrupt the regular pattern of solar emissions (NOAA, 1991a). Sunspots are accompanied by strong magnetic fields and have lifetimes ranging from days to a few months. Sunspot frequency rises and falls with the 11-yr solar cycle and provides an index of solar magnetic activity. In 1848, the Swiss astronomer Johann Rudolph Wolf introduced a daily measurement of sunspot number. His method, which is still used today, counts both the total number of spots visible on the face of the Sun and the number of groups into which they cluster because neither quantity alone satisfactorily measures sunspot activity. Results can vary greatly, however, since the measurement strongly depends on observer interpretation and experience and on the stability of the Earth's atmosphere above the observing site. To compensate for these limitations, each daily international number is computed as a weighted average of measurements made from a network of cooperating observatories. Monthly mean values are shown in Figure 4. The 27-day fluctuation that reflects the rotation period of the Sun has been smoothed. The highest daily counts on record occurred in December 1957.

Wilson (1989) found that major tropical volcanic activity (those that can inject sufficient quantities of aerosols into the atmosphere that persist up to 3 yrs) can account for 70% of El Niño events, although major volcanic activity regardless of latitude can account for 85% of the

Table 12. Volcanic eruptions observed to reach the stratosphere since 1883 (Jakorsky, 1986).

Date	Name	Plume height (km)	Latitude	
8/1883	Krakatau	27	-6	*
5/1886	Etna	14	38	
5/1902	Soufrière	16	13	*
4/1932	Quizapu	14	-45	*
3/1947	Hekla	26-27	64	
2/1952	Trident	9	58	
7/1953	Spurr	22	61	
3/1956	Bezymianny	36-45	56	
1/1962	Tokachidake	12	43	
3/1963	Agung	22	-8	*
4/1963	Trident	15	58	
11/1963	Surtsey	14.5	63	
7/1965	Taal	15-20	14	*
2/1966	Redoubt	12-16	60	
7/1967	Deception Is.	10	-63	
6/1968	Fernandina	22-24	-0.5	*
5/1970	Hekla	16	64	
10/1974	Fuego	22	14.5	*
1/1976	St. Augustine	11	59	
4/1979	Soufrière	17-19	13	*
5/1980	St. Helens	24	46	
8/1980	St. Helens	13	46	
10/1980	St. Helens	14	46	
4/1981	Alaid	15	51	
5/1981	Pagan	13.5	18	*
1/1982	"Mystery cloud"	17	~20	*
4/1982	El Chichon	28	17	*
1984	Home Reef	15	-19	*
1985	Nevado del Ruiz	11	5	*
1986	Pavlof	16		
1991	Mt. Pinatubo	18-28		

* Marks volcanoes within 20° of the Equator.

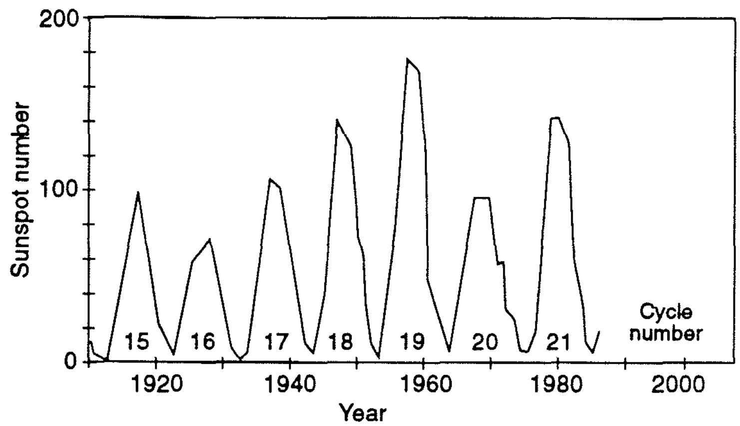

Figure 4. Sunspot cycles and numbers [Redrawn from Wilson (1989).].

El Niño events. For unknown reasons, moderate El Niño events appear to occur preferentially near the sunspot minimum and when annual sunspot numbers are low. Strong El Niño events appear to preferentially occur during the declining portion of the sunspot cycle.

It has been found recently that the solar radius is variable, with variations on an ~80 yr time scale, and that these variations may result in large changes in solar luminosity (Gilliland, 1982). This ~80 yr cycle, as well as the shorter 11-yr solar sunspot cycle and 22-yr Hale cycle of solar magnetic reversals may explain hemispheric temperature trends. A third possible cycle is the 18.6-yr lunar nodal cycle in which tidal influences may play an important role.

5.5. Sea level change

Global sea level has been rising since the last glacial maximum approximately 18,000 yrs ago and this rise has not been uniform. Wanless *et al.* (1994) has shown that the sea level rise for the past few thousand years has been about 0.04 cm/yr compared to that of the Holocene, approximately 0.25 cm/yr. Maul and Martin (1993) have determined the sea level rise at Key West using instrument records from 1846 - 1987. The linear sea level rise has been about 30 cm and there is a statistically weak but consistent indication that the rate of rise has increased slightly since the 1920s (Figure 5).

6. ENVIRONMENTAL CHANGES

6.1. Species status

There are several threatened and endangered species in Florida Bay under Federal and state protection. These include the key silverside, the green sea turtle, the loggerhead sea turtle, hawksbill sea turtle, the Kemp's Ridley sea turtle, the leatherback sea turtle, the manatee, the American crocodile, the brown pelican, the southern bald eagle, the osprey, the South American kestryl, the Florida sandhill crane, the white crowned pigeon, and others. The Florida Committee on Rare and Endangered Plants and Animals listed 72 taxonomic species of birds, twenty seven of which occur within the terrestrial and freshwater wetlands of the lower Everglades (Schomer and Drew, 1982). The Florida coast serves as turtle nesting habitat, supporting the second largest nesting population of loggerhead turtles in the world (Thompson,

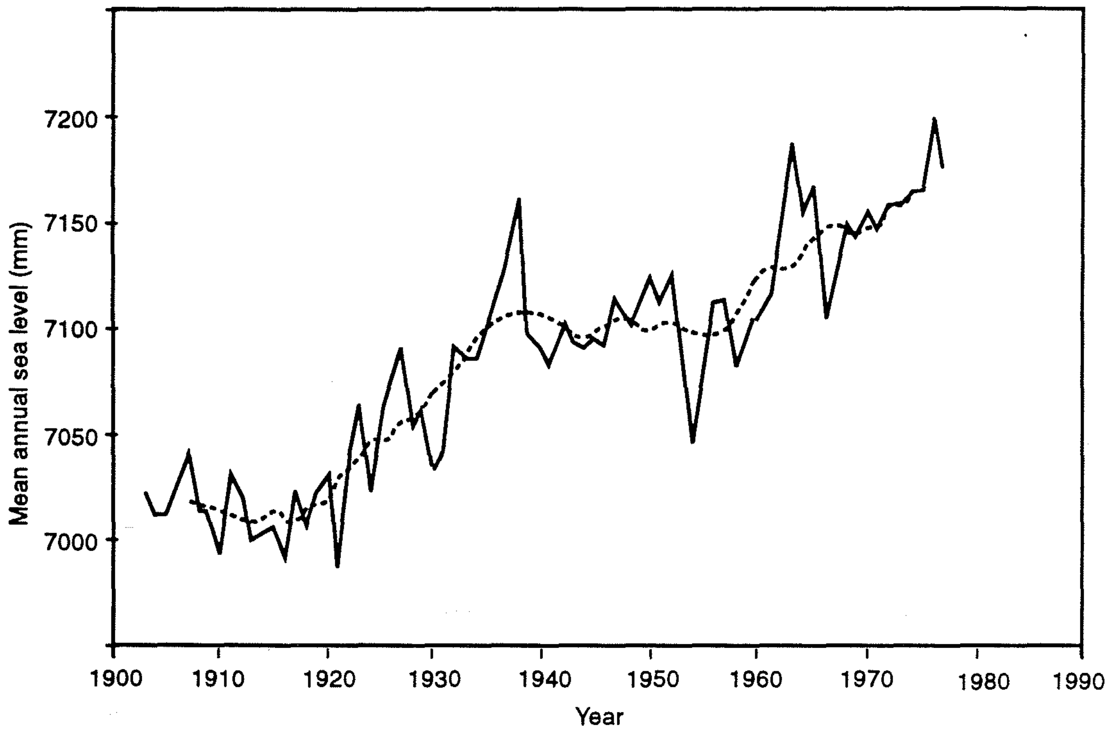

Figure 5. Tidal gauge data from Key West plotted as mean annual sea level as a 10-yr running average (dashed line) [Redrawn from Wanless *et al.* (1988).].

1994). Nonpoint source contamination of coastal waters may be either directly or indirectly linked to the fibropapilloma disease found primarily on green turtles in isolated areas of the world, including South Florida (Lutz, 1994; Thompson, 1994).

6.2. Algal blooms

Algal blooms are caused by a variety of environmental conditions, some of which are natural. Algal blooms have been noted in Florida Bay for many years. Anecdotal information collected by DeMaria (in press) mentions algal blooms in the Bay as early as the 1940s (See Section 9.5.1). Macroalgal blooms have been documented only since 1991 in the western side of the Bay. No seasonality was observed. Different taxa blooms have been reported in north central and southeastern portions of the Bay and these may have a seasonal signal.

6.3. Coral reef degradation and diseases

There are no large coral reefs in Florida Bay. Small patch reefs are found in the Bay although conditions for growth are not favorable due to variations in water temperature and suspended particulate matter in the water column. The barrier coral reefs are found on the Atlantic side of the Florida Keys. Studies from 1984 to 1991 found incidences of coral bleaching not accompanied by new growth in six different reefs along the Keys. Bleaching was also found in 1911, 1914, 1958, 1975, 1983 and 1987. Changes in water temperatures may be a cause of coral degradation (Roberts *et al.*, 1982; Roberts *et al.*, 1983; Walker *et al.*, 1982a and 1982b; and others). Western Atlantic coral reefs were affected by "bleaching" in 1987 (Lang *et al.*, 1992). Recovery occurred faster at shallow sites. Bleached points disappeared by 6 - 8 months. Bleaching is the result of the loss of endosymbiotic zooxanthellae (photosynthetic dinoflagellates) and/or loss of photosyntheric pigments from the algae remaining in the coral soft tissues. This can be caused by stress. Bleaching events have been noted worldwide and some have coincided with ENSO events. The 1987 event was studied mostly oo the outerFlorida Keys, Bahamas, Venezuela and St. Croix.

Black band disease is present throughout the coral reefs of the Florida Keys (Kuta and Richardson, 1994). The disease consists of a population of the cyanobacterium *Phormidiurn corallyticum* and associated microbial community, and is characterized by an active season which occurs during the warmer months when water temperature is at or above 25°C. No reports of the disease in Florida Bay were found.

6.4. Seagrass dieoffs

Seagrasses constitute a complex and highly productive ecosystem that predominates in shallow marine areas in South Florida. The seagrass ecosystem provides food and habitat for diverse species, including important sports and commercial fisheries. Livingston (1987) reviewed historic trends of human impacts on seagrass meadows of Florida. Municipalization, industrialization, and agricultural activities in coastal drainage systems have been accompanied by various impacts in almost every bay system in Florida. Seagrass meadows have been virtually eliminated in most portions of the Pensacola Bay and Tampa Bay systems. Significant losses have been noted over the past 20 - 40 yrs in Choctawhatchee Bay, Apalachee Bay, Charlotte Harbor, Biscayne Bay, and the Indian River. Lack of reliable data precluded appropriate evaluations in other areas. However, the two primary concentrations of seagrasses in the northern hemisphere, Florida Bay and the northwest Gulf coast (including Apalachee Bay), are currently threatened by wide-ranging forms of human activity, and a general lack of long-term, multidisciplinary ecological studies has inhibited a thorough understanding of the problem. Studies in Apalachee Bay indicated that relatively minor water-quality changes can destroy or severely alter seagrass distribution and productivity, and recovery after impact appears to be slow. Light penetration is the most important factor affecting seagrass growth and survival, and it is reduced directly or indirectly by algal blooms caused by nutrient enrichment, suspended sediments, and/or water color due to dissolved organic material (Kenworthy and Haugert, 1991).

More than 4,000 ha of *Thalassia* beds were lost in recurring dieoffs since 1987, and an additional 23,000 were affected to a lesser degree (Robblee *et al.*, 1991). The areas affected were Johnson Key Basin, Rabbit Key Basin, Rankin Lake, Cross Bank, and Sunset Cove. Dead and dying *Thalassia* were first observed near Cross Bank and Rankin Lake during the summer of 1987. By the summer of 1988, the dieoff was evident in about 30% of the *Thalassia* beds of western Florida Bay. The Sunset Cove bed died between November 1988 and January 1989. Dieoffs appear to occur most rapidly during the fall and spring. These recurring episodes of fast but patchy dieoffs are different from those observed as the result of eutrophication.

The dieoffs of *Thalassia* in Florida Bay have been reported since 1987 and continue as of this writing. Large areas were affected during the fall of 1987. There may be a seasonal pattern to the dieoffs associated with high temperatures and high salinities during periods of low fresh water flow. Drought conditions during which rainfall was lower than average contributed to the generation of hypersalinity conditions from 1986 to 1989. This was a major climatic stress that may have resulted in seagrass die-off (D. Morrison, National Audubon Society, personal communication, 1995). Zieman *et al.* (1992), in a retrospective analysis of earlier data coupled with current studies, showed a large increase in seagrass biomass prior to the dieoff and a decline in turnover rate or specific plant productivity during the dieoff. External stress in the form of hypersaline conditions, which are partly anthropogenically derived, were found to be prevalent during much of the dieoff. Climatic stresses were (1) excessively warm waters in the late summer and fall of 1986 - 1988, and 1990, and (2) a reduction of historical tropical storm frequency, and (3) reduced rainfall. Historical and anecdotal evidence suggests a continuing shift over the past decades from a mixed habitat to an increasingly monospecific *Thalassia* community. Recolonization processes are establishing a more diverse mixture of habitats with the potential of enhanced secondary productivity in some areas. In 1992, a major dieoff expansion occurred in western Florida Bay. Further evidence of the effect of warm temperatures on *Thalassia* was found by Thorhaug *et al.* (1973) in the seagrass community near the Turkey Point Nuclear Power Plant cooling water canal in Biscayne Bay. *Thalassia* disappeared in areas of water 5°C above ambient, and declined by 50% in waters 3-4°C above ambient temperature. Environmental stress caused by climatic variations or changes in salinity may also make *Thalassia* more susceptible to disease (Thayer *et al.*, 1994). Blackened, necrotic lesions on *Thalassia* leaves, caused by a previously undescribed species of the marine slime mold, genus *Labyrinthula,* are frequently associated with seagrass die-off in Florida Bay (Durako and Kuss, 1994). Sediment porewater sulfide concentrations in Florida Bay seagrass beds affected by the catastrophic mortality of *Thalassia* were considerably higher than those of seagrass beds elsewhere in Florida (Carlson *et al*, 1994). The high sulfide concentrations resulting from microbie degradation of dying *Thalassia* might have stressed adjacent seagrass beds.

There appears to be a high potential for recovery of *Thalassia* beds. Thayer *et al.* (1994) postulate a sequence of steps in the recovery process. The alga *Batophora oerstedii is* the first colonizer, with replacement by other algal species, and subsequently *Halodule wrightii,* and eventually *Thalassia.*

Seagrass habitats in western Florida Bay have been undergoing changes from monotypic *Thalassia* meadows to large landscapes of barren bottoms or to increasingly heterogeneous *Thalassia* meadows as a result of seagrass die-off patch formation. The cause of die-off is unknown but current hypotheses point to environmental stress making this seagrass susceptible to disease. The potential exists for colonization and recovery of these die-off patches but the sequence of events and the persistence of the recovery have not been evaluated.

6.5. Sponge dieoffs

The information in this section was found in Stevely *et al.* (1978). A historical account of the sponge fishery along the east coast of Florida can also be found in Shubow (1969).

Up until the 1940s, the sponge fishery was one of the most valuable fisheries in Florida. However, a combination of disease, heavy harvesting pressure, and the introduction of synthetic sponges resulted in reduction of the industry to a small fraction of its former importance. Production in the Tarpon Springs area, the traditional center for sponging in Florida, has declined to extremely low levels of harvesting activity. Dade County has emerged as the center of the existing sponge industry. Persistence of low level sponging activities in Florida for the last 30 yrs indicates that the sponge industry, as it is currently structured, will probably not return to former production levels.

Sponges (phylum Porifera) are considered to be primitive in relation to other animal groups because of their simple structure and the fact that apparently no other group of animals has evolved from them. There is low level of cellular specialization in sponges. These organisms lack distinct organs and tissues, and interdependence sponges closely resemble colonies of independent single cell organisms with primitive characteristics. The phylum Porifera is divided into three classes based primarily on the composition and structure of the animals' skeletal framework. The skeleton may be composed of calcareous spicules, siliceous spicules, protein spongin fiber, or a combination of the latter two. These spicules are either calcium carbonate or silicon dioxide. The commercial sponges all come from one group, those having their skeleton made of spongin fibers only. Spongin is related chemically and physically to silk, horn, and chitin. The arrangement of spongin into a fibrous network is responsible for the commercial sponges properties of compressibility, resiliency and ability to absorb large quantities of water.

The sheepswool sponge (*Hippiospongia lachne*) is considered to be the highest quality commercial sponge found in the western Atlantic. It is the most valuable species, representing 75% of the dollar value of sponges collected in Florida and 87.9% in Monroe County during 1976. The yellow sponge (*Spongia barbara*) is elastic and resilient and is harder than the sheepswool, harsher to the touch, less absorbent, less retentive of water, and less durable. Yellow sponges accounted for 14.7% of the dollar value of sponges collected in Florida and 6.3% in Monroe County in 1976. Grass sponges collected off the west coast of Florida differ considerably from those taken in the Keys. The grass sponges of the Florida Keys, Bahamas Islands, and Cuba, *Spongia graminea*, vary in form and general appearance, but generally grow in a rounded, more compact form with a flat or concave top that is perforated by a number of oscules up to 0.65 cm in diameter. Large numbers of these sponges are collected in Biscayne Bay but the market value of these sponges is the lowest of all the commercial species.

The commercial sponges apparently cannot tolerate salinities much below oceanic levels. Temperature has been shown to be an important factor affecting sponges. Commercial sponges appear to have a tolerance range from 10° C to 35° C. Sponges, due to their sessile nature, are dependent upon water currents to bring food, dissolved oxygen, disperse larvae, and to carry away wastes. The availability of clean, hard substrate for the sponge larvae to settle upon is extremely important since larvae are smothered by sediments. Only a small percentage of the large areas defined as the Florida sponge grounds actually support sponge populations due to the scarcity of rock outcroppings.

During 1938 - 1939, populations of commercial sponges throughout the western Atlantic were decimated by disease. The disease first appeared in the Bahama Islands and rapidly spread throughout the West Indies and the Gulf of Mexico. The progress of the mortality was recorded in a detailed manner and transmission of the disease was attributed to water currents. This disease has been attributed to the fungus *Spongiophaga communis*. In British Honduras, *Spongiophaga* was observed growing on the surface of turtle grass, *Thalassia*, with no apparent ill effect. As reported in 1978, a sponger in the Key West area reported that he continually found a small number of sponges affected by the fungus. Exactly why the blight has not triggered mass mortalities, as it has been reported to do in the past, is not understood.

During 1947 - 1948, a disease affecting the commercial sponges along the west coast of Florida was reported. Investigation of this phenomenon by members of the Marine Laboratory, University of Miami, did not reveal the cause of this sponge mortality. No evidence of fungal disease was found. Mortality of sponges due to the outbreak of red tide has been noted. Sponge fishermen have reported that sponges in shallow water are occasionally killed off by a phenomenon they call "mallee". This "mallee" is a heavy growth of fine algae that usually smothers sponges.

Recently, sponge dieoffs were observed in 1992, apparently related to microalgal blooms, with a time lag of 5-7 days. The region affected was mid-Bay to the southeast, adjacent to the Keys (Brown and Ortner, 1994). The population of juvenile Caribbean spiny lobster may have been impacted by the sponge die-off as sponges are a primary shelter for these animals (Childress and Herrnkind, 1994).

6.6. Mangrove dieoffs

The information in this section was found in Hanlon *et al.* (1975). A thorough discussion of mangrove forest ecology can be found in Odum *et al.* (1982).

The most common mangrove species in the tropical coastlines of North America are: the red mangrove (*Rhizophora mangle*); the black mangrove (*Avicennia germinans*); the white mangrove (*Laguncularia racemosa*); and the buttonwood (*Conocarpus erectus*). The mangroves characterize and dominate a large portion of the world's tropical coastal margins. As early as 330 BC, classical writers such as Theophrastus, Pliny the Elder, and Plutarch commented on these unusual trees that were nourished by salt water. The mangrove habitat is a unique blend of land and aquatic ecosystems.

There is a natural succession of mangroves from seaward to landward. The red mangrove occurs at the seaward edge, the black mangrove occurs further landward, and the white mangrove occurs farthest from the shore. The red mangrove, with its thick mass of prop roots, is particularly well established in the substrate, and only the most violent of hurricanes can disturb it. It forms a protective barrier along the coast, behind which the other mangroves and associated flora take root. The accumulation of sand, leaves, and debris which is caught in this web of roots eventually decomposes and raises soil levels. At the same time, red mangrove seedlings take root farther seaward as the soil level increases. In time, the result is a gradual seaward extension of the coastline. The landbuilding quality of the red mangrove is important. It does well on nearly all types of soil or substrate provided they are wet. The black mangrove does well on all soils, including some dry and salty ones. The white mangrove does best in sandy and drier soil, thus explaining its general occurrence on higher ground.

Until recently, mangrove forests in Florida were regarded as a wasteland suited only for development. It can be demonstrated, however, that these forests contribute in many ways to man's economic betterment. The contribution of the mangrove swamps to commercial and sport fisheries has been a subject of debate for some time. Only very recently have definitive studies of their contribution been undertaken. The role of the mangrove can be depicted in the following manner. The fallen leaves from the mangroves collect between the roots and begin to decompose. Ninety-five percent of the annual mangrove leaf production eventually enters the aquatic system. The decomposition is accomplished by the bacteria and fungi in the water, which turn the leaves into detritus. The detritus, or plant debris, of mangrove origin accounts for 35-60% of the suspended material in estuarine waters. Most of the other detrital material comes from the sea grasses. This detritus is the basis of the estuarine food chain, contrary to previous thought which maintained that estuarine food chains were based upon phytoplankton.

A host of small invertebrate animals, ranging from nematode roundworms to small crabs and shrimp, feed on this detritus. They in turn are eaten by the larger predators, including commercial and game fish. It has been pointed out that the commercial shrimp of the Dry Tortugas are dependent upon the mangrove swamp as a nursery ground. Equally important is the fact that several other commercially valuable species, including mullet, gray snapper, red drum, blue crabs, tarpon, snook, and spotted sea trout, also rely on the mangrove swamp as a nursery and feeding ground. It is therefore evident that the destruction of mangroves would be tantamount to the removal of the primary food source upon which many animals of commercial and recreational importance depend.

The role of the mangroves in landbuilding, shore protection and stabilization, and reforestation is of paramount importance. The tropical belts of the world are subjected annually to tropical depressions and hurricanes and mangrove forests are well suited to protect the coastline against the force of these storms.

During the last few years, mangrove dieoffs have been observed. There is no evidence of seasonality. The dieoffs were first observed in black mangrove at higher elevations but are currently observed in red mangrove at lower elevations. There is a rough correlation with seagrass dieoffs suggesting possible correlation to high salinities (Brown and Ortner, 1994).

Davis (1940) reports that, in numerous instances, fishermen and guides pointed out changes they observed during the past 20 to 40 yrs, and some of these observations, when checked against maps, were found to be reliable.

Snedaker (1994) suggests that changes in precipitation and runoff are the most important factors concerning mangrove survival in the face of global change. Reduced rainfall and runoff would result in higher salinity and greater seawater sulfate exposure. This change would likely be associated with decreased primary production and increased sediment organic matter decomposition leading to subsidence. Higher rainfall and runoff would result in reduced salinity and exposure to sulfate, and also increase delivery of terrigeneous nutrients. Consequently, mangrove production would increase and sediment elevations would be maintained. Support for this scenario derives from studies of the high production in saline mangrove impoundments which are depleted in seawater sulfate.

6.7. Fish dieoffs

During the summer/fall period of 1990, three large fish kills occurred in the Snake Bight area, east of Flamingo in north central Florida Bay (Schmidt and Robblee, 1994). Based on summaries of historical park fish kill events, it was found that 38 kills have occurred since 1944; seven took place during the passage of south Florida cold fronts while the remaining 31 occurred between March and November and appear to have resulted from hypoxic conditions due to local environmental extremes. Nearly half of the kills took place in the waters of either Florida or Whitewater Bays; 24% occurred east of Flamingo in Snake Bight. Over half of the Snake Bight kills were considered severe (1,000 to 100,000 fish reported as dead); most took place over the past 15 yrs.

6.8. Fish catch changes

The recorded history of fishing in Florida Bay and the Florida Keys can be traced back to the Caloosa Native Americans at the time of the early Spanish explorers (Tilmant, 1989). Native Americans from the Upper Keys grew and exported fish to Cuba and early explorers reported excellent fish catches in the Keys. Prior to the 1940s, fishing was largely subsistence oriented. Fishing activities increased during the 1950s and commercial activities reached a peak in the late 1970s. During this time, fishing guides became concerned with declining catches (Thayer and Chester, 1989). Evidence of the effect of salinity changes on the fish population of Florida Bay is circumstantial but there is evidence that the population size and behavior of several species have changed in recent years (Boesch *et al.*, 1993). These effects do not seem to extend to the open areas of the Bay.

Bohnsack *et al.*, (1994b) examined data from commercial, recreational, and marine life fisheries in Monroe County. Invertebrates comprised the majority of commercial landings. In 1992, the total reported commercial landings were composed of 52% invertebrates, 28% reef fishes, and 21% non-reef fishes. Landings for some species varied greatly over time. Total commercial and recreational catches of reef and non-reef fish for Monroe County are shown in Figure 6. The most conspicuous declines were for pink shrimp, combined grouper, and king mackerel (Figure 7), while the most conspicuous increases were for amberjack, stone crab, blue crab, and yellowtail snapper (Figure 8). Landings of spiny lobster have generally remained constant. Fisheries closed to harvest included queen conch, Nassau grouper, jewfish, and stony corals. Effective fishing effort has increased over time with more participants and more effective fishing technology. Since 1965, the number of registered private recreational vessels has increased over six times, while the number of commercial and headboat vessels has remained stable. The number of management actions have continually increased and become more restrictive with increased fishing effort.

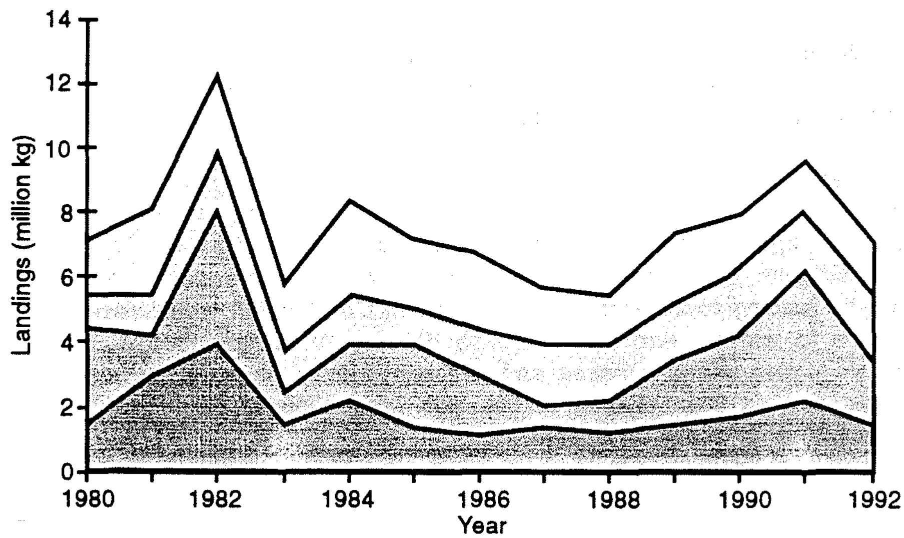

Figure 6. Comparison of total commercial and recreational landings for reef and non-reef fisheries in Monroe County. [1983 was an El Niño year. Redrawn from Bohnsack *et al.* (1994b).]

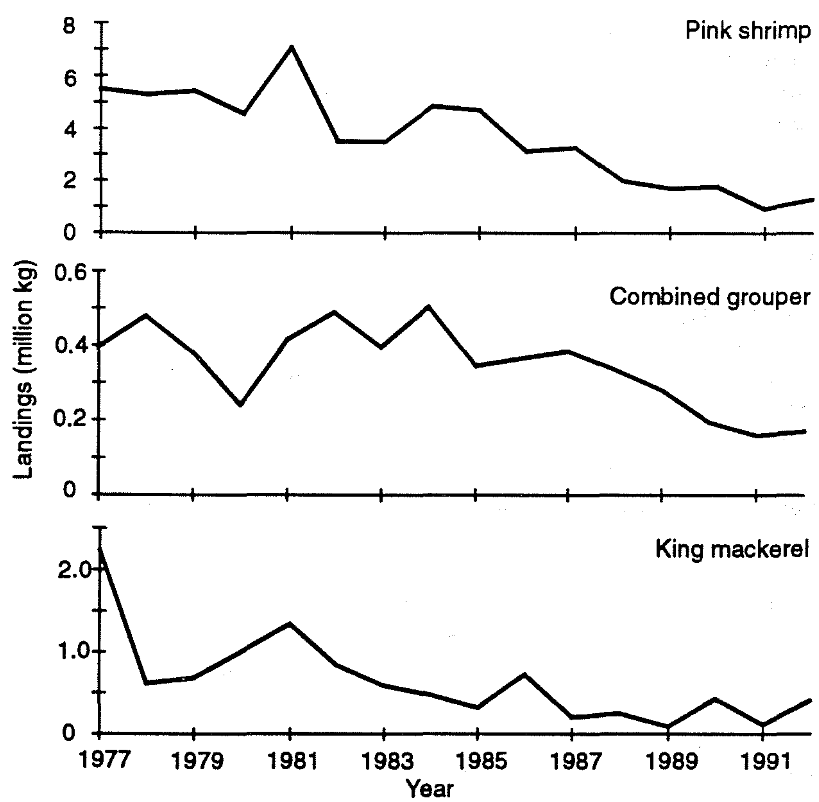

Figure 7. Commercial landings of pink shrimp, combined grouper species, and king mackerel in Monroe County. [Data from Bohnsack *et al.* (1994b).]

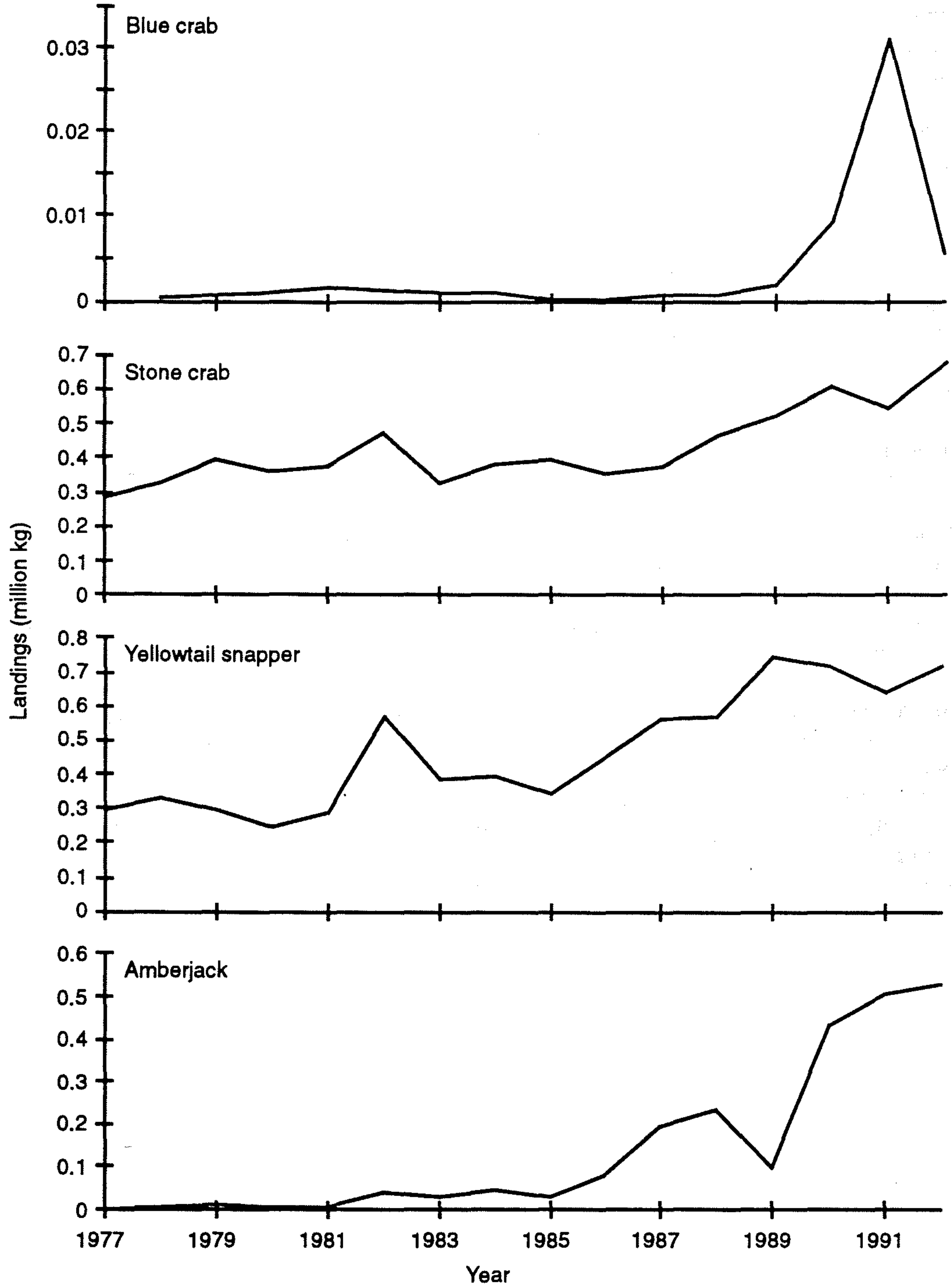

Figure 8. Commercial landings of blue crab, stone crab, yellowtail snapper and amberjack in Monroe County. [Data from Bohnsack *et al.* (1994b).]

Davis (1980) examined fisheries management in Everglades National Park, which involves over 20 commonly harvested species from six ecosystems, by both commercial and recreational fishermen. Analysis of data on catch fishing effort, population age structure of exploited species, boating activity, and environmental conditions from 1958 to 1978 show three types of change in fishery resources. Some species increased in abundance and shifted their population age structure from juvenile toward adult fish, while other species declined in abundance and their age structure remained unchanged, including both juvenile and adults. Both general and specific increases in boating activity were associated with sharp declines in catch rates, whereas decreased boating activity since 1973 was associated with increased catch rates. Year-to-year variation in the availability of major game species declined, which may have been related to decline in the frequency of extreme climatic events and/or watershed management activities. No effects of harvest on finfish stocks in the Park were detected.

6.9. Wading birds

[The information in this section is from Powell *et al.* (1989b), Bancroft *et al.* (1994), and Ogden (1994).]

Fourteen species of wading birds can be found in Florida Bay, and several of these are closely associated with the Bay's ecosystem. Powell *et al.*, (1989b) report that about 50% of the great white herons and reddish egrets, and 90% of the roseate spoonbills found in the southeast US nest in Florida Bay. Such restricted populations and the high trophic levels of these species make wading birds vulnerable to habitat changes. These three species were virtually extirpated from Florida Bay from the 1800s to the mid 1930s by harvesting as a food source for humans and for their feathers. Once the species were protected, the populations grew quickly (Figure 9 - 11). The number of great white herons, for example, increased from 20 specimens after the 1935 hurricane to 800 - 900 specimens in the 1960s. The absence of pre-1800s data does not permit comparison of current wading bird populations with those of the pristine environment of the early 19th century. The wading population at that time, however, was large. Audubon, for example, stated in 1832 that at Sandy Key there were "flocks of birds that covered the shelly beaches". Powell *et al.* (1989b) state that the current population seems to be at a lower density than those historically present.

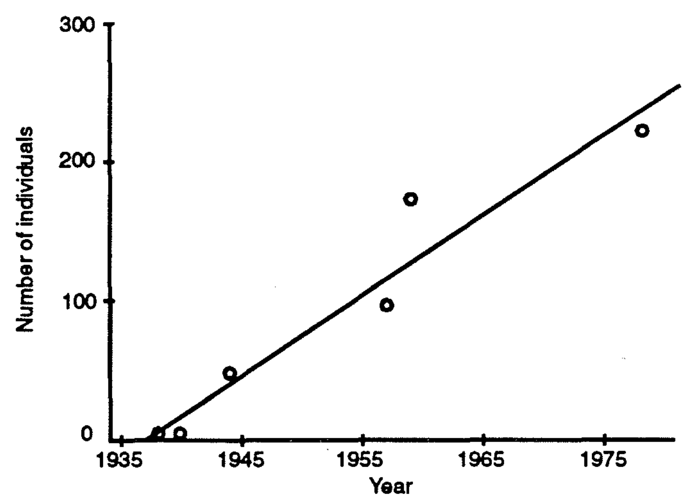

Figure 9. Population growth of reddish egret in Florida Bay. [Redrawn from Powell *et al.* (1989b).]

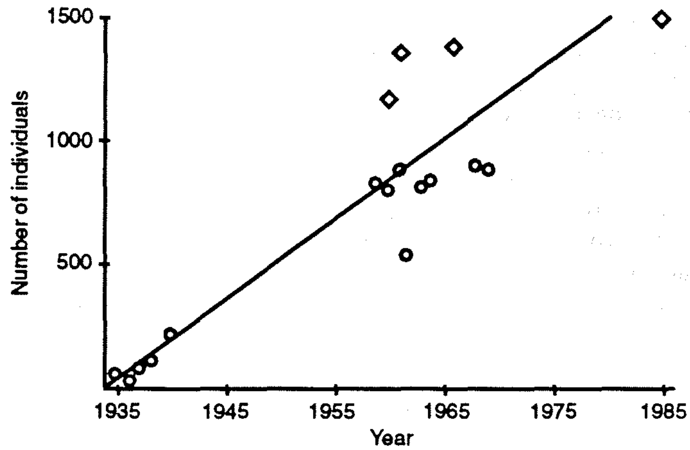

Figure 10. Population growth of great white heron in Florida Bay. (Data derived from observations from fixed wing aircraft. Open circles are summer censuses, and crossed circles are winter censuses.) [Redrawn from Powell *et al.* (1989b).]

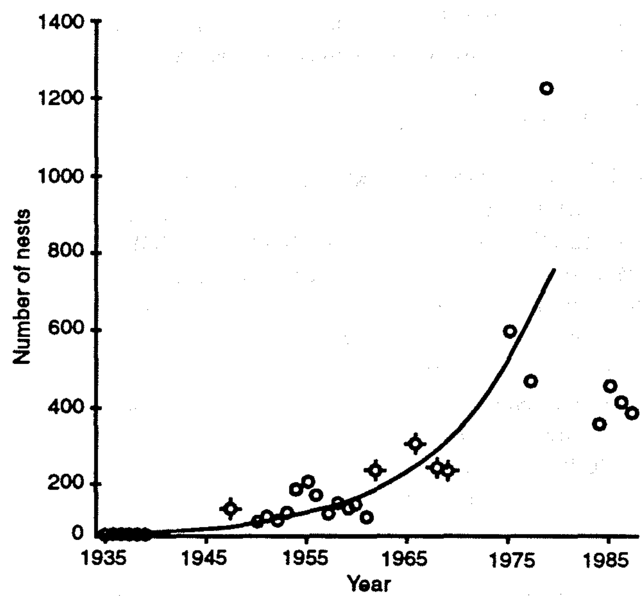

Figure 11. Population growth of roseate spoonbill in Florida Bay. (Simple circles are numbers of nests counted on ground visits to colonies. Crossed circles are estimates derived from aerial counts.) [Redrawn from Powell *et al.* (1989b).]

Bancroft *et al.* (1994) examined general foraging distribution data from systematic aerial surveys, specific foraging distribution data obtained from following flights, habitat data from the USGS orthophotomaps, hydrological data from gauges and aerial surveys, and colony location, size, and sucess data from three recent studies were analyzed. Nesting great egrets and white ibises typically foraged within 9 and 10 km, respectively, of their colonies. Historically, these species bred in large, mixed-species colonies in the mangrove zone of Everglades National Park, whereas currently they breed in much smaller colonies in the water Conservation Areas. Examination of the formation, growth and decline of a colony in the Water Conservation Areas during the drought year 1989 showed that initially the nesting birds were feeding close to the colony. As the area dried out, the overall foraging distribution shifted well south of the colony. The compartmentalization of the Everglades may have decresed the ability of forage fish to migrate through the system, especially into the deeper sloughs during the dry season, thus decreasing the productivity of these areas for nesting wading birds.

Ogden (1994) examined patterns of nesting for five species of colonial wading birds in the central and southern Everglades for two periods: an early drainage period (1931 - 1946) and a late drainage period (1974 - 1989). Parameters examined were (1) numbers of birds nesting in each colony, (2) locations of colonies, (3) timing and nesting, and (4) colony success. The five species analyzed were great egret, tricolored heron, snowy egret, white ibis, and wood stork. For all species except the wood stork, the locations of the largest colonies changed between periods from a headwaters subregion located at the lower end of the Shark River Slough to a central Everglades subregion located north of Everglades National Park. Reductions in the number of nesting birds and changes in the location of major colonies appear to correlate with the reduction in the total area of wetland foraging habitat, an increased frequency of extensive dry outs in the lower Shark Rivcr Slough marshes, and the relocation of the longer hydroperiod marshes into the Water Conservation Area impoundments.

6.10. Fires in the Everglades National Park

Fire and water are the two major natural factors affecting the environment of south Florida. Fires are part of the natural cycle of terrestrial and wetland communities, and are a natural means of maintaining specific ecosystems (Hofstetter, 1984). Fires are part of the recycling of nutrients. Fires prevent the invasion of grasslands by woody plants, and when fire is excluded, community succession continues, eventually ending with the climax community for that region. For southern Florida, the climax community is hardwood hammock. Natural fires are caused by lightning and are a wet season phenomenon. Lightning may also trigger fires during the dry season. These can be extensive and can consume peat, sawgrass and forest. The frequency of fires resulting from incendiary activities has increased in recent years. The largest fires in the Everglades National Park have been incendiary dry season fires. A detailed description of the effects of Everglades fires on the vegetation and animals of the Park can be found in Hofstetter (1984).

Fire records for the Everglades National Park, from 1948 through 1979, are reported in Taylor (1981). Number of fires and acres burned by year are listed in Table 13. The records contain 913 fire reports of which 682 reports cover 451,082 burned acres in Everglades National Park, and 251 reports cover 480,080 burned acres in the Everglades Fire Protection Zone outside the park. The recorded fires are categorized as human-caused, lightning-caused, or prescribed management fires. Total acres burned by each fire type are presented by year and month of occurrence. The number of human-caused fires was found to be highly correlated with water levels at Taylor Slough Bridge and with precipitation at Royal Palm. Extreme fire years, when 20,000 to 100,000 acres may burn, follow an average interval of 6 to 8 yrs; moderate to severe fire years, when 10,000 to 20,000 acres may burn, occur on a 3.2- to 4.3-yr interval. The Everglades National Park has been divided into three fire management

Table 13. Number of fires and acres burned by lightning fires, prescribed fires, man-caused fires, and all fires by year within the Everglades National Park, 1948 - 1979. (Includes portions of boundary fires.) [From Taylor, 1981.]

	Lightning fires		Prescribed fires		Human-induced fires		Total	
Year	No.	Acres	No.	Acres	No.	Acres	No.	Acres
1948	0	0	7	176	0	0	7	176
1949	1	1	15	7,652	0	0	16	7,652
1950	0	0	14	33,520	0	0	14	33,520
1951	9	43,155	7	785	0	0	16	43,840
1952	4	3,023	13	2,845	0	0	17	5,868
1953	1	110	7	8,971	0	0	8	9,081
1954	3	3,247	3	10	0	0	6	3,257
1955	2	127	9	3,604	0	0	11	3,731
1956	7	2,201	11	1,556	0	0	18	3,757
1957	7	1,132	4	20,082	0	0	11	21,214
1958	3	305	3	750	1	1,500	7	2,555
1959	4	480	13	836	2	1,950	19	3,266
1960	5	75	6	182	3	2,395	14	2,652
1961	3	54	10	1,861	0	0	13	1,915
1962	2	33	15	78,257	1	28	18	78,318
1963	7	1,236	12	1,367	2	1,530	21	4,133
1964	1	4	7	745	0	0	8	749
1965	2	1,289	1	1	0	0	3	1,290
1966	2	15	2	2,846	1	2,250	5	5,111
1967	2	9	5	4	3	1,564	10	1,577
1968	5	434	6	432	4	130	15	996
1969	0	0	2	1,415	7	3,155	9	4,570
1970	1	30	3	2,702	2	39	6	2,771
1971	1	300	15	2,164	19	11,361	35	13,825
1972	29	1,261	7	16,104	26	3,718	62	21,083
1973	17	1,009	11	3,008	50	13,607	78	16,624
1974	12	8,412	15	67,515	35	14,749	62	90,676
1975	27	9,724	12	7,698	36	11,497	75	28,919
1976	5	92	2	13,485	19	6,961	26	20,538
1977	6	373	4	9	9	6,078	19	6,460
1978	9	926	2	121	7	1,680	18	2,727
1979	13	2,236	3	19	19	5,975	35	8,230
Total	190	81,293	246	280,622	246	89,167	682	451,082
Percent of total	28	18	36	62	36	20		

Table 14. Population of Dade, Collier, and Monroe counties from 1900 to 1990 [Andriot, 1983; and Bureau of the Census, 1994].

Year	Dade	Monroe	Collier
1900	4955	18006	
1910	11933	21563	
1920	42753	19550	
1930	142955	13624	2883
1940	267739	14078	5102
1950	495084	29957	6488
1960	936047	47921	15753
1970	1267792	52586	37040
1980	1629701	63188	85971
1990	1937094	78024	152099

units: Unit 1, coastal prairie/mangrove swamp/estuarine marsh; Unit 2, Everglades prairie; and Unit 3, pineland. Of these three units, Unit 1 fires are closest to Florida Bay and the Ten Thousand Islands. Fires within the mangrove areas are mostly caused by lightning although some are human induced. Lightning fires in salt marshes can burn for several days, although the rate of spread is quite slow. These types of fires occur mostly during the wet season.

Fire records from freshwater wetlands in Everglades National Park (1948 - 1992) and Water Conservation Areas 2 and 3 (1980 - 1990) were analyzed by Gunderson and Snyder (1994) for temporal and spatial patterns. During the 45 yrs of record in Everglades National Park, 752 fires were registered, with sizes ranging up to ~75,000 ha. Over the 11 yrs of record in the Water Conservation Areas, 127 fires were registered, the largest of which was ~34,000 ha. Rank order pattern of fire sizes followed a log-normal distribution, with an anomalous clustering of fires ranging from 8000 to 15,000 ha. Fourier analyses of the two data sets revealed dominant cycles with frequencies of 7 months, 1 yr, and 10-14 yrs. The annual and monthly frequencies occur at the same scale as seasonal variation in both drying patterns (rainfall and surface moisture) and in nonhuman ignition sources. The factor influencing the longer cycles appeared to be climatic variation, although the causal mechanisms are unclear. Human-caused fires account for most fires and area burned, although more lightning fires have been recorded in recent years.

7. ANTHROPOGENIC CHANGES

7.1. Population changes

The population of the southeast United States has increased in recent decades and is projected to continue to do so at the highest rate of all regions in the Nation (Culliton *et al.*, 1990) further stressing the ecosystems within the Southeast. Eastern Florida counties are expected to grow at the fastest rate, and are projected to have the highest population density in the Southeast United States by 2010. Florida counties on the Gulf coast are also expected to increase in population, except for Monroe County, which is expected to have a low population density. The population in the three Florida counties surrounding Florida Bay from 1900 to the present is listed in Table 14 and shown graphically in Figure 12.

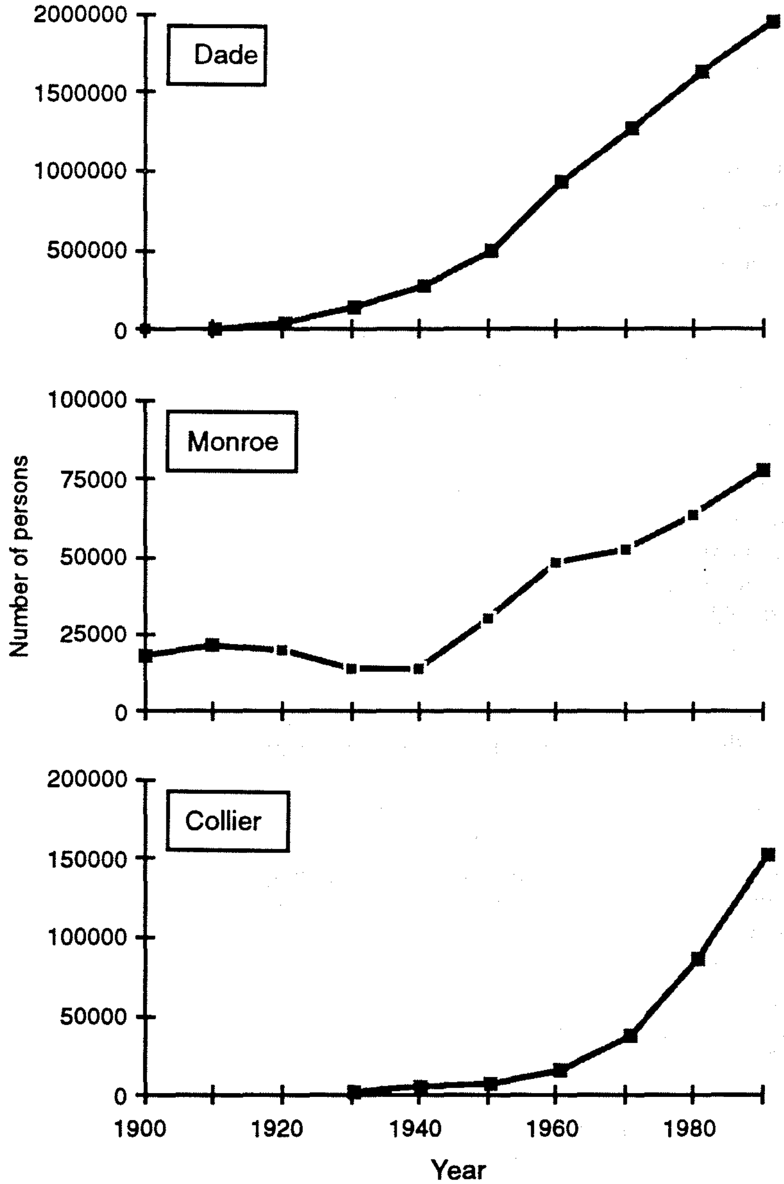

Figure 12. Numbers of persons in Dade, Collier, and Monroe counties from 1900 to 1990 [Andriot (1983), and Bureau of the Census (1994)].

7.2. Hydrology and canal construction

A description of the hydrology of the pre-drainage system of the Everglades and water management of the area can be found in Parker (1984), DeGrove (1984), and Light and Dineen (1994).

A detailed description of the hydrology of pre-drainage system of the Everglades can be found in Parker (1984) and is abstracted in this section. Descriptions of the Everglades, published as early as 1832, described the area southwest of Miami as sandy soil with large stone outcrops inundated by about two feet of water and very tall and dense sawgrass. During the latter part of the 19th century and the early part of the 20th, geologists and naturalists began scientific explorations of the Florida peninsula resulting in numerous published accounts documenting pre-drainage hydrologic conditions of the Everglades. In a paper on the topography of South Florida published in 1890, Shaler wrote that very large quantities of water were stored in the Everglades behind the Atlantic Coastal Ridge (current location of the city of Miami and adjacent municipalities). The Ridge was thickly penetrated with sink holes so that rain and fresh water appeared to flow via these underground channels to the sea where they emerged as fresh water springs. He further proposed a canal system to drain waters from the Everglades into Biscayne Bay. The naturalist Alexander Agassiz, in a note attached to the paper by Shaler, comments: "To the damming up of the waters in the Everglades and to the outbursts of gigantic masses of water charged with organic matter and lime, we may trace the immense destruction of fishes which so frequently occurs on the shores of the Florida Keys and the waters surrounding them."

Numerous early reports by land developers, promoters, their hired surveyors and engineers, and by early settlers preserve additional observed data. They all add up to the judgment that, in pre-drainage days, the Everglades were generally either wet or flooded most of the time but that occasionally a drought of two or more years' duration would occur and the glades would then become dried out. During such times the surficial soils in the higher parts of this almost perfectly flat land would become powdery dry and deeply cracked. Fires would then sweep the glades, creating deep, burned-out pockets in the organic soils floored with gray-to-black ash layers up to several inches thick. The drainage plan was part of a populist movement designed to attract settlers to South Florida (Light and Deneen, 1994), and as early as 1913, a system of drainage canals was proposed to drain "excess" water from Lake Okeechobee and the Florida Everglades (Florida Everglades Engineering Commission, 1913). These canals interrupted the flow of the Everglades, which is a very shallow, slow moving river, flowing from Lake Okeechobee south-southwest into Florida Bay. The slope of this drainage basin is only 2 in. per mile. Early efforts at water control included the Everglades Drainage District works, consisting of 440 mi (70.8 km) of canals and levees, and the Okeechobee Flood Control District, which constructed a federally subsidized dike around the southern rim of Lake Okeechobee. However, these efforts were a prelude to a massive federal project (Central and Southern Florida Project for Flood Control and Other Purposes) which was authorized after the massive flooding during 1948.

The Everglades Drainage District was established at that time, with boundaries running just north of Lake Okeechobee down to the Florida Straits excluding the coastal urban areas, the Kissimmee and St. Johns valleys and the western part of the Caloosahatchee valley (DeGrove, 1984). The basic drainage plan of this agency was to lower the level of Lake Okeechobee by outlet canals and to furnish additional drainage by a series of canals from the southern shores of the Lake southeasterly through the Everglades to connect with the short lower east coast rivers. Operations lasted until 1928 with the financial collapse of the Everglades Drainage District agency, and basic maintenance was neglected and system efficiency decreased. From 1931 to 1947, a comprehensive water control program was developed to replace the old drainage efforts. In 1949, a comprehensive plan was adopted by the Federal Government through the US Army Corps of Engineers.

Systematic, comprehensive studies of the area began after the 1940s. Studies of the soils indicated that they could only have accumulated in a perennially wet, marshy environment beginning about 5,500 yrs ago. The organic materials accumulated slowly to a depth of approximately 14 feet in the deeper and upper parts of the Everglades. The climate did not change significantly during the period of soil accumulation.

The reduction of the freshwater flow to the Everglades and consequently to Florida Bay has resulted in increased salinities in the Bay in more locations and for longer periods than during pre-drainage (McIvor *et al.*, 1994). The filling of passes and shallow banks between several of the Keys during construction of the Overseas Railroad reduced circulation in the Bay, worsening the high salinity conditions. Effects on the biota have been noted including reduced recruitment of pink shrimp, snook, and redfish; lowered reproductive success of ospreys and great white herons; and shifts in distribution of West Indian manatees, American crocodiles, and others.

Natural fluorescence of river water, caused by dissolved humic acids, has been used as a tracer of freshwater input to nearshore environments (Smith *et al.*, 1989). It has been shown that massive hermatypic corals such as *Solenastrea bournoni* possess fluorescent bands within their skeletons, and the frequency and intensity of the bands have a high correlation with terrestrial runoff. A core taken from the *S. bournoni* specimen from the Petersen Key Basin showed clear fluorescent banding under ultraviolet light. The relationship between flow in the Shark River and Taylor Sloughs and the fluorescent banding from 1940 to the present were used to hindcast flow for the period of 1881 - 1939. From the fluorescence pattern, a sustained, marked decline in freshwater flow, which began in 1912 and ended around 1931, was noted. Fluorescence was significantly higher earlier in the record (prior to 1932) than later on, and Smith *et al.* (1989) interpreted this as indicating decreased freshwater flow from the Everglades into Florida Bay of perhaps as much as 59% in the later period. This onset of decreased freshwater flow coincided with the construction of drainage canals to the east and south of Lake Okeechobee. Periods of reduced growth observed in growth patterns of a 1-m-high specimen of the coral *S. bournoni* from the Petersen Key Basin, Florida Bay, appeared to correlate with major anthropogenic environmental perturbations (Hudson *et al.*, 1989). This coral species is resistant to sedimentation and water temperature extremes, and no correlation was apparent between growth rates and major meteorological events such as hurricanes and freezes.

7.3. Soil subsidence

A review of subsidence of organic soils in the Everglades can be found in Stephens (1984) and is abstracted in this section. The Everglades contains the largest single tract of organic soils in the world, over 3,100 square miles. These soils formed under marshy conditions and subsided when drained. The subsidence was caused by compaction due to: dissecation, consolidation, and tillage; biochemical oxidation; wind erosion; and/or burning. Biochemical oxidation accounted for approximately two thirds of the total loss of arable soils in the region. Subsidence has had serious environmental effects on agriculture, water supplies and wildlife. The sequence of observed subsidence of organic soils at three sites in the Everglades is shown in Figure 13. The sites are the North River Canal, just below old South Bay Lock; the Bolles Canal, a major drain at Okeelanta; and the Everglades Experiment Station. Ground surface elevation has decreased by approximately 9 ft at all three sites. Soil losses have been greatest near the original drainage canals and "subsidence valleys" several miles wide were formed along either side. Valley depths were greatest where drainage was best.

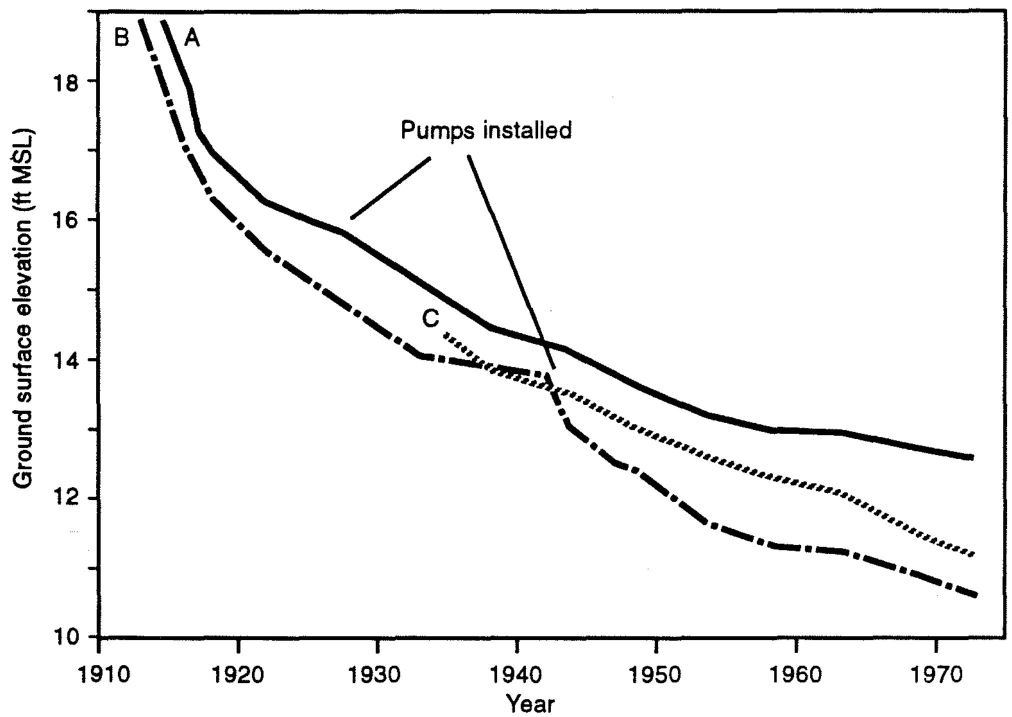

Figure 13. Sequence of observed subsidence of organic soils in the Florida Everglades after initial drainage circa 1912. [Redrawn from Stephens (1984).]

7.4. Railroad and Overseas Highway

As early as 1831, Key West was one of the first cities in Florida to express an interest in railroads (Albury, 1991; Corliss, 1969). By the turn of the century, Henry Flagler had built a railroad, the Florida East Coast Railway, from Jacksonville, close to the Florida - Georgia border, to Miami. To promote use of the railroad and trade with Cuba and countries in South America, Flagler knew that access to a deep water port was necessary, and the deepest water port south of Norfolk, VA, was Key West. Construction of the Panama Canal was another incentive since this would place the Florida East Coast Railway within 1000 st. miles of the Canal. One of the surveyed routes was through the Everglades to Cape Sable and across Florida Bay via a bridge.* The chosen route, however, was that of the existing Overseas Highway through Homestead to Key Largo and down the Florida Keys. Construction began in 1905 and completed in 1912. It was the first major alteration by man of the Florida Keys and Florida Bay. Construction of the railroad resulted in the destruction of forests and peats, in part as the result of a fire ignited by sparks from the locomotives (Simpson, 1920). During construction, three major hurricanes passed over the Florida Keys resulting in deaths and heavy damage to the work and equipment. The railroad was destroyed by the Labor Day hurricane of 1935 and was not rebuilt.

The highway which connects the Keys to the mainland was begun in 1928 (Windhorn and Langley, 1974). At that time, a combination of bridges and ferries was used to span the channels between the Keys. Rather than repair the railroad after the hurricane, it was converted into the Overseas Highway, an extension of US Highway 1. Construction began in 1936 and the highway opened in 1938. During the construction of the highway, dredge and fill

* An excellent account of the surveying activities can be found in Krome (1979).

operations changed the shorelines of the Keys. The remnants of the railroad were completely destroyed during a hurricane in 1953 and the remains of the track were used for the Overseas Highway. The highway was completed in the 1950s, although alterations such as the replacement structure for the 7-Mile Bridge and maintenance activities continue into the 1990s.

7.5. Homestead Air Force Base

[The information in this section was supplied by the Public Affairs Office of Homestead Air Force Base (AFB). The history of the base is an indicator of level of activity, air traffic and personnel associated with base operations.]

During the 1940s, Pan American Ferries, Inc. constructed a landing strip in rural Dade County that was turned over to the US Government before the beginning of World War II. Shortly after the attack on Pearl Harbor, Army Air Corps officials decided the site would better serve defense needs as a maintenance stopover point for aircraft being ferried to the Caribbean and North Africa. Soon after, construction of a fully operational military base, the Homestead Army Air Field (AAF), began at the site. By 1943, the base assumed a more vital role with the activation of the 2nd Operational Training Unit that provided advance training for air crews. As the need for trained transport pilots grew, the entire base was transferred to Air Transport Command's (ATC) Ferrying Division, with the sole mission of preparing C-54 air crews to fly from Burma to China. In September 1945, a massive hurricane passed through the area, with winds of up to 145 mph. Because of destruction caused by the storm, the base was shut down in December of that year.

In the early 1950's, as the Korean conflict was winding down, defense officials once again looked toward Homestead as a key site in continental defense. In mid-1954, an advance party arrived at the old base to begin clean up, and on February 1955, the installation was reactivated as Homestead AFB. The base quickly became home for the 823rd Air Division, an umbrella organization encompassing the 379th and the 19th Bomber Wings. By this time, Homestead AFB represented the largest four-engine transport training operation in the entire ATC. In 1962, the 31st Tactical Fighter Wing (TFW), a tactical air fighter unit, was moved from George AFB, CA, to Homestead in response to the growing Communist threat from Cuba. In October of that year, it was discovered that the Soviet Union was placing medium-range missiles on the island. Troops and aircraft were sent to Homestead, swelling its population to the tens of thousands. Though still nominally a Strategic Air Command base, Homestead then had the dual mission to stand ready to project air power around the world, and to maintain an operationally ready tactical air force. With the presence of the 31st TFW made permanent, the role of the Tactical Air Command (TAC) at Homestead AFB increased rapidly throughout the 1960s. In late 1966, the 31st TFW was deployed to Vietnam, and the 4531st TFW was activated to maintain TAC's presence at Homestead. In 1968, TAC officially took control of the base. In 1970, the 31st TFW returned from Vietnam and became the host unit. In 1981, the 31st TFW became the 31st Tactical Training Wing and took the task of training F-4 air crews. Training remained the base primary mission until 1985, when the first F-16 arrived. With that event, the host unit again reclaimed the designation of the 31st TFW.

Hurricane Andrew struck Homestead AFB and the surrounding area in 1992, causing severe damage to the facility. At that time, the base was home to the 31st and the 482nd Fighter Wings, both units flew F-16s. Other units in the base were the 301st Rescue Squadron, Air Force Reserve; the Det 1, 125th Fighter Interceptor Group, Florida Air National Guard; and the US Customs Miami Air Branch. The storm caused extensive damage to the facilities of the base. These units were relocated to various other locations during the salvage and recovery phase although the 301st Rescue Squadron along with the Coast Guard provided the only emergency medical rescue capability in south Dade County after the hurricane. In 1993, the Base

Realignment and Closure Commission recommended the conversion of the base to a military/civilian joint use airfield. The Commission recommended that the host unit, the 31st Fighter Wing, be activated and that the 482nd Fighter Wing, the 301st Rescue Squadron, and the 125th Fighter Interceptor Group be returned to the base. The US Customs unit is scheduled to return. Other units have been transferred elsewhere. Approximately one third of the base will remain a military installation, the Homestead Air Reserve Station, and the rest will eventually be transferred to Dade County.

7.6. Everglades Jetport

[Information in this section is from the Wilderness Society (1969), Derr (1989), and National Academy of Science (1970).]

During the late 1960s, Dade County purchased 30 square miles of land in the Everglades for construction a small airport at the site. This airport, originally called the Dade-Collier Training and Transition Airport (later known as the Everglades Jetport), was to serve for training operations to relieve the overburdened Miami International Airport. The Jetport site is 6 mi north of the Everglades National Park's 40-Mile Bend Ranger Station and the Miccosukee Reservation, and its eastern boundary is nearly common with the west boundary of Conservation Area 3A. The site is approximately midway between the two coasts. Construction of the 39-square mile facility started in 1968 and runways and maintenance buildings were constructed. Each training landing strip destroyed approximately 400 acres of habitat. An access corridor to the airport was planned, including one which would have passed through Water Conservation Area 3. A coalition of environmentalists, Native Americans, water managers and politicians led the nationwide examination of environmental impacts and potential adverse effects to the Everglades and adjacent areas. Noise, water flow disruption, pollution from airport operations, and many other factors were considered. "The Everglades Jetport Pact", executed in 1970, resulted in the transfer of the Jetport property to the US Department of the Interior in exchange for acquisition of a site with a reasonable possibility for ultimate potential development and the immediate construction of comparable training facilities. As potential alternative to the Jetport site, locations in Florida Bay, Key Largo, Biscayne Bay and Soldier Key were considered. All these sites required major construction in shallow water. The Jetport site became part of the Big Cypress National Reserve. No further construction activities have taken place but the site has not been restored.

7.7. Turkey Point Nuclear Power Plant

The Florida Power and Light Turkey Point Nuclear Power Plant is located in Homestead and covers 22,295 acres (Florida Power and Light, 1994). The facility is a combination of two fossil fuel and two nuclear units, and it is linked to the statewide electrical power transmission system. The fossil fuel units began operation in 1967 and 1968, and the nuclear units in 1972 and 1973. The fossil fuel storage units hold 554,000 barrels of low sulfur oil. The fossil fuel units consume 20,000 barrels of oil and 4,000 barrels of natural gas daily. Approximately 300 tons of uranium are required to produce a year's supply of fuel for both nuclear units.

7.8. Agricultural activities

Agricultural activities in and around the Everglades, south of Lake Okeechobee, began after the drainage projects of 1906 - 1927, and intensified after the water control projects of the early 1950s, which created the Everglades Agricultural Area (Snyder and Davidson, 1994). Currently, more than $750 million is earned annually from production of sugarcane, vegetables, sod, and rice and over 20,000 full-time equivalent jobs are provided by the agricultural industry of South Florida. The future of this industry is uncertain since the loss of organic soils, concerns over nutrients and pesticides drainage, and possible flooding of lands as part of the South Florida Ecosystem Restoration Project may result in a reduction of agricultural activities.

8. LEGISLATION

8.1. Federal legislation

[The information in this section is condensed from NOAA (1981), Hildreth and Johnson (1983), McClain (1991), and Wolf (1988).]

8.1.1. Federal Clean Water Act

The Federal Clean Water Act (FWPCA) (33 U. S. C. §§ 1251 et. seq.) was originally enacted in 1972 to restore and maintain the chemical, physical and biological integrity of the nation's waters. This Act was amended with major provisions in 1977, 1981 and 1987. The three objectives of the Act were to: eliminate the discharge of pollutants into navigable waters by 1985; to attain, whenever possible, water quality that allows for fishing and recreational use by 1983; and to prohibit the discharge of toxic pollutants in toxic amounts. The FWPCA also established a national policy for providing financial assistance to construct publicly owned waste water treatment plants. EPA was given the principal responsibility for administering the FWPCA. The National Pollutant Discharge Elimination System (NPDES) is part of the FWPCA. The FWPCA prohibits discharges into navigable waters unless authorized by an NPDES permit.

8.1.2. Clean Air Act

The Clean Air Act (CAA) (42 U. S. C. §§ 7401 et. seq.) was enacted in 1970 and extended and substantially amended in 1977. The purpose of this act is to protect and enhance the quality of the nation's air resources in order to promote public health and welfare and the productive capacity of the population. The CAA provides for two principal ways of controlling air pollution: national ambient air standards, and point source emission limitations. EPA is required to publish a list of air pollutants which is used to set the ambient air standards.

8.1.3. Toxic Substances Control Act

The Toxic Substances Control Act (TSCA) (15 U. S. C. §§ 2601 et. seq.) was first enacted in 1976 and its primary purpose is to regulate the chemical substances that present a hazard to human health or to the environment. This act greatly expanded regulation of chemicals. It is intended to control chemical hazards at the source. TSCA applies not only to pure chemical substances but also to the impurities contained in these materials.

8.1.4. Federal Insecticide, Fungicide and Rodenticide Act

The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) (7 U. S. C. §§ 136 et. seq.) was originally enacted in 1947 and was amended significantly in 1972 and 1978. When first enacted, FIFRA was primarily a pesticide labeling law. The 1972 legislation required registration of all pesticides, constituting a premarket clearance for these substances. In order to approve registration of a pesticide, EPA must insure that the substance will not affect the environment or the population. EPA must also determine that the benefits of using the pesticide outweigh the risks associated with its use.

8.1.5. Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act (RCRA) (42 U. S. C. §§ 6901 et. seq.), also known as the Solid Waste Disposal Act, was enacted in 1976 and substantially changed the federal regulations for solid waste disposal and control of hazardous waste.

8.1.6. Comprehensive Environmental Response, Compensation, and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 U. S. C. §§ 9601 et. seq.), unofficially known as the Superfund Act, was enacted in 1980 and it established a federally-directed program to clean up the nation's most hazardous waste and chemical contamination sites. CERCLA enabled the federal government to respond to actual or threatened releases of hazardous substances and to recover damages for the destruction or harm to natural resources. The original Superfund legislation was disappointing because EPA, which was responsible for the administration of the Act, was only able to begin clean up of a few sites of the thousands identified nationwide. The Superfund Amendments and Reauthorization Act of 1986 amended CERCLA and expanded and toughened the cleanup authority of the federal government.

8.1.7. Emergency Planning and Community Right-to-Know Act

The Emergency Planning and Community Right-to-Know Act (42 U. S. C. §§ 11001 et. seq.) was part of CERCLA and established emergency planning, reporting and notification requirements that were meant to protect the public in the event of a release of hazardous substances.

8.1.8. The Endangered Species Act

The Endangered Species Act (ESA) (16 US §§ 1531 - 1543) was approved in 1973 and last amended by PL 100-707 in 1988. The purpose of this Act is to provide a program for the conservation of threatened and endangered species of plants and animals, and the habitats in which they are found. The Act provides the legislative authority to implement the treaties and conventions on endangered species to which the US is signatory. The endangered and threatened species found in Florida Bay are listed in Table 2.

8.1.9. National Marine Protection, Research, and Sanctuaries Act

The National Marine Protection, Research, and Sanctuaries Act was approved in 1972 and last amended in 1988 (Marine Sanctuaries §§ 1431 - 1445). The purposes and policies of this chapter of the Act are to identify marine areas of special significance, provide for their management, support research, enhance public awareness, and to promote all public and private uses of the marine environment to the extent that these issues are compatible with resource protection. The Florida Keys National Marine Sanctuary was established in 1990 under this Act and implemented in 1994.

8.1.10. Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) was approved in 1972 and last amended in 1992 (16 US §§ 1361 - 1384; §§ 1401 - 1407). The purpose of this Act is to protect, conserve, and encourage international research on marine mammals.

8.1.11. Federal Coastal Zone Management Act

Congress passed the Federal Coastal Zone Management Act in 1972 to further a national interest in the effective management, beneficial use, protection, and development of the coastal zone.

8.1.12. Magnuson Fishery Conservation and Management Act

The Magnuson Fishery Conservation and Management Act authorizes the Federal government to conserve and manage all fishery resources, except tuna, within the US fishery conservation zone which extends from the seaward boundary of the territorial sea to 200 n mi from shore. The Act also provides for exclusive management authority over Continental Shelf fishery resources and over anadromous species beyond the US fishery conservation zone.

8.1.13. Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act (FWCA) was enacted in 1934 and subsequently broadened and modified by amendments in 1946, 1958, and 1965. Sections of this Act deal specifically with wildlife resources in relation to Federal water resource development actions. FWCA recognizes the importance of wildlife resources and mandates that wildlife conservation shall receive equal consideration and treatment as other features of water resources development.

8.2. State legislation

8.2.1. Bahia Honda State Park

The Bahia Honda State Park, established in 1968, is Florida's southernmost state park and comprises 635 acres of uplands and submerged lands (Florida, 1990). The northern boundary of the Park is in Florida Bay. Bahia Honda was part of the land holdings of the Florida East Coast Railroad until the company abandoned the line after the 1935 hurricane. The original train trestle can still be seen as part of the old Bahia Honda Bridge. The majority of the Park land was donated by Monroe County from 1961 to 1970, and the most recent parcel was purchased using Save Our Coast funds in 1983 and 1984. The Park has several biological communities including beach dune, coastal berm, mangrove forest, tropical hardwood hammock and submerged marine habitats.

8.2.2. Lignumvitae Key State Botanical Park

Lignumvitae Key State Park is a 280-acre island that was acquired by William Matheson in 1919. The island supports many trees native to tropical forests. Lignumvitae Key is within Florida Bay.

9. ENVIRONMENTAL PROGRAMS AND STUDIES

A significant number of federal, state, municipal, academic and private organizations are currently involved in the South Florida Restoration Project which includes Florida Bay. A good indicator of current research efforts is the list of permits issued by the Everglades National Park for work in Florida Bay waters under the jurisdiction of the Park. These are listed in Table 15. Brief descriptions of previous and current research interests by these organizations are listed in this section. The information was compiled from various sources including the Interagency Spatial Data Workshop report (Anonymous, 1994). These descriptions should not be considered comprehensive.

Table 15. Permits issued by Everglades National Park for work in Florida Bay, 1989 - 1995 [Everglades National Park, personal communication, 1995].

1989 - 1993 permits

900048	Arnold, W. S.	Florida Marine Research Institute	Morphological and genetic relationships among species groups of the genus *Argopecten* (Mollusca: Pectinidae)
890024	Bishof, D./Rios, G.	Florida Dept. of Environmental Regulation	Aerojet Canal (C-111) monitoring Study to assess current conditions and continuing trends in the water quality of Barnes Sound and Manatee Bay area
900020	Bullock, L.	Florida Marine Research Institute	Life history data on jewfish, *Epinephelus itajara*
930045, 920005, 910006, 900006, 890015	Carlson, P.	Florida Marine Research Institute	Seagrass dieoff related studies
930060	Cohen, A.	University of South Carolina	Paleoecological and compositional investigations of the peat deposits of Southern Florida
920042	Cohen, A.	University of South Carolina	Effects of Hurricane Andrew on surficial peat accumulation in southeastern Florida. Implications relative to GCC and paleological history of region
930058	Colvocoresses, J./McMichael, R.	Florida Dept. of Environmental Protection	Florida marine fisheries-independent monitoring program In Florida Bay
920032	Crabtree, R.	Florida Marine Research Institute	Research on the life history of bonefish *Albula vulpes* in south Florida
920001, 910002, 900002, 890006	Crabtree, R.	Florida Marine Research Institute	Research on abundance, distribution, and life history of tarpon and bonefish in Florida
890038	Davis, W. P.	EPA	Distribution of the killifish mangrove rivulus (*Rivulus marmoratus*)
930027, 920004, 910005, 900005, 890014	Durako, M.	Florida Marine Research Institute	Seagrass dieoff study
890035	Enos, P.	University of Kansas	Porosity in carbonate sediments in Florida and the Bahamas
920041	Frewin, N.	University of London	The effects of Hurricane Andrew on the distribution of organic matter in the lagoonal swamp-marginal areas
910021	Frewin, N.	University of London	Source rock potential of shelf carbonates
910017	Ginsburg, R.	University of Miami	Mapping of the distribution of the mineral dolomite
930015	Glenister, B.	University of Iowa	Collected unconsolidated surface samples from Florida Bay. Macroscopic biota for education purposes
930059	Graves, G./Strom, D.	Florida Dept. of Environmental Protection	Mercury in estuarine fish. Water quality study
920036	Graves, G./Strom, D.	Florida Dept. of Environmental Protection	Identify and document the existing condition of the surface waters of the State. Document potential problem areas and establish ecoregion reference sites for comparison purposes
920039	Graves, G.	Florida Dept. of Environmental Protection	Analysis of tissue mercury concentrations (estaurine fish)
930028a, 920038	Hanisak, D./Miller, S.	Harbor Branch and UNC National underseas Rsearch Center	Nearshore seawater and macroalgal dynamics in the Florida Keys
930033, 920026, 910034, 900039, 890026	Herrnkind, W.	Florida State University	Ecology and recruitment of spiny lobsters in Florida Bay

Table 15. Permits issued by Everglades National Park for work in Florida Bay, 1989 - 1995 [Everglades National Park, personal communication, 1995]. (cont.)

1989 - 1993 permits

890028	Hesselman, D.	Florida Dept. of Natural Resources	Sampling and classification of shellfish harvesting waters
910032, 890020	Holmquist, J.	Florida State University	Faunal utilization of a mobile habitat in a marine benthic community in Florida Bay
930032	Hopkins, T.	University of Miami	Determine the seasonal cycle of oreogenic enzymes and to see if habitat affects ureogenic abilities and stress levels in Gulf toadfish (*Opsanus beta*)
900034	Hoss, D.	NOAA/NMFS	Response of fish and shellfish to changes in composition and heterogeneity of habitats in western Florida Bay resulting from the dieoff of seagrasses
920006, 910007, 900007, 890016	Jones, R.	Florida International University	Microbiological and water quality parameters associated with seagrass dieoff
900028	Lapointe, B.	Florida Keys Land and Sea Trust	Hydrologic and nutrient coupling between the Everglades and Florida Bay: the role of submarine groundwater discharge
890030	Lapointe, B.	Florida Keys Land and Sea Trust	Trophic baseline study
890007	Ley, J.	University of Florida	Use of edge habitat by fishes in northeast Florida Bay in the region south of C-111 canal
930038, 920037	Lindquist, N./Hay, M.	University of North Carolina - NOAA/NURP	The role of secondary metabolites in reducing invertebrate egg and larval mortality from predation and uv exposure
900035	Lipcius, R.	William and Mary	Test hypothesis that shelter availability limits spiny lobster abundance in habitats with expansive seagrass beds but little matural shelter
920013	Marelli, D./Arnold, W.	Florida Marine Research Institute	Investigate morphological and genetic relationships among putative subspecies of the genus *Argopecten*
930054	Markley, S./Hefty, L.	METRO Dade Environmental Resources Management	C-111/Taylor Slough water quality and biological monitoring
920030, 910036, 900040, 890030	Mazzotti, F.	University of Florida	Crocodile nest monitoring
920023	McKee, K.	Louisiana State University	Interactions among nutrients, chemical, and structural defense, and herbivory in mangroves of South Florida
930003, 920001A	McMillen-Jackson, A.	Florida Marine Research Institute	Genetic stock identification of Florida gamefish species: spotted seatrout
930055	Mealey, B.	Miami Museum of Science	Bald eagle DNA polymorphism in Florida Bay, Everglades National Park and tissue analysis of debilitated wading birds in Florida Bay for mercury concentrations
930007	Mealey, B.	Miami Museum of Science	Blood serum chemistry analysis of free ranging osprey nestlings in Florida Bay
900023	Oleinik, A.	University of Miami	Geologic record of mollusks in Florida Bay
920002, 910003, 900003, 890012	Porter, D.	University of Georgia	Seagrass dieoff in Florida Bay
890037	Powell, G.	National Audubon Society	Quantitative analysis of small fish and invertebrates in the mangrove zones of Everglades National Park
920033	Reese, C.	Florida International University	Satellite remote sensing of seagrass abundance and algal blooms

Table 15. Permits issued by Everglades National Park for work in Florida Bay, 1989 - 1995 [Everglades National Park, personal communication, 1995]. (con.)

1989 - 1993 permits

930041	Richardson, L./Buisson, D.	Florida International University	Satellite remote sensing of seagrass abundance and algal blooms
890032	Roberts, D.	Florida Marine Research Institute	Genetic study of marine fish - red drum
900027	Schropp, S.	Florida Dept. of Environmental Regulation	Coastal pollution assessment program
930044, 920035, 910031	Sheridan, P.	NOAA/NMFS	Define the macrofaunal and benthic community structure and function in healthy *Thalassia testudinum* habitats in Everglades National Park and compare dieoff areas.
930046	Shinn, E.	USGS	Eight (25-ft) cores drilled in Florida Bay to monitor water quality
910033	Snedaker, S.	University of Miami	Determining concentrations of registered and unregistered pesticides, polycyclic aromatic hydrocarbons, and aliphatic hydrocarbons in marine sessile feeders
920045-47, 920017-19, 910012-14, 900029-31	Sprunt, A.	National Audubon Society	Florida Bay cooperative agreement
930026, 920029, 910040	Stevely, J.	University of Florida	Survey of sponge community biomass in the Florida Keys
930022	Swart, P.	University of Miami	Analysis of climate records in coral skeleton
910044	Swart, P./Kramer, P.	University of Miami	The hydrology and geochemistry of Holocene mud islands in Florida Bay: implications for reflux and carbonate diagenesis
930023, 910035	Walter, L.	University of Michigan	Chemical and isotopic exchange among carbonate minerals, organic matter and seawater on modern carbonate platforms, Florida and Bahamas
920027	Webb, R.	University of Florida	Preliminary characterization of the branch and stem gall/canker disease etiology of red mangrove
920003, 910004, 900004, 890013	Zieman, J.	University of Virginia	Seagrass dieoff related study

1994 permits

940022	Bancroft, T. G.	Audubon Society	Small fish, invertebrates, algae, etc.
940023	Bancroft, T. G.	Audubon Society	Census of birds. Salvage dead birds.
940052	Barr, B.	University of Miami	Alligators stomach contents
940004	Bayless, J.	University of Wisconsin	Plants
940061	Bourrouilh, R.	University of Bordeaux (France)	Sediment cores and water samples
940060	Browder, J.	NOAA/NMFS	Pink Shrimp in WWB
940036	Buhnack, J.	NOAA	Fish for identification
940036	Buhnack, J.	NOAA	Fish for identification
940064	Craig, I.	Florida Dept. of Agriculture	Slash pine cones and invertebrate pests, assess hurricane insect infestation
940063	Decker, F.	The Nature Conservancy	Benthic seagrass. Determine health of seagrass beds.

Table 15. Permits issued by Everglades National Park for work in Florida Bay, 1989 - 1995 [Everglades National Park, personal communication, 1995]. (cont.)

1994 permits

940067	Durako, M.	Florida Marine Research Institute	Seagrass die-off monitoring and fisheries habitat assessment.
940002	Fay, R.	Texas A & M University	Oysters and sediment
940017	Federick, P. C.	University of Florida	Bird observation
940001	Gaines, M. S.	University of Miami	Sympatric rodents
940058	Gardner, W.	NOAA/GLERL	Nutrient and biotic
940027	Goldman, D. H.	University of Texas	Plants (orchids)
940051	Gottlieb, R.	University of Florida	Plant artist
940031	GYC, Inc.	Surveyors	Land surveying areas of Long Sound, etc.
940007	Halley, R. B.	USGS	Survey, no collection
940038	Halley, R. B.	USGS	Sediment cores and surface samples
940038	Halley, R. B.	USGS	Sediment cores and surface samples
940066	Hansen, M.	USGS	Placement of global positioning system on Lower Arsnicker Key.
940028	Henry,V.	Georgia Southern University	Lake Ingraham core
940033	Herrnkind, W.	Florida State University	Spiny lobster released
940055	Hitchock, G. L.	University of Miami	Seawater for nutrients
940035	Holtmeier, C. L.	Cornell University	Fish
940035	Holtmeier, C. L.	Cornell University	Fish
940013	Howard, F. W.	University of Florida	Mahogany seeds
940025	Hunt, J./Matheson, R.	Florida Marine Research Institute	Fish, crustaceans
940026	Hunt, J./Steidinger, K.	Florida Marine Research Institute	Water samples
940040	Hunt/Lyons, W.	Florida Marine Research Institute	Mollusks
940040	Hunt/Lyons, W.	Florida Marine Research Institute	Mollusks
940032	Klein, J. C.	NOAA/NOS	Review bathymetry aircraft
940005	Koptur, C. C.	University of Miami	Seeds of *Ardisia*
940015	Krysko, K.	Florida International University	Florida king snake and reptile road kills
940016	Lange, T.	Florida Game and Fresh Water Comm.	Fish
940009	Lavoie, D.	Naval Research Laboratory	Gravity piston cores
940046	Macauley, J.	EPA	Fish and benthic grabs
940046	Macauley, J.	EPA	Fish and benthic grabs
940030	Maguire, J.	METRO Dade Environmental Resources Management	Needles and buds of slash pines
940057	Mazzotti, F.	University of Florida	Nesting efforts of American crocodile
940003	Meshaka, W.	Florida International University	Reptiles, amphibians
940019	Miller, S.	University of North Carolina	Seaweeds
940010	Morrison, D.	US Fish and Wildlife Service	Racoon
940065	Morrison, D.	US Fish and Wildlife Service	Fish, water in treated effluent at Flamingo and sites in Shark River Slough

Table 15. Permits issued by Everglades National Park for work in Florida Bay, 1989 - 1995 [Everglades National Park, personal communication, 1995]. (cont.)

1994 permits

940012	O'Meara,G. F.	University of Florida	Exotic mosquitoes
940048	Pascarella, J. B.	University of Miami	Fruits, seeds
940048	Pascarella, J. B.	University of Miami	Fruits, seeds
940037	Peck, S.	Carelton University (Canada)	Insects
940037	Peck, S.	Carlton University (Canada)	Insects
940014	Philips, E. J.	University of Florida	Water and phytoplankton
940029	Pimm, S./Curnutt, J.	University of Tennessee	Seaside sparrow banding
940047	Quackenbush, L. S.	Florida International University	Crustaceans
940047	Quackenbush, L. S.	Florida International University	Crustaceans
940041	Rademacher, K.	NOAA	Reef fish
940041	Rademacher, K.	NOAA	Reef fish
940024	Rainboth, W.	University of Wisconsin	Plants, insects, fish
940034	Robblee, M./Anderson, G.	NBS	Monitoring stations
940018	Schaffer, B.	University of Florida	Pond apple fruit and seeds
940062	Scheidt, D.	EPA	Water, sediment, soil for mercury content.
940053	Sheridan, P./Thayer, G.	NOAA	Fish, seagrass, sediment
940020	Smith, S,	Everglades National Park	Road kills for skin preparation
940008	Smith, T.	EPA	Mangrove wood, leaves, crabs, etc.
940011	Sternberg, L.	University of Miami	Sawgrass
940059	Sturdy, L.	Cooper City High School	Soil, compare wetlands
940039	Sullivan, K.	University of Miami/RSMAS	Sponge, crustaceans
940039	Sullivan, K.	University of Miami	Sponge, crustaceans
940044	Swart, P./ Lutz, M.	University of Miami	Plant, water, sediment
940043	Swart, P./Healy, G.	University of Miami	Core from coral
940043	Swart, P./Healy, G.	University of Miami	Core from coral
940045	Swart, P./Keder/Kramer/ Lutz	University of Miami	Small corals
940049	Swart, P./Kramer, P.	University of Miami	Mud cores
940049	Swart, P./Kramer, P.	University of Miami	Mud cores
940044	Swart, P./Lutz, M.	University of Miami	Plant, water, sediment
940045	Swart/Keder/Kramer/Lutz	University of Miami	Small corals
940021	Taylor, H. L.	Private research	Rotifer fauna
940050	Twilley, R.	University of Southwestern Louisiana	Mangrove litter - WWB
940050	Twilley, R.	University of Southwestern Louisiana	Mangrove litter - WWB
940054	Wang, J.	University of Miami	Salinity, temperature, chlorophyll
940042	Wilson, S.	Central Missouri State University	Plant hoppers

Table 15. Permits issued by Everglades National Park for work in Florida Bay, 1989 - 1995 [Everglades National Park, personal communication, 1995]. (cont.)

1994 permits			
940042	Wilson, S.	Central Missouri State University	Plant hoppers
940068	NA	Florida Dept. of Environmental Protection	Surveying benchmarks along main park road.
1995 permits			
NA	Browder, J.	NOAA/NMFS	An integrated study of pink shrimp as indicators of habitat health in Florida Bay
NA	Cantillo, A.	NOAA/NOS	Natural and anthropogenic events impacting Florida Bay: 1910 - 1993 timeline
NA	Canton, J.	Florida State University	Significance of submarine groundwater discharge on seagrass distribution, biomass and produtivity
NA	Carlson, P.	Florida Marine Research Institute	Mangrove mortality and die-back in Florida Bay
NA	Cohen, A.	University of South Carolina	Paleoecological and compositional investigations of the peat deposits of southern Florida
NA	Colvocoresses, J.	Florida Marine Research Institute	Florida marine fisheries - independent monitoring program
NA	Cross, F.	NOAA/NMFS	Habitat inventory and change in aquatic beds in Florida Bay
NA	Decker, F.	The Nature Conservancy	Health and location of seagrass beds in Florida Bay
NA	Decker, F.	The Nature Conservancy	Florida Bay Watch environmental monitoring program
NA	Doyle, L.	University of South Florida	Sedimentology of Florida Bay (joint project with Bourrouilh, University of Bordeaux, France)
NA	Durako, M.	Florida Marine Research Institute	Status and trends of vegetative fisheries habitats in Florida Bay
NA	Fay, R.	Texas A&M University	NOAA's Mussel Watch Program using oysters (*Crassostrea virginica*) in Florida Bay
NA	Fitterman, D.	USGS	Geophysical mapping and monitoring of saltwater intrusion, water quality, and fresh water discharge to Florida Bay
NA	Fourqurean, J.	Florida International University	Development of a hydrologic mass-balance model of Florida Bay
NA	Fourqurean, J.	Florida International University	Revisiting seagrass long-term monitoring stations around Cross Bank
NA	Galperin, B.	University of South Florida	The design of a modeling strategy for Florida Bay
NA	Gardner, W.	NOAA/GLERL	Nutrient dynamics and limitations in the water and sediments of Florida Bay
NA	Halley, R.	USGS	Coring and analyses of Florida Bay sediments
NA	Halley, R.	USGS	Sedimentation, sea-level rise, and circulation in Florida Bay
NA	Hansen, M.	USGS	Sea-floor sedimentation in Florida Bay
NA	Hefty, L.	METRO Dade Environmental Resources Management	C-111 and Taylor Slough water quality and biological monitoring program

Table 15. Permits issued by Everglades National Park for work in Florida Bay, 1989 - 1995 [Everglades National Park, personal communication, 1995]. (cont.)

1995 permits

NA	Herrnkind, W.	Florida State University	The future of Florida spiny lobster: developing a predictive model and putting aritifical shelters to the acid test
NA	Herrnkind, W.	Florida State University	Estimation of juvenile spiny lobster recruitment in Florida Bay
NA	Hitchcock, G.	University of Miami	Conducting surface drifter observations to determine circulation and nutrient distribution in the coastal waters adjacent to Everglades National Park
NA	Jones, R.	Florida International University	Florida Bay water quality monitoring
NA	Kramer, P.	University of Miami	The hydrology and geochemistry of Holocene mud-islands in Florida Bay: implications for reflux and carbonate diagenesis
NA	Ley, J.	South Florida Water Management District	Prerestoration assessment of selected faunal components of the Florida Bay biota
NA	Lyons, W.	Florida Marine Research Institute	Benthic daunal communities in Florida Bay
NA	Macauley, J.	EPA	EPA EMAP: collection of sediment, fish, infaunal organisms and water for assessing contaminants in Florida Bay
NA	Matheson, R.	Florida Marine Research Institute	Prerestoration assessment of selected faunal communities in Florida Bay: predicting changes under differing water management regimes
NA	Maul, G.	Florida Institute of Technology	Regional research model of the Intra-Americas Seas for Florida Bay boundary conditions
NA	Mazzotti, F.	University of Florida	A monitoring program for the American crocodile in northeastern Florida Bay, ENP
NA	Nelsen, T.	NOAA/AOML	Restrospective analysis of the southern Everglades and the northern Florida Bay sediment record as an indicator of natural and anthropogenic influences and changes
NA	Ortner, P.	NOAA/AOML	Zooplankton abundance and grazing potential in Florida Bay
NA	Patino, E.	USGS	Fresh surface water discharge to the east coast
NA	Patino, E.	USGS	Freshwater discharge to Florida Bay
NA	Philips, E.	University of Florida	Blue-green algal blooms in Florida Bay: controlling factors and consequences for food webs
NA	Robblee, M.	NBS	Temporal and spatial variation in seagrass associated fish and inverterbates in western Florida Bay: a comparison with and without seagrass die-off in Johnson Key Basin
NA	Schmidt, T.	Everglades National Park	ENP creel census survey
NA	Scott, G.	NOAA/NMFS	Pesticide analysis of agricultural nonpoint source runoff into Florida Bay
NA	Sheng, Y.	University of Florida	A perliminary study on circulation dynamics in Florida Bay

Table 15. Permits issued by Everglades National Park for work in Florida Bay, 1989 - 1995 [Everglades National Park, personal communication, 1995]. (cont.)

1995 permits

NA	Sheridan, P.	NOAA/NMFS	Effects of increased freshwater delivery to Taylor Slough on fauna inhabiting seagrasses in receiving waters of Florida Bay
NA	Shinn, E.	USGS	Measurement and quality of tidally induced groundwater discharge in the Florida Keys
NA	Shinn, E.	USGS	Determination of groundwater-flow direction and rate beneath the Florida Keys and reef tract
NA	Smith, D.	Everglades National Park	Marine monitoring network of fixed stations in Shark Slough estuaries, Florida Bay, Manatee Bay, and Barnes Sound
NA	Smith, N.	Harbour Branch Oceanographic Institution	Tidal and nontidal processes in Florida Bay
NA	Snow, R.	Everglades National Park	The distribution and abundance of the Florida manatee in Florida Bay and the Upper Keys
NA	Steidinger, K.	Florida Marine Research Institute	Florida Bay microalgal blooms: composition, abundance, distribution and dynamic processes
NA	Stumpf, R.	NA	Remote sensing of water turbidity and sedimentation in Florida Bay
NA	Swain, E.	USGS	Hydrologic modeling review and assessment
NA	Swart, P.	University of Miami	Collection of scleractinian corals to assess the climatic and environmental variables of Florida Bay
NA	Thayer, G.	NOAA/NMFS	Response of fish and shellfish to changes in habitat in Florida Bay
NA	Wang, J.	University of Miami	A study to define data and model needs for a Florida Bay circulation model
NA	Wang, J.	University of Miami	Current patterns in western Florida Bay
NA	Wingard, G.	USGS	Ecosystem history of Florida Bay and the southwest coast
NA	Winkler, M.	University of the West Indies	Paleoecological studies in South Florida
NA	Zieman, J.	University of Virginia	Revisiting seagrass productivity stations

NA - Not available.

9.1. Federal programs

9.1.1. National Park Service

The Everglades National Park is located on the southern tip of Florida and is part of the National Park Service (NPS). The park was authorized in 1934 and established in 1947. An excellent description of the Park can be found in the official guidebook (George, 1988). The Everglades is a low, flat region, mostly under water, which sustains a variety of habitats. The Everglades is also a river, about 6 in. deep, which originally flowed from Lake Okeechobee, more than 100 miles north in central Florida, into Florida Bay and the Gulf of Mexico. Drainage canals constructed after the turn of the century changed both the rate and direction of freshwater outflow. The coastal ecosystem of the Everglades is composed of a variety of habitats: Florida Bay; the coastal prairie; the vast mangrove forest and its waterways; cypress swamps; the true everglades, the extensive freshwater marsh dotted with tree islands and occasional ponds; and the driest zone, the pine-and-hammock rockland. Underlying the entire Park is porous limestone covered by a thin mantle of marl and peat which provides soil for rooting plants. The Everglades fauna and flora are a blend of tropical species, most of which migrated from the Caribbean islands, and species from the Temperate Zone, which embraces all of Florida. These species have adapted to the region's peculiar cycles of flood, drought, and fire. The coastal mangrove forests, traversed by thousands of estuarine channels and containing numerous bays and sounds, are extremely productive biologically. On the west side of the Park is the Flamingo Visitor Center, located on Cape Sable. Whitewater Bay is located between Cape Sable and the mainland Everglades. An ecological study of the Cape Sable-Whitewater Bay ecosystem can be found in Tabb and Dubrow (1962) and Tabb and Manning (1962). The Park was designated an International Biosphere Reserve in 1976; World Heritage Site in 1979; National Trails Designation in 1981; and a Wetland of International Significance in 1987. The Everglades Expansion Act added 107,600 acres to the Park in 1989. Chekika was added to the Park in 1991. Currently its total acreage is approximately 1,500,000 acres, including land and water.

Robblee *et al.* (1989) compiled quantitative observations on salinity within Florida Bay since 1936 from 29 published and unpublished studies and analyzed these data to characterize typical salinity conditions and determine long-term temporal and spatial changes that may occur within this estuary. Multiple spatially distributed observations within a given year were not available until 1957. A total of 6,231 records were available for this analysis. During all but unusually high rainfall years, evaporation exceeds upland runoff into Florida Bay and hypersaline conditions (>35 ‰) prevail throughout most of the main body of the Bay. Annual monthly average salinity observations exceeded 35 ‰ within one or more areas of the Bay 12 out of the 17 yrs for which data was available since 1956. One or more areas of the Bay have exceeded 35 ‰ during at least one month every year for which sufficient spatial and temporal data were available. The highest salinity conditions consistently occurred within the central basins lying between the Whipray-Buttonwood Keys on the west and Captains, Russell and Black Betsy Keys to the east. Lowest salinities consistently occurred within the upper northeast reaches including Little Madeira and Joe Bays. An increasing salinity gradient consistently occurred from the upper Nest Key basin eastward into Blackwater Sound suggesting the major region of upland runoff lies between Little Madeira and Joe Bays. Seasonal dynamics of salinity conditions within the Bay were tied to the distinct seasonal rainfall conditions of south Florida although considerable annual variability has occurred in the specific month of maximum and minimum salinity. Lowest concentrations have typically occurred during the late summer or fall months while highest salinities occur during late spring. Seasonal and annual variability in concentrations were greatest within the northeastern region of the Bay. Within year ranges of monthly mean values as great as 52 ‰ have been recorded within Little Madeira Bay. High concentrations occurring in late spring were often rapidly diluted following

Table 16. Everglades National Park Marine Monitoring Network stations

Station	Station name	Latitude (N)	Longitude (W)	Start date
BA	Bob Allen Key	25° 1" 33'	80° 40" 55'	4/88
BK	Buoy Key	25° 7" 15'	80° 50" 2'	4/88
BN	Butternut Key	25° 5" 8'	80° 31" 6'	3/88
BR	Broad River	25° 28" 40'	80° 59" 23'	1/90
BS	Blackwater Sound	25° 10" 42'	80° 26" 18'	9/91
CN	Cane Patch	25° 25" 18'	80° 56" 33'	1/90
DK	Suck Key	25° 10" 46'	80° 29" 23'	4/88
HC	Highway Creek	25° 15" 14'	80° 26" 41'	4/88
JB	Joe Bay	25° 13" 26'	80° 32" 29'	4/88
JK	Johnson Key	25° 3" 7'	80° 54" 13'	3/88
LB	Little Blackwater Sound	25° 12" 48'	80° 26" 0'	9/91
LM	Little Madeira	25° 10" 31'	80° 37" 56'	3/88
LR	Little Rabbit Key	24° 58" 52'	80° 49" 33'	4/88
LS	Long Sound	25° 14" 5'	80° 27" 27'	3/88
MK	Murray Key	25° 6" 20'	80° 56" 32'	4/88
NR	North River	25° 20" 23'	80° 54" 41'	2/90
PK	Peterson Key	24° 55" 5'	80° 44" 46'	3/88
TB	Terrapin Bay	25° 9" 36'	80° 43" 30'	9/91
TC	Trout Cove	25° 12" 44'	80° 32" 1'	3/88
TR	Taylor River	25° 13" 28'	80° 39" 11'	3/88
WB	Whipray Basin	25° 4" 41'	80° 43" 39'	3/88

the onset of the rainy season within this upper Bay region. Consistent temporal data upon which to evaluate long-term changes in environmental conditions at any given location were limited. Strong evidence for long-term changes, given the high annual variability in conditions, was lacking.

9.1.1.1. Inventorying and Monitoring Program

Hydrological data are collected at the ENP. These data are used to assess the current hydrological conditions within the Park and are incorporated in hydrological models. Marine monitoring sites have also been established in Florida Bay and the Gulf coast estuaries. The ENP Marine Monitoring Network (MMN) currently occupies 21 stations within the Park, 18 in Florida Bay and 3 in the Shark Slough estuary. Twelve additional stations were added in early 1994. Other stations operated in cooperation with the South Florida Water Management District (SFWMD) are located in Barnes Sound, Manatee Bay, and Joe Bay. The locations of the stations, and duration of operation are listed in Table 16. Data parameters collected are conductivity, water depth, precipitation and temperature. Parameters varied with station. Biological monitoring of the distribution and abundance of wildlife and fish is also carried out. The data is shared and integrated with that collected by other agencies such as the USGS, the SFWMD, and the US Army Corp of Engineers (COE).[Δ]

[Δ] D. Busch, Everglades National Park, 40001 State Rd. 9336, Homestead, FL 33034-6733. 305 242 7800.

9.1.1.2. Everglades National Park GIS Program

The Everglades National Park GIS (EVER GIS) is working with researchers and resource managers to develop Global Information System (GIS) data themes useful for ecosystem restoration and management of the Park. Data themes representing all aspects of the natural environment are contained in the GIS or are planned for the future. The data themes in the GIS cover a wide range of areas, scales and subjects. The availability of these themes varies. Current databases include distribution of foraging wading birds, deer, alligator nests, Cape Sable seaside sparrows, Florida panthers, manatees, and fires. Hydrological researchers are developing data themes representing actual and modeled water levels and depths. USGS 1:24,000 quad data have been digitized for all of the south Florida park areas. Detailed vegetation maps for both before and after Hurricane Andrew are currently being developed using aerial photographs. A Florida Bay bathymetry map is nearing completion. The locations of all of the Park's physical monitoring stations are in the GIS. [*]

9.1.2. US Army Corps of Engineers

The US Army COE has the responsibility of construction and maintenance of the system of canals in South Florida.

9.1.2.1. Water Management Decision Support System

The Water Management Decision Support System[*] of the Water Management and Meteorology Section monitors and regulates COE structures throughout the Central and Southern Florida project. Hydrologic and meteorological data is collected, processed, analyzed, and stored. The data includes water surface elevations, stream stages, reservoir elevations, and cumulative precipitation. The Section supports numerous Data Collection Platforms (DCP) installed at remote gaging stations which measure real-time data including water surface elevations, stream stages, reservoir elevations, and cumulative precipitation. The USGS maintains the DCP's and collects the data via the Geostationary Operational Environmental Satellite (GOES).

9.1.2.2. Hydrographic and Topographic Surveys

The Survey Branch, Engineering Division, conducts hydrographic and topographic survey of Corps of Engineers Projects throughout the Central and Southern Florida project. Both historical and current data is maintained in digital format.[◊]

9.1.3. Environmental Protection Agency

9.1.3.1. Everglades Mercury Study

The Everglades Mercury Study (REMAP) of the Environmental Protection Agency (EPA) is designed to determine the extent and magnitude of Hg contamination in the Everglades ecosystem. It is an integral part of a larger interagency effort that is using ecological risk assessment as the organizing framework to evaluate critical mercury sources and pathways through the ecosystem and asses the relative risk to various biological components, including any relationship of eutrophication to Hg methylation. A probability-based random sampling grid is being used to obtain consistent estimates of Hg contamination over the 9600 km^2 area. Two

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[*] D. Buker, Everglades National Park, 40001 State Rd. 9336, Homestead, FL 33034-6733. 305 242 7800.

[*] K. Jones or S. Bullock, CESAJ-EN-HW, Jacksonville District Corps of Engineers, PO BOX 4970, Jacksonville, FL 32233-0019. 904 232 1786 or 1185.

[◊] H. W. Rimmer, CESAJ-EN-S, Jacksonville District Corps of Engineers, PO BOX 4970, Jacksonville, FL 32233-0019. 904 232 1606.

hundred canal sampling locations were selected as probability samples by associating grid points on the sampling frame with specific canal sections for independent sampling cycles. Of this number, 50 locations are randomly selected for sampling during alternate wet and dry seasons through spring 1995. Water, sediment and fish are sampled and analyzed for ultra trace level total and methyl Hg. Additional water quality measurements include temperature, turbidity, conductivity, dissolved oxygen, pH, dissolved organic carbon, total phosphate, and other parameters. A similar effort to obtain a random sample of the greater marsh, including all habitats, began in 1995 on 179 sites per cycle, where water, three soil horizons, and biota will be sampled. Additional cycles are dependent on funding. Water, soil (3 horizons), and fish are being sampled along four marsh transects located across nutrient gradients during wet and dry seasons. Water at seven structures is being monitored bi-weekly for one year for total and methyl Hg to develop a time series. This is only part of a comprehensive ecological risk assessment of Hg.[+]

9.1.3.2. Environmental Monitoring and Assessment Program - Estuaries

One hundred forty two sites in the West Indian Province (Anclote Anchorage around to the mouth of the Indian River Lagoon) will be sampled in 1995 - 1996 as part of the EPA Environmental Monitoring and Assessment Program - Estuaries (EMAP-E). Sampling will include triplicate benthic community analyses, fish trawls, water quality measurements, sediment chemistry, tissue residual analysis, and eutrophication measurements. These data are a part of the continuing development of the EMAP-Estuaries Program throughout the country. The data for south Florida will include the following measurements at 142 sites during quality measurements: instantaneous salinity, temperature, pH, dissolved oxygen, and light penetration (relative light and Secchi), and 24-hr continuous measurements of salinity, temperature, depth, pH, and dissolved oxygen (a random 24-hr segment during the sampling period). Chemical water column measurements include nutrient analyses. Chemical sediment measurements include percent silt/clay, grain size, acid volatile sulfide concentration, analysis for 125 contaminants [polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), pesticides, heavy metals, butyltins), and sediment toxicity (10-day, acute *Ampelisca* bioassay and 1-day Microtox bioassay). Chemical biota measurements include tissue residues from the fillets of selected target species and tailmeat from shrimp for about 75 contaminants, and selected biomarkers of fish health condition (e.g., DNA adducts, EROD, AHH, vitellogenin). Biological measurements include collection of triplicate benthic community samples, duplicate fish trawls or traps, chlorophyll, and presence and condition of submerged aquatic vegetation. All data collected are stored in the EMAP-E Information Management System.[Δ]

9.1.3.3. Florida Keys Water Quality Protection Program

The Florida Keys Water Quality Protection Program monitoring objectives are to (1) monitor the status and trends of water quality parameters throughout the Florida Keys National Marine Sanctuary (FKNMS), and (2) monitor the status and trends of biological resources such as coral reefs, hard bottom areas, and seagrass beds, potentially affected by water quality problems. The FKMS is stratified into nine segments. Water quality and seagrass communities will be monitored using a stratified random design based on the segmentation framework. The seagrass, coral reef/hardbottom, and water quality monitoring programs will determine spatial and temporal variability, with the focus being water quality as it affects resources.

[+] J. Stober or D. Scheidt, USEPA, Environmental Services Division, Colleae Station Rd., Athens, GA 30613. 706 546 2207.

[Δ] K. Summers or J. Macauley, USEPA, EMAP-Estuaries, 1 Sabine Island Dr., Gulf Breeze, FL 32561. 904 934 9244 (Summers). 904 934 9353 (Macauley).

This Program is a joint effort by EPA and the Florida Department of Environmental Protection (FDEP).*

9.1.3.4. Toxics Release Inventory System

The Toxics Release Inventory System (TRIS) is an EPA Superfund database that contains information on storage, use and release of 300 toxic and hazardous substances.

9.1.3.5. Research File 3

Research File 3 (RF3) is a national hydrographic database that interconnects and identifies 3.5 million stream segments that comprise the nation's surface water drainage system.

9.1.3.6. Waterbody System

The Waterbody System (WBS) is a database that houses the monitoring and assessment data provided by states in 305b water quality assessments. Florida is a full participant in WBS.

9.1.3.7. Permit Compliance System

The Permit Compliance System (PCS) is a national database of all NPDES permits.

9.1.3.8. North American Landscape Characterization

The Global Change Research Program North American Landscape Characterization (NALC) is working with the EROS Data Center to develop MSS triplicate covering the entire continent. Triplicates are matched Landsat MSS scenes from the 1970s, 1980s and 1990s. EPA has requested high priority on the development of South Florida scenes.

9.1.3.9. Gulf of Mexico Program

This major geographic initiative is cooperating with EPA Region 4 on South Florida planning and monitoring.

9.1.3.10. STORET

STORET is the major national EPA database that contains station locations and measurements of many water quality parameters.

9.1.3.11. CERCLIS/RCRIS

These information systems contain all reported occurrences of active and abandoned waste sites, including highest priority Superfund sites.

9.1.3.12. Facility Index System

The Facility Index System (FINDS) is a database of cross referenced file showing EPA identification codes for regulated facilities.

* F. McManus, USEPA, 345 Courtland St., NE, Atlanta, GA 30365. 404 347 1797. P. Mathews, Florida Department of Environmental Protection, 3900 Commonwealth Blvd., Tallahassee, FL 32399-3000. 904 488 4892.

9.1.3.13. Taxonomic File

The Taxonomic File is a database, under development, based on the NOAA National Oceanographic Data Center (NODC) taxonomic codes.

9.1.3.14. Gateway/ENVIROFACTS Information Management System

This relational data management system encompasses several other EPA databases. It has been pilot tested in the Great Lakes and in southeastern Virginia, and a proposal for a South Florida information system is in preparation by EPA's Office of Information Resources Management.

9.1.3.15. Research and development

EPA's Office of Research and Development is preparing proposals involving remote sensing as applied to Florida Bay issues in coordination with the EPA Office of Water.

9.1.3.16. Spatial Data Clearinghouse

EPA's Spatial Data Clearinghouse provides access to various types of spatial data in ARC/INFO export format. These data enable users of perform analytical functions through the use of a geographic information system. Many systems and tools being built by EPA will utilize the data in the Clearinghouse.

9.1.4. US Fish and Wildlife Service

9.1.4.1. National Wetlands Inventory

The National Wetlands Inventory (NWI) of the US Fish and Wildlife Service (FWS) develops and disseminates biologically sound scientific information on the characteristics and extent of the Nation's wetland resources. Data are supplied to policy makers, planners, land managers, and the public for the purpose of making informed decisions affecting the wise use and management of wetland resources. To accomplish this, two types of information are gathered: (1) detailed wetlands maps, and (2) status and trends reports. NWI has produced wetlands maps for the entire state of Florida at the scale of 1:24,000 using NAPP photography. Wetlands maps portray point, line, and area features overlaid on a USGS 7.5-min topographic map. All wetland features discernible by the photointerpreter are delineated. Wetlands are classified using the Cowardin wetlands classification system and delineated using protocols and conventions developed by NWI. NWI also compiles information on the status and trends of the Nation's wetlands. These comprehensive data are prepared as a Report to Congress on a 10-yr cycle. The most current report covers wetlands status and trends through the mid-1980's. NWI has developed the following collateral data sources to assist in the mapping of wetlands nation-wide: National List of Plant Species That Occur in Wetlands (currently contains over 6,600 plant species); Hydric Soils of the United States (with Soil Conservation Service); conventions for photointerpretation, cartographic design, and digitizing; and a wetlands values database comprising over 15,000 bibliographic records describing functions and values of wetlands.★

9.1.4.2. Wetland Status and Trends

The NWI Wetland Status and Trends, a wetland status and trends study, is responsible for monitoring the current status and recent trends in wetland acreage for the Nation. The overriding objective of this study is to produce comprehensive statistically valid acreage estimates of the Nation's wetlands. There are three components to the status and trends

★ D. Woodard, NWI, 9720 Executive Center Drive, Suite 101, Monroe Building, St. Petersburg, Florida 33702. 813 570-5412.

operations. These include monitoring the wetlands by periodically updating a random sample of 3650 4-sq mi sample plots. This is done with the use of aerial photography to measure land changes over time. In addition, the Fish and Wildlife Service has determined additional information is needed to assess wetland acreage trends in key regions of the country. More accurate regionalized trend data are being produced for the Gulf and Atlantic coastal flats, the Great Lakes watershed, the Lower Mississippi Alluvial Plain, and the Prairie Pothole Region. Specialized study areas or "Hot Spots" of wetland loss are further identified. These are areas where wetland changes can be detected and analyzed for discrete geographical units (usually counties). Collier County is currently being studied. There are a number of crosscutting tasks relating to status and trends work. Some of these tasks include: developing projection methodologies and modeling; database development and maintenance; GIS development; remotely sensed image acquisition and analysis; USGS topographic maps; NOAA charts; soil surveys; and other data.◊

9.1.4.3. Ecological Services

Although the Ecological Services Vero Beach Field Office does not generate large amounts of data, the organization uses existing data to document distribution of wildlife, produce simple habitat use models for wildlife, review impact of proposed development or restoration projects on species of wildlife and ecosystems in general. A variety of derived data that vary in precision is used. Species distribution/habitat use models are probabilistic in nature and their use to predict impact is dependent on sampling methodology, scope of search, precision of measurements, and biology of the species.▲

9.1.5. National Biological Survey

Land cover maps are being created statewide by the National Biological Survey (NBS) Florida Biological Diversity Project to serve as a base for modeling potential habitat and species-richness of terrestrial vertebrates and butterflies. The spatially-explicit species-richness coverages are being compared to coverages of lands owned for conservation purposes to locate gaps in biodiversity protection. Land cover is being mapped from classification of Landsat satellite imagery at 30 m resolution. The hierarchical classification scheme is a modification of the Florida Natural Areas Inventory (FNAI) scheme. Faunal distributions and habitat associations are being compiled from museum records, literature, and expert consultation. Spatial GIS models of potential habitat of each species are being constructed and will be used in overlays to generate maps of species richness. Spatial resolution of the faunal maps will vary depending on the appropriate scale for the individual species.*

9.1.6. National Oceanic and Atmospheric Administration

9.1.6.1. National Ocean Service

9.1.6.1.1. Tide gauges

The tide station locations in Florida Bay were retrieved from the Tides Automated Login and Retrieval System (TALARS) and are listed in Table 17 (M. Gibson, NOAA/NOS, Silver Spring, MD, personal communication, 1994). Some historic sites have not been listed yet in TALARS. The data typically available for these stations are: times and heights of high and low tides, hourly heights, 6-min heights, summary information (monthly tidal extremes and other

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◊ T. E. Dahl, US Fish and Wildlife Service, 9720 Executive Center Dr., Ste 101, St. Petersburg, FL 33702.

▲ R. Pace, USFWS, P.O. Box 2676, Vero Beach, FL 32962. 407 562 3909.

* L. Pearlstine, Florida Cooperative Fish and Wildlife Research Unit, P.O. Box 110450, Gainesville, FL 32611-0450. 904 392 1861.

statistics), bench marks sheet of tide data, time series plots, harmonic analysis, tidal predictions, daily and monthly sea surface water temperature and density, frequency and duration of inundation of high and low water, and daily mean sea level. Tide data can be obtained from the NOAA/National Ocean Service (NOS)/Tidal Datum Quality Assurance Branch.[Δ]

9.1.6.1.2. National Status and Trends Program

NOAA's National Status and Trends (NS&T) Program[◊] assesses the current status of, and changes over time in the environmental health of the estuarine and coastal waters of the United States, including Alaska and Hawaii. The NS&T Program consists of seven major component projects: National Benthic Surveillance, Mussel Watch, Bioeffects Surveys, Coastal Contaminant Assessments, Historical Trends Assessments, Specimen Banking, and Quality Assurance (QA). NS&T data can be found in various publications, including NOAA (1988, 1989, and 1991b) and on the NOAA Internet home page. Concentrations of organic and inorganic contaminants in sediments and mollusks taken in the same area are determined as part of the Mussel Watch Project at sites located around the nation. The analytes include 24 PAHs, 20 PCB congeners, DDT and its metabolites, 9 other chlorinated pesticides, organotins, 4 major elements, and 12 trace elements. NS&T Program sampling and analytical methods, and the list of analytes are described in Lauenstein and Cantillo (1993). NS&T sampling sites are described in Lauenstein *et al.* (1993). The quality of the NS&T analytical data is overseen by the QA Project, which is designed to assure and document the quality of the data, to document sampling protocols and analytical procedures, and to reduce intralaboratory and interlaboratory variation. The QA Project description can be found in Cantillo and Lauenstein (1993).

Five NS&T Mussel Watch sites are located in South Florida and one in the Florida Keys (Table 17). In order to evaluate the impact on Florida Bay of the restoration project in the Everglades, two new Mussel Watch sites were established in 1994. These are located at Flamingo and in Blackwater Sound. At these NS&T sites, either the American oyster (*Crassostrea virginica*) or the smooth-edged jewel box (*Chama sinuosa*) are collected during the winter months prior to spawning. Two organizations have been responsible for all sample collection and analysis of samples from South Florida: Texas A&M University (TAMU) Geochemical and Environmental Research Group (GERG) for the Gulf Coast and Florida Keys, and Battelle Ocean Sciences for the Atlantic Coast. The NS&T data for the South Florida sites is listed in Cantillo *et al.* (1993), NOAA (1988, 1989, and 1991b) and Cantillo *et al.* (1995). An NS&T Bioeffects Survey of Biscayne Bay in cooperation with the NOAA Coastal Ocean Program and the State of Florida is being planned. The survey will include sediment toxicity, fish reproduction, genetic damage, and other studies. The NS&T Program will also conduct a joint monitoring survey of the benthos in Florida Bay and the region to the west with the EPA EMAP-E. Samples of macrobenthos will be collected at 50-100 sites in Florida Bay and the adjacent waters out to a line between Naples and Key West. The number of species and individuals of each species will be used to calculate a Benthic Index of the health of the benthic community and to obtain baseline information on the composition and biodiversity of the macrobenthic community of this region. Sampling is planned for the summer 1994.

[Δ] NOAA/NOS/Tidal Datum Quality Assurance Branch, 1305 East West Hwy., rm. 7606, Silver Spring, MD 20910. 301 713 2877.

[◊] T. O'Connor, NOAA National Status and Trends Program Office, NOAA/NOS/ORCA21, 1305 East West Hwy., 10614, Silver Spring, MD 10910. 301 713 3028.

Table 17. Tide station locations in Florida Bay and the Keys from the Tides Automated Log and Retrieval System (Information listed in the database in early 1994. More stations could be in operation.).

Station number	Station name	Latitude (N)	Longitude (W)	Installation date	Removal date
8723644	Flamingo	25° 8.5'	80° 55.4'	1964	1965
8723646	Blackwater Sound	25° 8.4'	80° 24.2	1974	1974
8723655	Tarpon Basin	25° 8.4'	80° 26.3'	1934	1934
8723668	Sever	25° 6.5'	80° 29.3'	1934	1934
8723678	Sunset Cove	25° 5.7'	80° 26.6'	1975	1975
8723721	Adobe Casa	25° 2.1'	80° 30.3'	1975	1975
8723741	Tavernier	25° 0.9'	80° 30.9'	1970	1975
8723746	Crane Key	25° 0.3'	80° 37.1'	1975	1975
8723752	Plantation Key	25° 0.1'	80° 32.6'	1975	1975
8723752	East Key	24° 59.8'	80° 36.6'	1975	1975
8723776	Plantation Key	24° 57.9'	80° 34.1'	1975	1975
8723807	Shell Key	24° 55.4'	80° 40.3'	1975	1975
8723808	Upper Matecumber Key	24° 55.5'	80° 37.9'	1971	1973
8723812	Shell Key	24° 54.8'	80° 39.6'	1975	1975
8723824	Lignumvitae Key East	24° 54.2'	80° 41.7'	1975	1975
8723825	Lignumvitae Key West	24° 54.0'	80° 42.3'	1975	1975
8723836	Nine Mile Pt.	24° 53.1'	80° 47.3'	1935	1935
8723838	East Horseneck Shoal	24° 53.0'	80° 51.8'	1935	1935
8723852	Lower Matecumbe Key	24° 51.9'	80° 43.0'	1970	1975
8723853	Middle Shoal	24° 51.8'	80° 57.0'	1935	1935
8723873	Long Key	24° 50.3'	80° 47.9'	1975	1975
8723889	S. Horseneck Shoal	24° 48.8'	80° 0.8'	1935	1935
8723921	Grassy Key	24° 46.3'	80° 56.4'	1970	1975
8723931	John Sawyer Bank	24° 45.5'	81° 6.5'	1935	1935
8723970	Vaca Key	24° 42.7'	81° 6.3'	1970	Present
8724033	Pigeon Key	24° 42.3'	81° 9.4'	1973	1974
8724176	Johnson Key	24° 45.7'	81° 19.7'	1936	1936

Table 18. NS&T Mussel Watch Project sampling sites in South Florida and the Florida Keys.

Site	Main location	Site code	Latitude (N)	Longitude (W)	Species collected	Years of data*
Mussel Watch Project						
North Miami	Maule Lake	NMML	25° 56.13'	80° 08.77'	CV	6
Biscayne Bay	Goulds Canal	BBGC	25° 31.39'	80° 18.85'	CV	4
Biscayne Bay	Princeton Canal	BBPC	25° 31.13'	80° 19.75'	CV	2
Florida Keys	Bahia Honda Key	BHKF	24° 39.52'	81° 16.43'	CS	2
Florida Bay	Joe Bay	FBJB	25°12.53'	80° 32.0'	CV	1
Florida Bay	Flamingo Bay	FBFO	25°8.27'	80° 55.25'	CV	1
Everglades	Faka Union Bay	EVFU	25° 54.08'	81° 30.78'	CV	8
Rookery Bay	Henderson Creek	RBHC	26° 1.50'	81° 44.20'	CV	9
Naples Bay	Naples Bay	NBNB	26° 6.85'	81° 47.20'	CV	8

CV - *Crassostrea virginica* (American oyster). CS - *Chama sinuosa* (Smooth-edged jewel box).
* Years of data available as of this writing.

9.1.6.1.3. National Marine Sanctuaries

The Florida Keys National Marine Sanctuary (FKNMS) was established in 1990 under this Act and implemented in 1994. The Sanctuary extends from Card Sound to the Dry Tortugas and covers both sides of the Florida Reef Track. The Florida Keys encompass the 345-km long Florida Reef Track, the only living tropical coral reef along the mainland United States. There are three National Marine Sanctuaries established and managed by NOAA along the reef track: the Florida Keys National Marine Sanctuary, the Key Largo National Marine Sanctuary, and the Looe Key National Marine Sanctuary. There are also other sanctuaries in the area such as the National Key Deer Refuge, the John Pennekamp Coral Reef State Park, the Great White Heron National Wildlife Refuge, and the Key West National Wildlife Refuge. The ecosystem on the northern side of the Reef is similar to that of Florida Bay and the shore lines are characterized by mangrove communities. Urban development has resulted in riprap and gravel beaches, rocky shores, and seawalls. There are few sand beaches in the Florida Keys. The coral species most abundant in the Florida Reef Track are *Montastrea annularis, M. cavernosa, Acropora palmata, A. cervicornis, Diploria* spp., *Siderastrea siderea*, and *Colpophyllia* spp. Many of these species have been affected by coral bleaching, and white band and black band disease. Also, cold water resulting from the passage, in recent years, of severe cold fronts from Florida Bay across the reefs has stressed or killed many corals. The ecosystem has been impacted by excessive amounts of nutrients from Florida Bay and non-point sources, the effects of over development of the Keys, and of damage by large vessels such as ship groundings and minor oil spills. There are a number of mechanisms transporting water within the Keys (Schomer and Drew, 1982). These include oceanic currents, evaporation processes, tides, winds, freshwater flow (from land runoff and rainfall), and catastrophic climatological events such as hurricanes. Salinities are variable but are approximately 36 ‰.

A total of 30 stations have or will be established to monitor water temperature along the Florida Keys reef tract and along the Florida Bay side of the Keys. Most of these stations were established in 1990 and include thermographs deployed within 30 cm of the seabed at each location. Instruments are programmed to record at 2-hr intervals and operate 530 days. Units are retrieved annually.[Δ]

9.1.6.2. National Marine Fisheries Service

9.1.6.2.1. Coastal Change Analysis Program

The NOAA/National Marine Fisheries Service (NMFS) Coastal Change Analysis Program (C-CAP) is developing a nationally standardized database on land cover and habitat change in the coastal regions of the US. C-CAP inventories coastal submersed habitats, wetland habitats and adjacent uplands and monitors changes in these habitats on a 1- to 5-yr cycle. 1992 aerial photography of Florida Bay (co-funded with the Florida Department of Environmental Protection) consists of 389 color photos at a scale of 1:48,000. All photographs not negatively affected by turbidity are currently being interpreted by personnel at Florida International University (FIU). The data will be digitized and serve as a basis for future change detection efforts. Beginning in the fall of 1994, six LANDSAT Thematic Mapper (TM) scenes from 1992/93 (Path 15, rows 41 - 43 and Path 16, rows 41-43) were analyzed to determine the location and extent of emergent wetlands and surrounding uplands. This data will also serve as a basis for future change detection efforts. C-CAP uses an assortment of digital and analog products as ancillary data sources. They include, but are not limited to: NOAA nautical charts and shoreline manuscripts, NWI maps, USGS 7.5-min quads, TIGER files, soils maps, timber surveys and digital elevation models. The information is from a variety of federal, state, local governments and private entities.[*]

9.1.6.2.2. Fisheries Statistical Data Collection

Seven federal fishery management plans involve fishery species found in Florida Bay. The NOAA/NMFS Southeast Fisheries Science Center[◊] (SEFSC) is responsible for management of these species under the Plan. These plans are: the Gulf of Mexico Shrimp Plan, the Joint South Atlantic and Gulf, the Gulf of Mexico Reef Fish Plan, the South Atlantic Reef Fish Plan, the Gulf of Mexico Red Drum Plan, the Gulf of Mexico Stone Crab Plan, and the Joint South Atlantic and Gulf of Mexico Coastal Migratory Species Plan. Under these plans, NMFS is responsible for management of the following species for which Florida Bay is a major nursery habitat: pink shrimp, spiny lobster, stone crab, red drum, Spanish mackerel, gray snapper, mutton snapper, jewfish, and other species of snapper, grunts and porgies. Under the Endangered Species Act, NMFS is responsible for the following species found in Florida Bay: loggerhead turtle (threatened), Kemp's Ridley turtle (endangered), and the green turtle (endangered). Florida Bay is a very important developmental area for green turtles and may soon be listed as critical habitat under the Endangered Species Act. A candidate species for endangered species designation found in Florida Bay is the jewfish. Under the Marine Mammal Act, NMFS is responsible for the bottlenose dolphin, a species found in the Bay.

9.1.6.2.3. AVHRR Coastal Satellite Imagery

Four-kilometer sea surface temperature fields are being acquired by NMFS/SEFSC from the University of Miami (UM) Rosenstiel School of Marine and Atmospheric Science (RSMAS) and are being used to construct 5-day composites of the waters of the western North Atlantic along the eastern seaboard. The dataset will contain data from 1983 to the present.

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[*] F. A. Cross, Coastal Change Analysis Program, NOAA/NMFS, Beaufort Laboratory, 101 Pivers Island Road, Beaufort, NC 28516-9722. 919 728 8724.

[◊] NOAA/NMFS/SEFSC, 75 Virginia Beach Dr., Miami, FL 33149. 305 361 5761.

9.1.6.2.4. Responses of fish and shellfish to habitat changes

The purpose of this program is to quantify and compare densities of fishes and decapods in central Florida Bay basins (subject to hypersalinity) and western Florida Bay (not subject to hypersalinity) as freshwater flow to central basins is increased. This work is being done in cooperation with the National Biological Survey.[◊]

9.1.6.2.5. Marine mammals

Aerial surveys beginning in the late 1970s indicated that Florida bay and the Florida Keys are habitat for bottlenose dolphins. This species accumulates toxins and pollutants and can be used as an indicator of ecosystem health. To provide census information, movements, and habitat use, field observer surveys will be supplemented with satellite and/or radio/sonic tags. To obtain information on animal condition and health, individuals will be captured alive and tissue samples obtained for chemical analyses. Repeated captures of the same individuals over time will be necessary to establish an adequate time series.[•]

9.1.6.2.6. Seagrass habitat health

The NMFS Beaufort and Galveston Laboratories are conducting fishery habitat sampling along salinity gradients in northwestern Florida Bay. To date, three sampling trips have been conducted to evaluate fisheries populations in low salinities (9 - 17 $^{o}/_{oo}$) and salinity transition (>20 $^{o}/_{oo}$) areas in the vicinity of Little Madeira and Madeira bays. At each station, salinity, temperature, and bottom samples are taken for vegetation type and abundance. Fish and shellfish are identified from each collection and data will be compared with similar samples taken during 1990 - 1993 in the high salinity portion of the Bay for community structure comparisons. Additionally, Beaufort has established Global Positioning System (GPS) coordinates for these sites as well as for published sites sampled during the 1984 - 1985 pre-seagrass dieoff studies.[*]

9.1.6.2.7. Pink Shrimp

Pink shrimp are an indicator of the ecological health of Florida Bay. Pink shrimp support a valuable commercial fishery for which a relatively long time series of catch and effort is available. Statistical analysis of commercial catches suggests that pink shrimp are sensitive for freshwater inflow. Pink shrimp are a principal prey item of many game fish in the Bay. This study involves statistical analysis, biological modeling, physiological trials, caging experiments, resource analysis and genetic analysis. The study will characterize the within-year cohorts in the fishery and link them to specific nursery grounds in Florida Bay and nearby estuaries.[◊] This study is being done in cooperation with UM RSMAS and NBS.

9.1.6.2.8. Pesticide analysis of agricultural nonpoint source waters

There are significant agricultural activities in the upland areas adjacent to Florida Bay and these are potential sources of pesticides to the ecosystem. A baseline study to address potential inputs of agricultural pesticides was conducted in 1993 - 1994. As more freshwater runoff is diverted into Florida Bay as the result of the recent agreement on Everglades reflooding, there is an increased possibility of these pesticides entering the Bay. Research

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activities will include expanded monitoring of pesticide runoff, toxicological assessment of runoff effects on crustaceans, establishment of loading models, and comparison of the 1993 - 1994 data with historical information.[Δ] This is a joint project between NOAA/NMFS and FDEP.

9.1.6.2.9. Photointerpretation of bottom habitats

Quantification of the status and recent change in the spatial distribution and extent of seagrasses is central to understanding the nature and extent of the environmental declines observed in Florida Bay and to guide research and management efforts. This project is a joint effort of C-CAP and FDEP and augments and extends ongoing studies. Completion of the inventory and change detection will require a combination of new and historical photography.[•]

9.1.6.3. National Environmental Satellite, Data, and Information Service

The NOAA/National Environmental Satellite, Data, and Information Service[*] (NESDIS) NODC is the national facility established to acquire, process, store, and disseminate global oceanographic data. NODC is one of the three NOAA national data centers. The others are the National Climatic Data Center (NCDC) and the National Geophysical Data Center (NGDC). NODC's files include data collected by NOAA, other federal agencies, state and local governments, universities and research institutions, and private industry. During January 1994, the NODC files were searched for any information on Florida Bay. None were found.

The NOAA data contribution to the Federal/state Florida bay task force will be managed in Miami by the NOAA Data Administrator (Crane, 1995). Data from the NESDIS Data Centers will be coordinated and it is anticipated that data from the C-MAN stations in South Florida and the NODC taxonomic codes will be made available. CD-ROM files will be loaded on disks connected to the Internet. Data will be stored on workstations with Internet addresses in the standard Oracle database structure. The Geographic Information System software will be ARC/INFO and ARCVIEW2.[✱]

9.1.6.4. National Weather Service

9.1.6.4.1. National Data Buoy Center

The National Data Buoy Center (NDBC) was originally initiated by the US Coast Guard as the National Data Buoy Development Program during the late 1960s (NOAA, 1992). In late 1979, it was transferred to NOAA. NDBC is part of the National Weather Service and is located at Stennis Space Center, MS. The Coastal-Marine Automated Network (C-MAN) program began in 1981 and in 1992 there were 63 moored buoys and 40 C-MAN stations. Many of the buoys are operated by NDBC for agencies such as National Aeronautics and Space Administration (NASA), Minerals Management Service (MMS) and Office of Naval Research (ONR) on a reimbursable basis.

The baseline C-MAN measurements are wind speed and direction, barometric pressure, air temperature, and sea surface temperature. This capability is augmented at specific sites to satisfy other requirements. Enhanced meteorological sensor capabilities include relative humidity, rain, wind speed and direction, air temperature, and solar radiation in air. Oceanographic enhancements include water temperature (surface and 3 m), water level (using

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Table 19. C-MAN locations in South Florida.

Station name	Latitude	Longitude	Year deployed
Fowey Rocks (east of Biscayne Bay)	25.59° N	80.10° W	
Molasses Reef (east of Elliot Key)	25.01° N	80.36° W	
Sombrero Key (Atlantic side of Reef Tract)	24.63° N	81.11° W	
Sand Key (south of Bahia Honda)	24.46° N	81.86° W	
Dry Tortugas	24.38° N	82.52° W	
Long Key (south of Cape Sable)	24.52° N	80.51° W	
1.8-m d buoy (south of Molasses Reef)	AQUARIUS site		1993 ?

an acoustic rain gauge), ocean surface waves, salinity (surface and 3 m), and solar radiation (surface and 3 m). Data is transmitted to shore hourly via the Global Operational Environmental Satellite (GOES), and every 15 min via telephone in C-MAN code (modified FM-12 format). The data are subjected to quality control in real time and prior to archival through algorithms (dual sensors, wind vs. wave energy, swell direction, analyses vs. observation), graphics (time series, spectral wave curves and contours, and regional weather maps), support service visits, and performance statistics. The data are stored at NOAA/NESDIS. The C-MAN sites in South Florida are listed in Table 19. The C-MAN installations at Molasses Reef and Sombrero Key are part of NOAA/NWS.*

9.1.6.4.2. Precipitation

Spatial precipitation measurements are available from the WSR-88D radar installed at Miami and Tampa. These new radars interrogate the sky up to 125 mi from the radar site on an hourly basis using newly developed algorithms that provide spatial rainfall measurements on a 4 x 4 km grid.◊

9.1.6.5. Oceans and Atmospheric Research

9.1.6.5.1. Atlantic Oceanographic and Meteorological Laboratory

In collaboration with the University of Miami and the Intergovernmental Oceanographic Commission, the NOAA/Office of Oceanic and Atmospheric Research (OAR)/Environmental Research Laboratories (ERL)/Atlantic Oceanographic and Meteorological Laboratory (AOML) is developing the capability to provide nowcasts and forecasts of ocean currents for Florida Bay and the Straits of Florida. In conjunction with the University of Miami and the United Nations Environment Programme, AOML analyzed the effect of temperature and sea level rise on the Caribbean ecosystem, including mangroves and coral reefs. In collaboration with the NMFS/SEFSC and the University of Miami through the SEFCAR program, AOML is using advanced optical and acoustic sampling technology to study fisheries recruitment and its control by physical processes adjacent to the Florida Keys. AOML has begun the design of a portable sensor package with satellite data relay, for deployment on remote coral reefs which will permit remote monitoring of reef condition in Biscayne National Park and the FKNMS. In collaboration with the NDBC and the Florida Institute of Oceanography, AOML collects from the GOES satellite the data from NOAA buoys and C-MAN stations in the Keys and posts it on a dial-

* For further information on C-MAN, contact Dave Gilhousen, NOAA/NDBC, Stennis Space Center, MS. 601 688 2800.

◊ J. Vogel, NOAA/NWS, 1325 East West Hwy., Silver Spring, MD 20910. 301 713 1669.

in bulletin board for regional users. Additionally, three times a week an automated fax of this data is sent to test users. This is a demonstration project that will soon have to be discontinued since no operational support has been identified.

9.1.6.5.2. Mesoscale Atmospheric Modeling

A high resolution non-hydrostatic mesoscale atmospheric model will be employed for prediction of the initiation, evolution and distribution of rainfall in the Everglades and Florida Bay and for predicting surface wind fields relevant to circulation patterns in Florida Bay. This project is being done in cooperation between NOAA/OAR, NOAA/NWS and SFWMD.[Δ]

9.1.6.5.3. Regional Numerical Ocean Circulation Model

The circulation of the Intra-Americas Sea (Gulf of Mexico, Caribbean Sea and adjacent waters) is central to understanding the external forcing of Florida Bay. A modeling system is needed that can resolve the mesoscale variability, utilize effectively whatever data are available and provide guidance for enhancing the observing system with critical observations. A hierarchy of numerical circulation diagnostic and circulation models is envisioned whereby a Florida Bay model is nested into a Straits of Florida model, which in turn is nested into a regional scale Gulf/Caribbean/Bahamas/Guianas model, which is nested in an existing operational Atlantic basin model. This effort is being done in cooperation with NOAA/OAR, NOAA/NWS, University of Miami, and the Florida Institute of Technology.[◊]

9.1.6.5.4. Zooplankton abundance and grazing potential

Little research has been conducted on zooplankton grazers in Florida Bay. Until recently, the Bay was extremely clear and seagrasses dominated primary production. This suggested that macroinvertebrates and teleosts grazing directly upon macrophytic plant production were the dominant trophic link between primary and secondary production. Key research components of this project will be to sample the abundance of the zooplankton community and determine grazing rates. Analyses of the seasonal and spatial distribution will be linked to environmental parameters. Estimates of primary consumption and fish larval impacts will be made in collaboration with other NOAA, FDEP, and academic investigators.[◊]

9.1.6.5.5. Environmental controls upon algal blooms, food web structure and carbon flow

Multifactorial field microcosm and mesocosm experiments will be used to determine the importance of various micronutrients, light, salinity, and turbulence in initiating bloom formation. Autoecological laboratory experiments will also be conducted. Translocation mesocosm experiments will be used where distinct food webs could be subjected to remineralization and nutrient regeneration pathways particularly in regard to sediment/water column flux.[*] This work is a joint effort between NOAA/OAR, SFWMD, and FDEP.

9.1.6.5.6. National Undersea Research Program

The University of North Carolina, Wilmington, NC, under contract to the National Undersea Research Program (NURP) has established a science support base in the Florida Keys, and deployed the AQUARIUS habitat. NURP also established local nutrient chemistry laboratories in

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cooperation with Florida International University Harbor Branch Foundation. NURP deployed and operated a wave buoy off Key Largo in cooperation with NDBC. In collaboration with the Florida Institute of Oceanography, the University of Miami, and the Harbor Branch Oceanographic Institute, NURP conducted weekly water quality monitoring in the upper, middle, and lower Keys since June 1992. In collaboration with the USGS, NURP conducted groundwater monitoring in the Keys to investigate sewage and septic nutrient sources. NURP concluded a cooperative agreement with the Sanctuaries and Reserves Division to provide expertise and assistance to advance science, education, and management within the FKNMS.

9.1.6.5.7. National Sea Grant College Program

The National Sea Grant College Program is a nationwide partnership with public and private sectors combining research, education and technology transfer.[Δ] The Florida Sea Grant is the only statewide university-based program of coastal research, education, extension and public services in Florida. Faculty from a network of public and private universities and laboratories conduct studies in areas such as biotechnology, aquaculture, fisheries, seafood technology, policy, ocean engineering, and recreation. Information transfer takes place via a statewide network of marine extension faculty in key coastal locations. Education includes training of graduate students, instruction of teachers and non-formal public awareness programs. Literally, hundreds of publications, plus videos and posters, have been produced by Florida Sea Grant. The program works closely with agencies and businesses to achieve long-range goals relating to development and conservation of coastal resources on a sustainable basis. Through the Florida Sea Grant Program, a number of research and outreach efforts have been or are being conducted by Sea Grant and academic investigators.[•] Current and past research projects are listed in Table 20.

9.1.7. US Geological Survey

There are five USGS programs ongoing in South Florida: the Federal/State Cooperative Program, the National Mapping Program, the National Geologic Mapping Program, the Marine and Coastal Geology Program, and the National Water Quality Assessment Program (NWQAP) (Halley, 1994). In addition, the USGS is collaborating with many of the agencies working in South Florida, such as NOAA, EPA, NBS, and SFWMD in a variety of programs.[*]

9.1.7.1. Water quantity measurements

9.1.7.1.1. Freshwater discharge - East Coast

Discharge at 20 highly regulated coastal canals was measured and calibrated to gate openings in cooperation with the South Florida Water Management Disctrict. Together with 6 other canals that are part of the long-term USGS gaging station program, these data will provide the total freshwater discharge to the bays and estuaries between the West Palm Beach Canal (C-51) in the north and C-111 in southern Dade County. These data were needed to refine the regional water budget and to calibrate the regional hydrologic models used by all management agencies in South Florida.

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Table 20. Florida Sea Grant College Program research and extension activities and projects concerning Florida Bay and the Florida Keys, and the greater South Florida area, 1972 - 1994 [W. Seaman, Florida Sea Grant Project, personal communication, 1994].

Year started	Title	Project number	Investigator
	SECTION A: FLORIDA BAY - FLORIDA KEYS PROJECTS		
	<u>Longer-term, multi-year projects by subject area</u>		
Economics			
1988	Predicting change and maintaining productivity in a fishery transformed by real estate development and tourism	R/LR-E-11	Meltzoff
Biology			
1975	Biological studies of the spiny lobster in South Florida	R/LR-B-I	Labisky, Warner
1975	Attractants of the spiny lobster *Panulirus argus*	R/LR-B-2	Ache
1978	Spiny lobster larval recruitment in the Florida Keys	R/LR-B-5	Menzies, Kerrigan
1980	A case study of the exploitation of virgin deepwater fish stocks	R/LR-B-7	Labisky
1983	Habitat requirements of early benthic post-larval spiny lobsters	R/LR-B-9	Herrnkind, Marx
1983	Development of an artificial bait for the Florida spiny lobster fishery	R/LR-B-10	Ache
1984	Effects of oceanographic parameters on the distribution and abundance of swordfish in the Florida Straits	R/LR-B-15-PD	Berkeley, Roffer
1985	Factors influencing the support capacity of post-larval settlement habitat of Florida spiny lobster	R/LR-B-16	Herrnkind
1985	The effects of man-made reef deployment on nearby resident fish populations	R/LR-B-20	Alevizon
1987	Spiny lobster recruitment	R/LR-B-26	Herrnkind
1991	Limits to recruitment of spiny lobster in Florida: assessment of artificial enhancement techniques	R/LR-B-30	Butler, Herrnkind
Design and structure			
1983	Evaluation of existing and potential hurricane shelters	R/C-D-8	Spangler, Jones
Policy			
1988	Impact of the liveaboard boating population on Florida's shore environment and coastal communities: a case study of the Florida Keys	R/C-P-15	Antonini, Zobler, Tupper
1989	A computer-directed geographic coastal use classification system for ecologic planning: the case of the Florida Keys	R/C-P-17	Antonini

Table 20. Florida Sea Grant College Program research and extension activities and projects concerning Florida Bay and the Florida Keys, and the greater South Florida area, 1972 - 1994 (cont.).

Year started	Title	Project number	Investigator
Short-term program development and pilot projects			
1974	Problem analysis of the South Florida spiny lobster fishery	IR-74-1	Craig
1974	TRIAL Spiny Lobster Bibliography	IR-74-7	Herrnkind
1976	Signs design for Monroe County	IR-76-13	Warner
1979	Trash fish as stone crab bait	IR-79-5	Murray
1980	Maritime agriculture training experience	IR-80-6	Estes, Liederman
1981	Habitat requirements of benthic post larval spiny lobsters	IR-81-11-PD	Herrnkind, Andree
1981	Effects of predator removal on coral reef Fish community	IR-81-12	Bohnsack
1982	Demonstration of sponge cutting and regeneration as an alternative harvesting technique	IR-82-15	Sweat, Stevely
1982	Development of an artificial bait for the Florida spiny lobster fishery	IR-82-19	Ache, Carr
1984	Comparative field evaluation of visual methods of assessing fish populations	IR-84-8	Alevizon
1984	Workshop on Florida spiny lobster research and management	IR-84-17	Herrnkind
1984	To collect Year 2 regeneration and growth data on sponges harvested by cutting compared to hooking	IR-84-29	Stevely, Sweat
1985	Factors influencing the support capacity of post-larval settlement of Florida spiny lobster	IR-85-1	Herrnkind
1987	Predicting change and maintaining productivity in a fishery transformed by real estate and tourism	IR-87-6	Meltzoff
1987	Diagnosis of coral bleaching	IR-87-11	Dodge, Kleppel
1989	Influence of changes in freshwater to northeast Florida Bay on use of mangrove prop root habitat by fishes	IR-89-5	Montague
1990	The American shoreline in transition: lessons from the Florida Keys	IR-90 9	Antonini
1991	Florida Keys sponge survey	IR-91-6	Stevely
1992	Reef damage and other ecological impacts of hurricane Andrew, with emphasis on productive fishery habitats	PD-92-2-G	Herrnkind, Butler
1992	Florida Keys Symposium	PD-92-2-I	Gregory
1992	Florida Keys GIS presentation	PD-92-7-A	Gregory, Antonini
1993	Florida Bay sponge mortality workshop	PD-93-7	Stevely, Sweat
1993	Tracking of Mississippi River plume in Florida Bay	PD-93-9	Wang
1993	Limiting factors for phytoplankton production in Florida Bay	PD-93-6	Philips

Table 20. Florida Sea Grant College Program research and extension activities and projects concerning Florida Bay and the Florida Keys, and the greater South Florida area, 1972 - 1994.

Year started	Title	Project number	Investigator
	SECTION B: GREATER SOUTH FLORIDA AREA PROJECTS		
	<u>Longer-term, multi-year projects by subject area</u>		
	Economics		
1984	User benefits and economic impact of artificial reefs in southeast Florida	R/LR-E-9-PD	Milon
1993	Estimating non-use values for marine ecosystems and endangered species	R/LR-E-15	Milon, Thunberg, Adams
	Biology		
1980	Fishery and biology of swordfish in southeast Florida	R/LR-B-6	Berkeley, DeSylva, Houde
1982	Shark by-catch in the Florida longline swordfishery	R/LR-B-8	Berkeley
1984	Utility of standard yield models for protogynic hermaphroditic life history strategies of groupers	R/LR-B-11	Fox, Bohnsack
1984	Enhancement of the fishery for golden tilefish, *Lopholatilus chamaeleonticeps*	R/LR-B-13	Able, Grimes, Jones
1987	The relative importance of recruitment, attraction and production of reef fishes on natural and modular artificial reefs	R/LR-B-22	Walsh, McGowan, Bohnsack, Richards
1991	Dynamic fishery stock recuperation under variable annual quota allocations: the Florida mackerels	R/LR-B-31	Ehrhardt
1990	The Gulf Stream front, its role in larval fish survival and recruitment in Florida	R/LR-B-29	Kleppel, Clarke
1991	Nutrient cycles and optimum productivity of shallow-water artificial reefs	R/LR-B-34	Szmant
1993	Influence of artificial reef shelter characteristics on fish community structure and promotion	R/LR-B-36	Szmant, Bohnsack
1993	Evaluation of shrimp bycatch impacts on single species fishery management alternatives	R/LR-B-37	Ehrhardt
	Aquaculture		
1987	Regulation of gonad development in shrimp	R/LR-A-11	Quackenbush
1989	Peptide hormone control of reproduction in a marine shrimp	R/LR-A-12	Quackenbush
1991	Regulation of yolk production in a marine shrimp, *Penaeus vannamei*	R/LR-A-16	Quackenbush
1991	Enzyme activities as biochemical indices of condition in larval and juvenile red drum	R/LR-A-17	Clarke, Walsh
	Shore dynamics and planning		
1982	Design and stability of multiple inlet bay systems	R/C-S-16	van de Kreeke
1987	Cross-sectional stability of multiple inlets	R/C-S-25	van de Kreeke
1989	Field experiment evaluation of the effects of beach restoration on stony corals of southeast Florida	R/C-S-29	Goldberg, Dodge
1989	Coastal turbidity associated with natural and man-Induced phenomena	R/C-S-30	Hanes

Table 20. Florida Sea Grant College Program research and extension activities and projects concerning Florida Bay and the Florida Keys, and the greater South Florida area, 1972 - 1994 (cont.).

Year started	Title	Project number	Investigator
Design and structure			
1985	Design and testing of a wave absorber for a vertical seawall	R/C-D-12	van de Kreeke
Estuarine productivity and restoration			
1982	Restoration of urban estuarine I. hydrodynamic transport in north Biscayne Bay	R/C-E-21	Wang, van de Kreeke
1982	Restoration of urban estuarine II. suspended particulates in north Biscayne Bay	R/C-E-22	Wanless
1993	Algal blooms in coastal waters: using corals to differentiate nutrients from pollution or natural sources	R/C-E-33	Dodge, Fisher, Swart, Hawley
1993	Algal blooms in coastal waters: eutrophication on coral reefs of southeast Florida	R/C-E-34	LaPointe, Hanisak
Short-term program development and pilot projects			
1977	Conference on hermit crabs	IR-77-4	McLaughlin
1977	Lobster attractant field trials	IR-77-15	Ache
1982	Determination of food sources of the pink shrimp, *Penaeus duorarum* in South Florida	IR-82-13	Zieman
1982	Small scale aquaculture demonstration project	IR-82-17	Pybas, Lawlor
1983	Bait shrimp fishery of Biscayne Bay	IR-83-9	Berkeley
1983	User benefits and economic impacts of artificial reefs in southeast Florida	IR-83-14-PD	Milon
1984	Symposium: Physics of Shallow Estuaries and Bays	IR-84-16	van de Kreeke
1984	The role of nutrients in the enhancement of the productivity of shallow water artificial Reefs	IR-84-27	Szmant-Froelich
1990	Biscayne Bay, a bibliography of the marine environment	IR-90-12	Hale
1992	Prioritizing the removal of damaged, sunk boats, caused by hurricane Andrew	PD-92-10	Antonini, Clarke
1992	Analysis of hurricane Andrew economic damage and recovery options for the boating, marina and marine service industries, major employers in South Florida	PD-92-11	Baker, Villanueva
1992	An engineering comparison of beach and coastal structural damage from hurricanes Andrew and Hugo	PD-92-12	Wang
1992	Preliminary characterization of red mangrove disease	PD-92-13	Webb
1993	Workshop of pre-hurricane preparation and post-hurricane response and recovery plans	PD-93-8	Villanueva, Pybas

Table 20. Florida Sea Grant College Program research and extension activities and projects concerning Florida Bay and the Florida Keys, and the greater South Florida area, 1972 - 1994 (cont.).

SECTION C: EXTENSION ACTIVITIES:

Florida Sea Grant is the only academic or state or federal governmental organization to conduct a state wide program of outreach, information and technology transfer, extension and public service dealing with coastal issues. As part of its network of state wide specialists concerned with various technical subjects and 12 professionals in coastal locations across the state, Florida Sea Grant has two marine extension agents working in southern Florida, in Dade and Monroe counties.

The Monroe County Sea Grant Extension agent is based in Key West, and serves the entire Keys and Florida Bay area. The Dade County Sea Grant Extension agent is based in Miami, serving all of the county including the Biscayne Bay waterfront. Both conduct public information programs and work to provide objective, scientifically based information to user groups in marine industries, fishing, tourism, management, and others.

9.1.7.1.2. Freshwater discharge to Florida Bay

The primary channels carrying fresh water into Florida Bay were instrumented and dishcarge measurements made in order to obtain stage-discharge relations. These data are needed to understand the water budget and controls on salinity within the Bay, and to calibrate the hydrologic models prepared by the National Park Service and NOAA. Water samples were collected at the time discharge measurements were made, and in conjunction with other sampling programs. The flow and water quality data increased the understanding of nutrient transport mechanisms into the Bay.

9.1.7.2. Modeling enhancements

9.1.7.2.1. Model review

Existing hydrologic models being used to simulate flow conditions that existed in South Florida prior to construction of canals, levees, and pumping stations cannot be verified because of a lack of historical data. This short-term limited scope project analyzed the sensitivity of the model to various parameters using statistical techniques to define model errors. Results were used to place confidence limits on the ability of the model to reasonably simulate various hydrologic conditions and alternatives.

9.1.7.2.2. Vegetative resistance to flow

Surface water models in the Everglades are highly sensitive to the surface roughness coefficient used in the flow equation. This project utilized laboratory flume experiments to provide resistance coefficients representing characteristic Everglades conditions. These data were used by the SFWMD to refine the hydrologic models relied on by all federal and state agencies to plan Everglades restoration.

9.1.7.2.3. Evapotranspiration measurements and modeling

Although evapotranspiration is a major component of the Everglades water budget, few measurements have been made for the variey of land-cover environments characteristic of the region. This project installed instrumentation at 8 sites in a variety of environmental settings and will develop field measurements of evapotranspiration based on a process-oriented model. Data developed at the eight sites was used to extrapolate areal evapotranspiration values for use in the hydrologic model relied on by all federal and state agencies to plan Everglades restoration.

9.1.7.2.4. Elevation data

Modeling of sheet flow and surface water stage are highly sensitive to land-surface elevation data which are poorly defined throughout much of the flat terrain of South Florida. Using new GPS technology made available by NOAA, elevation data with an accuracy of better then 0.5 ft were obtained in critical areas. These data improved the performance of hydrologic models and also provided useful ancillary data for biologic studies planned by federal and state agencies.

9.1.7.2.5. Groundwater flow beneath Conservation Area 3B levee

A major component of Everglades restoration is the maintenance of higher water levels in Conservation Area 3B and construction of a flow way between the levee and the adjacent urban area. Uncontrolled groundwater flow beneath the levee had not been measured but was estimated to be as much as 30% of the outlfow from the conservation area. A combination of surface water measurments and groundwater modeling provided improved estimates of leakage beneath the levee and improved the calibration and predictions of regional hydrologic models.

9.1.7.2.6. Open channel and wetlands flow transport

Linkage of models depicting flow within various hydrologic components of the Everglades flow system is needed to better understand and simulate the movement of nutrients. This project developed a model to simulate fluid-driven mass and a constituent transport in canals, groundwater, and wetlands (sheet flow).

9.1.7.3. Everglades water quality

9.1.7.3.1. Mercury accumulation and cycling

Although considerable monitoring of Hg in water, sediments and fish was done in South Florida, only limited work was done to understand the processes by which Hg enters the food chain. This project determined the effect that various environmental factors, such as levels of dissolved organic C, nutrients, S, and hydrologic conditions, have on transport, sedimentation, volatilization, and methylation of Hg.

9.1.7.3.2. Geochemical processes in organic-rich surficial sediments

To an unknown but potentially significant degree, the concentrations of dissolved elements such as C, P, N, and trace and heavy metals, are controlled by chemical and biochemical reactions occurring in the peat and other organic-rich soil underlying much of the Everglades. This project looked at regional geochemical processes and trends as well as the effect of alternating periods of wetting and drying.

9.1.7.3.3. Terrestrial and freshwater ecosystem history

Although considerable effort is going into understanding the nature of the observed stress on the Everglades ecosystem, there is little knowledge of what conditions were like prior to anthropogenic influences and particularly what, if any, natural ecosystem cycles existed in the past. This project compared modern, historic, and prehistoric biotic assemblages in sediments from a wide variety of settings. Data on naturally occurring ecosystem variability, including dires and biodiversity, helped established a baseline for restoration of the ecosystem.

9.1.7.4. Florida Bay Water quality

9.1.7.4.1. Geophysical mapping of fresh ground water

The groundwater component of freshwater flow into Florida Bay is not quantified. This project used airborne geophysical techniques to map the freshwater/salt-water interface beneath the Everglades immediately north of the Bay. Repeated surveys related the interface position to hydrologic conditions and provided the basis for supplying groundwater discharge values to future salinity models.

9.1.7.4.2. Marine groundwater seepage

The effect of groundwater inflow on the quality of water in Florida Bay is largely ignored in assessments and models. Seepage meters were installed in Florida Bay as well as the coastal reef tract to measure pressure and collect samples of fluid seeping through the rock-water interface. Ground water was analyzed for nutrients, salinity, dissolved oxygen and fecal coliform bacteria. These data furthered the understanding of the water and chemical budget for the Bay.

9.1.7.4.3. Groundwater flow from the Florida Keys

The fresh and saline ground water beneath the Florida Keys is known to be contaminated by effluent from domestic sewage-disposal systems but the flow mechanism and pathways that enable this water to reach Florida Bay and coastal waters is poorly understood. This project quantified groundwater flow by means of observation wells and tracer studies. This project was the onshore complement to a planned study of seepage rates and quality in the Bay.

9.1.7.4.4. Florida Bay sedimentation

The bathymetry of Florida Bay has not been systematically mapped in 30 yrs and new bathymetric data helped assess sedimentation rates and provided a foundation for a sediment budget. This project employed new techniques allowing for the collection of highly accurate data in shallow water and provided bank-top and tidal flat elevation data previously unavailable. These data are critical to the development of circulation and sediment budget models.

9.1.7.4.5. Remote sensing of turbidity and sedimentation

Although current monitoring programs provide data on water quality at periodic intervals, they do not address the questions of the frequency and magnitude of turbidity events or the quantity and fate of the sediment being transported. This project used highly processed satellite imagery, coupled with field measurements, to produce time-series data on water reflectance, sediment load, light attenuation and water temperature.

9.1.7.4.6. Sedimentation, sea-level rise, and circulation

A one-foot sea-level rise since 1850 may have resulted in a deepening of Florida Bay of about 25% (to about 5 ft) with an accompanying increase in water exchange with the ocean and the Gulf. However, recent data indicate restricted rather than enhanced exchange with these adjacent water bodies. This project integrated existing and planned turbidity and sediment studies in order to develop a sediment budget and an evaluation of the effect of sea-level rise, storms, and sedimentation on circulation and nutrient supply in the Bay.

9.1.7.4.7. Florida Bay ecosystem history

Although considerable effort is going into understanding the nature of the observed stress on the ecosystem of Florida Bay, there is little knowledge of what conditions were like prior to anthropogenic influences and what, if any, natural ecosystem cycles existed in the past. This project compared modern, historic and prehistoric biotic assemblages in sediments beneath the Bay. Data on non-anthropogenic salinity distributions, algal blooms and red tides assisted in establishing goals for remediation efforts.

9.1.7.5. Data base development

Color infrared digital orthophoto maps will not only serve as a base-map source for the work of all Federal and Stage agencies engaged in Everglades restoration work, but will also greatly assist efforts to map vegetative cover. This project provided current and enhanced digital orthophoto format data to replace outdated topographic quadrangles. The digital format of the maps provided maximum flexibility to users. A 1:500,000 regional base map prepared from rectified satellite imagery will also be produced by this project.

9.2. State of Florida

9.2.1. Florida Department of Environmental Protection

9.2.1.1. Florida Geological Survey

The Florida Geological Survey (FGS), as part of its ongoing coring and auger drilling programs, is collecting lithologic samples that are utilized in geologic research projects such as aquifer studies and surface geologic mapping in the south Florida region. The FGS maintains these samples as well as those contributed from other sources such as the SFWMD, private water wells, and others, in a core library/repository in Tallahassee. Descriptions of these samples are entered into a computer database. The locations of the core or auger holes are spotted on Dept. of Transportation Highway maps. The FGS is currently conducting a geologic framework study of the lower Floridian aquifer system that utilizes this data base. The FGS also collects and maintains a borehole geophysical log data base for wells in the South Florida Region.*

9.2.1.2. Bureau of Information Systems Geographic Information System Program

The Bureau of Information Systems Geographic Information System (BIS GIS) program gathers and maintains data layers which are used across multiple programs in the agency. Currently, these are used primarily for environmental regulatory and assessment projects. Land use, soils, transportation, public land survey, boundaries, hydrography, surface water sheds,

* W. Schmidt. Florida Geoloaical Survey, 903 Tennessee St.,. Tallahassee, FL 32304-7795. 904 488 9380.

ground water quality, LANDSAT satellite imagery, census data, and NWI data are being collected state-wide, for input into this system.[Δ]

9.2.1.3. Park Management

Each nesting season, sea turtle population trends and nest surveys are conducted along shorelines. Data collected includes nesting locations, species type, strandings, survival rates, predation, and false crawls. Shorebird and wading bird data is also collected along shorelines. Nesting and resting areas, species type, number of nests, rookery locations, and nesting patterns are compiled quarterly. Water quality data are collected in several areas. Park roadways and adjacent highways are monitored daily for roadkills and the number and species type are recorded. Exotic species removal takes place in several regions. Species type, number removed, methodology for removal, and general trends of exotic species invasion is collected and entered into a database. Each state park collects data for its plant and animal inventory. This inventory includes vertebrates, invertebrates, and native and exotic plant species.[◊]

9.2.1.4. Federal Facilities

The Federal Facilities Program provides direction regarding assessment and cleanup at military installations. Site assessment includes the collection and analysis of groundwater, surface water, soil and sediment samples as well as ecological assessments. Homestead Air Force Base and the Key West Naval Facility are the closest military installations to Florida Bay.

9.2.1.5. Artificial Reef Program

The Office of Fisheries Management Artificial Reef Program administers grant money for construction of artificial fishing reefs throughout the state. Some US Fish and Wildlife Wallop Breaux Sportfish Restoration Money and Saltwater Fishing License revenue grant money has helped finance artificial reefs in the Dade and Collier County areas in the past and will probably continue to do so. Approximately 84 artificial reefs used for fishing and diving are located between the Dade/Broward Line and old Rhodes Key, most in Federal Waters, some in state waters. Another unknown number are in the Florida Keys. Collier County has nine permitted reef sites between 2.5 and 9 mi offshore. Monroe County formerly had 13 permitted artificial reef sites all of which have expired, leaving only two active artificial reef permit sites in the keys. Limited information will be available in the future in the form of qualitative fish census related data obtained from compliance spot checks of reefs built with state or federal money. No artificial reef grants have been given to Monroe County in the past two years. The role of the artificial reef in the Florida Keys National Marine Sanctuary, other than as mitigation in grounding incidents, has not been finalized.[s]

9.2.1.6. Surface Water Quality Data Collection and Assessment

Surface water quality ambient monitoring data are collected by the Division of Water Facilities Bureau of Surface Water Management and a variety of regional, county and city governments. The data are stored in the EPA STORET water quality data base. The Bureau oversees the Florida portion of the data base and provides training in retrieval of the data. The data are also assessed in the 305(b) statewide water quality assessment which is produced every 2 yrs. The

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[◊] M. Glisson. Department of Environmental Protection, Division of Recreation and Parks, 3900 Commonwealth Blvd.,. Mail Station 53Q, Tallahassee. FL 32399-3000.

[s] J. Dodrill, Environmental Administrator, Office of Fisheries Management, MS 240. B. Mostkoff, DERM, Miami, FL. 305 372 6699. K. Dugan, Reef Coordinator, Collier County. 813 774 8454.

report presents status of the waters and trends. The report uses 4,400 watersheds throughout the state and presents results for each watershed which contains STORET data. A qualitative nonpoint source assessment using the same watersheds and based on questionnaires sent to local experts is also presented.[n]

9.2.1.7. Florida Marine Research Institute

The Florida Marine Research Institute (FMRI) is collecting data in the entire coastal region but at different levels in different regions. General projects developing data in Florida Bay include, algal bloom mapping, phytoplankton distribution and production, juvenile and resident fish population monitoring, surveys of crustacean and molluscan microfauna, bay scallops, spiny lobsters, sponges, water quality circulation, benthic mapping of 26 community types, seagrass and macroalgae monitoring, endangered marine species monitoring. mangrove monitoring and mapping, coral monitoring, marine facilities locations, and commercial fishery landings. FMRI has been developing a GIS database for the region to be used by the public and researchers and managers. Information being used in digital formats are nautical charts, shoreline, NWI data, benthic maps, water color, bathymetry, navigation aides, road networks, marine facilities, wildlife and endangered and threatened species locations, and scanned USGS 7.5-min quads. The information is from a variety of federal, state, local governments and private entities.[*]

9.2.1.8. Wetlands Regulation Tracking and Assessment

ORACLE-based database and ORACLE forms application house the data and assist in processing gathered information. ORACLE consists of selected information on permits issued by the Department of Environmental Protection, including site location, permit type, size and nature of impact, acreage and types of wetlands lost, created, enhanced, and preserved. Benefits include accurate information on potential and actual impacts of permitted projects in the State of Florida. Information will be accessed by government agencies.[Δ]

9.2.1.9. Living Marine Resources

This pilot project consists of development of a Geographic Information System to begin a statewide dock inventory. It will facilitate the Bureau of Submerged Land and Preserves in the Review and authorization of docks on state owned lands by providing a computerized method to display geographic data and to assist the impact of new dock construction on the submerged and emergent resources including seagrass, mangroves, and hardbottoms. The GIS system includes land title information, aerial photography, historical records, and ground truthing for submerged lands.[◊]

9.2.1.10. Water Quality Monitoring of Western Florida Bay

The FDEP conducts water quality sampling and analysis of surface water of the southwest Florida shelf in an area extending westward form the west coast of Florida between Cape Romano and the Florida Keys to a line running north from Key West. The project monitors

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nutrients, chlorophyll, and other water quality parameters. This is an extension of the Florida International University (FIU - ENP - SFWMD network.*

9.2.2. Florida Game and Fresh Water Fish Commission

9.2.2.1. Nongame Habitat Protection and Restoration

The Florida Game and Fresh Water Fish Commission (FGFWFC) maintains a GIS database containing information pertinent to habitat protection for nongame and endangered species. The primary data layers include land cover from LANDSAT imagery, conservation areas, hot spots of biological diversity for 54 vertebrate taxa, and critical wetlands.•

9.2.2.2. Nongame Wildlife Survey and Monitoring

The Bureau of Nongame Wildlife maintains the Wildlife Observation Database (WILDOBS) of spatially-referenced occurrence records for selected nongame species. The Bureau also maintains the Florida Breeding Bird Atlas database which includes records of the status of breeding birds in Florida within each block of a grid system covering the entire state.Δ

9.2.2.3. Wildlife Research

The FGFWFC Bureau of Wildlife conducts survey and monitoring programs to determine statewide status and trends of Florida panther, brown pelican, and bald eagle populations. Status and trends studies are also conducted for specific areas of the state. In South Florida, black bear, Florida grasshopper sparrow, snail kite, and American crocodile studies have been conducted.◊

9.2.3. Florida Coastal Management Program

The Department of Community Affairs of the Florida Coastal Management Program maintains the Coastal Information Exchange Bulletin Board System (CIE-BBS), an online information for environmental professionals statewide.•

9.2.2. South Florida Water Management District

The South Florida Water Management District (SFWMD) was instituted in 1949 to manage the system of canals built by the Army COE in South Florida. SFWMD jurisdiction boundaries, drainage basin, shorelines and other parameters can be obtained from the District office.* Two of these canals, the C-111 and Taylor Slough (S174), directly impact Florida Bay, and freshwater flow in these two systems can be directed either to the southwest (Taylor Slough) or the southeast (C-111) (Ley, 1994). Prior to 1987, the system was operated so that greater flows were diverted towards C-111. Recent operations have sent greater flows towards the

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• R. Kurtz, Florida Game and Fresh Water Fish Commission, 620 S. Meridian St., Tallahassee, FL 32399-1600. 904 488 6661.

Δ G. Reynolds, Florida Game and Fresh Water Fish Commission, 620 S. Meridian St., Tallahassee, FL 32399-1600. 904 921 5982.

◊ T. Logan, Florida Game and Fresh Water Fish Commission, 620 S. Meridian St., Tallahassee, FL 32399-1600. 904 488 3831.

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Taylor Slough. The SFWMD plans to expand its monitoring network. In partnership with the Everglades National Park, data acquisition has been intensified in the freshwater wetlands of Taylor Slough, the transition zone south of C-111, and in Florida Bay. The SFWMD is monitoring water quality, salinity, groundwater, and surface water over an intensive network of stations.

9.2.2.1. GIS Database

The SFWMD maintains a GIS database containing existing and future land use/cover, water permit information, monitoring station sites, hydrography data including canals, rivers, lakes and streams, structures, demographic data, transportation, soils, and others. Water use permit boundaries of the properties that the permits are issued to are also included.*

9.2.2.2. Hydrography

A set of DLG hydrography data from USGS is maintained in a SFWMD database in the original 1:100.000 quad maps. The District is working on a more detailed hydrography data layer derived from 1:24,000 scale quad maps.*

9.2.2.3. Public land

The public land data contain the boundaries of public owned lands which consist of Save Our Rivers lands, state and federal lands, Indian lands, conservation and recreational lands, and water conservation areas.*

9.2.2.4. Demographic data

The coverage was developed from the US Census Bureau TIGER files, and the attributes and records are from the 1990 Census count. The data are divided into population (62 attributes) and housing (59 attributes). The coverage contains two different levels of geography, the Census track, and block groups.*

9.3. Academia

The two largest universities in the South Florida are the UM and FIU. These two institutions have conducted research in Florida Bay for many years. Other universities in the state, such as Florida State University and the University of Florida, have also been active. Brief summaries of activities of the South Florida based universities are included below. Other universities that conducted studies in the area can be found in the list of permits issued by ENP for work in Florida Bay in recent years (Table 15).

9.4. Local agencies

9.4.1. Dade County

Dade County's Department of Environmental Resources Management (DERM), working jointly with the SFWMD, conducted a water qualtiy and biological monitoring program in northeast Florida Bay. The C-111/Taylor Slough water quality and biological monitoring project began in October 1993. The purpose of the project is to monitor water quality and benthic vegetation in response to changes in water management practices of the C-111 canal and increased water delivery to Taylor Slough. Dade County DERM also conducts expeditious monitoring of water quality during events of large pulse discharges to northeast Florida Bay and Manatee Bay.

The C-111/Taylor Slough Water Quality and Biological Monitoring Program involves monthly visits to a series of stations in northeast Florida Bay in the region from Little Madeira Bay east to US Highway 1. Physical water quality parameters measured at the surface, one meter, and bottom of each station include temperature, pH, conductivity, oxidation/reduction potential, salinity, dissolved oxygen, and photosynthetically active radiation. Biological parameters include seagrass shoot and blade density by species, and seagrass standing crop biomass.

9.4.2. Monroe County

As of this writting, the environmental programs conducted by Monroe County focused on land and freshwater not on Florida Bay.

9.5. Private sector

9.5.1. The Nature Conservancy

The Florida Bay Watch Program[◊] of The Nature Conservancy, which became active in March 1994, has a two-fold mission in Florida Keys: to collect valuable scientific information about the health and status of the Florida Bay ecosystem and to involve concerned citizens in the Keys in formulating solutions for the problems of the Bay. Program participants will learn about environmental monitoring and observation of the cycles and responses of natural systems that are influential in the livelihood and lifestyle of area residents. The deteriorating water quality in Florida Bay is affecting commercial and sports fishing in the Bay, and commercial fishermen were among the first to recognize and report the problem.

The Florida Bay Watch Program trains and empowers volunteers to monitor water quality and related phenomena in the Bay and adjacent waters. Volunteers are collecting scientific and observational data such as water quality and associated phenomena, and anecdotal information such as location of fish kills and deformities, sponge die-offs, and the location of algal blooms. Sampling began at nine stations in June 1994 and more will be added. Monthly aerial flyovers are also carried out. A plane flies over the Bay looking for discolored water patches. A scientist with a GPS takes waypoints and maps the areas of discolored water. Then FMRI scientists and Bay Watch volunteers go out and take samples at selected sites. Data for March, April, May, and June will be available by August 1995. The volunteers collect a water sample to be analyzed for algal species, relative abundance, presence of cyanobacteria, chlorophyll, total particulate load, organic and inorganic load. A second sample is analyzed for total P. The volunteers also take hydrometer, thermometer and secchi disk readings, wind speed and direction, current speed and direction, color of the water and note tides for the day. This information is stored at FMRI. Dr. R.Jones, FIU, analyzed these samples for Bay Watch. Benthic sampling, CTD tows and anecdotal information projects began in the summer of 1994. Bay Watch is designed and coordinated to augment ongoing water quality studies conducted by FIU, the FMRI and ENP.

The Nature Conservancy recently completed an anecdotal and historical chronology of events that affected the marine environment of the Florida Keys from 1714 to the present (DeMaria, in press). Excerpts of this work are listed in Table 21.

[◊] F. Decker, Florida Bay Watch Program, PO Box 500368, Marathon, FL 33050. 305 743 2437 or 800 2149BAY.

Table 21. Excerpts of the anecdotal and historical chronology of events that affected the marine environment of the Florida Keys from 1714 to the present prepared by The Nature Conservancy (text as found in draft document except for minor editing) [DeMaria (in press)].

Year(s)	Event
1917	Canals dug in the Cape area for drainage. Before ditches were dug, fishing was not great in that area. Afterward, once the ditches were opened and connected all the lakes to each other, the fishing became phenomenal.
1917	Sponge disease hits the lower Keys.
1918-1923	Everglades Drainage District was formed to cut canals and drain the muck lands of the Everglades.
1919	Lobster regulations in existence.
1920-1963	Intensive time for water management. Conservation areas are enclosed for better management control. Cut off the flow of water going into the northeast Shark River slough which causes seepage problems for the Biscayne Aquifer.
1926	October, large lobster crawl observed off Elliot Key.
	A hurricane blows water out of Lake Okeechobee and drowns many people. Soon afterwards, the Army Corps of Engineers begins building a dike to hold the water in the lake. (Note: The hurricane hit while canals were being dug in the Everglades.)
	Bad year for lobsters fishing in the upper Keys.
	The Upper Keys Highway opens.
1928	Tamiami Trail Highway has some culverts, but is still an impediment to the southward flow of water. It officially opens.
1929	The canals overdrained the area and did not provide for adequate flood protection during heavy rains.
	Work is completed on the Miami, Hillsboro, and North New River canals which are designed to drain the Everglades.
1929-1930	Winter, temperature reaches 32°F numerous times in Miami.
1929-1950	No major changes to water management in the Everglades.
1930s	No lobster in Key West.
1931	Scientists growing conch pearls in Key West.
1932	Unusually cold winter.
1932-1935	Lobster leave the Keys. None around to be harvested.
1934	July, first tourism push by the state of Florida in order to revive the economy of Key West.
Pre 1935	Huge drifts of grass observed in the west Florida Bay area.
	Prior to 1935, the upper Bay is sealed off from other water bodies due to the construction of the railroad, which is almost all filled causeways. There are no bridges from Lower Matecumbe Key to Key Largo and Homestead.
1935	September 2, the Great Labor Day Hurricane hits the Keys. The eye wall passes over Islamorada. Describing the scene during and after the great 1935 hurricane: "Blue, green and gold vistas had turned lead gray". Waves crash over track in Islamorada, which is only seven feet above sea level. Seventeen foot high tidal wave crosses over tracks. Forty two miles of roadbed are washed out. A temporary track of fill was constructed in order to get the old 447 engine free.
	September, mangroves in the middle keys wiped out due to hurricane.
1936	Flood Control Act of 1936 gives the Army Corps of Engineers responsibility for federal flood protection.
1937-1938	Winter is very dry.

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Year(s)	Event
1938	In March, the Overseas Highway is opened which was created on top of the old railroad system.
	"Saw big red shoals of lobsters swimming off Key West."
	There is a fishing wharf at Flamingo where boats are rented out.
	Clear water is found in Florida Bay only when there has not been a great deal of rain or wind.
	Commercial fishers object to the inclusion of Florida Bay as part of the Everglades National Park.
	Sport fishing not as good in Florida Bay proper as in nearby waters.
1939	Sponge blight kills sponges throughout the Keys.
	Winter, severe cold front hits the Keys. Temperature down to 41°F.
	Fish become "paralyzed" due to cold front.
	1940s County law stated that you could only have 200 wooden slated lobster traps.
	The first lobster traps begin being used in the Keys.
1940	Before flood control project, average rainfall in Everglades is 55 in/yr.
Pre WWII	Few boat basins or marinas exist in the Keys.
1941	Algae bloom observed in the area of Rabbit Key, Arsenicker Key, Twin Keys and Ninemile Bank.
	Navy pipeline brings fresh water from mainland wells to Key West, Civilians not allowed to hook up until after the war. The Navy creates an airfield on Boca Chica Key during WW II.
1940s-1950s	Queen conch population plentiful.
	Northeast Florida Bay is muddy all the time, a pale white muddy clay. No real vegetation exists.
Pre WWII	A red tide bloom is observed near Bahia Honda/Harbor Key/Content Key area. This disease almost decimates the sponges as well as killing uncountable tons of fish.
WW II	Key West and Marathon become rejuvenated with military stations and training programs. The navy's water line ensures water supply throughout the chain .
1943	August, 818 pounds of jewfish are caught off Pigeon Key in the span of 90 minutes. Two people catch the fish while fishing from the 7-mile bridge . The largest of the 6 fish is 280 pounds, the smallest is 16 pounds.
	Monroe County Commission issues an order halting the practice of drying shark skins on the No Name Key causeway. (Shark processing plant at the time is located on the eastern shore of Big Pine Key.)
1944	October, hurricane hits the Key West area.
1945	Illegal to catch bonefish in nets and seines. Bonefish used to be sold on the streets of Key West by the "Conchs".
Post WW II	Development boom in south Florida and the Keys. Commercial and sport fishing industries flourish and some tourism begins.
1946	Sponge blight kills sponges throughout the Keys.
1946-47	Major flood in Ft. Lauderdale/Miami area. East coast under water for a while.
1946 or 1947	Two big storms move through the Key Largo area the first six weeks of lobster season.

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Year(s)	Event
1947	On December 6, the Everglades National Park is established. (It was authorized May 10, 1934.)
1947 or 1948	Large lobster crawl observed off Elliot Key.
1948	The Army Corps of Engineers and the State of Florida start work on a comprehensive plan for flood control in central and south Florida.
	Small local hurricane called "Conchita" hits the lower Keys and Key West.
1948, 1950	Square wooden lobster traps become popular in the Keys.
	Whitewater Bay, which used to be white and one of the most productive fishing grounds, turns brown.
1949	South Florida Water management District is established.
1949	"Pink gold" shrimp discovered off Tortugas. Beginning of shrimp boom in the Florida Keys.
1950	Florida Keys Aqueduct Authority expands water lines up the Keys. Population starts to shift.
	Central and South Florida flood control project is begun. East Coast containment levy is built.
1950-1955	Whitewater Bay, which used to be white and one of the most productive fishing areas, turns brown.
1950s	Researchers from the University of Miami, led by ecologist Durbin Tabb, warn of environmental changes caused by the shortage of fresh water in the Florida Bay region.
	Rainfall stays the same (55 in) in the Everglades area. Much water flows out Shark River slough.
	Organized efforts in mosquito control begin. Monroe County provides diesel-based mosquito spray for residents.
	Artificial sponges are developed, commercial crawfish traps are being used in the Keys.
	Coral reef looks "spectacular". High water turbidity due to the large amounts of dredge and fill projects in the Keys.
	Navy begins aerial mosquito spraying.
	Droughts and fires in the Everglades prompt Florida officials to store water during wet seasons for later use by urban and agricultural interests. In the years since, no high fluorescent bands occur in corals.
	Stable population of scallops located in the basin between Rabbit Key and Man of War Key.
	In the fall and winter, a reoccurring, short-lived algae bloom near Buchanan and Arsenicker Keys.
	Big clam bed located off Shark River that reaches out to twelve feet of water (Quahog clams?).
	Late, mechanical pullers come to be used in the lobster fishery.
1952	Monroe County Mosquito Control District created.
	Last known Caribbean monk seal in the Florida Keys killed near Key West.
1954	Levee is built from Lake Okeechobee to Miami to keep Everglades water to the west of the city.

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Year(s)	Event
	Key West ocean outfall sewage pipe is built. Located approximately one quarter mile offshore, east of the shipping channel in 20 ft of water, this pipe pumps raw sewage from the city of Key West into the ocean.
1950s-1960s	Massive population of diadema on the banks.
	Fishing guides fished five miles upstream in Taylor River Slough for largemouth Bass.
1959-1961	Cuban exiles move to the Keys.
1950-1970	Sewage outfall from Miami is placed in the shallow waters of Biscayne Bay.
1954-1959	Drainage district emphasis is on forming the northern boundary of the Everglades Agricultural Area.
1955-1976	Can see the bottom of Florida Bay.
1956, 1957	"Being on Hawk's Channel on a boat is like being on air can see the bottom."
1957	An especially cold winter.
1960	Vaca cut created.
	Hurricane Donna wipes out all of the tall mangroves next to Shark River, near Flamingo, and the middle Keys. The eye moves over Long Key.
	December, John Pennekamp Coral Reef State Park is dedicated. Regarding Pennekamp Park: "no commercial shell, coral, or seaweed hunters would be permitted to destroy the natural beauty of the reef. On days when the ocean is calm, visitors will be able to look down through up to 60 ft of water, so clear that the barracuda, shark and rays swimming beneath them seem uncomfortably close".
1960s	Extension of water management canal system into Dade County.
	Height of Army Corps of Engineers construction activity in South Florida.
	Slight decrease in rainfall in the Everglades area, increased water flow out Shark River.
	Anglos and Cubans have separate fishhouses. Increase in the amount of Cuban lobstermen in the Keys. Anglos will not buy Cuban crawfish nor sell them traps. "Crawfishing is an Anglo trade. Cubans fish for yellowtail, stone crabs, conchs, and turtles".
	Traveling back and forth between Flamingo and Marathon, Florida Bay water is crystal clear all the way.
	Stone crab industry expands and increases
	Muddy sparse *Halodule* seagrass beds are present in northeast Florida Bay.
	A lot of lobsters are caught in international waters and land in Monroe County.
	Scallop bloom in Florida Bay north of Lower Matecumbe Key in the late 1960s. The scallops stay for about two years, then vanish.
	Late, the first lobster traps from the Keys placed in Florida Bay.
	Mid to late 1960s, see a decline in the amount of fish in the upper and middle Keys in the nearshore waters, bayside.
1960s-1970s	Increase in deer herd in the northwest conservation area 3A, due to decrease in water retention. High deer mortality during wet season when standing water is everywhere.
1961	February, Marvin Adams waterway in Key Largo constructed.
1963	Mosquito Control District buys planes and starts aerial spraying.
1965	Hurricane Betsy.

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Year(s)	Event
	Approximately 27 shrimp boats are working out of Marathon, over 300 shrimp boats are working out of Key West.
1965-1974	Alligator Alley is completed. The Miami Canal is deepened.
1966	Hurricane Inez.
1967	C-111 Canal is constructed.
1967 or 1968	Algae bloom associated with the Gulf Loop current and water coming from the north observed off Everglades City.
1968 or 1970	Bad lobster catch year.
1969-1970	In the winter, cold water from Florida Bay kills many of the corals at Hens and Chickens Reef, an inshore patch reef.
1970s	Miami's sewage outfall extends out to deeper water.
	Early crawfish are so thick in Biscayne Bay that men use a light at night to gig them from a skiff.
	You can go up Taylor River (slough) in a boat.
	The water at Mallory docks and in Key West Harbor is clear.
	Mid 1970s, powerheads become popular in the Keys.
	In the late 1970s, water clarity starts going bad, coral reefs start to decline throughout the middle and lower Keys.
	Short-lived green algae blooms observed in the water column at Marquesas.
	Begins to be an increase in the rolling moss brown algae in western Florida Bay.
	Tourism and land development are at a fevered pitch. Steady increase in the population in the Keys and steady increase in water/boat use.
	Steady population growth in the Keys causes steady growth in water usage rate.
	Population of diadema starts to decline.
	A daily bag limit of ten queen conch is established.
	Mid 1970s, lobster traps at Red Bay Bank covered with green slimy algae and filled with "rolling moss" brown algae.
	Late, "watched as areas of traditionally pristine water develop a green tinge" in the west Florida Bay area.
1970s-1980s	Mid to late, increase in live aboard Cuban sponge boat population.
1971	Green filamentous algae bloom observed north of Big Pine Key at the rockpile. Re-occurs every summer afterward for short periods of time.
	Late, areas of traditionally pristine water develop a green tinge in the west Florida Bay area.
1972	Can clearly see a lobster trap in 30-40 feet of water in Hawk's channel.
	Key Largo National Marine Sanctuary is established.
	Indian Key bought by the State of Florida.
1972 or 1973	Notice an algae bloom ten miles west of Sandy Key.
1973	Begin seeing a gradual change in the water clarity near Sandy Key and East Cape.
1973-1975	Increase in the catfish catch in western Florida Bay.
1974-1979	More water is moved into the Miami/South Dade area for flood control.
1975	Winter, water clarity on the reef in the lower Keys averages one hundred feet.
	Keys are designated an "Area of Critical Concern" by the Governor due to rampant development.

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Year(s)	Event
1975-1976	Coral bleaching observed on some patch reefs of the lower Keys in Hawk's Channel.
1976	A state report says that the individual lobster catches are down but the total take of lobster in the Keys has actually increased.
	Federal fishery councils are formed.
	June, the harvest of fire coral, hard coral, and sea fans prohibited in Federal waters under the Continental Shelf Act (struck down in Court in 1979).
	October, the UN designates the Everglades National Park an International Biosphere Reserve.
1977	Hard freeze, considered to be the last real cold spell. Cold water fish die-off, staghorn coral die-off in several shallow waters areas including the Tortugas.
1977-1978	Shrimpers notice a significant lower catch. It is also an extremely dry year.
1978	Red algae bloom observed south and west of Cape Sable.
	Key West Coast Guard opens.
1978 or 1979	Summertime, Zestra Barrel sponges and other large sponges in Big Pine Key Shoals die off.
1979	October, Everglades National Park is designated a World Heritage Site.
	Work on a new and improved road and bridge system is begun in Monroe County.
	Area south and southwest of Cape Sable and west of Sand Key is a lush seagrass area (this is the area to be called the Dead Zone in the late 1980's by commercial fishers).
	Halodule seagrass beds in northeast Florida Bay replaced by turtle grass.
	The development of macro algae blooms starts in west Florida Bay
	The use of Lorans becomes popular in the Keys.
1979-1981	Electric reels in use.
1980	April to June, the Mariel Boatlift results in an influx of Cuban exiles to the Keys.
	June, very hot August, canal water temperatures near 94°F. Fish are on the surface on their sides (possibly due to oxygen depletion). Some minor coral bleaching.
1980-1985	A lot of mullet caught in Florida Bay have "tumors" on them.
1980s	Early, the water in Hawk's Channel starts becoming "dirty".
	Drug money flows into the Keys; development increases; more commercial boats, commercial gear, and recreational speed boats.
	Short-lived green algae blooms observed in the water column off Marquesas.
	Improvements are made to canals surrounding agricultural areas. Water management changed. Reduced deer herd in conservation areas.
	Middle 1980s, significant increase in the population of the Keys.
	Middle 1980s, an increase in moonjellies is observed throughout the Keys.
1981	Water clarity in west Florida Bay starts to decline.
	Looe Key National Marine Sanctuary is created.
	New Seven Mile Bridge is finished. FKAA water line capacity triples.
1981 or 1982	Pea green colored water observed at Rabbit Key Basin.
1981-1986	Decline of western Florida was gradual.

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Year(s)	Event
1982	Around 1982, John Stevely (Sarasota Sea Grant agent) and wife encounter a pea soup green algae bloom at Rabbit Key that allows for less than six inches of visibility.
	Many shrimp boats are being sold due to fishing regulations.
	Ricordia coral on top of Looe Key. By 1985/86, the Ricordia moves out of the direct flow of water moving over Looe Key and into the areas where there is cooler water.
	Hot weather and warm water, sponge dieoff bayside of Grassy Key and Long Key (yellow and wool sponges).
	July, coral bleaching observed in the lower Keys from Looe Key to Western Dry Rocks.
	Start of seagrass die off west of Sandy Key. Diadema (sea urchin) dieoff in Florida, the Bahamas and the Caribbean (lasted a year).
	Area of green water observed in Plantation Yacht Harbor and near the Coast Guard Station.
	Juvenile conch released at Pennekamp.
	Water clarity becomes noticeably bad; corresponds to the completion of the new bridges.
	Water clarity in the shallow water area starts to decline. Prior to 1983, water along Keys described as "gin clear".
1983	State fishery council is formed.
	Army Corps of Engineers starts to draw down the L-31W canal due to increase in water going into Shark River Slough.
1983-1984	Longsnout butterfly fish become displaced; move to deeper water. Crinoids disappear from the shallow waters off the lower Keys.
	Disappearance of crinoids on the reef in the Lower Keys.
1984	Freighter Mini Laurel grounds at Molasses Reef.
	Beginning 1984, there is a 4% loss of coral cover at Looe Key and Key Largo.
1985	Queen conch declared a protected species.
	South Florida Water Management District changes to a more natural way of water control management.
	Hurricanes Elena and Kate cause the fragmentation of corals, especially staghorn and elkhorn varieties.
	Approximately 750 full-time Keys' commercial crawfishers. Cubans represent 50% in Key West, 5% in the lower Keys, 15% in the middle Keys, and 20% in the upper Keys.
	Sponge disease/blight hits the Mediterranean.
	Conch moratorium (the taking or harvesting of conch is prohibited).
	The productive shrimping area moved to the west. It used to start at Smith shoals. Now the productive shrimp area starts at New Ground, northwest of Marquesas.
	A brown, slimy, grass-like algae bloom observed all throughout the water column at Tortugas.
	Large areas of seagrass die off observed in western Florida Bay. Also, a change in the kind of algae blooms is observed.

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Year(s)	Event
	Large areas of seagrass die-off near Johnson Key and East Bahia Honda.
1985-1986	Outbreak of black band disease at the Sambos.
	Change in water clarity observed off Marathon, bayside and oceanside.
	Start catching less fish in the Sprigger Bank area. "The gorgonians died then the water went to hell and turned muddy, no clarity."
1986	January, all commercial fishing prohibited in the Everglades National Park.
	March, water temperature off Key West is 46°F.
	In May, outbreak of black band disease at Looe Key.
	Change in water clarity becomes noticeable off the lower Keys.
	1986-1987 From July to June, there was a 40% decrease from the average in the shrimp catch on the Tortugas grounds.
	Good year for crawfish catch in west Florida Bay.
1987	January, had very low tides.
	In June, period of slick calm, hot water. Coral turned off color. Significant coral bleaching in the Florida Keys.
	In June and July, low oxygen content in the waters of Florida Bay.
	August, coral bleaching observed and documented throughout the Caribbean.
	Scallops moved into the area called the "smokehouse" near Smith Shoals and the shrimp moved out. In 1992, shrimp return to that area and the scallops disappear.
	Practically every fishhouse in Key West area up for sale due to high land prices and the demand for marinas for yachts.
	Fall, seagrass (turtle grass) dieoff in Florida Bay is documented in the Rankin Lake, Cross Bank and Rabbit Key area.
	Fall, algae bloom observed at Sprigger Key up to Oxfoot Bank.
	In October, coral bleaching observed throughout the IndoPacific.
	One of the hottest winters on record.
1987 or 1988	Water clarity and quality decline in Florida bay begins to become more severe.
1987-1988	Worms and barnacles on wooden traps begin to cause serious problems.
	Phenomenal year for crawfish catch in west Florida Bay.
1987-1990	Scientific evidence shows a significant increase in the adult queen conch on the reef. Concurrently, there is a significant decrease in juveniles in the seagrass areas.
1988	Big outbreak of sea lice in south Florida.
	August, the C-111 canal (Aerojet Canal) plug is pulled. Two weeks of uncontrolled fresh water flows into Barnes Sound.
	October, major fish kills in the upper Keys due to release of massive amounts of fresh water into Barnes, Blackwater, and Florida Bays.
1988-1989	Great bait shrimp year at Manatee and Barnes Sounds. Manatee Bay by 1992 is no longer a good shrimping area.
	Wooden traps in Tortugas start getting barnacles.
	Good lobster catch year in west Florida Bay.
	From November to January, seagrass die off observed in north Key Largo next to the Park boat dock at Sunset Cove.
1988-1990	Drought in south Florida, much seagrass decays and dies in Florida Bay.

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Year(s)	Event
	Big freeze in Southern Florida.
	Coral bleaching observed on the shallow water coral heads off of Key West.
1988 or 1989	Begin seeing a change in the visibility in the water along the shoreline at Long Key Lab (bayside).
	Macroalgae bloom covered the patch reefs in Hawk's channel out to Tortugas Hump.
1989	Water restrictions placed on South Florida residents due to drought.
	East Everglades Land is added to the Everglades National Park.
	February, sewage treatment plant built in Key West. Secondary treated sewage goes to the ocean via the old outfall pipe.
	Summer, minor coral bleaching event, mainly hits lettuce coral in the Keys, Puerto Rico, and Lee Stocking Island Bahamas. The mangroves and adjacent shallow areas off Key West stop "growing" and erosion from boat wakes become more obvious.
	Sea lice ("bathers itch") noticed off key West and the lower Keys.
	December, hard freeze in South Florida.
	Winter, big freeze kills many mangroves in the northeast Florida Bay area that were already stressed due to dry weather conditions.
1989-1990	Low rainfall years (drought), high temperatures and hot water temperatures (large amount of hot water) in the Caribbean (Cuba area to the Gulf of Mexico).
	Crawfish catch in western Florida Bay declines.
1990	February, very low tides.
	High salinity levels are recorded in Florida Bay.
	The decline in water clarity and quality become really noticeable on the reef off Key West.
	In July and August, significant coral bleaching in the Keys. 65% of the fire coral dies.
	Hot water temperatures recorded. Coral bleaching not confined to the reef, also hits the patch reefs and inshore corals.
	Algae bloom observed at Cotton Key near Islamorada.
	Very fine brown/green algae bloom observed off Long Key Lab in the water column.
	Summer, between Man of War Harbor and Pearl Basin, north of Key West, the gorgonians, seafans and conchs disappear from the area.
1990 or 1991	Green filamentous algae bloom at the Rockpile, north of Big Pine Key, starts becoming really bad.
1990-1993	The shallow patch reefs near the small islands west of Key West have become undiveable due to poor water clarity.
1991	Chekika land is added to the Everglades National Park.
	January, "pea green" algae bloom in Florida Bay first noted by a scientist. Others notice bloom at Sandy Key basin and Sandy Key Bank.
	Some turtle grass starts to recover in the "lost" areas of Florida Bay only to die off again.
	Diadema dieoff at Vestal Shoals, off Key West.
	South Florida Water Management District increases fresh water flow into Taylor Slough during April and May.

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Year(s)	Event
	Algae bloom in the water column at Tortugas (see 1985).
	Summer, large amounts of sargassum wash up on gulf coast shores.
	Brown macroalgae bloom observed near Tortugas Hump.
	Algae blooms in western Florida Bay become dominated by microalgae blooms.
	December, algae bloom off Long Key Lab exists for four days along the shoreline. All sponge harvesting is stopped in Biscayne National Park.
1991-1992	Cyanobacteria algae bloom spreads throughout Florida Bay. Sponge dieoff is documented. Juvenile lobster abundance subsequently declines by more than 30%.
	Good bait shrimp catches off Lower Matecumbe Key near the location of the algal bloom in Florida Bay.
1991, 1992	Summer, water "inversion" off the middle Keys out to Alligator Reef. Hot salty water on the bottom. White hydrogen sulfide type bubbles coming up from the reef. Dead fish and gorgonians observed.
1992	Dry Tortugas is declared a national park.
	February and March, very high tides and very low tides observed.
	May, barrel sponges observed dying on the reef off Marathon.
	May, sponge mortality in Florida Bay noted.
	Between July and September, extensive sponge mortality noted in Florida Bay.
	July, salinity levels in Florida Bay fall below sea water levels.
	August, Hurricane Andrew hits Homestead and moves west across the Everglades, killing mangroves and causing excess detritus to be flushed into the water.
	December, sponge die-off observed on the east side of Big Pine Key.
	December, algae bloom off Long Key Lab lasts for sixteen days along the shoreline.
	Visibility at Schooner Bank declines.
	Massive macroalgae bloom in western Florida Bay. Clogs strainers and intakes on boats.
	In Card Sound, a white fungus is observed growing on seagrass beds.
	Extensive sponge mortality noted between July and September in Florida Bay.
	Black band disease is observed near Jewfish Basin, north of Boca Chica Key.
	Last Marathon shrimp boat sold. Only a couple of shrimp boats still exist in Stock Island and Key West.
	Increase in decorator crabs observed on the bayside of Lower Matecumbe Key in the nearshore, shallow waters.
	Sea lice abundant.
1992-1993	"Tremendous amount" of moon lilies observed in Florida say and Boot Key Harbor.
	Winter, cannonball jellyfish observed off Key West and Marathon.
	Best bait shrimp catches are out of Card and Barnes Sound.
	From November to January, a sponge die-off is observed five miles north of Grassy Key.
	Winter, pea green algae bloom is observed as having crossed into the ocean.
1993	South Florida Water Management District increases water flow into Taylor Slough to a natural sheet flow.

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Year(s)	Event
	January and February, green bloom water from the Bay moves over the reef.
	Before March, "Storm of the Century", the surface water temperature off Key West is 75°F. Fifteen feet below the surface the water temperature is 71°F.
	March, "Storm of the Century" front moves from Tortugas, northeast through the Gulf of Mexico. Winds are clocked at 109 mph at Ft. Jefferson.
	March, population of diadema increasing in the nearshore waters off Long Key.
	March, July, and August, green phytoplankton bloom observed south of Marquesas, on the reef tract. Zero visibility.
	May, fishers from Duck Key tell of large pods of white and blue marlin in 1000 feet of water. Describe the water color from stream to shore as being dark blue, to aquamarine, to a light blue, to a green near the shoreline.
	May, fifteen horseshoe crabs observed dead and washed into a canal system on the bayside of Key Largo.
	July, great Upper Mississippi River floods.
	July, coral bleaching documented at Sand Key, Rock Key, and Western Dry Rocks to a depth of 60 ft, and includes stony corals, sea mat, sponges, and fire coral. The seawater temperature at that time was 30.9°C, indicating that the lower Keys reef tract was experiencing thermal stress.
	August, off Key West the water is hot and coral bleaching is observed.
	"The freshwater in the canals in the southern everglades is higher than ever before (since 1978)."

9.5.2. The Audubon Society

The National Audubon Society (NAS) has maintained a science center in Tavernier on Plantation Key since 1939. This was the first NAS field science station. NAS scientists at this facility have conducted ecological research in Florida Bay, the terrestrial Florida Keys, and the southern Everglades. Research areas and topics include wading bird ecology, migratory bird conservation, seagrass ecology, fish ecology, habitat conservation, forest ecology, marine geology, and the ecological effects of altered freshwater inflow in the Florida Bay-Everglades ecotone. These studies were conducted by Allen (roseate spoonbills and other research projects involving Florida Bay), Bancroft (white-crowned pigeon breeding and foraging ecology, overall Keys ecology), Bjork (roseate spoonbills nesting and feeding ecology, and effects of reduced water flows to Florida Bay and to the C-111 Basin), Hoffman (vegetational composition of Florida Bay key berms and the relationships with white-crowned Pigeons and hammock tree species), Lorenz (influece of freshwater inflow patterns and salinity fluctuations on fish assemblages in the Florida Bay - Everglades ecotone), Meeder (geological studies on Florida Bay sediments and bedrock), Morrison (seasonal and longer-term patterns in benthic macrophyte communities in Florida Bay along upper Keys, influece of freshwater inflow patterns and salinity fluctuations on benthic macrophyte and invertebrate assemblages in the Florida Bay -Everglades ecotone), Paul (reddish egrets in Florida Bay and other projects), Powell (great white herons studies, roseate spoonbill studies, sea grass studies, nutrient studies, coral studies, and others), Ross (habitat characterization study of Florida Keys, effects of Hurricane Andrew on upper Keys forest structure), Sprunt (wading bird studies in Florida Bay, research study of bald eagles, white-crowned pigeons in Florida Bay and the Bahamas), and others.

10. OTHER EVENTS

10.1. Mercury levels in Everglades

Increasing Hg contamination in the Everglades has been noted in the literature (Rood *et al.*, 1993; Barkay *et al.*, 1994; Guentzel *et al.*, 1994; Rood *et al.*, 1994; and others). Newspapers and magazines have been actively reporting on this problem, attributing the Hg contamination to smoke stacks (Staff, Miami Herald, 1993; Zaneski, 1993; and others). Further efforts to understand the Hg problem continue.

10.2. Lead in gasoline ban

Use of alkyl lead in gasoline began after 1940 and ended in the early 1970s.

Shen and Boyle (1987) used a sample of the coral *Monastrea annularis* collected 1 km from shore at 4 m depth at the Hens and Chickens Reef in 1978 and 1983 respectively to reconstruct historical industrial Pb fluxes to the ocean surface. Samples were also collected at other sites worldwide. This survey of stable Pb and Pb isotopes in corals from four major ocean basins confirms (by independent means) the previously-inferred anthropogenic dominance of Pb found throughout the surface ocean today, and over the past century. Shen and Boyle (1987) found that the Florida Keys maintained a surface water concentration of 38 pM Pb until about 1930, which was probably supported by shelf/resuspended Pb inputs. Levels grew gradually to a peak of 190 pM in 1977, followed by a decline to 142 pM in 1982. Relative to the Bermuda records, the Florida coral lacks a strong industrial revolution signal and exhibits a moderated post-World War II Pb increase and muted maximum. These patterns reflect dilution of US Pb sources and delayed response due to long-range horizontal transport.

10.3. DDT and other pesticides

DDT (4,4'-DDT), or 1,1'-(2,2,2-trichloroethylidene)bis[4-chlorobenzene], was first described early in the century and resynthesized during the late 1930s as part of a research program at Geigy (Stetler, 1983). This program was a search for a contact insecticide characterized by a long duration of activity. Following the discovery of the pronounced insecticidal properties of the new agent and the registration of the first patents in 1940, the product, formulated in Switzerland, was introduced to the market in the spring of 1942 for use in crop protection and hygiene. The epidemic-promoting circumstances of World War II and the post-war years brought about increased and effective use of DDT in the field of medicinal hygiene. Malaria, typhus, typhoid fever, and cholera were drastically reduced by the effective control of *Anopheles* mosquitoes, lice, and flies of all types or, as in the case of malaria, were virtually eradicated in many countries. It has been estimated that almost 1 billion people in all parts of the world have been saved from malaria by the use of DDT.

4,4'-DDT is metabolized by the loss of a chlorine to yield the non-insecticidal 4,4'-DDE {(1,1'-(dichloroethylidene)bis[4-chlorobenzene]}, and by the substitution of a chlorine by a hydrogen to yield 4,4'-DDD {(1,1'-(2,2-dichloroethylidene)bis[4-chlorobenzene]}. DDT and some of its metabolites are toxicants, with long-term persistence in soil and water. They are widely dispersed by erosion, runoff, and volatilization, and accumulate in adipose tissue in wildlife and humans. The pronounced contact activity of DDT is due to the highly lipophilic character of the compound, which enables it to penetrate the insect cuticle. According to some biochemical models, a disturbance in the sodium balance of the nerve membranes, caused by the "fit" of the DDT molecule, is responsible for the poisoning of the insect. Buildup of resistance to DDT is connected with the enzyme catalyzed conversion into inactive DDE. DDT coatings on solid surfaces have a considerable duration of activity. Acute mammalian toxicity is relatively insignificant.

Restrictions introduced by most Western industrialized countries on the production of DDT and other chlorohydrocarbons at the start of the 1970s have reduced use of chemicals to a fraction of the original quantities. The use of DDT was banned in the US in 1972. The special situation of the Third World countries, however, resulted in production peaks (on a worldwide basis) as late as the mid-1970s. Without sufficient quantities of DDT and dieldrin, the World Health Organization is unable to fulfill its vector-control programs.

In a study published in 1974, Ogden *et al.* (1974) found DDT, DDE, DDD, dieldrin, and PCBs in concentrations well below amounts known to have either acute or chronic effects on species from Florida Bay. Chlorinated pesticides and PCBs in melon tissue from Atlantic bottlenose dolphins (*Tursiops truncatus*) and pygmy sperm whales (*Kogia breviceps*) collected in Florida Bay were determined by King (1987).

10.4. PCBs ban

Polychlorinated biphenyls (PCBs) are widely distributed in the environment, and have no known natural source. PCBs were manufactured by Monsanto and were available in the US from 1930 to 1977 as a series of mixtures of congeners called Aroclors, having different average compositions of congeners. PCB concentrations have also been reported as Aroclors (EPA, 1993). There are 209 congeners, having from one to ten chlorines. Twenty of these congeners have non-ortho chlorine substitutions and so can attain a planar structure which makes them similar in structure to the highly toxic polychlorinated dibenzo-*p*-dioxins and dibenzofurans (McKinney *et al.*, 1985; Sericano *et al.*, 1991). In the scientific literature, total PCB concentrations are often reported and these values are calculated based on the response factors of PCB congeners representative of each chlorination level.

10.5. Mosquito control

From June 3 to 14, 1979, a pesticide use observation study was conducted by the National Enforcement Investigations Center in Monroe County (Anonymous, 1980). During the study, an EPA team evaluated the environmental effects resulting from the aerial application of Naled (Dibrom-14) and ground application of Baytex for the control of mosquitoes. A reconnaissance survey in March of the marine environment in the ENP revealed no pesticide residues were detected prior to the initiation of the mosquito control program by Monroe County.

11. DISCUSSION

[As this document was going to press, the Florida Bay Science Conference took place in Gainesville, FL. The conference proceedings contains abstracts by the major investigators working in Florida Bay (University of Florida and Sea Grant Florida, 1995). These abstracts are not included in this compilation.]

11.1. Subject distribution of published literature

More than 750 citations and data sources were collected during the preparation of the time line for Florida Bay. Of these, 599 were published works on Florida Bay. The abstracts of the Florida Bay citations in chronological order are in Appendix I. The other collected works include citations to historical events, global phenomena and other topics. The subject distribution of the Florida Bay citations is listed in Table 22 and shown in Figures 14 and 15. It should be noted that often the same authors publish several papers using the same study results and these were counted as separate publications. Some papers summarize large data sets and these have been counted as a single publication. Some papers are very short and general in nature and were included for completeness.

The geology of Florida Bay has been well characterized. Approximately one third of the citations found are on the geology of the area. Most papers discussed the evolution of the Bay and the formation and stratification of sediments. Little information was found on pollutant levels in sediments. The climate and oceanography of the Bay are covered. It is known that unpublished sources of oceanographic data exist. Some aspects of the biology of Florida Bay are well covered. Almost half of the citations founds cover biology. The largest number of citations on fauna are on fish and crustacea. There were few citations on marine mammals.

11.2. Time lines

The chloronological sequence (time line) by date of sampling (if known) or in the case of calculated or inferred parameters, by the earliest date determined, are listed in Appendix I and II and shown in the figures in Appendix III. Geological studies describing formation of geological features in the area are listed by publication date. It has been surprising that a large number of citations, including thesis and dissertations, do not list sampling dates. It is obvious that the number of citations has increased steadily with time.

Few papers on seagrasses in Florida Bay were found published prior to the dieoff. The best source of information about dieoffs prior to the late 1980s dieoff is the anecdotal data collected by DeMaria (1994). It must be remembered that simply because little information about instances of seagrass dieoffs prior to the late 1980s have been found, does not mean that these did not occur. They were simply either not recorded in the printed forms examined thus far, the dieoffs occurred prior to interest in adverse environmental phenomena and so were not

Table 22. Subject distribution of published citations on Florida Bay included in this study.

General papers			19
Climatology			19
Geology (total)			170
Field guides		5	
General		16	
Evolution/development/stratigraphy		23	
Sea level rise		6	
Sediments/Sedimentation		59	
Sediment and interstitial water chemistry/composition		31	
Mudbanks and basins		20	
Peats		10	
Hydrography and suspended particulates			16
Water chemistry			14
Freshwater management and soil subsidence			11
Biology (total)			339
General		8	
Microorganisms		33	
Flora (total)		64	
General	4		
Algae	10		
Seagrass	37		
Mangroves	13		
Fauna (total)		234	
General	7		
Corals	16		
Echinoderms	3		
Crust	69		
Fish	81		
Birds	19		
Reptiles	25		
Mammals	14		
Pollutant studies			6
Related studies			15
Total			610

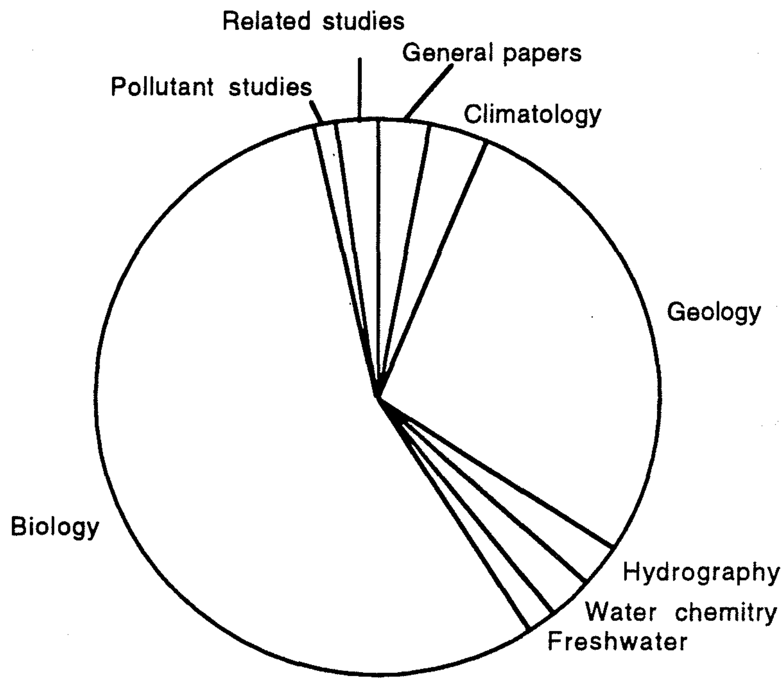

Figure 14. Distribution of citations by subject.

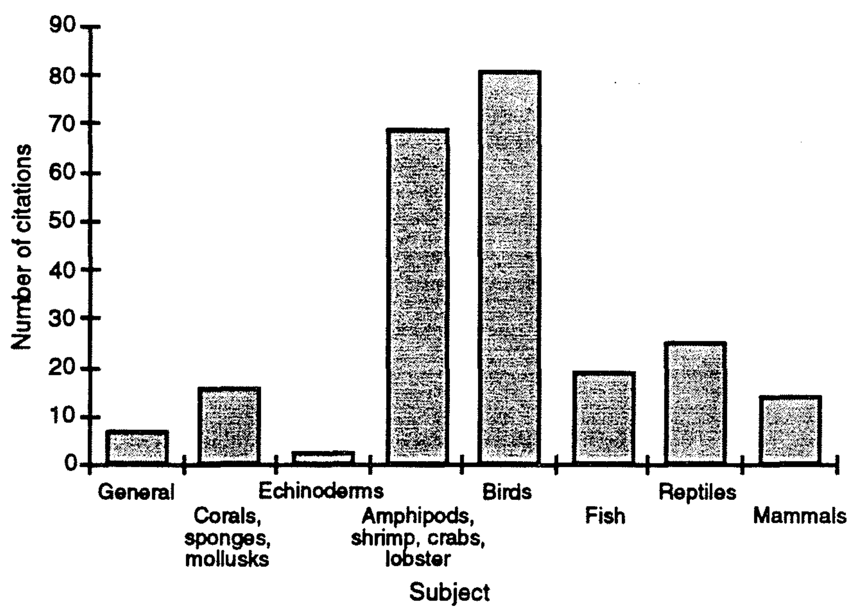

Figure 15. Distribution of citations on fauna by subject.

recorded, and/or individuals with knowledge of such dieoffs have not come forward. There is evidence that the seagrass dieoffs and other adverse environmental effects, such as coral disease may be related to temperature extremes, especially if the affected biota is under stress due to high or low salinity.

Also included in the time line in Appendix III are the dates of significant events and legislature related to or affecting Florida Bay.

11.3. Information needs in Florida Bay

There is insufficient or no information on several types of data necessary to adequately describe the current status of Florida Bay and any changes that may be the result of the increased fresh water flow into the area. Determination of baselines of these parameters is needed. The data needs include suspended particulates; pollutant levels; nutrient loadings; marine mammal population; and others. Also further search of historical records in the Florida Keys may supplement the anecdotal information collected by The Nature Conservancy.

12. CONCLUSIONS

Although the case cannot be proven since little data is available prior to the flow restrictions, the decreased freshwater flow into Florida Bay may be only one of the causes of the changes in the Florida Bay ecosystem. The ideal goal for the restoration of the South Florida ecosystem is to restore to predrainage conditions. The restored ecosystem should be resilient to chronic stresses and catastrophic events with as little human intervention as possible (Science Subgroup Report, 1993).

The predrainage conditions of the Florida Bay ecosystem are not well characterized.

Left alone, the Bay ecosystem will become a balanced system, probably different from the one present prior to man's influence in the region.

An increase in freshwater flow in the ENP will shift the present ecosystem, resulting in dieoffs and shifts in species distribution until a balance is once again achieved.

Global weather cycles may affect the Bay as changes in temperature and rainfall in the area or upstream will have an impact. These cycles may be longer than the time observations available. There may be a delay in ecosystem response to variations in solar fluctuations and global weather patterns.

The effect of hurricanes to the South Florida ecosystem can be considerable yet the ecosystem recovers within a few years. These storms, however, may be part of the tropical ecosystem just as fires have been shown to be part of forest ecosystems.

There is anecdotal evidence of seagrass dieoffs prior to the construction of the drainage canals. The cause of these dieoffs, however, may be different from those found at present.

The construction of the railroad to Key West and the subsequent construction of the highway were the first changes to the water flow pattern between Florida Bay and the Florida Straits. Such flow cannot be reestablished.

T ..re is anecdotal evidence of dieoffs at times c. extreme temperatures (cold winters or h.. : summers).*

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APPENDIX I

Abstracts in chronological sequence of published studies about Florida Bay

Chronological sequence is by date of sampling (if known) or in the case of calculated or inferred parameters by the earliest date determined. Geological studies describing formation of geological features in the area are listed by publication date. Publication date of a paper or report are noted with a diamond next to the year of publication. The study dates are listed in Appendix II and are shown in a common time line in Appendix III. Related papers/reports are listed at the end of this section. Abstracts/summaries/conclusions listed are as provided by the author, with minor modifications, unless noted. In cases where a copy of the paper/report could not be found, this is noted or the abstract found in Schmidt (1991) was listed. All citations in Appendix I are listed in Appendix IV. Author and subject indices are provided after the Appendices.

1700 - 1983

Shen, G. T., and E. A. Boyle (1987) Lead in corals: reconstruction of historical industrial fluxes to the surface ocean. Earth Planet. Sci. Lett., 82:289-304.

Twentieth century environmental Pb chronologies for the western North Atlantic, Pacific, and Indian Oceans were reconstructed from annually-banded scleractinian corals. The skeletal Pb concentrations in a *Montastrea annularis* specimen from Florida Bay were determined from 1700 to 1983. This survey of lattice-bound stable Pb and Pb isotopes in corals from four major ocean basins confirms (by independent means) the previously-inferred anthropogenic dominance of Pb found throughout the surface ocean today, and over the past century. Perturbations were observable in all specimens studied, attesting to global augmentation of environmental Pb by industrialization. In the western North Atlantic, Pb perturbations have occurred in direct response to the American industrial revolution and the subsequent introduction and phasing-out of alkyl Pb additives in gasoline. Surface ocean conditions near Bermuda may be reliably reconstructed from the coral data via a Pb distribution coefficient of 2.3 for the species, *Diploria strigosa.* Based on ^{210}Pb measurements, a similar distribution coefficient may be characteristic of corals in general. Surface Pb concentrations in the pre-industrial Sargasso Sea were about 15 - 20 pM. Concentrations rose to near 90 pM by 1923 as a result of metals manufacture and fossil fuel combustion. Beginning in the late 1940's, increased utilization of leaded gasoline eventually led to a peak concentration of 240 pM in 1971, representing an approximate 15-fold increase over background. Surface ocean concentrations are presently declining rapidly (128 pM in 1984) as a result of curtailed alkyl Pb usage. Lead isotopic shifts parallel the concentration record indicating that characteristic industrial and alkyl Pb source signatures have not changed appreciably over time. Samples of the coral *Montastrea annularis* collected 1 km from shore at 4 m depth at the Hens and Chickens Reef in 1978 and 1983 respectively were used to reconstruct historical industrial Pb fluxes to the ocean surface. Industrial releases recorded in the Florida Keys reflect a weaker source and evidence of recirculated Pb (5 - 6 yrs old) from the North Atlantic subtropical gyre. An inferred background concentration of 38 pM suggests influence of shelf and/or resuspended inputs of Pb to these coastal waters.

1825 - 1968

Thomas, T. T. (1970) A detailed analysis of climatological and hydrological records of south Florida with reference to man's influence upon ecosystem evolution. Final Rep. to the NPS. Contr. DI-NPS-14-10-1-160-18. Rosenstiel School of Marine and Atmospheric Science, University of Miami, Miami, FL. 89 pp.

An attempt has been made to summarize the historical climatological records of southern Florida, south of latitude 29° N. Rainfall and temperature records were obtained for 157 stations within this region. The records covered the period from 1825 to 1968. Calculations determined that a minimum of seven years data per station was required to obtain statistically valid monthly and annual averages, but that the 10 - 15 yrs, suggested by Sass were more suitable. Using monthly and annual averages calculated for 119 stations, many of which dated prior to 1900 synoptic maps, were constructed displaying the geographical distribution of these two climatic variables. From statistical inference, i.e. averages, standard deviations and coefficients of variation, areas with similar characteristics were isolated and reduced to a single monthly time series record varying from 50 to 70 yrs in length and analyzed for evidence of long term changes as well as cyclical behavior. This analysis suggests that no long term changes have occurred when independently considering all the Januarys, Februarys, Marches, etc., but that from a standpoint of a linear record by month, by years a bi-annual component appears as well as one in the proximity of five years. This five year component seems to be most pronounced in the area along the eastern coastal ridge, disappearing in areas west and north-west of it. The results of this analysis are considered with respect to changes in the elevation of the freshwater table due to man's influence, the natural rise in sea level due to deglaciation, and the mechanism effecting changes in estuarine and near shore salinities.

1879 - 1977

Schmidt, T. W., and G. E. Davis (1978) A summary of estuarine and marine water quality information collected in Everglades National Park, Biscayne National Monument, and adjacent estuaries from 1879 to 1977. Rep. T-519. US National Park Service, Everglades National Park, Homestead, FL. 59 pp.

For the purposes of this report, the South Florida area was divided into four drainage systems based on climate, physiography, freshwater runoff-salinity dilution dynamics, and the influence of man: (1) Big Cypress, (2) Everglades, (3) Taylor Slough, and the (4) Southeastern Atlantic Coastal Ridge. The estuaries and coastal waters were divided into six zones based on physiography and watershed: (1) Big Cypress estuary, (2) Everglades estuary, (3) Florida Bay, (4) Barnes Sound, and Card Sound, (5) southern Biscayne Bay, and (6) northern coral reef tract. The central Everglades drainage comprises over three-fourths of the region upstream from Whitewater Bay and the southeastern Gulf of Mexico estuaries. To the west and east, the Big Cypress and Taylor Slough watersheds flow into the Big Cypress estuaries and Florida Bay respectively. These three estuaries are each approximately 1,000 km in size. The remaining watershed southeast of the Atlantic Coastal Ridge influences the much smaller systems of Card-Barnes Sounds, southern Biscayne Bay, and to a lesser extent, the northern coral reef track east of the upper Florida Keys. To protect and perpetuate the biotic communities in these aquatic ecosystems in a natural state, it is necessary to be able to evaluate the effects of watershed management on the estuaries and to detect contamination from adjacent systems. A comprehensive water quality monitoring system is needed to provide the information to make such evaluations. This report summarizes many published and unpublished reports of water quality information in Everglades National Park, Biscayne National Monument, and adjacent estuaries as the first step in the design, development, and implementation of a comprehensive monitoring system. Most of these data were collected in conjunction with short-term multi-disciplinary investigations. A total of 55 hydrographic studies dating from 1879 to the present are summarized. Over half of the studies were conducted for a period of one year or less; less than 40% between one and five years; and only 6% were over five years in duration. Twenty-three studies were conducted in Florida Bay, 17 in the Everglades estuary, 16 in southern Biscayne Bay, 14 in Card - Barnes Sound, 7 in the Big Cypress estuary, and five in the area of the northern coral reef tract. A total of 981 coastal water quality stations were identified from 47 studies reporting specific station locations. In decreasing order, the most frequently measured water quality parameters from the 55 studies were salinity (87%), water temperature (74%), dissolved oxygen (38%), pH (26%), turbidity (11%), and chemical constituents (8%). A summary of variations and minimum and maximum values of these parameters is included. The greatest variations in salinity occur in Florida Bay. During the intensive drought periods of 1965-66 and 1974-75, salinities varied along the northern Florida Bay shoreline from 0 to 67 ‰ and 1 to 67 ‰ respectively. The highest coastal salinity known in the region, 70 ‰ was recorded in Snake Bight (Florida Bay) during the 1954 drought period. Water temperatures ranged between 11 and 42°C. Temperatures ranged from 11°C near the Buttonwood Canal to 40°C over the shallow eastern Florida Bay mud flats while temperatures in southern Biscayne Bay varied from 11°C to about 42°C in waters near the influence of the Turkey Point Power Plant. Dissolved oxygen concentrations ranged from 0 to 15 ppm. The lowest values were recorded during peak periods of freshwater runoff in river headwaters and northeast Florida Bay, and in north central Florida Bay during the late summer dieoff of seagrasses. The highest value (15 ‰) of record was observed over a shallow water, shoalgrass-algal community in western Florida Bay. The most extensive coastal dissolved oxygen analyses (diel observations) were recorded in the Everglades estuary. The Florida Bay waters also showed the greatest variations in recorded pH values. Coastal pH values ranged from 5.8 over the shallow western Florida Bay seagrass flats to 9.6 over the mid-bay, shallow water algal beds. These pH and dissolved oxygen values reflected the peak periods of respiratory and photosynthetic activity, respectively. Turbidities fluctuated from 0 to 73 FTU. In Florida Bay, turbidity ranged from 0.3 FTU, offshore in the western portions of the Bay and along the eastern boundary near Key Largo, to 53 - 73 FTU near the northern Florida Bay coastline. Consistently low values of 0 - 3 FTU were reported in the Everglades estuary and in southern Biscayne Bay. Several investigations reported chemical data for selected drainage basins. These publications give the range of variation, minima-maxima over occasionally very irregular sampling periods. Constituents of particular importance are those that have exceeded recommended levels which constitute a hazard in the marine environment as determined by EPA and include the following: NH_4^+, Al, As, Fe, Cu, Mn, Hg, F, Mg, and Ca.

1881 - 1982

Smith, T. J., J. H. Hudson, M. B. Robblee, G. V. N. Powell, and P. J. Isdale(1989) Freshwater flow from the Everglades to Florida Bay: a historical reconstruction based on fluorescent banding in the coral *Solenastrea bournoni*. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):274-82.

Fluorescent banding was found in a core taken from a 1-m high colony of the coral *Solenastrea bournoni* which was growing in the Petersen Key Basin region of Florida Bay in 1986. Fluorescent banding in massive, hermatypic corals from the Great Barrier Reef, Australia, is known to result from the input of fulvic and humic compounds of terrestrial origin into the nearshore environment via river runoff. Relationships between the fluorescent banding pattern in the *Solenastrea* skeleton and flow in Shark River Slough (SRS) and Taylor Slough (TS), the two major outlets of freshwater from the Everglades, were investigated. These relationships were then used to hindcast flow for the period 1881 - 1939. In hindcasting flow in SRS, 57.2% of the variance in annual flow could be recovered from the fluorescent record, based on the period 1961 - 1986. When the model was tested on a validation sample (known SRS flow for 1940 - 1960), approximately 45% of the interannual variation was explained. The fluorescence record showed a sustained, marked decline which began about 1912 and ended around 1931. Fluorescence is significantly higher ($P < 0.001$) early in the record (pre 1932) than late in the record (1932 and later). Based on the significant relationship between fluorescence and SRS flow, this decrease is interpreted as recording decreased freshwater flow from the Everglades into Florida Bay and adjacent waters, perhaps by as much as 59%. The onset of decreased flow corresponded with the timing of construction of the extensive network of drainage canals to the east and south of Lake Okeechobee. These canals diverted water into the Atlantic Ocean which would normally have flowed into the Everglades from Lake Okeechobee.

1895 - 1989

Hanson, K., and G. A. Maul (1991) Florida precipitation and the Pacific El Niño, 1895-1989. Fla. Sci., 54(3/4):160-8.

This study identifies rainfall anomalies, timed with major El Niño events, in seven climatic divisions of Florida. The study also determines the statistical significance of these rainfall anomalies. The seasonal and annual climatology of rainfall is presented for seven climatic divisions of the state for the period 1895 to 1989. Periodogram analysis indicates 5 to 6 yr variability in rainfall throughout most of Florida, in particular during winter and spring. Super-posed epoch analysis, utilizing only rainfall during the year prior to and concurrent with a major El Niño, shows that state-wide rainfall anomalies are timed with these Pacific events. The most significant anomalies are: (1) below normal rainfall over all of the state during winter and spring the second year of an El Niño; and (2) above normal rainfall over all of the state during winter and spring the second year of an El Niño. Largest rainfall anomalies have occurred in the southern climatic divisions of Florida. During winters of the second year of El Niño south Florida rainfall anomalies range from +76 to +94 mm (+3.0 to +3.7 in) depending on the climatic division. These anomalies are 45 to 66 percent above normal winter rainfall, and are significant at the 0.999 level.

1905 - 1976

DeGrove, J. M. (1983) History of water management in South Florida. In: Environments of South Florida: Present and Past II. P. J. Gleason (ed.). Miami Geological Society, Coral Gables, FL. 22-7.

This paper describes the history of water management in South Florida from early efforts to secure federal assistance for the project during 1845 to 1850 to legislation passed in 1975 and 1976.

1908

Vaughan, T. W. (1910) A contribution to the geological history of peninsular Florida. Carnegie Inst. Publ. 133. Carnegie Institution, Washington, DC. 185 pp.

This citation describes the geological history of the Florida Plateau as of 1910. The work contains descriptions of sampling expeditions to Florida Bay, the Florida Keys, Biscayne Bay, Card Sound, Barnes Sound, Blackwater Sound, Hoodoo Sound and the Bahamas in 1908 to collect sediment samples. The samples were found to be mostly silica and "carbonate of lime" ($CaCO_3$). Silica was abundant in the form of sand in the northern portion of Biscayne Bay, becoming rarer toward the southwest. It was present in small quantities as far as Big Pine Key. Towards the southwest, as the siliceous material became rarer, calcium carbonate became progressively more abundant, occurring as a flocculent sediment or ooze over practically the entire region from the lower portion of Biscayne Bay to the gulf end of Florida Bay.

1908 - 1994

Swart, P. K., P. Kramer, J. J. Leder, R. B. Halley, and J. H. Hudson (1994) A 120 year record of natural and anthropogenic variations in Florida Bay based on oxygen and carbon isotopic variations in a coral *Solenastrea bournoni*. Bull. Mar. Sci., 54(3):1085.

[ABSTRACT ONLY.] The unusual occurrence of a specimen of *Solenastrea bournoni* within Lignumvitae basin in Florida Bay has allowed us to use stable O and C isotopes to investigate the effect of anthropogenic activities and natural phenomena (hurricanes) upon the water circulation in the area. This coral shows a marked increase in the $\delta^{18}O$ and a decrease in the $\delta^{13}C$ around 1908 - 1910 coincident with the infilling of passages between adjacent keys during the construction of the railway from Miami to Key West. The addition of fill between the Keys allowed increased evaporation (higher $\delta^{18}O$) and limited the exchange of $\delta^{13}C$ depleted waters with the Florida Reef tract. Since 1910, major hurricanes have had the effect of breaking down this isolation and causing the basin to return temporarily to more marine conditions producing an enrichment of $\delta^{13}C$ and a depletion in $\delta^{18}O$. From 1946 to 1964, the carbon isotopic composition of the coral became increasingly negative reflecting the lack of hurricanes during this period. After three hurricanes in 1964, 1965 and 1966, during which the $\delta^{13}C$ became heavier, this trend continued to the present day. The increase is not seen in the $\delta^{18}O$ as the water in the Bay is already at equilibrium with the atmosphere and increasing evaporation does not act to increase the isotopic composition of the water. Although there are only limited salinity measurements available for the Bay over this period, those that do not exist appear to correlate extremely well with the oxygen isotopic record and support our interpretation that the $\delta^{18}O$ of the coral records previous salinity levels in Florida Bay. [NOTE: Data prior to 1908 not discussed in abstract.]

1910 - 1986

Hudson, J. H., G. V. N. Powell, M. E. Robblee, and T. J. Smith (1989) A 107-year-old coral from Florida Bay: barometer of natural and man-induced catastrophes? Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):283-91.

The 107-yr growth history of a massive coral *Solenastrea bournoni* from Lignumvitae Basin was reconstructed with x-ray imagery from a single 4-in diameter (10 cm) core that penetrated the exact epicenter of the 95.3-cm high colony. The growth record core was collected in October 1986, and another "proof" core was drilled 1 yr later to verify annual density banding in this species. Growth increments totaled 952.9 mm, averaging 8.9 mm yr^{-1} over the life of the coral. To our knowledge, this is the first time that growth rate of *S. bournoni* has been determined. Growth rate trends in the Florida Bay coral were compared to those in a *Montastraea annularis* of similar age from Hen and Chickens, a nearby patch reef on the Atlantic Ocean side of the Florida Keys. Both corals were rated as potential indicators of natural and man-induced perturbations by comparing their growth rates in years of severe environmental stress to each coral's long-term growth rate average. It was concluded that growth rate, at least in these specimens, is a questionable indicator of past hurricanes and freezes. There does appear to be, however, a possible cause-and-effect relationship between major man-induced environmental perturbations and a prolonged reduction in growth rate in each coral's growth record.

1912 - 1988

Wanless, H. R., R. W. Parkinson, and L. P. Tedesco (1994) Sea level control on stability of Everglades wetlands. Everglades: The Ecosystem and Its Restoration. S. M. Davis and J. C. Ogden (eds.) St. Lucie Press, Delray Beach, FL. 199-223.

The expansive coastal wetlands and freshwater marsh of south Florida are a result of the very slow relative rise of sea level during the past 3200 yrs (average rate of 4 cm

100 yr^{-1}). Prior to that time, relative sea level was rising at a rate of 23 - 50 cm 100 yr^{-1}, too fast for coastal swamp, marl, or sand environments to stabilize along south Florida's coastlines. The establishment of a broad, coastal wetland during the past 3200 yrs has provided a natural barrier to marine waters and permitted freshwater environments of the Everglades to expand. Tide gauges throughout the US record a dramatic increase in the rate of relative sea level rise beginning about 1930. During the following 60 yrs, the relative rise in sea level for south Florida has averaged 3 - 4 mm yr^{-1} (equivalent to 20 - 40 cm 100 yr^{-1}). This rate is 6 - 10 times that of the past 3200 yrs and is triggering dramatic changes in the coastal wetland communities, including accelerated erosion of shore margins, landward encroachment of marine wetlands, and saltwater encroachment of surficial and ground waters. Continuation at these rates or acceleration, as expected due to global warming, will cause dramatic to catastrophic modifications of both the coastal and freshwater wetlands of south Florida. Major hurricanes will cause dramatic steps of erosion as well as overstepping of coastal wetland margins.

1913 - 1984

Stephens, J. C. (1984) Subsidence of organic soils in the Florida Everglades - a review and update. Environments of South Florida: Present and Past II. P. J. Gleason (ed.). Miami Geological Society, Coral Gables, FL. 22-7.

The Everglades contains the largest single tract of organic soils in the world, over 3,100 square miles. Formed under marshy conditions, they subsided when drained by compaction, biochemical oxidation, or burning. The first elevations of surface subsidence profiles were started in 1913, and in the early 1930s, lines were added at the Everglades Experiment Station where land use and treatment could be controlled. Altogether 15 lines were established, and 11 were still surveyed by 1984. Those abandoned have been negated by construction or subsided until the organic cover disappeared and underlying mineral deposits were exposed. Biochemical oxidation has accounted for approximately two-thirds of the total loss of the arable soils in the Everglades. Subsidence has had serious environmental effects on agriculture, water supplies, and wildlife. Flooding the land in Conservation Areas will halt subsidence, and losses on arable lands can be ameliorated by maintaining water tables as high as feasible, making productive use of drained lands as soon as possible, and increasing research.

1919 - 1989

Meeder, J. F., and L. B. Meeder (1989) Hurricanes in Florida Bay: a dominant physical process. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):518.

[ABSTRACT ONLY.] Hurricanes produce major ecological perturbations important to long term maintenance of the Florida Bay ecosystem. The effects of hurricanes on the Bay ecosystem are described and contrasted to the effects of fire in south Florida terrestrial ecosystems. Just as the importance of fires has been recognized in the management of terrestrial ecosystems, the role of hurricanes on coastal and shallow bay communities must also be recognized. Many perturbations produced by hurricanes are uncontrollable and, therefore their impact on the Florida Bay ecosystem has remained unaltered by man's activities. Alteration of hurricane runoff quantity and timing, quality of runoff water and tidal exchange rates are major exceptions. Intense periods of rapid runoff appear to be very significant in maintaining the Florida Bay ecosystem. Physical processes associated with hurricanes are: rainfall, storm tides, extreme wind and waves, and outwash. Although predicting the precise effects of any hurricane is difficult, several observations are made after analysis of storm data since 1971: (1) a total of 95 tropical storms have affected the Florida Bay ecosystem (20 major storms); (2) nearly 50% of all the storms fell with three general tracts (vectors); (3) of 39 storms analyzed since 1916, rainfall from individual storms made up 1.7 to 14% of annual rainfall; (4) storms from different vectors produced different rainfall characteristics; and (5) 11 storms from two vectors produced more than twice as much rain as other storms (averaging 213 mm). From these observations, two generalizations can be made: storms that affect the Bay bottom and coastline occur at reasonably predictable intervals of one every 3 - 5 yrs and storms which produce extreme freshwater runoff occur once every 6 - 7 yrs. The significance of tropical storms becomes apparent when these frequencies are understood.

1920 ◊

Simpson, C. T. (1920) In Florida Waters. G. P. Putnam's Sons., New York. 404 pp.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] This book is an account of a naturalist's observations on the life, physical geography, and geology of the tropical part of the state of Florida. The author lived in South Florida from 1882 until the 1920s. During this time he "thoroughly explored the territory described in this volume, both as a collector and a general naturalist." He notes, "To-day most of its hammocks are destroyed, the streams are being dredged out and deepened, the Everglades are nearly drained; even the pine forests are being cut down. At the time when I first resided in the State, flamingoes, roseate spoonbills, scarlet ibises, and the beautiful plumed herons were abundant. Deer and otter could be seen at any time and the west coast waters were alive with immense schools of mullet and other fish, while manatee were not rare. The streams and swamps were full of alligators; in fact the wonderful fauna of our region filled the land and the waters everywhere. It seemed to me fitting that some record of this life should be made, in view of the fact that it is so rapidly disappearing - and forever." Simpson's work covers the Florida Keys, the Ten Thousand Islands, Cape Sable, the Everglades south coast, the mangrove shore, and other inland areas.

1920 - 1960

Wade, R. A. (1962) The tarpon, *Megalops atlanticus*, and the ox-eye, *Megalops cyprinioides*, emphasizing larval development. M. S.. Thesis, University of Miami., Coral Gables, FL. 168 pp.

The distribution of the genus *Megalops* in the Atlantic, Pacific, and Indian Oceans briefly discussed. Colloquial names for both species are given. Materials and methods of collection and study of the larval and juvenile specimens from the DANA, GILL and TOTO cruises and miscellaneous collections obtained from 1920 to 1960 for North Carolina, Florida, Cuba, Haiti, and Puerto Rico are summarized. Florida Bay specimens were collected in 1957. Stages were designated for the purpose of describing the unusual post-larval development of *Megalops.* Characters found useful in separating the two species were eye diameter, prepelvic length, fin-ray and myomere counts. A developmental series consisting of seven Stage-I, 11 Stage-II, 217 Stage-IIIA, and 221 Stage-IIIB specimens of *Megalops atlanticus* and 69 Stage-I, 15 Stage-II, and 5 Stage-IIIA specimens of *M. cyprinoides* ranging in size from 11.0 mm to 311.0 mm is presented and representative specimens are described and figured. This is the first time that Stage-I specimens of *M. cyprinoides* were available for study. Indices and graphs of gross morphological changes occurring during development are presented. The majority of obvious body proportions in Stages I, II, and IIIA show allometry with reference to head length and standard length, all the proportions becoming isometric in Stage III. The geographical distribution of the material studied and records from the literature are presented. The known range of *M. atlanticus* includes the middle and southern Atlantic states, Gulf states, the Caribbean Sea, the Bahamas, and the northern and eastern coasts of South America to Brazil. The known range of *M. cyprinoides* extends from Tahiti, Society Islands to Durban, South Africa. Records of tarpon beyond their normal range are discussed. Occurrence of the larval material studied suggests that both species of the genus *Megalops* spawn in offshore waters nearly paralleling the range of the adults. Habitat, behavior, relationship to salinity, temperature, natural enemies, red tide, sport fishing qualities, and economic value are discussed.

1920 - 1960

Wade, R. A. (1962) The biology of the tarpon, *Megalops atlanticus,* and the ox-eye, *Megalops cyprinoides*, with emphasis on larval development. Bull. Mar. Sci. Gulf and Caribb., 12:545-622.

[SAMPLES OBTAINED FROM MULTIPLE SOURCES.] The larval and juvenile development of the tarpon, *Megalops atlanticus,* and the ox-eye, *Megalops cyprinoides,* are compared. A developmental series was compiled from the plankton specimens and material obtained from many sources, from 1920 to 1960, representing the following periods or stages of development: larval (Stage I, Stage II, Stage III A, Stage III B), and juvenile. The series is illustrated and described; and changes in form are discussed, in particular those characters useful in separating the two species. The geographical distribution of the material studied and records from the literature are presented. The biology of both species is discussed including habitat, behavior, relationship to physical and chemical factors, natural enemies and sport fishing qualities.

1923, 1981 - 1984 [intermittent years]

Powell, G. V. N., and A. H. Powell (1986) Reproduction by great white herons *Ardea herodias* in Florida Bay as an indicator of habitat quality. Biol. Conservation, 36:101-13.

Reproduction parameters of great white herons were used to evaluate the habitat quality of eastern Florida Bay. Clutch size and reproductivity of the herons during three breeding seasons (1981 - 1984) were compared with similar data from 1923 which predated suspected human alteration of the Bay ecosystem. In addition, since about 15% of the great white herons nesting in eastern Florida Bay supplemented their diet with food obtained from people, it was possible to evaluate the impact of food availability on reproduction. Herons fed naturally in Florida Bay (unsupplemented) had significantly smaller clutches and reproduced significantly fewer fledglings than those of 1923. Herons that received supplemental food had reproductive parameters similar to those of 1923. This may indicate a reduction of habitat quality since 1923. The results supported the prediction that wading bird reproduction can be sensitive to habitat and that these species should be useful as biological indicators for monitoring habitat quality. [The 1923 study was described in: Holt, E. G. (1928) The status of the great white heron and Wudermann's heron. Cleveland Mus. Nat. Hist., 1:1-35.]

1926 ◊

Dimock, A. W. (1926) Florida Enchantments. New York, NY. Stokes. 338 pp.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] This book is an account of a sampling expedition through South Florida during the 1920s. It contains chapters on the capture of manatees, dolphins, crocodiles, turtles, and various species of fish. Although the misadventures of the author and his colleagues are humorous, the killing of what are now protected species is unfortunate and points out changes in environmental awareness.

1928 ◊

Holt, E. G. (1928) The status of the great white heron and Wurdermann's heron. Cleveland Mus. Nat. Hist., 1:1-35.

[NO COPY OF PAPER AVAILABLE.]

1928 - 1994

Frederick, B. C., S. Gelsanliter, J. A. Risi, and H. R. Wanless (1994) Historical evolution of the southwest Florida coastline and its effects on adjacent marine environments. Bull. Mar. Sci., 54(3):1074.

[ABSTRACT ONLY.] An examination of historical aerial photography (1928 - present) reveals three significant types of change in the coastal/wetland environment on the southwest coast of Florida between Cape Sable and Chatham River: coastal erosion, erosion of shorelines and islands in larger interior bays, and landward expansion of mangrove communities. There are two types of coastal erosion. Progressive erosion from winter storms has affected significant portions of this west-facing coastline. Hurricane surges penetrating tidal creek complexes have created local patches of catastrophic erosion within the wetland environment. Coastlines and islands within larger interior bays are eroding, especially along the north and east shores. This erosion has resulted from both recurrent winter storm waves and episodic hurricane scour. Eroded sediment is largely organic and is oxidized, dissolved or transported out of the system. Shore erosion within bays has resulted in the expansion of tidal prisms and in the enlargement of channels connecting to the offshore marine environment. During the past 52 yrs of historical records, some mangrove community boundaries have remained relatively stable while others have dramatically expanded across adjacent transitional and freshwater marshes. As much as 86 m of landward expansion is recognized. Mangrove community expansion occurs by both episodic, storm-generated seedling introduction and progressive expansion. Gently sloping coastlines provide a setting to record the temporary advance of infringing mangrove communities in this wetland coastal landscape. Erosion of these coastlines is providing a significant volume of dissolved and particulate organics and nutrients into adjacent mangrove, transitional, and freshwater wetlands and into the adjacent marine environments. Organics and nutrients discharged into coastal marine waters are pulsed southward by winter storms into Florida Bay and the Florida Keys. Future global warming with increased rates of sea-level rise and increased frequency of hurricanes, should dramatically increase rates of erosion of this wetland coastline and increase the importance of this area as a source for organic and nutrient discharge.

1929 ◊

Cooke, C. W., and S. Mossom (1929) Geology of Florida. 1927-28. Twentieth Ann. Rep. Florida State Geological Survey, Tallahassee, FL. 29-228.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] The geologic formations that make up the Floridian Plateau were named and described in this report. Additionally, the general features and local details for marine formations (Miami Oolite and Key Largo Limestone) underlying the coastal areas of the Everglades National Park were discussed.

1930 ◊

Small, J. K. (1930) The vegetation and erosion on the Everglade Keys. Sci. Mon., 30:33-49.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The pinewoods or pinelands of Florida are nearly level areas of greater or lesser extent. The high pinelands are dry and often somewhat rolling. The low pinelands where the water table is always near the surface are often called "flatwoods" because of the flatness of the land. They are composed, according to locality or region, of one or another of the several long-lead pines. The undergrowth consists of saw-palmetto, shrubs, and annual and perennial herbs. They are often fire-swept, and consequently the soil, sand or rock is nearly or quite devoid of humus. The evidence furnished by the character of the surface erosion similar in both the hammocks and the pinelands shows that the ancient islands, now the

Everglades Keys, were formerly hammock-clad. That they were formerly more elevated is evidenced by the rock floor of Biscayne Bay showing the same character of erosion as that of the present hammocks and pinelands. The fact of this one-time elevation is also established by the present existence of subaqueous caverns in the limestone, with immense stalactites which must have been formed above the water table

1934 - 1986 [intermittent years]

Powell, G. V. N., R. D. Bjork, J. C. Ogden, R. T. Paul, A. H. Powell, and W. B. Robertson (1989) Population trends in some Florida Bay wading birds. Wilson Bull., 101(3):436-57.

Roseate spoonbills (*Ajaja ajaja*), reddish egrets (*Egretta rufescens*), and great white herons (*Ardea herodias occidentalis*) have unique subpopulations that are largely restricted to Florida Bay. All three species are believed to have had relatively large populations in Florida Bay, but the birds were virtually extirpated from the area between the late 1800s and the mid-1930s by human harvesting for food and feathers. After the birds were protected, they reestablished small populations that initially grew quickly. The great white heron population in Florida Bay increased from a low of about 20 individuals after the 1935 hurricane to a population of 800-900 resident adults in the early 1960s. As many as 400 additional birds (juveniles and possibly seasonal migrants) were present in winter censuses. The population remained at about that level through the 1960s after recovering from a 20 - 40% decrease caused by a 1960 hurricane. After 1968, the population was surveyed only once, in 1984, when about the same number of birds were censused. The reddish egret recovered more slowly from total extirpation around 1935 to an estimated 200-250 adults in the late 1970s. Casual observations in the 1980s suggest the population has remained at about that level. Roseate spoonbills showed an exponential recovery from just a few individuals up to a maximum of 2400 breeding birds by 1978-79. Subsequent censuses (1984 - 1986) revealed only about 800-900 nesting adults. The virtual absence of pre-1880s data precludes comparing present populations with those of the pristine environment. However, the most recently surveyed population of each of these species seems to be at a lower density than was historically present. The recent decline in the spoonbill population and low reproductive success of the great white heron population are causes for concern about the future of the populations. These findings point out the importance of continued monitoring and analysis of population trends. This study is based on intermittent aerial counts of great white herons between 1935 and 1968, and in 1984; population estimates of reddish egrets based on ground counts 1977 and 1978; and counts of spoonbill nests beginning in the 1930s. During the 1960s and 1970s, the spoonbill population of Florida Bay was also estimated from aerial reconnaissance.

1935 - 1989

Wanless, H. R., and M. G. Tagett (1989) Origin, growth and evolution of carbonate mudbanks in Florida Bay. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):454-89.

Between 4,500 and 3,000 yrs ago, rising sea level inundated the area now known as Florida Bay. Coastal and freshwater peat and shore levee deposits, positioned by irregularities in the underlying limestone surface, were repeatedly embayed and overstepped during this transgression. Inundated and dissected coastal deposits then served as nuclei from which the present complex of Florida Bay islands, mudbanks, bank spits and bays evolved. Portions of the islands have maintained supratidal facies (peats and supratidal muds) throughout their growth history and are capped remnants of once laterally continuous coastal levees. Other portions are the result of supratidal progradation across younger mudbank buildups. Marine mudbanks nucleated on inundated coastal levees and mangrove peats. Mudbank cores are composed of layered mudstone reflecting an early history dominated by physical sedimentation. There is, however, striking lateral gradation in bank morphology, internal stratigraphy (textural and compositional sequence) and bank dynamics. These reflect gradients in sediment supply, physical processes and biogenic communities during later Holocene flooding history. Four zones are recognized: (1) Inner Destructional Zone in eastern Florida Bay has small, discontinuous erosional mudbanks with a grainstone veneer separated by rock floored basins. This zone is sediment starved. (2) Central Migration Zone in central Florida Bay has an anastomosing maze of narrow, continuous banks dominated by layered mudstone sequences. These are actively migrating across a veneer of basal skeletal packstone on the limestone bedrock. This zone receives sufficient sediment supply to maintain banks. (3) Western Contructional Zone in western Florida Bay has very broad, actively expanding banks separated by shallow lakes containing about I m of molluscan wackestone. The broad banks have coalesced from smaller core banks of layered mudstone. Excess sediment from local production and/or detrital input has caused bank growth and lake infilling. (4) Outer Destructional Zone along the exposed western margin of Florida Bay has scattered, erosional bank remnants with layered mudstone cores surrounded by a barren Pleistocene limestone surface. Intense marine burrowing has (a) destroyed aspects of the transgressive depositional facies sequence in Florida Bay including much evidence of bank nucleation, and (b) blurred evidence of physical sedimentation during the later stages of bank development. Seagrasses are a dominant community covering vast portions of bank and lake sediments in Florida Bay at present. This study of the Bay's sediment history indicated that (a) seagrasses are now at a peak in their influence in Florida Bay's history, (b) they are episodically eliminated from much of Florida Bay, and (c) seagrasses have had only a minor to moderate influence on the growth and evolution of Florida Bay's mudbanks. This study was based on historical aerial photography beginning in 1935, description and mapping of surficial sediments, internal stratigraphy by core transects, and bedrock topography beneath the mudbanks.

1936 - 1938

Davis, J. H. (1940) The ecology and geologic role of mangroves in Florida. Publ. 517. Carnegie Institute, Washington, DC. Pap., Tortugas Lab., 32:305-412.

A fairly thorough reconnaissance of most of the Florida coasts south of 30° N latitude was made, and the regions for special study were chosen. Exploration was by boat, automobile, airplane, and on foot and was supplemented by examination of photos, maps and charts. From the air, zonation of the swamps and depth of the water were most plainly visible. No large area was neglected, so that the results are representative of conditions along all of the Florida coasts. The regions for study, and particularly the stations for special study, were chosen with regard to the types of mangrove communities and the evidences of land-area changes. Some of the stations were selected at random so as to avoid the error of choosing too many with similar vegetation and environmental conditions. Florida Bay was one of the five regions where stations were established. At each station, observations were made and data on soil, water and other features were recorded. [SAMPLING WAS DONE DURING THE SEASONS OF 1936 TO 1938 ACCORDING TO SCHMIDT (1991).]

1940 ◊

Carr, A. F. (1940) A contribution to the herpetology of Florida. University of Florida Pub., Biological Science Ser., 3(1):1-118.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] This citation is a discussion of early works on the herpetology of Florida. A list of species in included.

1940

Miller, E. M. (1940) Mortality of fishes due to cold on the southeast Florida coast, 1940. Ecology, 21(3):420-21.

There was a killing cold period in South Florida January 27 - 29, 1940. Temperature low recorded at Miami was 36°F, at Elliott Key, 38°F, and at Key West, 50°F. First hand observations were made by the author at Miami and Key Largo; and reports from reliable fishermen were taken for the Key Largo - Key West portion of the area. Many fish were observed to be stunned or killed and estimates were attempted as to relative numbers affected. The list of the fish species affected may have been prejudiced by reports of fishermen who were interested in collecting only the stunned specimens having some food or commercial value. Nearly 1 million pounds of stunned but good specimens were sold during this period from Key Largo to Key West. Species reported were bonefish, moonfish, gray snapper, grunts, porgie, mullet, and jacks.

1940 - 1977

Stevely, J. M., J. C. Thompson, and R. E. Warner (1978) The biology and utilization of Florida's commercial sponges. Florida Sea Grant Tech. paper 8. Florida Sea Grant College Program, University of Florida, Gainesville, FL. 45 pp.

Since the time of the Ancient Greeks man has recognized the usefulness of the natural sponge. Because of their ability to absorb large amounts of water, compressable nature, and durability, sponges have been used for a wide variety of tasks ranging from washing dishes to packing instrument panels in rockets. Up until the 1940's the sponge fishery was one of the most valuable fisheries in Florida. However, a combination of disease, heavy harvesting pressure, and the introduction of synthetic sponges resulted in reduction of the industry to a small fraction of its former importance. Production in the Tarpon Springs area, the traditional center for sponging in Florida, has declined to extremely low levels of harvesting activity. Dade County has emerged as the center of the existing sponge industry. Persistence of low level sponging activities in Florida for the last 30 yrs indicates that the sponge industry, as it is currently structured, will probably not return to former production levels without specific kinds of help. This paper reviews the sponge fishery from several points of view, utilizing data from scientific literature, state and federal fishery statistics, commercial fishermen, and sponge processors and discusses the extent of available biological information, the present status of the resource, and future potential.

1940 - 1978

Tilmant, J. T. (1989) A history and an overview of recent trends in the fisheries of Florida Bay. Bull. Mar. Sci., 44(1):3-33.

This paper presents a historical review and description of the fisheries of the Florida Bay. Documented interest in the fishery resources of Florida Bay dates from the earliest accounts of human activity. However, prior to the 1940's, fishing activities were largely subsistence oriented, providing only supplemental family income. The first large-scale directed fishery was for striped mullet which provided the primary economic support of the historic Flamingo fishing village in the 1920's. Increased development of south Florida, improved transportation, and population growth all led to increased sport fishing activities during the 1940's and 1950's, which increased the development of the commercial silver mullet and live shrimp bait fisheries. By the early 1970's, there were an estimated 25,000 recreational fishing trips a year to Florida Bay. Commercial activities reached a peak between 1977 and 1978 when over 350 individuals held permits to guide or fish commercially using nets, hook-and-line, or traps. Concern for the conservation of Florida Bay's marine resources quickly followed the explosion of commercial and recreational use occurring in the late 1940's. Florida Bay was added to Everglades National Park in 1950 and, in 1951, the first special government regulations were established to control the methods, species, and locations of fish harvest, although no systematic effort was made to collect accurate catch and harvest statistics until 1958. The National Park Service monitoring program has provided detailed data on the fishing effort and harvest of both commercial and recreational fisheries up to the present time. Five species (gray snapper, spotted seatrout, red drum, sheepshead and black drum) have comprised over 86% of the sportfish harvest since 1958. The total recreational fish harvest from Florida Bay by guided and non-guided parties has ranged between 700,000 and 800,000 fish per year since 1984. Species most frequently sought by guide fishermen include tarpon, bonefish, snook, spotted seatrout, gray snapper, red drum, and Spanish mackerel.

1940 - 1987 ◊

Lewis, R. R. (1987) The restoration and creation of seagrass meadows in the southeast United States. Fla. Mar. Res. Publ., 42:153-73.

The restoration and creation of seagrass meadows is of increasing concern in the southeast United States, due to large scale declines in seagrass meadow coverage. Researchers and environmentalists estimate that approximately one-third of the 600,000 ha of seagrass meadows that were present in coastal Florida in the 1940's no longer exist. Associated declines in fisheries harvests have been documented. In Mississippi, 1,970 ha of seagrasses remain, representing a loss of almost two-thirds. Both restoration and creation of meadows have been successful in individual projects at sites up to 6 ha in size, but failures are common. A more analytical approach to successful plantings is encouraged; prior knowledge of water quality and stresses on existing seagrass meadows is essential, Simple transplanting with plugs from existing healthy meadows (particularly *Thalassia testudinum* plugs) is not encouraged for large-scale projects. The use of non-destructive sources of material for culture of planting units is documented and recommended. Salvage of seagrasses from areas to be impacted can ensure successful, non-destructive meadow restoration and creation, and is encouraged.

1943 ◊

Davis, J. H. (1943) The natural features of southern Florida, especially the vegetation and the Everglades. Fla. Geol. Surv. Bull., 25:1-311.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] This citation is a detailed description of the South Florida ecosystem, including the marine portion of the Everglades National Park. The effect of canals and dikes, probable former conditions, soil subsidence and land utilization as of the time of publication in 1943 are discussed.

1944 ◊

Parker, G. G., and C. W. Cooke (1944) Late Cenozoic geology of southern Florida, with a discussion of the ground water. Geol. Bull. 27. The Florida Geological Society, Tallahassee, FL.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Southern Florida gives evidence of repeated oscillations of sea level but of little structural deformation. The oldest outcropping formations are the Caloosahatchee marl, the Buckingham marl, and the Tamiami formation. The Caloosahatchee consists predominantly of sand and shell marl; the Buckingham of calcareous clay with phosphate grains; and the Tamiami of calcareous sandstone and sandy limestone with beds and pockets of quartz sand. Well records show that the Caloosahatchee marl and the Tamiami formation interfinger and are essentially contemporaneous, though the outcropping tongue of the Tamiami overlies the facies represented by the Caloosahatchee. The Buckingham marl merges into the Caloosahatchee. These Pliocene formations are separated from the overlying Pleistocene formations by an erosional unconformity which indicates that they were above sea level during middle and late Pliocene time and earliest (Nebraskan stage) Pleistocene time. They may have been very slightly tilted toward the west at the time of their emergence. The Fort Thompson formation (including the Coffee Mill Hammock marl member at the top) consists of three thin marine shell beds separated from one another by two freshwater limestones or marls, each of the younger beds filling solution holes in the older. The total thickness at the type locality is about 8 ft. The marine beds are interpreted as deposits formed during Aftonian, Yarmouth, and Sangamon interglacial stages, when the region was flooded by the sea to depths apparently as great as 270, 215, and 100 ft. The solution holes and the freshwater limestones and marls apparently were formed during the Kansan and Illinoian glacial stages, when the sea temporarily withdrew to considerable distances below its present level. The Anastasia formation (predominantly sand and shells), the Key Largo limestone (an extinct coral reef), and the Miami oolite are contemporaneous Pleistocene formations which apparently accumulated on and along the southeastern coast mainly during the Sangamon interglacial stage and therefore are equivalent to only part of the Fort Thompson formation developed in the Everglades and the Caloosahatchee River area. The Penholoway and Talbot formations, which are coastal terrace deposits, consist of sand swept down from the north by longshore currents during the middle and late parts of the same interglacial stage. A thin shift of sand, the Pamlico formation, was spread over part of the shallow sea floor during a mid-Wisconsin invasion by the sea. The accumulation of these Pleistocene deposits to various thicknesses on the nearly level Pliocene surface formed a very shallow basin (the Lake Okeechobee Everglades depression) adjacent to highlands on the north and partly enclosed by a low coastal ridge of oolite on the east and a slightly higher plain on the west. The northern and lowest part of this basin is now occupied by Lake Okeechobee, which, before drainage and diking operations changed it, overflowed southward across the open Everglades more or less as a sheet flow that imposed an aligned drainage pattern on the organic deposits of the Everglades. Tests made in ground water investigations of the Miami area indicate that the Tamiami formation is among the most productive water bearing formations ever investigated by the US Geological Survey. Its coefficient of permeability is about 35,000, which indicates that through a section of the formation a mile wide and a foot thick 35,000 gallons of water a day, at 60°F, would pass through under a hydraulic gradient of one foot. Large areas of salty ground water in the northern part of the Everglades are considered to be remnants of seawater left during Pleistocene sea invasions and now altered by dilution with freshwater and by chemical reactions, mainly of the base-exchange variety, with the enclosing rocks.

1945 - 1959, 1991

Strong, A. M., and G. T. Bancroft (1994) Patterns of deforestation and fragmentation of mangrove and decidous seasonal forests in the upper Florida Keys. Bull. Mar. Sci. 54(3):795-804.

The forested ecosystems of the Florida Keys contain a tropical flora with many species found nowhere else in the conterminous US. These forests have gone through three periods of anthropogenic perturbations resulting in forests that are smaller, more fragmented, and have an altered species composition. We digitized 1991 aerial photographs of the remaining mangrove and deciduous seasonal forests of the Upper Keys (Ragged Keys to Long Key) to determine the changes in forest coverage from the original condition [as determined from 1945 - 1959 aerial photographs]. Forty-one percent of the original 4,816 ha of deciduous seasonal forests and 15% of the original 8,306 ha of mangrove forests have been cleared for development. Losses were greatest on those keys accessible from U.S. 1, intermediate on keys accessible from Rt. 905, and least on keys accessible only by boat. Mean forest size decreased from 50.7 ha to 2.6 ha and from 67.5 ha to 28.1 ha for deciduous seasonal and mangrove forests, respectively. The edge to area ratio for deciduous seasonal forests accessible by road has increased from 5.2 km km^{-2} in the original condition to 269 km km^{-2} currently. The loss of forested area and increase in forest fragmentation has probably affected the physical condition of the forests and plant and animal populations in the keys. A regional approach to conservation of the keys forested ecosystems is needed to preserve the biodiversity of the archipelago.

1944 - 1974

Emiliani, C., J. H. Hudson, E. A. Shinn, and R. Y. George (1978) Oxygen and carbon isotopic growth record in a reef coral from the Florida Keys and a deep-sea coral from Blake Plateau. Science, 202:627-9.

Carbon and oxygen isotope analysis through a 30-yr (1944 to 1974) growth of *Montastrea annularis* from Hen and Chickens Reef showed a strong yearly variation in the abundances of both ^{13}C and ^{18}O and a broad inverse relationship between the two isotopes. Normal annual dense bands formed during the summer and were characterized by heavy carbon and light oxygen. "Stress bands" were formed during particularly severe winters and were characterized by heavy carbon and heavy oxygen. The isotopic effect of Zooxanthellae metabolism dominated the temperature effect on the $^{18}O/^{16}O$ ratio. The isotopic results on the deep-sea solitary coral *Bathypsammia tintinnabulum*, where Zooxanthellae were nonexistent, indicated that the abundance of the heavy isotopes ^{13}C and ^{18}O was inversely related to the growth rate, with both carbon and oxygen approaching equilibrium values with increasing skeletal age.

1947

Davis, C. C. (1949) Observations of plankton taken in marine waters of Florida in 1947 and 1948. Quart. J. Fla. Acad. Sci., 12(2):67-103.

A series of 100 samples of plankton was obtained from a number of marine localities, mostly along the southern east coast of Florida and in the Gulf of Mexico and adjacent waters. They were analyzed and the proportional numbers of various plankton categories was estimated. One hundred ninety seven (197) categories of plankton were encountered. An attempt was made whenever possible to identify the forms to species, but this was not always possible because of unavailability of literature, or because of total lack of information, specially as regards larval stages of various organisms. Each category is discussed separately, and the seasonal and local distribution is discussed in so far as the data allowed. The various species characteristic of the various environmental portions of the area investigated are listed, and many of them are thought to be of value as indicators of waters of different origin. Conversely, the differing plankton populations found in the different regions are thought to be of significance as an indication of varying, but as yet undetermined, nutritional and other environmental influences. The plankton data was obtained through the analysis of samples taken at widely scattered locations in Florida and at various times of the year, and is exploratory in nature. The Florida Bay sites located at Garfield Bight and off Shark Point were sampled in 1947.

1947 - 1948

Davis, C. C., and R. H. Williams (1950) Brackish water plankton of mangrove areas in southern Florida. Ecology, 31(4):519-31.

A total of 39 plankton samples from 28 mangrove-bordered inland bodies of water along the lower west coast and the south coast of Florida were analyzed. Salinity was also determined at each locality. Biologically similar areas have hardly been investigated previously anywhere in the world. Salinities varied from 0.61 ‰ in Broad River to 29.09 ‰ in Garfield Bight off Florida Bay. West coast localities were found to differ from south coast localities in their plankton content, probably primarily due to isolation. On the west coast, Chokoloskee Bay, with high salinity, contained more species than other west coast localities, and the species were more of the oceanic type than those elsewhere. The five bays with the lowest salinities contained a good proportion of freshwater types. Bays with intermediate salinities were more closely similar to Chokoloskee Bay than to the freshed bodies of water. On the south coast, the plankton content of the open Florida Bay and similar bodies of water differed from that of the more enclosed lakes in many respects. The lakes are isolated by independent drainage systems into two groups, and this fact was clearly shown in specific plankton differences. Within each group of lakes, differences of plankton content occurred. These differences probably were associated most closely with salinity differences. Free swimming parasitic copepods, tychopelagic species, and abundant larval forms were encountered.

1947 - 1957

Tabb, D. C. (1963) A summary of existing information on the fresh-water, brackish-water and marine ecology of the Florida Everglades region in relation to fresh-water needs of Everglades National Park. ML No.63609. The Marine Laboratory, University of Miami, Coral Gables, FL. 85 pp.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] This report reviews the literature (published and unpublished) on Everglades water studies in relation to the water supply problems of Everglades National Park. Based on the examination of over 400 references pertaining in some way to the problem, it was found that there have been pronounced changes in water level, water supply, and water dispersal in and around the park; that major changes in the water shed took place prior to the finalization of the park boundary in 1947, and that the park biota had adjusted to these changes by that time. Results also showed that, although the park cannot be returned to pre-drainage conditions, there should be sufficient water during most years to maintain the park ecology at the 1947 - 1957 level. Hypersaline conditions and the effects of the reduction of freshwater runoff to Florida Bay was discussed. It was concluded that the National Park Service should undertake immediately, biological and ecological studies on the problems discussed.

1949

King, J. E. (1949) A preliminary report on the plankton of the west coast of Florida. Quart. J. Fla. Acad. Sci., 12(2):109-37.

At intervals from November 1946 to September 1947, the Gulf coastal waters of southwest Florida were discolored by the tremendous abundance of the dinoflagellate *Gymnodinium brevis*, a species new to science. This condition, called "red tide", was accompanied by heavy mortality of fish and invertebrates. The purpose of this paper is to describe in general the plankton forms characteristic of coastal waters of Florida, specifically the dinoflagellates and copepods. One site was sampled in Florida Bay just off Matecumbe Key in 1949.

1949 - 1950

Moore, J. C. (1951) The status of the manatee in the Everglades National Park, with notes on its natural history. J. Mamm., 32(1):22-36.

This citation is a description of the status of manatees in the Everglades National Park. Accounts of observations of manatee behavior from various sources are discussed.

1949 - 1951

Moore, J. C. (1953) The crocodile in the Everglades National Park. Copeia, 1953(1):54-9.

This citation is a review of the status of the American crocodile and is based on observations by the authors from 1949 to 1951, and on intermittent observations from other sources from 1900 to 1951.

1949 - 1955

Moore, J. C. (1956) Observations of manatees in aggregations. Amer. Muse. Nov., 1811:1-24.

The difficulties of observing wild manatees under ordinary circumstances were found to be substantial and were considered to explain the absence of any previous report of systematized field observations. Natural cold-induced aggregations of wild manatees were found to provide favorable circumstances for field observations. Identification of individuals by means of scars permitted recognition of some of them five and a quarter years after first identification. The study took place from 1949 to 1955. During the last winter season of observations, 1954 - 1955, in 10 aggregations, 57 marked individuals were recognized and 195 individuals were estimated to have been present. Some of these evidently reside in the vicinity at least during the winter season. And of these some appear to move in for the winter season, possibly taking part in a seasonal migration. Presence or absence of barnacles and algae on the skin indicates that some individuals reside in freshwater up river, others in the saline waters of the Bay. Pattern of attendance of aggregations by marked individuals suggests that their ranges were dispersed and reveals no evidence of social organization. Mothers with young were not accompanied by other individuals. Groups within the aggregations engaged in play. The muzzle-to-muzzle contact between individuals involves lifting snouts above the surface, perhaps as relict behavior inherited from territorial ancestors. The usually observed courtship behavior was of a male approaching, nuzzling, "embracing", and presenting its venter to some presumed female, which most frequently turned away or swam off before courtship proceeded further. Of the identifiable sample of 65 individuals about 15% were recorded as inmatures and 15% as calves, each closely accompanying an adult. The relative sizes of calves and other evidence suggests lack of any distinct breeding season. Annual reproduction by adult females is questioned. Young sometimes rode on mother's back. Suckling took place in horizontal position, under water, without embrace. Very young calves swam only with flippers. Adults ordinarily swam only with tail, but only one adult regularly used its flippers also.

1952 - 1954

Ginsburg, R. N. (1956) Environmental relationships of grain size and constituent particles in some south Florida carbonate sediments. Am. Assoc. Petrol. Geol. Bull., 40(10):2384-427.

In the southern extension of the Florida peninsula variations in the submarine topography, areal geography, and hydrography which control the distribution of sediment-producing organisms are reflected in the grain size and constituent particle of the calcareous sediments being deposited. Two major environments can be recognized: (1) a curving band-shaped reef tract with good water circulation, and (2) Florida Bay, a very shallow triangular area with semi-restricted water circulation. Florida Bay sediments have larger proportions of particles less than 1/8 mm than the sediments of the reef tract. The constituent particle composition of the fraction larger than 1/8 mm in Florida Bay is almost exclusively molluscan and foraminiferal, but in the same size fraction of the reef tract sediments fragments of algae and corals are abundant. Similar distinctions in grain size and constituent particles for comparable environments can be derived from published data for the sediments around Andros Island Bahamas. In Florida Bay large local variations in physical environment obscure the expected effects of differences in environment from one part of the Bay to another, and no distinct subenvironments could be recognized from the gross grain size and constituent particle composition. However, in the reef tract local variations of environment are smaller, and the gradual but consistent changes in depth and water circulation effect differences in the fauna and flora, and thereby produce sediments which have recognizably different abundances of the major constituent. The three sub-environments, back reef, outer reef arc, and fore reef are indicated by progressive changes in constituent composition, and in less degree by variations in gross grain size. Because the estimates of constituent particle composition of the reef-tract sediments were made by point counts on standard petrographic thin sections this approach can be used to analyze ancient limestones.

1952 - 1979

Lew, R. M., M. D. Flora, and P. C. Rosendahl (1982) An analysis of rainfall in Shark Slough. Rep. T-646. US National Park Service, Everglades National Park, Homestead, FL. 46 pp.

Thiessen polygon analysis was used to estimate direct rainfall inputs into the 1000 km^2 Shark River Slough. Previous methods used to monitor precipitation in this region were reviewed. Comparisons were made between estimates based data collected biweekly during a 22 month period (December 1977 - September 1979) among rain gauge networks containing 87, 29, 11 and 3 gauges. These results were also compared with data collected daily at three long-term NOAA stations located on the periphery of the study area. A comparison between managed surface water inflows and uncontrolled precipitation contributions to the slough during this time was also made. Data from the three long-term NOAA stations were further used to compute a reconstruction of direct rainfall inputs into the slough on a monthly and yearly basis for the period 1952 to 1979.

1953 ◊

Moore, J. C. (1953) Distribution of marine mammals in Florida. Amer. Midl. Nat., 49:117-58.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] This citation contains descriptions of observations, strandings, and finds of dead specimens of marine mammals in Florida waters. There are several descriptions of such events in the Florida Keys and Florida Bay.

1953

Moore, W. E. (1957) Ecology of recent foraminifera in northern Florida Keys. Bull. Amer. Assoc. Petrol. Geol., 41:727-41.

[SAMPLING TOOK PLACE PRIOR TO AND INCLUDING 1953.] Foraminifera live in the following environments in the Florida Keys area: Florida Bay, water 0 - 10 ft deep; the back-reef, water mostly 15 - 30 ft deep but ranging from 0 to 40 ft deep; the reef, locally awash at low tide but extending seaward to a depth of about 60 ft; and the fore-reef water deeper than 60 ft The boundaries between the back-reef and the reef and between the reef and the fore-reef environments are transitional. The Florida Bay samples were collected in Swash Key, South Park Key Bank, Nest Key Pass, Black Betsy Keys, and Calusa Keys. The Florida Bay environment is characterized by great variations in the abundance of the Miliolidae, Peneroplidae, Nonionidae, and Rotaliidae, and by the absence of the Amphisteginiclae, Textulariidae, Lagenidae, and Buliminidae. Variations in the Florida Bay fauna suggest sorting. The Amphisteginindae and Buliminidae represent families present in the back-reef environment which are not found in Florida Bay. The Peneroplidae and Amphisteginidae are most abundant on the outer reef patches. The fore-reef environment is characterized by the appearance of the Cassidulinidae and the rise of the Anomalinade to a position of minor abundance. Angulogerina, Bulimia, Unigerina and Reusella do not occur at depths much shallower than 150 ft. These environments may be recognized and differentiated by noting the relative abundance of individuals belonging to the various families without regard to the species or genera involved.

1953 - 1954

Ginsburg, R. N., L. B. Isham, S. J. Bein, and J. Kuperberg (1954) Laminated algal sediments of South Florida and their recognition in the fossil record. Final Rep. 54-20 to the National Science Foundation from the Marine Laboratory, University of Miami., Coral Gables, FL. 33 pp. + Figs.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Laminated structures in calcareous rocks (stromatolites) which are abundant in the Pre-Cambrian and Paleozoic have been interpreted as algal from their gross morphologic similarities with modern forms. In order to develop more rigorous criteria of algal origin, to determine what class of algae were responsible for these structures, and to assess their environmental significance, laminated sediments forming in South Florida intertidal zones were studied. The sediments consist of alternately dark and light colored laminae of the order of a millimeter in thickness. The light laminae are fine-grained detrital sediment, and the darker ones contain varying amounts of algal debris. Definitely recognizable calcium carbonate precipitated as a result of algal photosynthesis is not quantitatively important in these deposits. A variety of structures such as domes, bubbles, undulations, and unconformities, all on several scales, are produced by differential sedimentation, preferential algal growth and sediment binding, configuration of the substrate, and desiccation. The laminations are formed by the alternation of heavy sedimentation with the growth of a mat of blue-green algae and associated organisms. Two end member types of organic mats and sediments are described, one from the rocky platforms of the open intertidal zone, and one from the intermittently flooded mud flats. The distinction between the two is based on the relative and absolute thickness of the mats and sediment laminae, structures, and grain size. Reference horizons of quartz grains which were established at several localities showed that the laminae are not necessarily annual and that their time value is variable and also depends on environments Criteria for the recognition of ancient stromatolites as deposits of this type are based on the presence of detrital sediment, and of structures which required a sediment-binding surface film. Because these recent algal-laminated sediments are limited to within a few feet of mean sea level, stromatolites of this type are perhaps the most reliable organic indicator of sea level available. Furthermore, because of the relationship between the properties and structures of the sediments and environment, they may provide useful geographic information. Study sites included Manatee Basin, Crane Key, and rocky platforms in the lower Florida Keys.

1953 - 1958

Turney, W. J., and B. F. Perkins (1972) Molluscan distribution in Florida Bay. Sedimenta III. R. N. Ginsburg (ed.) Univ. of Miami Rosenstiel School of Marine and Atmospheric Science, Miami, FL. 37 pp.

[THIS STUDY FIRST APPEARED IN SHELL OIL COMPANY REPORTS IN 1958 AND WAS REVISED FOR PUBLICATION IN THIS WORK. SAMPLING DATES WERE REPORTED IN SCHMIDT (1991) AS 1953 - 1958.] Within Florida Bay, four subenvironments can be recognized by the physical characteristics of salinity and variability of salinity, water circulation, and wind. The Northern Subenvironment is characterized by low and variable salinities due to freshwater runoff from the Florida mainland. The Interior Subenvironment is characterized by restricted circulation and is relatively unaffected by tidal exchange with either the Gulf of Mexico or the Atlantic Ocean. It is subject to large salinity variations due to seasonal or annual climatic variations. The Atlantic Subenvironment has near-normal marine salinity, with mixing of waters with the

Atlantic Ocean through tidal passes in the Florida Keys. The Gulf Subenvironment has near-normal marine salinity, but its position in a wind and current "shadow" causes its waters to be more stagnant than those in the Atlantic Subenvironment. The fauna of Florida Bay is dominantly molluscan, principally gastropods and bivalves which are represented by approximately 100 genera and 140 recognized species. A few "index species" and several "consistently common species" define four molluscan suites whose distributions appear to be controlled by the environmental influences characterizing the four subenvironments. Molluscan debris comprises 58 to 95% of the sediment particles greater than 1/8 mm. It is believed that the disintegration process is almost entirely organic and effected by crabs, boring sponges, perforating algae, holothurians, worms, and *Thalassia* roots. Thin-shelled bivalves tend to break down more rapidly than thick shelled bivalves and gastropods.

1954 ◊

Galtsoff, P. (Coordinator) (1954) Gulf of Mexico: Its origin, waters and marine life. Fish. Bull., 55(89):1-604.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] This citation is a detailed description of the Gulf of Mexico. The chapter topics are: history, geology, marine meteorology, physical and chemical oceanography, plant and animals communities, and pollution. Florida Bay is briefly discussed in several chapters.

1954 - 1955

Kilby, J. D. and D. K. Caldwell (1955) A list of fishes from the southern tip of the Florida peninsula. Quart. J. Fla. Acad. Sci., 18:195-206.

This paper describes fish collections conducted in 1954 and 1955 at sites with the Everglades National Park, Whitewater Bay and Florida Bay. The Florida Bay stations were at the end of Snake Bight canal and at Flamingo. Short descriptions of each collection site and species found are included in the paper.

1954 - 1957

Finucane, J. H., and A. Dragovich (1959) Counts of red tide organisms, *Gymnodinium breve*, and associated oceanographic data from Florida West coast, 1954-1957. Spec. Sci. Rep. Fish. No. 289. Fish & Wildlife Service, Washington, DC. 202-95.

This report presents original data giving enumerations of the red tide organism, *Gymnodinium breve*, and associated chemical and hydrographic data for the period from February 1954 to July 1957. Methods for collecting and analyzing samples are described. The citation contains counts of *G. breve*, data on salinity, pH, Cu, inorganic phosphorus, total phosphate, nitrate-nitrite, carbohydrates, and protein equivalents. These data were collected as part of a study on the distribution and incidence of *G. breve* and related ecological conditions.

1954 - 1957

Finucane, J. H. (1964) Distribution and seasonal occurrence of *Gymnodinum breve* on the west coast of Florida 1954-57. Spec. Sci. Rep. Fish. No. 487. US Fish. and Wildlife Service, Washington, DC. 14 pp.

The distribution and seasonal occurrence of *Gymnodinium breve,* the Florida red-tide organism, was recorded for a 4-yr period in estuarine and neritic waters along the Florida west coast. *G. breve* was found throughout the year in the area from Tarpon Springs south to the Florida Everglades. Blooms of this dinoflagellate occurred mainly from September through December in 1954 and 1957. Essentially, both 1955 and 1956 were not red-tide years. The observed salinities, temperatures, and distribution of *G. breve* are presented during both bloom and non-bloom periods.

1956 - 1958

McCallum, J. S., and K. W. Stockman (1961) Salinity of Florida Bay. Amer. Assoc. Petroleum Geol. Symp., Denver, CO. 78. (Abs.).

[ABSTRACT ONLY. NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] These authors made extensive bimonthly collections at 75 stations in eastern Florida Bay during an unusually dry year from December 1956 to December 1957, and found salinities as high as 58 °/oo. When normal rains returned in 1958, salinities were again on the brackish side. Comparing their data to rainfall records from previous years, the authors concluded that Florida Bay undergoes a cyclic alternation of brackish to hypersaline to brackish water in response to variations in rainfall. It was determined that in order to have runoff into Florida Bay there must be enough rainfall to raise the mainland water table to above that of Bay level.

1957 ◊

Ginsburg, R. N. (1957) Early diagenesis and lithification of shallow-water carbonate sediments in south Florida. Soc. Econ. Paleo. and Miner. Spec. Pub. No. 5. 80-99.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Diagenesis and lithification include processes which convert sediment into rock. They are of special importance to the study of limestones because of the ease with which they modify texture, structure, and composition of carbonate sediments The intense physical, chemical and biological processes which operate during deposition and within the first few feet of burial comprise early diagenesis. Subsequent processes are of longer duration and less intensity, and often, as in silicification and dolomitization, they obscure previous sediment properties, both depositional and early diagenetic. In contrast, the early phase does not generally mask original sediment properties, and often its effects may be just as indicative of the sedimentary environment as depositional features. Physico-chemical precipitation of calcium carbonate in the shallow tropical seas occurs under extreme conditions of temperature, salinity and nucleation. It may also take place within submarine sediments, but apparently not as a lithifying cement. Petrographic comparison of lithification of the late Pleistocene Miami Oolite with that of the Mississippian Fredonia Oolite suggests that cementation occurred in both cases only after removal from the marine environment. Unlithified carbonate sediments found well below the surface on some Pacific atolls support this view. Examples of the processes discussed are provided mostly from the eastern Florida Bay: Nest Key, Crane Key, Swash Key, and Calusa Key.

1957 - 1959

Tabb, D. C., D. L. Dubrow, and R. B. Manning (1959) Hydrographic data from the inshore bays and estuaries of Everglades National Park, Florida. 1957 - 1959. Rep. ML No.59253. The Marine Laboratory, University of Miami., Coral Gables, FL. 26 pp.

A study of the ecology of the estuarine waters of northern Florida Bay was conducted from 1957 to 1959. Surface and bottom temperatures and salinities, dissolved oxygen, percent saturation of dissolved oxygen, pH and tide stage were recorded.

1957 - 1960

Tabb, D. C., and R. B. Manning (1961) A checklist of the flora and fauna of northern Florida Bay and adjacent brackish waters of the Florida Mainland collected during the period July, 1957 through September, 1960. Bull. Mar. Sci. Gulf and Caribb., 11(4):552-649.

Four hundred thirty two species of plants, invertebrate animals and fish are reported from the marine and brackish-water areas of northern Florida Bay and adjacent estuaries. Notes on their abundance, tolerance to change in the physical environment, and distribution in relation to habitat are included. This work was done in order that their fluctuations in distribution and abundance in a natural environment might be better understood. This information could eventually aid in interpreting changes in populations due to man-made alterations in shallow water.

1957 - 1962

Tabb, D. C., D. L. Dubrow, and R. B. Manning (1962) The ecology of northern Florida Bay and adjacent estuaries. State of Florida Board of Conservation Tech. Ser. 39. Institute of Marine Science, University of Miami, Miami, FL. 79 pp.

This paper discusses some aspects of the ecosystem of Whitewater, Coot and Florida Bays. The sampling stations in Florida Bay were located from Cape Sable to Flamingo. Sampling occurred from 1957 to 1960. Winds of the Cape Sable region blow mainly from the east and southeast in summer and from the north-to-northwest in winter, with some influence being exerted by the easterly trade winds of winter which moderate the effects of polar air masses. Winds are the major factor in water circulation in Florida Bay. Tides generated by winds often exceed those due to lunar influence. Wind-generated turbulence is the major cause of the normally high rates of calcium carbonate mud turbidities in Florida Bay. Winds blowing across Florida Bay aid in evaporation. This has been shown to average more than 0.3 in day^{-1} in evaporating pans during the period March through July, 1961. Lunar tides in the estuarine portions of the study area and the nearby Gulf of Mexico are the mixed semi-daily type. At the end of the normal rainy season, June through November, there is marked decrease in air and water temperature. Just prior to that time, organic decomposition reaches a peak, causing a corresponding low dissolved oxygen content in the swamps and lagoons. This oxygen deficiency drives fish and invertebrates from the affected areas. This has been called the "bad water" period by commercial fishermen who often made good catches at that time. These oxygen deficiencies generally last about one month. Salinity values within the area fluctuate with rainfall and runoff from the watershed. No clearly defined relationship can be observed between salinity and local precipitation. In Florida Bay east of Flamingo were tidal circulation is absent or negligible, evaporation was nearly was important in salinity variations as runoff. The waters of the survey area generally show saturation of dissolved oxygen during the daylight hours and slightly below saturation at night. Highest oxygen values occur in areas of greatest plant growth, with Florida Bay turtle grass beds and the algae beds of Whitewater Bay being most productive. Lowest oxygen concentrations were always found in Coot Bay and eastern Whitewater Bay during the late summer and fall when runoff was highest and when plant cover was least dense. During periods of peak runoff there is usually a gradient in dissolved oxygen corresponding to the salinity gradient in Whitewater Bay. Total oxygen depletion was observed immediately following hurricane Donna of September, 1960, with conditions remaining between 80 and 37% saturation in Coot and southeastern Whitewater Bay, into October. By December, 1960, all stations had returned to near 100% saturation. The annual range of pH observed was normally between 7.7 and 8.2, with low values of 7.5 occurring during periods of oxygen depletion. Leaching of humic acids from the mangrove swamps had little effect on pH of adjoining bays. Runoff from the swamps produced pH values 0.5 to 0.8 units lower than the nearby bay water. The muds in the upper two centimeters of the bottom had pH values of the overlying water. At times, the diurnal range of pH was as great as the annual range. The normal daily range of pH was between 0.2 and 0.4 units. Turbidity in Florida Bay was specially severe along the shore of the upper Florida Keys and East Cape Sable. The heaviest turbidities were caused by the prevailing southeast winds and reach a peak concurrent with the period of defoliation of *Thalassia testudinum* in late summer. The turbidity was almost exclusively caused by fine particles of calcium carbonate marl in suspension. The invertebrate fauna of Florida Bay east and south of Flamingo is largely derived from the Carolinian-Gulf of Mexico faunal provinces. An examination of 355 species of invertebrate animals found in Biscayne Bay and Florida Bay produced only 15 species that were common to both areas, or 4.2% of the total number. The few Antillean forms that do occur in Florida Bay are found normally only along the edge of Florida Bay where it mixes with waters of the Straits of Florida and the Gulf of Mexico. Generally, the Antillean faunal elements are confined to waters having stable salinity and a high degree of clarity. Many of the common animals of the study area are extremely rare or absent in day time collections. The flora and fauna of the study area are regulated seasonally by temperature and salinity changes. However, the region has been divided into major habitats based on substratum characteristics as well. The inshore mudbanks and supratidal marl prairies support an impoverished biota able to survive the extremes of heat, cold and desiccation that prevail in those areas. The majority of the animals are burrowing forms that live in the upper layers of marl mud in the intertidal zone, under debris in the shore drift or construct deep burrows to water in the supratidal area. The turtle grass beds of the Florida Bay mudbanks form the largest single community restricted to a somewhat uniform substratum material. Greatest numbers of species, both plant and animal, were found in the stable high salinity region between Sandy Key and East Cape Sable. Areas of very high and very low salinity showed marked reduction in numbers of species. If turbidity became heavy in either hypersaline or very low salinity waters the numbers of species were reduced even further. The plant and animal populations were always greatest when salinity values were between 30 and 45 ‰. The numbers of species, and numbers within species declined with declines in salinity. An offshore movement of animals from bays and the estuary, begun each year by falling salinity during the rainy season, was hastened by a somewhat abrupt decrease in temperature characteristically beginning in November and lasting through January. The widest variety of species in Florida Bay was usually found during November-December as migrant animals from further north along the Florida coast were joined by species from local inshore areas. The normal November decrease in average temperatures was usually preceded by an oxygen depletion period in the shallow swamp ponds and lakes. This "bad water period" concentrated small fish from the swamps along the bay margins where they were heavily preyed upon by birds and larger fishes. Temperature fluctuations in southern Florida were seldom severe enough to cause mass mortality. There was, however, an annual offshore movement of Coot and Whitewater Bay species in November, December and January. Many of the animals participating in this movement were mature individuals of eurohaline species such as the blue crab, *Callinectes sapidus* and the striped mullet, *Mugil cephalus,* that are sea spawners in spite of wide temperature and salinity tolerances as adults. Other species, exemplified by the pink shrimp, *Penaeus duorarum,* use the bays as nursery grounds and leave these regions upon attainment of a certain size. Generally these begin leaving the estuaries prior to the onset of November cold weather but the offshore movement is accelerated by cold temperatures in shallow water. The offshore movements were most obvious in dry years when the bays fill with a variety of species and least obvious in years of heavy runoff that create low salinities in the back bays that exclude most marine species. Mass mortality of fishes due to cold was observed during December, 1957 when water temperatures of 14-16°C were recorded. A similar cold wave in February, 1958 caused no detectable kill and indicated a tendency to acclimatize on the part of the sensitive species. These studies have made it possible to describe probable past alterations in the ecology of the study area and to predict changes in the plant and animal communities under differing temperature, rainfall and runoff conditions. As a result, recommendations can be made as to the quantities of water and the runoff pattern likely to result in the greatest gain to the plant and animal community. These findings can probably be applied to other south Florida estuaries and, with due consideration to differences in rainfall patterns and temperature variation, can be useful in predicting the effects of man made changes in major estuarine systems of the southeastern United States and the Gulf of Mexico. Most of the significant changes in estuaries of this area are brought about by alteration in salinity and turbidity patterns. These changes are hastened by such developments as island building, bulkheading, causeway construction and construction of unnatural tidal inlets. Changes in the Everglades estuary were due principally to alterations in the watershed following the development of the Everglades for agriculture. In addition, local canal building has complicated the water exchange pattern, permitting high-salinity water to penetrate areas that were formerly fresh to brackish in nature. Salinity is the major environmental factor in the area affecting the plant and animal communities. Salinities have changed, beginning about 1920, with a reduction in runoff to the Shark River from an estimated average annual flow of 2.3 million acre-ft to a measured average of 473,200 acre-ft. Coot Bay and Whitewater Bay salinities are now thought to be about twice as high as in the average years prior to 1920. The hydroperiod (i.e. the annual period during which runoff measurably dilutes seawater in the estuary) probably lasted 12 months of each year of average to above average rainfall prior to 1920. Since then this has been reduced to about 7 months. Further reduction of runoff from the Everglades, to the area within the Park, will probably shorten the hydroperiod to about 5 months. This will permit rapid salinity increase in Coot and Whitewater Bays, both by evaporation and by salt intrusion through tidal inlets from Florida Bay and the Gulf of Mexico. Florida Bay has a limited watershed that acts as a moderating influence on the prevailing high salinities caused by evaporation. The salinity pattern of Florida Bay has probably not been altered in historic times. However, reduction of its small watershed, particularly the northern part near Homestead where annual rainfall is heaviest, could lead to permanent hypersalinity in Florida Bay. If salinity increases above 50 - 60 °/oo it may be expected that many plants will not survive and many animals will be unable to reproduce successfully. If salinity rises above 60 - 70 °/oo many species will die or be forced to leave the region. Hypersalinity in Florida Bay would be transmitted to Coot and Whitewater Bays by net gain of salt on each flood tide through Buttonwood Canal thereby making conditions unfavorable for many desirable animals and plants. At present, Coot and Whitewater Bays have salinities ranging between 0 - 5 and 30 - 40 °/oo, averaging about 18 - 25 °/oo. Under these salinity conditions a greater variety of plant and animal life is present than in pre-1920 times. With a slight increase in average salinity the region would be subject to an invasion by most of the marine species now found off-shore. This would favor angling and sightseeing pursuits but would create a situation different than in pre-drainage times. We believe that salinities observed are probably most favorable for the perpetuation of the area's nursery grounds for shrimp, menhaden, crabs and other valuable species. A return to conditions approximating those of the pre-drainage period would require a minimum average of 1.5 to 2.0 million acre-ft of runoff through the Shark River drainage annually. This should be spread over a full 12 month period. In many southern estuaries low to moderate salinities should be maintained if possible and control should aim at supplying enough freshwater to result in annual salinities of about 18 to 30 °/oo.

1957 - 1962

Tabb, D. C. (1967) Prediction of estuarine salinities in Everglades National Park, Florida, by the use of ground water records. Ph.D. Dissertation University of Miami, Coral Gables, FL. 107 pp.

There is a strong linear relationship between ground water level as expressed by elevation of water height in specified wells in the respective watersheds, and salinity in the estuaries of Everglades National Park. This relationship can be used to locate the freshwater line in the respective coastal rivers, and to predict the salinity of coastal estuaries and lagoons. There are two distinct watersheds in Everglades National Park: the Taylor Slough drainage discharges into Florida Bay, and the Shark River Valley-Everglades drainage feeds the Whitewater Bay - Shark River and lower Ten Thousand Islands estuaries. The precision of prediction of salinity increases with proximity to the land from which the water supply comes. Errors in prediction are greatest in regions having pronounced daily tide-influenced variations in salinity (e.g., near the mouth of the Shark River estuary) or in offshore stations of Florida Bay where wind causes shifting of the water masses from basin to basin. These water masses at times have markedly different salinity characteristics. Areas having strong daily tide effect produce characteristic inverted L distributions when salinity is plotted against ground water levels. A different, but equally distinctive distribution occurs in non-tidal areas at the peak of the dry season. In both cases prediction tables based on regressions of ground water elevation against salinity must treat the rising (wet season) and falling (dry season) separately. Local rainfall apparently has little effect in changing salinity except at the end of dry seasons and drought, especially the latter. At such times the ground water level may be several tenths of a foot below mean sea level. If heavy rains fall on the estuary at such times measurable dilution may occur, especially in shallow, non-tidal areas, before downward seepage of the new surface water has raised the ground water levels sufficiently to cause discharge into the coastal estuaries. It was shown that an elevation of 0.6 ft above mean sea level is necessary at wells in the Shark River Valley before seaward movement of the freshwater line in the estuary could be detected. These studies indicate that ground water discharge is by far the most significant factor in moderating salinities of coastal waters in Everglades National Park. Furthermore, it is concluded that the average (i.e., 45 - 55 in yr^{-1}) rainfall of southern Florida is not enough to cause the prolonged dilution of the estuaries as observed, and is insufficient to prevent an annual deficit between rainfall and evapo-transpiration. South Florida generally is classified as having a "tropical savannah climate" where there is a relatively long and severe dry season, and the rainfall during the wet season is not sufficient to make up the water lost to evapo-transpiration during drought and dry seasons. Such areas experience a constant water shortage during the dry season, and hence must depend on water from outside the region, in this case, from the Kissimmee River-Everglades drainage, to compensate for water losses through evapotranspiration and to prolong the period of estuarine dilution. As a result of these factors, prolonged and significant dilution of the extensive estuarine, lagoon and marsh habitats, as well as of Florida Bay, is made possible only by prolonged and massive displacement southward of freshwater "down gradient" in the aquifer. Much of this water has its origin in the Conservation areas of the Central and South Florida Flood Control District north of the Park, or in the undeveloped area west of Miami and north of Homestead known as the "Southwest Dade" area. This study spanned a period of severe drought and of heavier-than-average rainfall. Results of the study of Florida Bay salinity during this interval suggest that salinity may be expected to rise above 50.0 ‰ whenever ground water elevations in the Homestead well fall below 200 ft above mean sea level. Furthermore salinity at the stations more than a mile offshore will fluctuate between 25.0 and 35.0 ‰ when ground water levels fluctuate between 2.0 and 5.5 ft above mean sea level. However, if ground water levels increase to 6.0 ft above mean sea level an abrupt decline of 10.0 to 15.0 ‰ will occur in Florida Bay salinity. This suggests the height of ground water required to pour over the "sill" formed by the Miami Oolite ridge between the Florida City-Homestead area and Mahogany Hammock in Everglades National Park. Furthermore, this suggests that the ridge is more permeable to lateral flow southward, near the present ground surface than deeper down under the ridge. The prediction method could be refined by use of more refined salinity measuring and recording systems. Such measurements should record salinity hourly and should be related to a current direction and velocity meter. With this kind of instrumentation at strategic locations in the respective estuaries and lagoons it would be possible to eliminate most of the errors observed.

1957 - 1962 .

Ta..., D. C., L. L. Dubrow and A. C. Jones (1962) Studies on the biology of the pink shrimp, *Penaeus duorarum* Burkenroad, in Everglades National Park, Florida. Fla. St. Bd. Conserv. Tech. Ser. No. 37. Florida State Board of Conservation, Tallahassee, FL. 32 pp.

The biology of pink shrimp of northern Florida Bay was studied in conjunction with other studies on the ecology of estuarine plants and animals in a natural fluctuating environment. More than 25,000 juvenile pink shrimp collected during the period September, 1957, through April 1962 were examined for length and sex composition. Pink shrimp enter the Coot Bay area as postlarvae with a minimum carapace length of 1.7 mm and with 4 dorsal spines on the rostrum. The modal carapace length of entering postlarvae was 1.8 mm. with six dorsal and no ventral rostral spines. There appear to be peaks of postlarval abundance in the spring and early summer, low numbers in the late summer and fall and increasing numbers again beginning about November. Postlarvae enter the Coot Bay area on the flooding tides at night traversing the 3 mi length of Buttonwood Canal in approximately one hour at the peak velocity of the tide. Peak numbers of postlarvae in samples usually occur at the peak velocity of the flooding tides. Night plankton samples usually produce more postlarvae than day time samples. Catch-per-unit-effort data indicate that juvenile pink shrimp are most abundant during the period June through September. A smaller peak abundance is usually found sometime during the period February through May. Lowest catch rates normally occur in December and January. Among large samples of juvenile pink shrimp the sex ratio consisted of about 50% females and 50% males, however, small samples may show wide departure from a 1:1 ratio. Predation by fish is probably the major cause of shrimp mortality in southern Florida estuarine areas. Shrimp infected with sporozoan parasites causing the condition known as "cotton shrimp" were detected in only two instances during 55 months of sampling. Pink shrimp are sensitive to sudden cold temperatures of winter and respond by moving to deeper water. With warming of the shallows they move back unless they have reached the size for final emigration. Mass mortality of pink shrimp was observed following hurricane Donna. Deaths were caused by storm turbulence, stranding and post-hurricane oxygen depletion. Carapace length-frequency distributions show time and characteristics of periods of juvenile immigration into the nursery, and size at time of emigration to the offshore grounds. Orderly progression of modal groups along a similar pattern each year, followed by a sharp regression of size in June-July can be interpreted as indications of growth patterns and completion of offshore movement respectively. An average monthly carapace length increase of about 2 mm and a maximum of 3 to 4 mm is suggested by length frequency studies. Few shrimp having carapace lengths greater than 25 mm were taken in Coot Bay samples. This suggests that most have moved out of Coot Bay prior to attainment of that size. Petersen tags were used in an attempt to learn whether the shrimp of the mainland nursery areas actually did contribute to the Tortugas fishery. One shrimp, tagged in Coot Bay and recovered 123 days later in the Tortugas fishery, had increased from 110 count to 36 count per pound (heads off), and in carapace length from 21 to 32 mm. Three kinds of shrimp movement were noted; daily movement within the bay systems back and forth with the tides, short-term offshore movements to escape winter cold, and mass movement offshore in response to abnormal weather and water conditions attendant with hurricanes. Catches of small shrimp in the Tortugas during September and October, 1960, following hurricane Donna were far greater than the average for the same months of the preceding three years. The post-hurricane catches in the Tortugas contained much higher percentages of very small shrimp than usual at that time of year and suggests that hurricanes can cause shrimp to move offshore earlier and at a smaller size than is normal. Pink shrimp are tolerant of wide ranges in salinity. Postlarvae and juveniles to 28 mm. carapace length were taken throughout the full range of salinity observed in the study area. The general scarcity of shrimp larger than 28 mm carapace length in salinity lower than 32 ‰

suggest that they are less tolerant to salinity variation as they approach adult size. Two other penaeid shrimp species were found in small numbers. *Penaeus aztecus* was taken in samples of *P. duorarum*. *Trachypeneus constrictus* was usually found in marine salinity areas of Florida Bay, and occasionally, in the tidal portion of the Shark River estuary.

1957 - 1970

Tabb, D. C., and M. A. Roessler (1989) History of studies on juvenile fishes of coastal waters of Everglades National Park. Bull. Mar. Sci., 44(1):23-34. .

Knowledge of the species composition and general distribution of fishes in Everglades National Park coastal waters has a brief history beginning about 1957. Ten years later the list of fishes known to occur there, at least occasionally, had been lengthened to 167 species. Many of these occur in Park waters only as juvenile stages; they apparently move off-shore to mature, spawn, and then re-enter the Park as waves of larvae, post-larvae, or early juvenile stages. It was not until the late 1960's and early 1970's that life histories and environmental "preferences" came under investigation. These early studies, most of which were conducted in relatively low-salinity water, concluded that season of the year and presence or absence of bottom vegetation were the chief determinants of juvenile fish occurrence and spatial distribution, and other factors, such as salinity and temperature, had no statistically detectable influence on occurrence or abundance. However, studies of Florida Bay fish distribution and abundance during the extended drought of the early and mid-1960's did suggest that salinities between 45 and 70 ‰ were at least partly responsible for declines in both abundance and diversity, excluding both adult and juvenile stages.

1957 - 1974

Spackman, W., A. D. Cohen, P. H. Given, and D. J. Casagrande (1974) The comparative study of the Okeefenokee Swamp and the Everglades-mangrove swamp marsh complex of southern Florida: Field trip guidebook. Geol. Soc. Amer. Conv. Field Trip No. 6. 265 pp. + 3 App.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] This citation is a field guide to the geology of South Florida Bay and one of the sections discusses the sediments of Florida Bay. Subjects discussed include water circulation, molluscan fauna, isotope record of circulation gradients and texture and composition of sediments.

1957 - 1989

Robblee, M. B., J. T. Tilmant, and J. Emerson (1989) Quantitative observations on salinity. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):523. .

[ABSTRACT ONLY.] Quantitative observations on salinity within Florida Bay date from 1936. However, multiple spatially distributed observations within a given year were not available until 1957. With this paper, observation records from 29 published and unpublished studies have been compiled and analyzed to characterize typical salinity conditions and determine long-term temporal and spatial changes that may occur within this estuary. A total of 6,231 records were available for this analysis. During all but unusually high rainfall years, evaporation exceeds upland runoff into Florida Bay and hypersaline conditions (>35 ‰) prevail throughout most of the main body of the Bay. Annual monthly average salinity observations exceeded 35 ‰ within one or more areas of the Bay 12 out of the 17 yrs for which data was available since 1956. One or more areas of the Bay have exceeded 35 ‰ during at least one month every year for which sufficient spatial and temporal data were available. The highest salinity conditions consistently occurred within the central basins lying between the Whipray - Buttonwood Keys on the west and Captains, Russell and Black Betsy Keys to the east.

Lowest salinities consistently occurred within the upper northeast reaches including Little Madeira and Joe Bays. An increasing salinity gradient consistently occurred from the upper Nest Key basin eastward into Blackwater Sound suggesting the major region of upland runoff lies between Little Madeira and Joe Bays. Seasonal dynamics of salinity conditions within the Bay were tied to the distinct seasonal rainfall conditions of south Florida although considerable annual variability has occurred in the specific month of maximum and minimum salinity. Lowest concentrations have typically occurred during the late summer or fall months while highest salinities occur during late spring. Seasonal and annual variability in concentrations were greatest within the northeastern region of the Bay. Within year ranges of monthly mean values as great as 52 ⁰/₀₀ have been recorded within Little Madeira Bay. High concentrations occurring in late spring were often rapidly diluted following the onset of the rainy season within this upper Bay region. Consistent temporal data upon which to evaluate long-term changes in environmental conditions at any given location were limited. Strong evidence for long-term changes, given the high annual variability in conditions, was lacking. However, observable trends within the database will be present.

1958 ◊

Ginsburg, R. N., and H. A. Lowenstam (1958) The influence of marine bottom communities on the depositional environments of sediments. J. Geol., 66:310-18.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] The effects of benthic fauna on the sediment environment in Florida Bay was examined. This investigation described the ability of organisms, apart from reef builders, to control or modify their physical environment. It was found that certain organisms cause recognizable differences in sediment and other organisms.

1958

Thomas, L. P. (1961) Distribution and salinity tolerance of the amphiurid brittlestar, *Ophiophragus filograneus* (Lyman, 1985). Bull. Mar. Sci., 11(1):158-60.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).]The distribution of the amphiurid, *Ophiophragus filograneus* in Florida was presented along with a brief discussion of the ecology of the species. Based on collections of *O. filograneus* in Coot and Whitewater Bays, a new minimum salinity range (7.7 ⁰/₀₀) for echinoderms was reported.

1958, 1960

Lynts, G. W. (1962) Distribution of Recent foraminifera in upper Florida Bay and associated sounds. Cushman Found. Foram. Res. Contr., 13(4):127-44.

The distribution of the total population and standing crop from upper Florida Bay and associated sounds was investigated for distributional factors. A total of 68 samples were collected and investigated for foraminiferal content and analyzed for per cent of sand, salt and clay. The total population was used to divide the area into four faunal provinces: upper Florida Bay, Blackwater Sound, Barnes Sound and Card Sound, and to further subdivide these provinces into brackish and more marine biotopes. The relative abundance of the miliolidae. *Quinqueloculina lamarckiana* d'Orbigny and *Discorbis floridana* Cushman showed a direct relationship with salinity while that of *Streblus beccarii* (Linnaeus) and *Elphidium galvestonense* Kornfeld showed an inverse relationship. The whole area was characterized by the Miliolidae and was considered to be in the porcelaneous zone. The relationship between Foraminifera and sediment distribution was quantitatively analyzed and the results indicate that sediment size may be a factor controlling the distribution of certain Foraminifera. The quantitative considerations also indicate that the Foraminifera were not on the whole wave or current sorted. The study of the standing crop indicated that most of the families identified in the total population have living representatives in the area.

1958 - 1959

Costello, T. J., and D. M. Allen (1959) Migration, mortality, and growth of pink shrimp. Fishery research for the year ending June 30, 1959. Circ. No. 62. Bureau of Commercial Fisheries, US Fish and Wildlife Service, Galveston, TX. 13-8.

This citation describes migration, mortality, and growth of pink shrimp.

1958 - 1959 .

Costello, T. J., and D. M. Allen (1961) Notes on the migration and growth of pink shrimp, (*Penaeus duorarum*). Proc. Gulf and Carib. Fish. Inst., 12:5-9.

Fifteen verified recoveries of marked shrimp released in Florida Bay suggest the relative importance of certain areas as nursery grounds for the heavily exploited Tortugas pink shrimp. Previously, the only evidence linking the Florida Bay estuaries to the Tortugas grounds was the single tagged shrimp recovery reported in 1960. The useful information obtained attests to the utility of marking shrimp with biological stains. The method appears particularly suited to experiments which require observations over periods of several months. Though the data on migrations and growth are preliminary in nature, they will serve as the basis of more extensive investigations. The three mark-recovery experiments reported comprise a first step in delineating the areas which contribute to the maintenance of the Tortugas shrimp population. The marked shrimp were released off Flamingo in 1958, and off Peterson and Lower Matecumbe Keys in 1959.

1958 - 1959

Lloyd, R. M. (1964) Variations in the oxygen and carbon isotope ratios of Florida Bay mollusks and their environmental significance. Jour. Geol., 72:84-111.

The factors of climate and geography which produce salinity gradients and affect the molluscan fauna distribution in Florida Bay also cause variations in the δO^{18} composition of Florida Bay water. The isotopic composition of Bay water varies in response to (1) mixing of Atlantic and Gulf of Mexico waters having a relatively constant isotopic composition with Bay water along the western and southeastern margins; (2) evaporation of Florida Bay water which causes isotopic enrichment over the entire Bay; and (3) the introduction of isotopically enriched freshwater along the northern margin of the Bay. The net effect of these processes is to produce a persistent gradient of increasing δO^{18} from south to north in the Bay while water outside the Bay is maintained at a lower and more constant isotopic composition. Isotopic ratios from eight species of Florida Bay mollusk shells reflect clearly the sharp contrast between Bay and open water δO^{18} compositions and, to varying degrees, the gradient of increasing δO^{18} in the Bay itself. Temperature alone could not cause the variations found. Measurement of δC^{13} in Florida Bay mollusk shells reveals a gradient of decreasing δC^{13} going from open-shelf water into the Bay. The gradient is attributed to the equilibration of CO_2, derived locally from the oxidation of organic debris in sediment with carbonate ions in the water.

1958 - 1959

Manning, R. B. (1961) A redescription of the palaemonid shrimp, *Leander paulensis* Ortmann, based on material from Florida Bay. Bull. Mar. Sci. Gulf Carib., 11(4):525-36.

A series of *Leander* shrimp collected in Florida Bay represent a species distinct from the well-known *Leander tenuicornis*, and the characters used to separate the species are listed in the citation. The specimens were collected during an ecology study of northern Florida Bay estuaries.

1958 - 1963

Bock, W. D. (1971) A handbook of the benth ic foraminifera c Florida Bay and adjacent waters. Contribution 1360, Rosenstiel School Marine and Atmospheric Science, Miami, FL. Memoir 1, Miami Geological Society. A Symposium of Recent South Florida Foraminifera. J. I. Jones and W. D. Bock (eds.). Miami Geological Society, Miami, FL. 1-72.

Sediment samples from 108 stations in and around Florida Bay were examined for their benthonic foraminiferal content. This paper deals primarily with the taxonomy of the benthonic foraminiferal species and their distribution in sediments. 235 species belonging to 99 genera were identified. Five faunal groups were recognized and these correlated in a general way with areal changes in the physical environment.

1958 - 1963

Costello, T. J., and D. M. Allen (1966) Migrations and geographic distribution of pink shrimp, *Penaeus duorarum* of the Tortugas and Sanibel Grounds, Florida. Fish. Bull., 65:449-59.

Pink shrimp, *Penaeus duorarum,* frequent the estuarine waters of south Florida as juveniles. As adults, they support valuable fisheries on the offshore Tortugas and Sanibel trawling grounds in the Gulf of Mexico. To study the Tortugas and Sanibel shrimp stocks as biological units, 15 mark-recovery experiments in which biological stains were the marking agents were made. These experiments indicated: (1) timing and direction of shrimp migrations; (2) delineated estuarine nursery grounds; and (3) outlined geographic ranges of Tortugas and Sanibel shrimp stocks. Prior to migrating offshore, the length of time spent by juvenile pink shrimp in the nursery areas varies from about 2 to at least 6 months. In migrating from nursery areas, some shrimp travel at least 150 n mi before recovery on the offshore grounds. Although migration routes are broad, shrimp emanating from particular sections of the nursery grounds demonstrate distinct distributional patterns on the offshore grounds. The nursery grounds of the Tortugas shrimp stocks include Florida Bay and estuaries extending at least as far north as Indian Key on the southwest coast of Florida. The nursery grounds of the Sanibel shrimp stocks are confined to the southwest coast of Florida and include estuaries extending at least from Indian Key north to Pine Island Sound. The geographic ranges of the Tortugas and Sanibel pink shrimp stocks overlap in the nursery areas near Indian Key and in the offshore water between the two trawling grounds. Apparently, Tortugas shrimp do not migrate to the Sanibel grounds and migration from the Sanibel to the Tortugas grounds is minimal The geographic distributions depicted may constitute minimums for two reasons: First, the absence of fishing effort in certain contiguous areas prevented observation, which could extend the known distribution. Second larval and postlarval pink shrimp may migrate to or from areas beyond the ranges frequented by Tortugas and Sanibel shrimp as juveniles and adults.

1958 - 1964

Allen, D. M., and T. J. Costello (1966) Releases and recoveries of marked pink shrimp, *Penaeus duorarum*, in south Florida waters, 1958-1964. Data Rep. 11. US Fish and Wildlife Service, Washington, DC. 77 pp.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] Pink shrimp were captured, stain-marked, and released for recapture in 17 experiments in the following areas: Flamingo, Petersen Keys, Shark River and Bottle Key in Everglades National Park; Biscayne Bay, Lower Matecumbe Key, Barnes Sound, Hawk Channel, Pine Island Sound, Dry Tortugas Grounds, Sanibel Grounds, and Indian Key. Data reported includes location, date of release and recapture of shrimp, number, size, and sex of shrimp, and the stains used.

1958 - 1964

Robins, C. R., and D. C. Tabb (1965) Biological and taxonomic notes on the blue croaker, *Bairdiella batabana*. Bull. Mar. Sci., 15:495-511.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] Collections from Sandy Key Basin, western Florida Bay, resulted in the redescription of the little known blue croaker, *Bairdiella batabana*. The nomenclatural history and bibliographic synonymy of *B. batabana* is discussed. Analysis of meristic and morphological characters indicate that this species is very near *B. chrysoura*. Both species have been collected together in south Florida in mixed seagrass beds of *Thalassia - Syringodium-Halodule*. *B. batabana* feed on small crustaceans; larger specimens move to deeper water, its distribution is spotty due to its special habitat preferences. The authors suggest it may have a wide-spread distribution along the Atlantic coast of Central America.

1958 - 1978

Davis, G. E. (1980) Recreational and commercial fisheries in Everglades National Park: an ecosystem approach to resource management. Proc., Second Conf. on Scientific Research in National Parks. November 1979. San Francisco, CA. NTIS Report NPS/ST-80/02-7. 228-256.

Fisheries management in Everglades National Park involves over 20 commonly harvested species from six ecosystems, and both commercial and recreational fishermen. Analysis of data on catch fishing effort, population age structure of exploited species, boating activity, and environmental conditions ranging from 1958 to 1978 show three types of change in fishery resources. Some species increased in abundance and shifted their population age structure from juvenile toward adult fish, while other species declined in abundance and their age structure remained unchanged, including both juvenile and adults. Both general and specific increases in boating activity were associated with sharp declines in catch rates, whereas decreased boating activity since 1973 was associated with increased catch rates. Year-to-year variation in the availability of major game species declined, which may have been related to decline in the frequency of extreme climatic events and/or watershed management activities. No effects of harvest on finfish stocks in the Park were detected.

1958 - 1978

Davis, G. E. (1980) Changes in the Everglades National Park red drum and spotted seatrout fisheries, 1958-1978: Fishing pressure, environmental stress or natural cycles? Proc., Coll. on the Biology and Management of Red Drum and Seatrout. October 19-20, 1978. 81-7.

Everglades National Park supports mixed recreational and commercial fisheries for red drum, *Sciaenops ocellata*, and spotted seatrout, *Cynoscion nebulosus*. Within the 663,750 acres of the coastal waters of the Park, there are six ecologically discrete systems ranging from 51,000 to over 164,000 acres each. Commercial fishing is prohibited in a total of 94,000 acres in two of these systems. The numbers of commercial fishermen involved in these fisheries fluctuated between 125 and 276 from 1963 to 1978. Recreational fishing activity increased steadily from 58,000 angler-days in 1959 to 174,000 in 1965. It fell slightly in the late 1960s, reached another peak of about 160,000 angler-days in 1973 and 1974, and fell again to less than 100,000 angler-days in 1977. Recreational fishermen caught 96% of the red drum and 55% of the spotted seatrout landed in Everglades National Park from 1972 through 1977. The mean annual yield of red drum from Park waters was 0.366 pounds per acre, and 0.250 pounds per acre for spotted seatrout; producing mean annual harvests of 232,3000 pounds of red drum and 158,600 pounds of spotted seatrout from 1972 through 1977. In the past 20 yrs, three significant changes occurred in these fisheries:

(1) a shift in age structure towards larger mature fish; (2) consistent trends in catch rates, upward for red drum (24 to 127%) and downward for spotted seatrout (6 to 54%); and (3) marked reductions in the year-to-year variability of catch rates for both species. Preliminary analysis of these observations suggests that changes in environmental conditions in park estuaries caused the changes in fishery stocks and nature of harvest.

1958 - 1986

Rutherford, E. S., J. T. Tilmant, E. B. Thue, and T. W. Schmidt (1989) Fishery harvest and population dynamics of gray snapper, *Lutjanus griseus*, in Florida Bay and adjacent waters. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):139-54.

Catches of gray snapper, an important recreational gamefish species in south Florida, have been monitored nearly continuously since 1958 in Everglades National Park; total harvest and effort data have been collected since 1973, and lengths have been measured since 1974. Catch rates of gray snapper have fluctuated greatly since 1958 with peaks in 1959, 1964 - 1966, and 1977 - 1979. Most of the total annual harvest from 1973 to 1985 was taken by sport fishermen (78%) and guided parties (21%) with the remaining 1% taken by commercial hook-and-line fishermen and net fishermen. Total annual harvest of gray snapper in Florida Bay and adjacent waters dropped from 129,000 to 99,500 fish between 1973-1976, increased greatly to 156,000 fish in the mid-1970's, but declined again during the 1980's to 59,000 fish. Effort was linearly correlated with harvest ($r^2 = 0.973$, $n = 13$). The great increase in harvest in the mid-1970's was due to a great increase in guide harvest. The decline in effort, harvest, and harvest rates for gray snapper since 1979 is believed due to increased effort for other species such as spotted seatrout, as well as reduced stock abundance and recruitment. Gray snapper recruit to the park fishery at age 1 and are found in the catch to at least 7 yrs. Three and 4-yr-old fish make up 87% of the catch. Gray snapper are believed to migrate offshore out of the Park to spawn since very few ripe adult fish have ever been found in the Park. Gray snapper along the Keys and Florida's east coast live to at least 21 yrs old. Although fishing mortality on gray snapper in the park is high, averaging $F = 0.76$, and the stock is growth-overfished, population size and recruitment are not controlled by fishing effort within the Park. Environmental factors and possibly fishing effort on gray snapper in the adjacent Florida Keys may control stock size.

1958 - 1986

Rutherford, E. S., J. T. Tilmant, E. B. Thue, and T. W. Schmidt (1989) Fishery harvest and population dynamics of spotted seatrout, *Cynoscion nebulosus*, in Florida Bay and adjacent waters. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):108-25.

Catch rates of spotted seatrout, one of the four most popular recreational gamefish in Everglades National Park, have been monitored nearly continuously since 1958; total harvest and effort data and commercial landings have been monitored since 1973, and lengths have been measured since 1974. Sport fishermen catch rates of Florida Bay spotted seatrout were higher from 1958 to 1967 than from 1973 to 1985 and reached a period of record low in 1973 - 1977. Commercial hook-and-line fishermen and sport fishermen together accounted for an average 84% of the total annual spotted seatrout catch from 1973 to 1979, with guide fishermen and commercial net fishermen accounting for an average 13% and 3% of the catch. During 1973 - 1976, total harvest declined from 130,000 to 59,000 fish, then increased to 74,000 fish in 1979 because of increased commercial harvest, and declined again in 1980 when bag limits of 10 fish/person/day greatly restricted the commercial fishery and reduced recreational catch. Total annual effort was closely correlated with harvest ($r^2 = 0.950$). Since 1980, total annual harvest has increased to early 1970 levels with increases in both recreational and guide fishermen harvest. Catch rates and length frequency distributions suggest different unit stocks of spotted seatrout in the Florida Bay area and the Gulf Coast area of the park. The reduction in spotted seatrout harvest in the Florida Bay area appeared due to reduction in fishing effort and to environmental factors. Current harvest levels (avg. 100,000 fish yr^{-1}) have moderate impact on the stock. Average fishing mortality rate for 1973 - 1984 was 0.36 and ranged from 0.20 to 0.55. Between 13 and 28% of the total recruited stock in the Florida Bay area were harvested annually from 1973 to 1984. Age of harvested spotted seatrout ranged from age 1 - 8, with ages 3 - 5 providing up to 70% of the catch. Estimated population size of spotted seatrout in the Florida Bay area ranged from 686,000 to 786,000 fish from 1974 to 1978 and then decreased slowly to 631,800 fish by 1984. Recruitment of age-1 fish varied from 166,700 to 317,000 fish, peaking in 1976, 1977, and 1984 and being lowest in 1983. Catch rates were poorly correlated with rainfall and water levels in upland marshes. There was no relationship between estimated parent stock and recruitment or rainfall/upland water levels and recruitment.

1958 - 1986

Tilmant, J. T., E. S. Rutherford, and E. B. Thue (1989) Fishery harvest and population dynamics of the common snook (*Centropomus undecimalis*). Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):523-4.

[ABSTRACT ONLY.] The Everglades National Park fishery harvest monitoring program has provided a record of the recreational snook fishery catch and effort from 1958 to present. Length data are available on harvested fish since 1974. Although snook has comprised less than 1% of the total recreational fishing harvest they have been specifically sought by as many as 15% of the total fishing boats during a given year. This species has comprised 1.1% of the total annual reported guide fishermen catch since 1984. A marked decline was noted in the annual number of boats successfully catching snook from 1974 through 1982. These declines were due to a decline in the percent of boats successful for this species as well as a decline in total fishing boats within the park. Since 1982, there has been an annual increase in the percentage and total number of boats reporting catches and observed harvesting snook. This increase has occurred despite closed seasons being placed on the fishery during January-February and June - July (June - August 1985 and 1986). The average catch per successful boat reached a peak 5.5 fish in 1964 (0.36 fish man^{-1} hr^{-1} fished) but declined to only 2.5 fish (0.20 fish man^{-1} hr^{-1}) by 1966. Average reported catch rates continued to decline during the 1970's, reaching only 1.3 fish per successful boat (0.12 fish man^{-1} hr^{-1}) in 1979. The average reported catch of snook per successful boat remained extremely low through 1982, but then increased in 1983 and 1984. This increase in catch rate was not accompanied by an equal increase in harvest per boat indicating that large numbers of small snook were being released during 1983 and 1984. The size distributions of fish harvested during 1983-1984 also suggest a recruitment of large numbers of young fish occurred those years. An annual increase in the total number of fishermen catching snook since 1983, as well as the increase in the catch rate, led to over a two-fold increase in annual harvest from 1982 to 1986. This increase in annual harvest has occurred despite restricted size limits, a decreased bag limit, and a seasonal closure on the fishery. Since 1974, the average length of snook harvested from Everglades National Park has been approximately 635 mm FL (age 4.5 yrs). Thirty-one percent of the fish observed were less than the 24-in TL (610 mm) minimum size placed on the fishery in 1985. Significant differences in annual mean size were noted only during 1975 and again in 1982 when average size increased to 711 mm FL (28 in). Both 1975 and 1982 may reflect low recruitment year classes. This is supported by size distribution curves for those years. A drop in the average number of fish harvested per successful trip was observed in 1985 which reflects the 24-in minimum size limit placed on the fishery that year. An increase in average harvest per successful boat and average size fish harvested in 1986, even though the total catch rates of successful fishermen were down, reveal the entry of previously undersized fish into the fishery during 1986. Mortality rate of fish 24 to 30 in. appears higher in 1986, suggesting higher vulnerability to harvest once these fish reach 24 in. The data obtained indicate that the bag limits, minimum size limits, and closed seasons placed on this fishery to date have not resulted in a reduced total annual harvest. However, this is largely due to unusually good recruitment years in 1983 and 1984. The apparent increase in snook populations following the high rainfall years of 1982 and 1983 also suggests that larval recruitment and/or juvenile survival may be enhanced by increased upland runoff or marsh flooding.

1958 - 1986

Tilmant, J. T., E. S. Rutherford, and E. B. Thue (1989) Fishery harvest and population dynamics of red drum (*Sciaenops ocellatus*) from Florida Bay and adjacent waters. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):126-38.

A fisheries harvest monitoring program provided catch and effort data on the harvest of red drum from Florida Bay since 1958. Length data are available since 1974. Red Drum were sought by less than 7% of the fishermen in the late 1950's, but increased to nearly 40% of the fishermen during 1986. Red drum also comprised approximately 15% of the annual total reported harvest of commercial guide fishermen. The annual estimated total harvest from Florida Bay declined from 28,500 fish in 1973 to less than 17,500 fish in 1978, but then increased dramatically to a peak of 51,000 fish in 1984. Although fishing effort has continued to increase since 1984, total reported catch of red drum has seriously declined. The red drum fishery is largely comprised of newly recruited fish. Prior to a 18-in minimum size limit imposed in September 1985, 51% of the annual harvest were 1-yr-old fish, 38% were 2-yr-olds, and less than 12% were 3 yrs or older. Proportional age distribution within any given year has varied with annual recruitment to the fishery. A virtual population assessment suggests that the Everglades National Park's fishable population of red drum declined from around 120,000 fish in 1974 to a low of 90,000 in 1977, but then increased to over 180,000 by 1980. During 1985, an estimated 41% of the available population was harvested. Recent declines within the red drum population are not likely due to fishermen harvest unless such harvest has impaired offshore breeding stocks. Data are not available on the rate of escapement and offshore stock abundance. Assuming constant annual natural mortality and offshore migration rate, estimated instantaneous rates of total annual fishing mortality (F) have ranged from 1.1 to 1.9. Increased recruitment to the fishery followed high rainfall years ($r = 0.814$, $N = 10$), suggesting improved recruitment and/or survival of early stage juveniles during periods of increased upland runoff.

1959

Taft, W. H. (1962) Unconsolidated carbonate sediments in Florida Bay, Florida. Ph. D. Dissertation. Stanford University, Stanford, CA. 70 pp.

This report describes the chemical and mineralogical composition of modern unconsolidated carbonate sediments accumulating along the western margin of Florida Bay. The purpose of this investigation was to determine the possibility of using Ca, Mg and Sr content of ancient limestone, the counterpart of modern carbonate sediments, as indicators of depositional environment. Systematic variations of Ca/Mg and Sr/Ca ratios, and percentages of carbonate minerals do not occur in these sediments either laterally or vertically in sediments as old as 3600 yrs. Rhombohedral dolomite and hexagonal prisms of low-magnesium calcite are reported from these sediments for the first time. Metastable aragonite and high-magnesium calcite together constitute approximately 85% of the carbonate sediment; the remaining 15% is made up of low-magnesium calcite and dolomite. The metastable minerals exhibit no evidence of recrystallization and appear to be the most stable carbonates in this environment. Origin of aragonite and high-magnesium calcite is attributed to mollusks and foraminifers, whereas that of low-magnesium calcite and dolomite is not known.

1959 ◊

Thomas, L. P. (1959) A systematic study of the shallow water brittle stars of the family Amphiuridae of Florida. M. S. Thesis, University of Miami., Coral Gables, FL. 156 pp.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] This study is, in some respects, an enlargement over the originally planned study of shallow water South Florida amphiurids. Although "shallow water" in this case refers to that portion of the bottom from the intertidal zone to 20 - 30 ft, the author has made no distinction between true shallow water species and specimens of deep-water species which have strayed into shallow water. Too little is known concerning the distribution of the Florida Amphiuridae to make such a discrimination in more than a few species; however, suspected deep-water species are noted as such in the text. The study area, from Ft. Myers on the West Coast to Lake Worth on the East Coast, has provided the author with all the Florida species save two, of these, *Amphiura fibulata* Koehler, is known only from the type taken in five and a half fathoms off Key West. *Amphiodia rhabdota* H. L. Clark, originally known from the type at Tortugas, was reported from Biscayne Bay previously. These two species have been included in order that a complete study of the fauna might be produced. Besides those species previously known from Florida, two species known only from Tobago, *Amphipholis pachybactera* H. L. Clark are included. Two other species, *Ophionephthya limicola* Lutken and *Ophiophragmus pulcher* H. L. Clark, formerly known only from the Tortugas, have been found to be common in Biscayne. *Ophionephthys limicola* in particular is a dominant species of the level bottom community. A fifth species, *Ophiophragmus septus* Lutke, taken off Miami Beach has previously been recorded only from Cape Hatteras, Tobago, and St. Thomas.

1959

Wallis, O. L. (1959) Research and interpretation of marine areas of the US. National Park Service. Proc. Gulf Caribb. Fish. Inst., 11:134-8.

This citation discusses activities of the National Park Service and marine research projects underway or anticipated (in 1959) in the Everglades National Park.

1959, 1962

Taft, W. H., and J. W. Harbaugh (1964) Modern carbonate sediments of southern Florida, Bahamas, and Espirtu Santo Island, Baja, California: A comparison of their mineralogy and chemistry. Stanford Univ. Publ., Geol. Sci., 8(2). 133 pp.

The mineralogy and chemistry of modern, unconsolidated carbonate sediments have been studied in southern Florida, parts of the Bahama Islands region, and Espiritu Santo Island, Baja California. Sampling in Florida took place in 1959 and 1962. The principal purpose of the study has been to better understand the relationships of the different carbonate minerals (aragonite, dolomite, high-magnesium calcite and low-magnesium calcite) in different sedimentary environments, and the behavior of the inherently unstable carbonate minerals, aragonite and high-magnesium calcite, which tend, over long periods of time, to be transformed to dolomite and low-magnesium calcite. In southern Florida, studies were conducted in Florida Bay, Whitewater Bay, the Ten Thousand Islands area, Lake Ingraham, and the shoal area west of Key West. In the

Bahamas, studies were made along the western shore of Andros Island and on the Yellow Bank directly south of New Providence Island. In Baja California, samples were collected along the western side of Espiritu Santo Island, and to a lesser extent on adjacent parts of the Baja California peninsula. There is little evidence to suggest that either aragonite or high-magnesium calcite is being transformed within the unconsolidated sediments that we have investigated. Significant changes have not been found in the proportions of aragonite, high-magnesium calcite, low-magnesium calcite, and dolomite (where present) in respect to depth below the water-sediment interface in cores of sediment. If mineral transformations have taken place, one would expect to find a decrease in the proportions of the unstable forms (aragonite and high-magnesium calcite) and an increase in the stable forms (dolomite and low magnesium calcite) with increasing depth and age. It is suggested that aragonite and high-magnesium calcite are not being transformed to low-magnesium calcite because magnesium ions are present in sufficient concentration in the water surrounding the mineral grains in the sediment. The presence of enough Mg ions in interstitial water prevents transformation of aragonite and high-magnesium calcite. Experiments by Taft indicate that if Mg ions are present in interstitial water in sufficient concentration so that there is at least one Mg ion present in the water for each unit cell of aragonite in direct contact with the interstitial water, transformation of the aragonite to low-magnesium calcite does not take place. The concentrations of both magnesium and calcite ions is generally greater in interstitial water in sediments that we have investigated than in the overlying seawater; thus transformation of aragonite and high-magnesium calcite would not be expected to occur under existing conditions. In places in southern Florida, and adjacent to the west side of Andros Island, the carbonate sediment particles themselves, excluding interstitial water, generally contain more Mg than can be accounted for in terms of the proportions of high-magnesium calcite. In southern Florida, some of the Mg is probably associated with dolomite, which is present in small but highly variable proportions. Adjacent to the west side of Andros Island, however, dolomite appears to be lacking and yet there is still more Mg than can be accounted for by the presence of high-magnesium calcite, It seems likely that some of the excess Mg is associated with aragonite. Where very fine (less than 0.001 mm) particles of aragonite are abundant, Mg is generally present in excess. It is suggested that Mg ions tend to be concentrated on the surfaces of aragonite particles, and that the excess Mg associated with fine particles reflects that increased ratio of particle surface area to mass. We have found dolomite in unconsolidated carbonate sediments that we have studied only in southern Florida. In Florida, the dolomite forms from zero to about 15% of the total carbonate material present in the sediment, and forms a maximum of about 2% of the total material present in the sediment. Where the proportion of dolomite to total carbonate material is highest, there is generally a large proportion of non-carbonate material present, such as quartz sand. In southern Florida, some of the dolomite is detrital and apparently has been set free by disintegration of limestones. However, many of the dolomite grains appear to have overgrowths that have formed very recently. Much of the carbonate material in unconsolidated sediments that we have studied has probably been secreted by organisms. However, it is suggested that particles that have formed by direct chemical precipitation under inorganic condition sand have not been reworked (aggregated into fecal pellets, etc.), will be generally smaller than about 0.010 mm, and that the proportion of sediment with particle dimensions less than 0.010 mm forms a rough upper limit of the maximum proportion of the sediment that could have formed by inorganic precipitation. Radiocarbon age dates for different fractions of unconsolidated carbonate sediments reveal that carbonate carbon and organic carbon, within a given sediment sample, tend to yield different ages. This suggests that the individual components of carbonate sediments are heterogeneous in age, and that a radiocarbon age date for a given sample merely reflects a kind of average age for all of the components. Most of the carbonate sediments that we have studied that have formed in the past several thousand years and that have remained at or below sea level, generally have not undergone much consolidation. However, a notable exception is found on Yellow Bank, south of New Providence Island in the Bahamas, where specimens of consolidated and semi-consolidated grapestone sediment have yielded radiocarbon ages of carbonate carbon ranging from 874 to 1792 yrs. The specimens were collected where the water is about 10 ft deep, and presumably, any sediment accumulating at this depth has been continuously submerged beneath the sea for at least the past 4000 yrs. Consolidation appears to be due to cementation by aragonite. Determination of carbon isotope ratios reveals that sediment specimens rich in aragonite tend to have relatively high ^{13}C per mil deviation values, whereas specimens rich in low-Mg calcite have relatively low ^{13}C per mil values. The association of high ^{13}C per mil values with high proportions of aragonite may reflect the presence of inorganically precipitated aragonite that is enriched in ^{13}C.

1959 - 1960

Croker, R. A. (1960) A contribution to the life history of the gray (mangrove) snapper, *Lutjanus griseus* (Linnaeus). M. S. Thesis. University of Miami., Coral Gables, FL. 93 pp.

Gray snapper are found primarily in inshore tropical and subtropical marine and brackish waters on both sides of the Atlantic Ocean. Their center of abundance can be considered as Florida, the Gulf of Mexico, the West Indies, and the Bahamas and Bermuda Islands. The southern limit of *L. griseus* is in the waters of Brazil while stragglers are reported as far north as Cape Cod, MA. The southern tip of the Florida peninsula and extreme southwest coast, comprising Dade, Monroe, Collier, and Lee counties coincides with the area of largest gray snapper commercial landings. The habitat of this area has a constant feature of mangrove growth and estuarine bays and lagoons. Juvenile gray snapper have been collected in shallow grassy areas, or in close proximity to mangrove growth where salinities have varied widely. Sub-adult gray snapper are abundant in inshore, shallow water over muddy, hard, and rocky bottoms, especially in mangrove areas such as estuarine bays and lagoons. The precise habitat preferences of mature gray snapper are not known. *L. griseus* occurs further north in North America than any other species of the genus *Lutjanus*. The gray snapper reported in northern waters are usually very small fish carried northward by the Gulf stream. Abnormally low temperatures in southern waters will adversely affect gray snapper depending on the suddenness and amount of temperature drop, the minimum temperature attained, and the duration of the cold. Gray snapper in the Everglades National Park waters are subjected to a considerable range of temperatures. During the period June 1957 to June 1959, temperatures ranged at least from 15°C to 36.3°C in Park waters. Juvenile and sub-adult *L. griseus* are eurohaline, being tolerant of seawater higher than 35 ‰. brackish water, and excursions into Florida freshwater springs. During the period June 1957 to June 1959, inshore waters of the Everglades National Park where gray snapper are abundant, ranged in salinity at least from 4.5 to 4.7 ‰. Scales of gray snapper are readable, and have been critically examined for age and growth determinations. The annulus on gray snapper scales appears to be a region of different refractive properties than the remainder of the scale, and is a result of discontinuous and non uniform circuli. The validity of the annulus on gray snapper scales is shown by the agreement of calculated lengths from scale readings with empirical lengths of fish of the same growth year, and by the appearance of a mode for the sport fishery catch, and for scale readings. The annulus on gray snapper scales is laid down during the period December to February in south Florida. The sex ratio for 770 gray snapper was 404 to 366 (52.5 to 47.5%) females predominating. Females outnumbered males slightly in the most abundant age groups present in the most abundant age groups present in the sport fishery catch (age groups II and III). Gray snapper sampled from the sport fishery in the Everglades National Park ranged from one to five years of age. The 2- and 3-yr-old fish made up approximately 62 and 28% respectively of the catch.

Five gray snapper sampled by spear fishing from Bear Cut, Biscayne Bay (fork lengths 387 to 480 mm.) ranged in age from four to seven years. Gray snapper four years of age and older appear only infrequently in the sport fishery catch in the Everglades National Park. Gray snapper average 7.1 in fork length at two years of age, and are recruited into the sport fishery at this time. The age at maturity of gray snapper in south Florida is not known, although it is greater than three years. There is no consistent difference in the mean fork lengths of male and female gray snapper of the same age for first four years of life. Mean fork lengths of gray snapper for the first four years of life, sexes are combined, are: 3.2, 7.1, 9.5, and 11.6 in. Mean fork lengths of gray snapper for the first four years of life, sexes combined, are: 3.2, 7.1, 9.5, and 11.6 in. Growth of gray snapper from the Everglades National Park is rapid to the second year, followed by a moderate decrease to the third year, and almost similar growth to four years of age. Continued growth of gray snapper in south Florida beyond the age of four years is evident from the examination of scales from fish five to seven years of age taken from Biscayne Bay. The gonads of 790 gray snapper were examined for macroscopic appearance between July 1959, and April 1960. With the exception of five fish from Biscayne Bay, all fish were assigned to one of two initial maturity stages. Nearly ripe, ripe, and spent fish were not observed during this study. Gray snapper in the Everglades National Park, therefore, appear to pass through two immature gonad stages. Gonad studies have shown the sport fishery catch for gray snapper in the Everglades National Park to consist of immature fish. The five fish examined from Biscayne Bay, fork lengths 387 to 480 mm. and four to seven years of age, could conceivably be assigned to a third stage of gonad maturation. The specific time, duration, and place of spawning of gray snapper in south Florida is not known. Several factors point to a possible early summer spawning period. Collections of juvenile gray snapper from central Florida and the Florida Keys report the smallest fish collected during the late summer and early fall. Sizes of these fish when compared with mean fork lengths of gray snapper at first annulus formation during the period December to February, give evidence of a possible early summer spawning period. Gray snapper from the Everglades National Park may not be one year old at first annulus formation, but six- to eight-months of age. The Everglades National Park waters are important nursery grounds for young gray snapper one to three years of age. There is no significant difference in the length-weight relationship of male and female gray snapper sampled during the study. Gray snapper caught in the sport fishery in the Everglades National Park average one-half pound. The stomachs of 200 gray snapper were examined during this study. One hundred ninety-five were from the Everglades National Park specimens, and five were from Biscayne Bay. The fish ranged from 135 to 480 mm fork length. Fifty four, or 27%, of the stomachs were empty. All five of the Biscayne Bay stomachs were empty. No significant difference in food preference was noted from month to month, or for snappers of different sizes. *L. griseus* preys largely on crustacea; 79% of the stomachs contained at least one type of crustacea. Crustaceans made up 61.6% of food items by number, and 76.7% by volume. When bait shrimp were separated from naturally occurring shrimp, shrimp still held prominence over any other food item, occurring in 42% of the stomachs containing food. Fish and crabs occurred in 34 and 27% of the stomachs respectively. Gray snapper feed near rocky and mangrove shore-lines in addition to foraging further out onto grassy and sandy flats, and into nearby channels.

1959 - 1960

Croker, R. A. (1962) Growth and food of the gray snapper, *Lutjanus griseus* in Everglades National Park. Trans. Amer. Fish Soc., 91(4):379-83.

A study of the biology of the gray snapper was based on the examination of 849 fish collected primarily from the sport fishery of Everglades National Park. Gray snappers from Park waters ranged from 1 to 5 yrs of age, with age groups II and III making up 62 and 29% of the catch. Mean lengths for each age group, age and length at recruitment into the sport fishery length-weight relationship, and sex ratio of gray snapper are given. All Everglades Park fish were immature. The stomachs of 200 fish were examined for food contents. Crustaceans made up 61.6% of food items by number and 76.7% by volume, shrimp occurring most frequently. Fish and crabs occurred in 34 and 27% of the stomachs containing food.

1959 - 1960

Iversen, E. S., and D. C. Tabb (1962) Subpopulations based on growth and tagging studies of spotted seatrout, *Cynoscion nebulous*, in Florida. Copeia, 3:544-48.

Analyses of subpopulations of spotted seatrout were made using growth and tagging data from several locations along the coast of Florida (Cocoa, Flamingo, Fort Myers, Cedar Key, and Apalachicola). Growth rates from these areas show differences that suggest subpopulation of this species. These findings agree with tagging results wherein 95% of recaptured seatrout moved less than 30 mi from where they were tagged. Results of the two studies suggest a close association of the seatrout with the local environment.

1959 - 1960

Stewart, K. W. (1961) Contribution to the biology of the spotted seatrout (*Cynoscion nebulosus*) in the Everglades National Park, Florida. M. S. Thesis. University of Miami, Coral Gables, FL, 103 pp.

The Everglades National Park area is near the southernmost limit of distribution of the spotted seatrout. The spotted seatrout is more specific in its need for estuarine conditions than the other three species of *Cynoscion* found on the Atlantic and Gulf coasts of the United States. There is considerable variation in the relative proportions of the scales of the spotted sea-trout. The relationship of scale radius to body length is apparently linear although widely scattered. The spotted seatrout in the Everglades National Park form an annulus on their scales only once each year and at the same time each year. This is primarily in December, although a few fish form the annulus in November and January. The oldest observed age for the spotted seatrout of the Park was seven years. There is a pronounced sexual dimorphism in the age composition and growth rate of the spotted seatrout. The females grow more rapidly, reach peak abundance in the catch at a later age, and live longer than the males. The size at first maturity of the spotted seatrout ranges from 190 to 300 mm. There is no apparent difference in the size at first maturity between males and females. The spawning period of the spotted seatrout of the Everglades National Park is distinctly bimodal. A spring peak in spawning activity occurs in May, and a fall peak in September, and there are ripe fish of both sexes present every month of the year. Attempts made to determine the area of spawning and juvenile development within the Park were unsuccessful. The spotted seatrout of the Everglades National Park depend primarily upon the pink shrimp as a source of food. The feeding activity of the spotted seatrout is primarily governed by the availability of food. Minor ecological factors may affect the areas in which feeding takes place.

1959 - 1961

Stockman, K. W., R. N. Ginsburg and E. A. Shinn (1967) The production of lime mud by algae in south Florida. J. Sed. Petrol., 37(2):633-48.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] A study was made on the origin of recent lime muds in south Florida, mostly within the northeast interior of Florida Bay. Comparison of the annual production of fine aragonite mud (<15 ug) by the post-mortem disintegration of fragile algal skeletons, showed the algae, *Penicillus*, to be a major sediment contributor, accounting for all the fine aragonite mud in the inner Florida Reef Tract and 1/3 of the same material in northeast Florida Bay. The contribution of three other abundant algal species is assessed as well as the significance of mechanical breakdown of skeletons, mollusks, and corals. Movement of lime muds from their production sources to areas of accumulation such as the banks in western Florida Bay is discussed. It is suggested that plant and animal skeletons have been major sources of fine lime sediment in the past.

1959 - 1962

Jones, A. C., D. E. Dimitriou, J. J. Ewald, and J. Tweedy. (1970) Distribution of early development stages of pink shrimp, *Penaeus duorarum*, in Florida waters. Bull. Mar. Sci., 20:634-61.

Larval stages of pink shrimp were collected by plankton nets from the Tortugas Shelf and Florida Bay, off southwest Florida from 1959 to 1962. Protozoae and myses were distributed on the shelf mainly between the 8- and 30-fathom depth contours. Postlarvae were found both on the shelf and also in the shallower waters of Florida Bay. Older postlarval stages were almost entirely restricted to inshore waters. Pink shrimp spawned throughout the year in this area, but the intensity of spawning in winter was low. Variability of the net catches and vertical migration are discussed, and migration routes of the larvae to inshore areas are hypothesized.

1959 - 1965

Higman, J. B. (1967) Relationships between catch rates of sport fish and environmental conditions in Everglades National Park, Florida. Proc. Gulf and Carib. Fish. Inst., 19:129-40.

Catch rates have been determined for a period of 7 yrs showing the seasonal and long-term trends of availability of spotted seatrout, mangrove (gray) snapper, and redfish (red drum) in Everglades National Park. Park seasonal catch rates are apparently associated with the congragation of fish for spawning and by the response of fish to drastic changes in environmental conditions.

1959 - 1985

Tilmant, J. T., E. S. Rutherford, R. H. Dawson, and E. B. Thue (1990) Impacts of gamefish harvest in Everglades National Park. Proc., Conf. Sci. National Parks: Vol. 6: Fisheries and Coastal Wetlands Research. G. Larson and M. Soukup (eds.). Washington, DC. 75-103

The Everglades National Park Fisheries monitoring program has provided a 24-yr record of stock response conditions. Over 80 species of fish have been reported within the recreational and commercial catches; However, five species comprise over 86% of the snapper (*Lutjanus griseus*), seatrout (*Cynoscion nebulosus*), and red drum (*Sciaenops ocellatus*) has approached maximum sustainable yield (MSY in number) during the past 12 yrs. Recent bag and size limits have reduced harvest, but the popularity of red drum has increased and its harvest may now exceed MSY. Estimated fishing mortality rates (F) have averaged 0.36 for seatrout, 0.78 for gray snapper, and 1.45 for redfish. An overall decrease in fish stocks was noted during the mid -1970s. That decline is believed to have been the result of low rainfall and reduced estuary runoff resulting in increased natural mortality and reduced recruitment rather than harvest. High rainfall has been correlated with increased stock abundance during recent years.

1960

Ball, M. M., E. A. Shinn, and K. W. Stockman (1967) The geologic effects of Hurricane Donna in south Florida. J. Geol., 75(5):583-97.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] This paper discusses the effects of the passage of hurricane Donna (September 9 - 10, 1960) across south Florida in an area where detailed data on pre-storm sea-floor conditions existed. Much of the work in this paper was directed towards storm effects along the Florida reef tract. Elsewhere in Florida Bay, the ebb of the storm tides left large amounts of layered lime mud stranded on the supratidal flats. Sites discussed in Florida Bay include Whale Harbor Channel, Crane Key, Cross Bank, Sandy Key as well as the Florida mainland where mud deposits extended up to five miles inland. The large extent of the supratidal flats results from: (1) the ability of storm tides to strand sediment over large areas, (2) the inaccessibility of the tidal flat to processes that could rework the sediment into adjacent marine environments, and (3) the supply of the tidal-flat sediments at the expense of adjacent marine facies that compete with tidal-flat sediments for a place in the geologic record. The banks of Florida Bay were not greatly affected by storm-wave erosion and are more wave resistent than corals of patch reefs. The authors conclude that although such events may be catastrophic in terms of a man's lifetime, they are only commonplace events in terms of geologic time.

1960

Craighead, F. C., and V. D. Gilbert (1962) The effects of Hurricane Donna on the vegetation of southern Florida. Quart. J. Fla. Acad. Sci., 25(1):1-28.

Hurricane Donna passed over the southwest tip of Florida September 10, 1960. The storm moved at 14 mph and subjected the area to damaging winds for nearly 36 hr. The Flamingo area experienced sustained winds of 140 mph with gusts to 180 mph. The maximum storm tide at Flamingo was 12 ft above normal high tide. Hurricane damage to vegetation was most severe in the mangrove belt and on the keys in the western portion of Florida Bay. Hurricane Donna was the strongest hurricane to strike the area since the storm of 1935. This paper contains a detailed description of the damage caused by the storm.

1960 ◊

Dobkin, S. (1960) The early life history of the pink shrimp *Penaeus duorarum* Burkenroad from Florida waters. M. S. Thesis. University of Miami, Coral Gables, FL. 120 pp.

[NO COPY OF PAPER AVAILABLE.]

1960

Fleece, J. B. (1962) The carbonate geochemistry and sedimentology of the Keys of Florida Bay, Florida. M. S. Thesis. Florida State University, Tallahassee, FL. 112 pp. (Also published as Contribution number 5, Sedimentological Research Laboratory, Florida State University, Tallahassee, FL.)

The texture and mineralogy of the sediments comprising the cores from Florida Bay indicate that the overall depositional environment in the area studied has remained fairly constant for the past 4000 yrs. There is some evidence which suggests that the material at the base of each core was deposited at approximately the same time and under very similar conditions. The data concerning the organic matter and geochemistry, along with the random nature of the peat layers, indicate that after initiation each key-shoal area has had its own unique pattern of development. Further, at each locality the key appears to have had the more complex depositional history, and may have been initiated separately at a later time than its basal shoal. The data indicate that in less than 4000 yrs, several significant geochemical diagenetic alterations have occurred in the carbonate sediments. There is a significant loss of high-magnesium calcite at the base of all the cores. This loss is so great in several of the cores that almost all of the high-magnesium calcite has been removed. Strontium is also affected. There is no doubt that the sediments making up the keys and shoals have been enriched in strontium. It is thought that part of the additional strontium has been derived from the Mi ni Oolite where it was liberated in the process of the inversion of aragonite to calcite and that it has been transported into the keys and shoals by a process of ion diffusion. This interpretation is supported by the strong correlation between Sr and mean grain size which indicates that most of the Sr is concentrated in the finer sizes. While the overall concentration of Sr has been increased in the cores, there appears to be a start in the loss of Sr at the base of the cores. This is attributed to the beginning of the inversion of aragonite to calcite. The statistical tests for correlations show that there are a great number of weak interdependencies between the ten sediment properties studied. This indicates the extremely complex nature of the process of carbonate sedimentation. Two of the stronger linear are those which exist between Sr and mean grain size, and between standard deviation and mean grain size. The replacement of Ca^{+2} by Sr^{+2} in the finer grain sizes is possibly indicated by the correlation between Sr and mean grain size. The strong negative correlation between mean grain size and standard deviation indicates that the finer sediments are the best sorted. Since the finer grained materials are considered indicative of low energy conditions, good sorting, relatively speaking, appears to be the result of the lack of available energy. Higher energies enable greater than average accumulations of coarse shell material to be concentrated in the silts, and therefore cause poorer sorting of the resulting sediments. Thus the energy-sorting relationship in the carbonate sedimentary environment appears to be opposite to that in other detrital sedimentary environments where intermediate to high energies are needed for good sorting. The cores for this study were collected in 1960 from Pigeon Key, Pigeon Shoal, Bottle Key, Bottle Shoal, Stake Key, Stake Shoal, Crab Key, Crab Shoal, Captain Key and Captain Shoal.

1960 ◊

Lloyd, R. M. (1960) Shell chemistry of some Recent and Pleistocene mollusks and its environmental significance. Geol. Soc. Amer. Bull., 71(12):1917.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE. ABSTRACT ONLY.] Florida Bay is used as a model to show how climatic, geographic, and hydrographic factors can influence the $^{18}O/^{16}O$ and $^{13}C/^{12}C$ ratios and the Sr/Ca and Mg/Ca ratios of shallow-shelf marine waters. Some of the variations in water chemistry are reflected in variations in the chemistry of mollusk shells collected in the Bay. Geographic isolation and high evaporation in the Bay coupled with the influx of freshwater enriched in ^{18}O produce a gradient of increasing $H_2{}^{18}O$ into the Bay. Dilution of the Bay water by Ca-rich freshwater lowers the Sr/Ca in the Bay. The gradient of $H_2{}^{18}O$ in the water is clearly reflected in a similar gradient in the carbonate oxygen of mollusk shells. The effect of temperature on the carbonate isotopic composition is inadequate to explain the variations. Sr/Ca ratios of shells vary but show no simple relationship to environment. A gradient of decreasing ^{13}C in shells going into the Bay is attributed to the equilibration of CO_2 derived by oxidation of organic debris in the sediment with the carbonate of the water. Analyses of mollusks from sediment cores show that the present environmental framework of Florida Bay has existed for the last 3700 yrs. Analysis of the fine-grained sediment of the Bay suggests that part of it is derived from the Florida mainland. Fossil mollusks from the Pleistocene Caloosahatchee formation were analyzed. The $^{18}O/^{16}O$ ratios coupled with geological and faunal data indicate an environmental framework strikingly similar to the Florida Bay model. A landmass immediately west of the outcrop area is postulated for most of Caloosahatchee time. The carbon isotope and strontium data reveal little environmental information.

1960 ◊

Manning, R. B. (1960) Some growth changes in the stone crab, *Menippe mercenaria* (Say). Quart. J. Fla. Acad. Sci., 23(4):273-7.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Changes in body form with growth are well known in decapod crustaceans. The stone crab, *Menippe mercenaria* (Say), is a common inhabitant of inshore waters from North Carolina to Mexico. The narrow frontal region is the most characteristic feature of the adult stone crab. A marked difference in the relative width of the fronto-orbital region was noted in a series of juvenile *M. mercenaria* collected in the northern part of Florida Bay.

1960

Tabb, D. C., and A. C. Jones (1962) Effect of Hurricane Donna on the aquatic fauna of North Florida Bay. Trans. Am. Fish. Soc., 91(4):375-78.

A hurricane [Donna] caused heavy mortality among aquatic animals in north Florida Bay in September 1960. Fish and invertebrates were stranded by retreating salt water which had been driven inland or were killed by mud suffocation or turbulence. Oxygen depletion due to decomposition of organic material caused subsequent mortality. Salinities returned to normal within 6 weeks, but dissolved oxygen concentration remained abnormally low for a longer period. Fish and invertebrates were scarce for several months in the areas of greatest oxygen depletion. When environmental conditions again became suitable, the stricken areas were recolonized from surrounding regions. Sport-fish catches in the area declined immediately after the storm, but recovered within one to several months, depending on the locality. Catch statistics indicate that after the storm juvenile pink shrimp moved from their estuarine nursery grounds into deeper water about 60 mi offshore, where they were caught by the fishery. There is no evidence that the aquatic fauna of the area suffered any permanent damage.

1960, 1965

Perkins, R. D., and P. Enos (1968) Hurricane Betsy in the Florida-Bahamas area: geologic effects and comparison with Hurricane Donna. J. Geol., 76:710-17.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] Within a five year period (1960 - 1965) two violent hurricanes, Donna and Betsy, passed over the Florida Keys. Although they were of comparable size and intensity, their geologic effects differed. Both damaged the outer reefs extensively, although Donna had already removed the weaker elements before Betsy struck. In Florida Bay, supratidal sedimentation on the islands and mainland was extensive during Donna, but almost absent during Betsy. An exception to this was the deposition of spillover lobes of skeletal sand landward of the beach of Cape Sable.

1960 - 1961

Goodell, H. G., and D. S. Gorsline (1961) Data Report on the hydrography of Apalachicola and Florida Bays. Florida State University Sedimentology Research Laboratory Contribution 1. Florida State University, Tallahassee, FL. 316 pp.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] Investigations on the hydrology and marine geology of Appalachicola and Florida Bays were carried out to show the effects of hydrology on sedimentation and the interrelationships between sedimentation and bottom morphology on water motion and exchange within the bays. This report presents the hydrological data collected during the first year's work; no analysis of the data is presented herein. Future reports will cover the analysis of hydrological and sedimentological data.

1960 - 1961

Yokel, B. J. (1966) A contribution to the biology and distribution of the red drum, *Scianops ocellata*. M. S. Thesis, University of Miami., Coral Gables, FL. 160 pp.

The populations of red drum found in New Jersey are composed mostly of large fish (20 pounds or more), and are apparently migratory. In New Jersey, reduced commercial and angler catches of these fish since about 1935 suggest a considerable decline in abundance there in recent years. A lesser decline in abundance has apparently occurred in all the Atlantic states south of New Jersey with the possible exception of the east coast of Florida. The population in the Gulf of Mexico appears to be stable. Along the east coast of the US, the center of high relative abundance occurs on the east coast of Florida. In the Gulf of Mexico, centers of high relative abundance occur in Mississippi, Florida and Texas. The relative abundance in the Gulf of Mexico greatly exceeds that of the east coast of the US. States which have relatively high annual landings of red drum also have large estuaries. This is also true on a local basis for Florida and Louisiana. States which land relatively small amounts of red drum have comparatively little esturine area. Not all large estuaries within the range of the red drum are necessarily centers of high relative abundance. In the Gulf of Mexico, spawning apparently occurs in inshore areas from along the northern coast of Mexico to Cape Sable in Florida. The first indication of spawning in the Gulf is the appearance of schools of adult red drum near the entrance to passes and along inshore areas in the early fall. In southwestern Texas, spawning schools may contain individuals as small as 406 mm fork length (about l.5 pounds) and as large as 40 pounds or more. In the Gulf spawning starts in September, reaches a peak in October and then declines until it ends sometime in January. Spawning activity apparently takes place near passes and channels where the larval and post larval red drum are carried by tidal currents into shallow inside waters. The smallest red drum (5 - 7 mm total length) are almost invariably taken in water courses or shallow areas in or near the Gulf. Along the Atlantic coast the spawning of the red drum probably extends from Virginia southward to at least St. Lucie Inlet. As in the Gulf, adults appear in schools near shore and remain in the sea to spawn. In the Atlantic, spawning may begin in July and possibly earlier and continue at least through December with a peak in late September or October. In the Atlantic the spawning season starts earlier and lasts about one month longer than in the Gulf. In the Gulf of Mexico in barrier coast estuaries, post larval fish are carried into the estuaries by tidal currents. In southwestern Florida, a limited number of samples suggest that the post larval red drum move in the surface layers flooding tides after darkness. In drowned river valley estuaries such as Chesapeake Bay, small red drum may be carried passively into the estuary by sub-surface tidal currents which have a net inward movement. Once inside the estuaries the post larval and young fish seek quiet, shallow, muddy bottom areas, often with vegetative cover. In the Gulf of Mexico the young fish disperse into the estuary as they grow. In Chesapeake Bay and North Carolina the young red drum leave the shoals in the fall and early winter and move to deeper areas of the estuaries or to sea. In Texas there are seasonal movements of juvenile red drum to the Gulf which are not apparent in southwestern Florida. In Texas, Louisiana and Mississippi the period of greatest availability of red drum is in the fall of the year, whereas in Florida it is in the winter. Juveniles and adult red drum have a more pronounced seasonal pattern in Chesapeake Bay and North Carolina than in the Gulf of Mexico. They are most available in spring and fall, with the fall being the most important. In South Carolina they are most available in the fall. Tagging studies have shown that there is very little inter-bay movement of immature red drum Texas and Florida. After the first spawning, adult red drum spend increasingly more time in the sea and less in the bays and estuaries. Adult red drum found most often in schools near the surface close to the shore, although they have been observed as far as 12 mi off shore in the Gulf of Mexico. In the regions of North Carolina and Virginia there is a possibility of seasonal movement of adult red drum north in the spring and corresponding movement south in the fall. The evidence suggests that red drum winter over in the area just south of Cape Hatteras, along with related species. Red drum feed heavily on crustaceans in all areas of the range. In southwestern Florida red drum in the area of Flamingo consumed over five times more shrimp by per cent volume than red drum in the Ten Thousand Islands area. In the Ten Thousand Islands the diet of the red drum showed a heavier dependence on crabs (mainly xanthids) and a greater variety of food than the red drum from Flamingo. Stomach samples from both areas showed that as red drum grow larger they eat proportionately more crabs with xanthid crabs being the most important. Fish is a moderately important food for the smaller sizes but diminishes markedly in importance as food for the largest red drum. Red drum seem able to feed by visual or tactile means and can capture prey by a vigorous branchial expansion. Red drum often feed in a "head down" position with the body pointed upward in a 30 to 45 angle. In shallow water the tail may extend above the surface. In this position the ventral surface of the lower jaw is nudged along the bottom apparently searching for shallowly buried animals. Small extensions of the first pelvic fin rays apparently serve as tactile filaments and aid the fish in orienting itself with the bottom. Red drum also feed by laying in depressions or channels adjacent to sand bars and shallow flats where they feed on small animals which are swept off these areas by action or currents. Red drum have been found in temperatures which range from 2 to 33°C. Rapid drops in temperature can cause mortality. The older red drum seem more sensitive to cold than the young. Red drum are a euryhaline species and have been collected in salinities ranging from 0 to 50 ‰. Older fish appear to be more tolerant of hypersaline conditions than young fish. The young penetrate more deeply into low salinity areas than do the adults. Eight different species of parasites were collected of which the majority were copepods. No individual fish were found to be heavily parasitized.

1960 - 1964

Pierce, E. L. (1965) The distribution of lancelots (Amphioxi) along the coasts of Florida. Bull. Mar. Sci., 15:480-94.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] The distribution of lancelots (Amphioxi) was studied in nearshore areas along both coasts of Florida by sand dredge, principally during the summers of 1961 - 1962. A single species, *Branchiostomus caribaeum*, was found, occurring at times, in excess of 15 L^{-1} of sand. The largest numbers were found from Cape Sable to Cedar Key. The east coast, Indian River, and the Florida Keys yielded few or no specimens. The peninsular West coast area provides a more favorable environment than do other areas studied. The southernmost catches occurred in the Everglades National Park (Mormon Key). Areas of higher concentrations were characterized by clean, silicious sand with shell fragments, tidal currents, salinities between 22 - 35 ‰, and abundant phytoplankton.

1961 ◊

Bock, W. D. (1961) The benthonic foraminifera of southwestern Florida Bay. M. S. Thesis. University of Wisconsin-Madison, Madison, WI.

[NO COPY OF PAPER AVAILABLE.]

1961 ◊

Stehli, F. G., and J. Hower (1961) Mineralogy and early diagensis of carbonate sediments. J. Sed. Petrol., 31:358-71.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] This study concentrated on the chemistry and mineralogy of carbonate sediments and on the chemical and mineralogical changes which they undergo during alteration into carbonate rock. All of the comparable Pleistocene carbonate rocks and most of the Recent carbonate sediments studied were obtained from southern Florida, mainly within Florida Bay. Most sediments were found to consist of aragonite, high-Mg calcite, and Mg calcite. Shallow water carbonate sediments contain about 70% of unstable forms of $CaCO_3$, with aragonite predominating while in deep water sediments magnesium calcite dominates; compositional difference are due to the contributions of skeletal material in the two environments. Pleistocene rocks consisted mainly of magnesium calcite. Diagensis of carbonate sediments is accompanied by an important loss in the level of abundance of Mg, Sr, Ba, and Mn. The significance of volume changes which accompany diagensis can not yet be assessed.

1961 ◊

Taft, W. H. (1961) Authigenic dolomite in modern carbonate sediments along the southern coast of Florida. Science. 134(3478):561-2.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Crystalline authigenic dolomite in shallow-water marine sediments from the margins of the North American continent is described for the first time. Dolomite is probably forming at the water-sediment interface in Florida Bay because of an interaction between organic material and hypersaline seawater.

1961 ◊

Lynts, G. W. (1961) Distribution of Recent foraminifera in upper Florida Bay and associated sounds. M. S. Thesis. University of Wisconsin-Madison, Madison, WI.

[NO COPY OF PAPER AVAILABLE.]

1961 - 1962

Gorsline, D. S. (1965) Final data report marine geology and oceanography of Florida Bay, Apalachicola Bay and vicinity, Florida. Observation period - January, 1961 to December 1962. Report No. USC GEOL 65-1. Florida State University, Tallahassee, FL. 14 pp + tables.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] This data report is a summation of field and laboratory work on various coastal and estuarine environments located along the northern Gulf Coast of Florida and the Florida Keys. Water quality, circulation and substrate were studied in two different estuarine regimes to provide a body of data applicable to studies of similar lithologic bodies in the geologic records. Initial surveys took place in 1960. Monitoring stations were occupied monthly in Florida and Appalachicola Bays during 1961. Wind speed and direction, cloud cover, air temperature, water temperature, dissolved oxygen, silica, salinity and, in some cases, alkalinity, were determined at surface, 1.5 m, and 3 m at Florida Bay stations, and at surface only in Apalachicola Bay. During 1962, two special surveys were done in Florida Bay to examine in detail tidal water circulation and water character in a single "lake" (south of Crane Key). The parameters listed for the monthly monitoring effort were recorded. During the course of the survey, sediment grab and core samples were collected. The samples were used for textural analysis, mineralogical studies, organic nitrogen and carbon, and inorganic carbon were determined. Beach data records include wave height, period and meteorological conditions.

1961 - 1962

Iversen, E. S., and B. J. Yokel (1963) A myxosporidian (sporozoan) parasite in the red drum, *Sciaenops ocellatus*. Bull. Mar. Sci. Gulf Carib., 13(3):449-53.

A description is given of a new species of myoxsporidian parasite located in the intestine and pyloric caeca of the red drum, caught in saline waters of south Florida. During studies on the life history of red drum, *Sciaenops ocellatus* myxosporidian cysts were found in the intestine and pyloric caeca. This parasite is similar to a myxosporidian described from red drum captured North Carolina waters. In this paper, data is presented on the parasite from red drum caught in south Florida waters during 1961 - 1962 and a specific name is established. The parasites were studied in both fresh and formalin-preserved preparations.

1961 - 1962

Sprunt, A. (1977) Notes on the breeding biology of the white-crowned pigeon in Florida Bay. Proc., Internatl. White-crowned Pigeon Conf., Nassau, Bahamas. November 11 - 12, 1976. 40-2.

[NO ABSTRACT AVAILABLE.] Many mangrove keys occur throughout Florida Bay and these provide ideal nesting habitats for the white-crowned pigeon. In 1961 and 1962, a nesting study was carried out in Florida Bay, primarily on Middle Butternut Key in the Everglades National Park. During those two years, 368 nesting attempts were monitored. The nests were numbered using plastic tags to identify them individually. They were checked every two or three days throughout the nesting season. Records were kept on the type of tree, the height from the ground to the nest the number of eggs, the number of young produced and other parameters.

1962 ◊

Deffeyes, K. S., and E. L. Martin. 1962. Absence of carbon-14 activity in dolomite from Florida Bay. Science, 136(3518):782.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] A sample of dolomite crystals concentrated from Recent carbonate sediments in Florida Bay gave a ^{14}C age greater than 35,000 yrs. Since Recent sedimentation in Florida Bay began less than 4,000 yrs ago, the dolomite must be derived from older rocks, and Taft's hypothesis that dolomite is forming today is incorrect.

1962 ◊

Gleece, J. B. (1962) The carbonate geochemistry and sedimentology of the Keys of Florida Bay, Florida. M. S. Thesis. Florida State University, Tallahassee, FL.

[NO COPY OF PAPER AVAILABLE.]

1962

Lynts, G. W. (1966) Variation of foraminiferal standing crop over short lateral distances in Buttonwood Sound, Florida Bay. Limnol. Oceanogr., 11(4):562-6.

Standing crops of foraminifera collected in Buttonwood Sound were analyzed using analysis of variance and percentage data. There were no significant faunal variations, in terms of F-ratios, at 10 of the 19 stations, indicating foraminiferal microhabitats of at least 30 m^2. Data in terms of per cent of species occurring in all samples (S_c), and per cent of population made up of species occurring in all samples (P_c), were used to analyze faunal variation. $S_c$values indicated species composition varied considerably between samples at each station, while P_c values indicated foraminiferal standing crop varied appreciably between samples. S_c and P_c values at each station indicated dominant species are quite constant between samples at each station and variation is caused by fluctuation in rarer species.

1962 ◊

Taft, W. H. (1962) Dolomite in modern carbonate sediments, southern Florida. Am. Assoc. Petrol. Geol. Bull., 46(2):281.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The western margin of Florida Bay contains extensive shallow-water banks of unconsolidated, fine carbonate mud. The banks are separated by narrow tide channels and rest on hard

Pleistocene bedrock. The banks attain a maximum thickness of about 4.5 ft. Radiocarbon dates show that they have been formed in the past 4,000 yrs. The carbonate mud is composed principally of aragonite with lesser proportions of dolomite and both high- and low-magnesium calcite. The proportion of dolomite varies, ranging up to about 5% by weight of the total carbonate. Other constituents are quartz and opaline sponge spicules, but these rarely form more than 1 or 2%. Dolomite crystals are euhedral rhombohedrons varying in size from less than 1 µm to approximately 60 µm. They commonly have dark internal rhombohedrons that appear to be intergrowths of dolomite and organic materials. Complex clusters of interpenetrating rhombohedrons are present, but rare. The occurrence of interpenetrating rhombohedrons and intergrowths of organic and carbonate material suggest that dolomite has been formed in situ in Florida Bay; however, radiocarbon dating shows that the dolomite is older than 35,000 yrs and must be detrital.

1962 ◊

Taft, W. H. (1962) Mineralogy of carbonate sediments along the western margin of Florida Bay. Proc., First. Natl. Coastal and Shallow Water Res. Conf., 1961. Washington, DC. 676-7.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] This citation reviews the mineralogy of carbonate sediments in Florida Bay.

1962 - 1963

Lynts, G. W. (1966) Relationship of sediment-size distribution to ecologic factors in Buttonwood Sound, Florida Bay. J. Sediment. Petrol., 36:66-74.

Seventy-four sediment samples were collected from 19 stations located in Buttonwood Sound, in 1962 and 1963. At each occupation of stations, the following environmental parameters of sediment-water interface were measured: depth, temperature, salinity, pH and Eh. Techniques outlined for measuring pH and Eh must be strictly adhered to in order to obtain valid measurements of *in situ* environment. Factor-vector analysis of numerical data indicate that ecologic factors were not linearly related to sediment-size and were not linearly interrelated amongst themselves. Sediment-size distribution is closely correlated to turtle grass occurrence, which acts as an effective sediment stabilizer and trapper. Temperature and salinity are related to climate, while pH and Eh are related to organic activity. Carbonate sediments of Buttonwood Sound are probably almost wholly organically derived.

1962 - 1963

Lynts, G. W. (1971) Distribution and model studies on foraminifera living in Buttonwood Sound, Florida Bay. Memoir 1, Miami Geological Society. A Symposium of Recent South Florida Foraminifera. J. I. Jones and W. D. Bock (eds.). Miami Geological Society, Miami, FL. 73-115.

A total of 74 samples were collected from a grid system consisting of 19 stations. Stations were occupied three times during august 1962, and once during February 1963. The following environmental parameters of the water-sediment interface were measured: depth, temperature, salinity, pH and Eh. Each sample was analyzed for forminiferal standing crop and ratio of sand, silt and clay. Q-modal factor-vector analysis divided the standing crop into 17 faunal assemblages, consisting of five assemblages in a single collection. Distribution of most of these assemblages appeared to be controlled by an interaction of ecological parameters. A fauna which was related to sediment size and one which was related to bathymetry persisted throughout all collections. Distribution of foraminiferal species and environmental parameters indicated some such relationships. The faunal information indicated there was no simple linear relationship between distribution of foraminifera and environmental parameters.

Distribution of foraminifera living in Buttonwood Sound was controlled by a complex interplay of physicochemical and biological factors, only partially reflected by the measured parameters.

1962 - 1966

Kolipinski, M. C., H. Klein, and A. L. Higer (1967) Field guidebook on geology and ecology of Everglades National Park. Miami Geol. Soc., Miami, FL. 28 pp.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] This field trip guidebook summarizes the geology and ecology of the Everglades Nationla Park with emphasis on the Whitewater Bay - Shark River estuary and upper Florida Bay from various publications compiled to complement a carbonate field course taught by the senior author. Also, a list of field stops are provided with brief ecological descriptions of each site. Provisional water quality measurements from the Shark River are given for the period of November through December 1966.

1963

Eidman, M. (1967) Contribution to the biology of needlefishes, *Strongylura* spp., in south Florida. M. S. Thesis, University of Miami., Coral Gables, FL. 84 pp.

In South Florida, the needlefishes occurred in all seasons. Needlefishes were caught in greatest numbers in Buttonwood Canal during the period March through May. A smaller peak of abundance was found from September through November. These fish favor shallow and quiet water although they are sometimes found in swift currents. Sand flats are their typical habitat. The needlefishes in Virginia Key feed mostly on fish. In Buttonwood Canal insects and crustaceans were of considerable importance in the diet In winter, crustaceans comprised almost 50% of the total volume of the diet. Fish ranked second, followed by insects. In spring and summer more than 60% of the total volume of the diet consisted of insects. Fishes ranked second, and crustaceans were not important. In fall, fish comprised almost 70% of total volume; the rest consisted of insects and crustaceans. Feeding activities seem to be mostly in daylight, but continues through the night with lower intensity. The needlefishes are surface or near-surface predators. The smallest fish feed mainly on plankton. *Strongylura timucu* have paired gonads; the right gonads are always longer than the left. In *Strongylura marina* only the right gonad is functional, the left being vestigial. Females can be classified into six maturity stages, and males into four maturity stages. The individual needlefishes spawned in a restricted period. The populations spawned over an extended period; spawning takes place mainly in spring in Buttonwood Canal. The mean size of female needlefishes was significantly greater than of the males. The sex ratio fluctuated from one month to the next, and averaged 12 females to 5 males in 1963. Size of ova does not change between locations in the ovary. The eggs are demersal. Each female produces between 800 and 4000 eggs in one season. Males and females mature more or less at the same size, about 200 mm in standard length, at 2 yrs of age. Females are heavier than males of the same length.

1963 ◊

Fleece, J. B. and H. G. Goodell (1963) Carbonate geochemistry and sedimentology of the keys of Florida Bay, Florida. Geol. Soc. Am. Spec. Pap., 73:6. (Abs.).

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The shoals within Florida Bay are elongate depositional features oriented roughly either northwest-southeast or northeast-southwest; in many instances they intersect at nearly right angles. All the small mangrove keys within the bay are located along these shoals. The sediments within the Bay are almost entirely clastic biogenetically deposited carbonate. Five of these keys, together with their adjacent shoal areas, have been cored throughout their depth. The lithologies of the cores from the shoal areas are only slightly more homogeneous than the corresponding key borings and consist predominantly of carbonate material finer than sand. The coarse fractions of the sediments consist largely of mollusk shell fragments. Some of the keys have, in addition to this type of sediment, layers of peat, and in one instance shell sand, which cannot be correlated between keys. Aragonite constitutes 55-80% of the carbonate; the remainder is composed of two types of magnesium calcite—high and low magnesium varieties averaging from 11 to 16% and <5% magnesium carbonate respectively. The organic content and the ratios of aragonite to calcite and high to low magnesium calcite are more uniform throughout the shoals than in the keys, reflecting a more uniform depositional history of the shoals. At the bottom of the cores organic content tends to increase, and the percentages of high magnesium calcite and of aragonite tend to decrease. The depositional conditions within the shoals appear to be fairly constant, but the patterns of key development vary widely and are unique within themselves.

1963 ◊

Gorsline, D. S. (1963) Environments of carbonate deposition Florida Bay and the Florida Straits. Shelf Carbonates of the Paradox Basin; a symp.; Fourth Field Conf. R. O. Bass (ed). June 12 - 16, 1963. Four Corners Geological Society, Durango, CO. 130-43.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Clastic carbonates are a common sedimentary type on the outer parts of broad continental shelves and on insular shelves. Pelagic carbonates are of large areal extent in the oceanic basins. However, regions of shallow water *in situ* calcareous deposition are limited to tropical coral islands, the southern Florida Peninsula, the Bahama Islands, the Yucatan Shelf and the Central Barrier Reef of Australia. The accessibility of the Florida deposits has stimulated research on the chemistry, mineralogy, sedimentology and biological aspects of these unique sediments. Recent studies of water characteristics and motion has provided an additional insight into the provenance of these materials, their distribution and the mechanisms that produce them. The question of the direct precipitation of carbonate is still controversial but much of the field evidence would seem to be better interpreted by biological origins. The Florida Straits is an area of strong water flow and relatively great depth. The present carbonate deposits in this channel are apparently derived from pelagic sources and from the transport of surrounding shelf deposits by strong currents. The similarity between the relatively deep deposits of the Straits and those of Florida Bay is striking. Both would be lithified into essentially identical formations and yet they represent a considerable contrast in depositional environments.

1963

Idyll, C. P., E. S. Iversen, and B. J. Yokel (1965) Abundance of pink shrimp on the Everglades National Park nursery grounds. Circ. No. 230. US. Fish and Wildlife Service, Washington, DC. 28-29.

The major objective of this work was to measure the relative abundance of juvenile shrimp leaving a nursery area and to describe the environmental factors which control their numbers, size composition and other biological characteristics. A large channel net blocking the entire width of the Buttonwood Canal was used to catch all animals above a certain size range moving on the ebb tide from adjacent estuarine areas. Only samples taken within three days of a new or full moon were used in the calculations. Although juvenile shrimp move out of the estuary in abundance in all months of the year, during 1963, peaks in abundance occurred during January, April and September.

1963

Sastrakusumah, S. (1971) A study of the food of juvenile migrating pink shrimp, *Penaeus duorarum* Burkenroad. M. S. Thesis, University of Miami, Miami, FL. 37 pp.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] [Also published as Sea Grant Tech. Bull. No. 9, University of Miami Sea Grant Prog., Miami, FL, 1-37.

(1971).] Qualitative information on the foods of juvenile pink shrimp in the Buttonwood Canal was gathered over a year's period. Using the frequency of occurrence method of analysis, it was found that the pink shrimp in the Buttonwood Canal is omnivorous with a preference for certain foods, including crustaceans and polychaetes. Lowest feeding activity was reported in late winter and in summer. It was concluded that there was no change in diet with season or with size of shrimp examined.

1963

Smith, S. L. (1971) Distribution of recent foraminifera in lower Florida Bay. Memoir 1, Miami Geological Society. A Symposium of Recent South Florida Foraminifera. J. I. Jones and W. D. Bock (eds.). Miami Geological Society, Miami, FL. 116-20.

This study was undertaken as part of a reconnaissance study of the present benthonic foraminifera of Florida Bay and adjacent waters. Its primary purpose was to describe the fauna and its distribution, and secondarily to consider ecological factors as they may influence observed distribution patterns. The study area consisted of the western portion of lower Florida Bay, a shallow carbonate shelf with water depths ranging from less than one foot to as much as 17 ft. Twenty six samples were collected in March 1963. Most were obtained by coring but a few were taken using a grab sampler where the sediment layer was too coarse or thin to obtain a core. At each station, bottom temperature, water depth, and bottom community information were recorded and hydrographic samples were collected.

1963 ◊

Studer, H. P. (1963) Electron Microscope study of aragonite crystals in marine sediments. Am. Am. Assoc. Petrol. Geol. Bull., 47(2):371.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The occurrence of aragonite needles in the carbonate mud of the surface sediments of Florida Bay, the Florida Keys, and the Great Bahama Bank is of interest to problems of carbonate deposition. Older views regarding the origin of the aragonite needles support inorganic precipitation. More recent theories favor a biogenic formation and link the mud particles to the aragonite sheath of algae, mainly *Penicillus, Rhipocephalus*, and *Halimeda*. Electron microscope studies of mud suspensions and of aragonite crystals from *Penicillus* reveal a remarkable similarity between the aragonite formed on the algal surface, and the aragonite sheath peeled from Penicillus show needle like crystals scattered between a network of fiber or film like algal material. The closely interwoven system of plant material and aragonite needles supports the suggestion of the algal substrate acting as a matrix for the aragonic formation.

1963 ◊

Taft, W. H. (1963) Cation influence on the recrystallization of metastable carbonates, aragonites and high-magnesium calcite. Geol. Soc. Am. Spec. Pap. No. 73:252. (Abs.).

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Unconsolidated carbonate sediments of Florida Bay consists of more than 80% aragonite and high - magnesium calcite. These carbonate minerals are reported to be metastable and in time should recrystallize to a more stable form- presumably calcite or dolomite. However, Florida Bay sediments dated by ^{14}C techniques are as old as 3600 yrs and exhibit no evidence of recrystallization. Recrystallization rates of artificially prepared aragonite and high-magnesium calcite are controlled by concentration and particular cation in the surrounding liquid. Magnesium chloride solution and the magnesium in seawater appear to prevent recrystallization of aragonite and high-magnesium calcite at different rates. The Miami Oolite is used as a model to explain recrystallization of exposed Pleistocene metastable carbonates. Metastable marine carbonates tend to remain unstable for long periods until they are exposed to water deficient in magnesium. Therefore oxygen and carbon isotopic analyses of these exposed carbonates should be similar to those of freshwater carbonates.

1963 - 1964

Overstreet, R. M. (1966) Parasites of the inshore lizardfish, *Synodus foetens*, from south Florida. M. S.. Thesis, University of Miami., Coral Gables, FL. 69 pp.

Parasites of *Synodus foetens* were studied from collections taken from Buttonwood Canal between January 1963 and December 1964. The fish were found every month except July 1963. They constituted year classes which remained in the canal for approximately one year. The diet of *S. foetens* included the pink shrimp, *Penaeus duorarum*, and a palaemonid shrimp; and the fishes *S. foetens, Anchoa mitchilli, Lagodon rhomboides, Eucinostomus argenteus, Sphaeroides* sp., *Cvprinodon variegatus, Poecilia latipina, Gobionellus* sp., a cyprinodontid, an atherinid, and others too digested to identify. The lizardfish was infected by *Oodinlum* sp., *Sterrhurus musculus, Distomum fenestratum, Stomachicola maqna, Goezia minuta*, a cestode described as *Dibothrium tortum, Opecoeloides* sp., several larval cestode plerocercoids, a larval *Contracaecum* sp., a larval ascarid, and a larval acanthocephalan. All of these are new locality records. *Oodinium* sp., *D. fenestratum, G. minuta, Opecoeloides* sp., *Contracaecum* sp., and the acanthocephalan and tetrahynch larvae are new host records. Extension of the geographic ranges for infection of *S. foetens* are recorded for *Sterrhurus musculus, Stomachicola maqna*, the pseudophyllid, and *Scolex polymorphus*. There is an increase in number of parasitic species with length of *S. foetens* up to about 11 cm. The incidence of infection was higher in 1963 than in 1964 for all but *Oodinium* sp. and *Opecoeloides* sp. The difference between the two years was slight for *Oodinium*. *Opecoeloides* infected *Synodus* from February through June 1964 only. The only parasite to infect every fish was a tetraphyllidean plerocercoid larva in the pyloric caeca. Several factors appeared to play a role in the intensity of infection rates. There is a difference in infection rates among year classes. The monthly mean number of *Sterrhurus* per fish is negatively correlated with the mean salinity when *Synodus* lengths are held constant. The mean number of body cavity cysts is positively correlated with *Synodus* length when salinity is held constant. The mean number of *Stomachicola* has an inverse relationship with salinity, and the mean number of pseudophyllids has a slight inverse relationship with temperature. Possible reasons for relationships among these and other interacting factors are discussed. There is a positive relationship between mean salinity and the percentage of the pseudophyllid located in the posterior end of the intestine. Contingency tests indicate positive associations between the presence of *Sterrhurus* and *Stomachicola*, and among *Sterrhurus, Stomachicola,* and *Goezia*. Possible reasons for the associations are given.

1963 - 1964

Overstreet, R. M. (1968) Parasites of the inshore lizardfish, *Synodus foetens*, from south Florida, including a description of a new genus of Cestoda. Bull. Mar. Sci., 18:444-470.

The parasites of the inshore lizardfish, *Synodus foetens,* were studied from collections taken from an estuarine canal in south Florida between January 1963 and December 1964. A new genus of Cestoda (Bothriocephalidae) has been erected with the proposed name *Anantrum.* Several larval and adult helminths and a dinoflagellate were studied from monthly samples of samples of *Synodus.* Incidence of infection, intensity of infection, location of parasites in the host, and associations among parasites are discussed. Extensions of ranges for parasites in *S. foetens* and parasites heretofore not recorded from S. *foetens are* noted.

1963 - 1964

Waldinger, F. J. (1968) Relationships of environmental parameters and catch of three species of the mojarra family (Gerridae), *Eucinostomus gula, Eucinostomus argenteus*, and *Diapterus plumieri*, collected in 1963 and 1964 in Buttonwood Canal, Everglades National Park, Florida. M. S. Thesis, University of Miami, Coral Gables, FL. 68 pp.

Highly significant relationships existed between temperature and salinity, between temperature and water height as recorded in the wells, between temperature and months, between salinity and water height, between salinity and months, and between water height and months in both 1963 and 1964. Catches of *Eucinostomus gula* appeared best related with ground water and surface runoff through the close association of catches with water height records in well P-38 and rainfall. Catches of *Eucinostomus argenteus* appeared best related to salinity and rainfall and greatest catches of this species are dependent upon the interactions and optimal occurrences of environmental parameters. Catches of *Diapterus plumieri* appeared best related with water height in well P-38, moon phase, and temperature. The analytical results for 1963 and 1964 were similar for this species. The results of this study indicated that *E. argenteus* is the mojarra that favors waters of high salinities (marine environment) and *D. plumieri* favors a brackish to freshwater environment. The habitat for *E. gula* was not as apparent but this fish appeared to be able to extend its range throughout the environment indicating that it was an estuarine species. Increased efficiency in the results of this study may be possible through a logarithmic transformation of the catch data plus the elimination of certain environmental parameters which are highly interdependent. The design of a program oriented specifically to study the mojarras of this area was indicated by the analysis of this data. The program would be expanded to include investigation of catches with not only the environmental parameters used in this study but also the differences in catches due to lunar, tidal, and diel variations. Spawning and migration activities of these fishes should also be examined as well as size difference in tolerance to environmental conditions. This may be accomplished by extending sampling operations to include Florida Bay, the Whitewater - Coot Bay estuary, and the Shark River.

1963 - 1965

Yokel, B. J., E. S. Iversen, and C. P. Idyll (1969) Prediction of the success of commercial shrimp fishing on the Tortugas grounds based on enumeration of emigrants from the Everglades National Park estuary. FAO Fish. Rep., 3(57):1027-89.

Studies have been underway since 1962 on the juvenile stages of the pink shrimp (*Penaeus duorarum* Burkenroad) in the Everglades National Park estuary. The objectives of this study have been to increase knowledge of the biology and migration of the shrimp and to determine if a relationship exists between the relative abundance of emigrating juveniles and the catches of adults on the Tortugas commercial fishing grounds. From January 1963 through June 1965 the relative monthly abundance of juveniles was estimated from catches in Buttonwood Canal at Flamingo in Everglades National Park using a large "channel net." The entire canal was fished by this gear, which relied on tidal currents to collect samples. Subsequently experiments showed that "wing nets" could reliably subsample the shrimp moving in the canal and all samples were thereafter taken with this gear. Catches of juveniles made near the times of the new and full moon are used as indices of monthly abundance. These show a positive correlation with the commercial landings of the smallest size shrimp. During periods of high abundance, when the average size of the emigrants is small (11 m carapace length or smaller) there is a delay of 2 to 2.5 months from the time they leave the estuary until they appear in the commercial catches. In periods of high abundance, when the shrimp are larger, the delay between the estuary and the commercial catch is reduced to one month. Growth rates suggest that the differences in migration times are caused by a ay in the arrival of the shrimp at a size large enough for the trawls to capture. en an appropriate time lag is used the correlation is improved between the relative abundance of emigrating juveniles and the catch per unit of effort of small shrimp on the Tortugas grounds. Based on this relationship a forecast of increased abundance o small shrimp on the fishing grounds can be made before they are available to the fishery. Using commercial landing data an apparent movement through the Tortugas can be seen. This appears reliable enough so that a forecast of up to 4 months can be made of increased abundance of 41 - 50 count shrimp.

1964

Costello, T. J., and D. M. Allen (1965) Pink shrimp life history. Fishery research for the year ending June 30 1964. Circ. No. 230. Bureau of Commercial Fisheries, US Fish and Wildlife Service, Galveston, TX. 22-4.

This citation describes pink shrimp life history.

1964 ◊

Craighead, F. C. (1964) Land, mangroves and hurricanes. Fairchild Trop. Gard. Bull., 19(4):1-28.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] This citation reviews the role of mangroves in building new land in South Florida and the effects of the deposits of silt and shell by hurricanes in this process. The effects of hurricane Donna in South Florida are discussed.

1964

Holden, M. W. (1964) Sea turtle nesting survey on Cape Sable beach, Everglades National Park, Florida, 1964 season. Open File Rep. N4415. South Florida Research Center, Everglades National Park, Homestead, FL.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] This paper presents the earliest known National Park Service report of sea turtle nesting on Cape Sable. It is the traditional nesting ground for the loggerhead turtle, *Caretta caretta*, and once was used by the green turtle, *Chelonia mydas*. Five miles of beach was surveyed, from East Cape to SE of Middle Cape. Data is provided on the marking and counting of turtle crawls, destroyed nests, and hatching with additional notes on racoon observations in the survey area.

1964 ◊

Price, W. A. (1964) Cyclic cuspate sand spits and sediment transport efficiency. J. Geol., 72(6):876-80.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] Contrasts in the occurrence of cyclic cuspate spits are found between: (1) a smooth, sandy oceanic barrier shoreline and spit-decorated shorelines of the associated narrow barrier lagoon; (2) In spit development varying from none on a straight sandy shoreline to progressively prominent development with increasing convexity along an adjoining sandy headland. Critical factors in this selectivity seem to be wave fetch and shoreline curvature. An example of sandy cuspate foreland and small sandy foreland is Cape Sable.

1964 ◊

Scholl, D. W. (1964) Recent sedimentary record in mangrove swamps and rise in sea level over the southwest coast of Florida. Part 1. Mar. Geol., 1:344-66.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Beneath the shallowly submerged coastal mangrove forest (paralic mangrove swamps) of southwestern Florida, marine and brackish-water sediments of Recent age overlie freshwater calcitic mud that was deposited on bedrock or freshwater peat about 4,000 yr ago. This sedimentary succession is thought to be the record of a marine inundation of the western margin of the extensive freshwater swamps (Everglades) of southern Florida. To map the extent of the submergence a stratigraphic study was made of piston core samples of unconsolidated sediments underlying waterways dissecting the coastal forest and intra-forest bays enclosed within it. These cores were primarily taken in the vicinity of Whitewater Bay and in the Ten Thousand Islands area. The latter region forms the northern end of approximately 50 nautical mi of swamps and coastal mangrove forest; this belt of paralic swamps is typically 1 - 3 mi broad, although it is as much as 10 mi wide in some areas. Whitewater Bay is situated at the southern terminus of these swamps. The sequence of transgressive sediments consists of a basal unit of autochthonous (*in situ*) fibrous peat, largely derived from mangrove and other rooted halopllylic plants, and an overlying allochthonous unit of peaty and calcareous shell debris (Whitewater Bay) or shelly quartz-rich sand and silt (Ten Thousand Islands area). Judging from radiocarbon dates, the basal peat unit began to form 3,000 - 3,400 yr ago after cessation of calcitic mud formation. Within a period of a few hundred to a few thousand years formation of in situ fibrous peat in areas which are now waterways and intra-forest bays gave way to the deposition of shelly brackish-water and marine sediments of the upper member of the transgressive sequence. The environmental shift from freshwater to brackish-water and marine milieus came about in response to a more or less steady rise in sea level and marine inundation of former mainland paludal swamps.

1964 ◊

Scholl, D. W. (1964) Recent sedimentary record in mangrove swamps and rise in sea level over the southwest coast of Florida. Part 2. Mar. Geol., 2:343-64.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Coastal mangrove swamps formed in the Whitewater Bay region of southwestern Florida about 3,000 yrs ago. Development of these swamps and the associated mangrove forest resulted from the landward penetration of marine water behind a rapidly constructed or pre-existing barrier (Cape Sable). Marine flooding took place over freshwater swamps. By about 2,000 BP 1 - 2 ft of autochthonous (*in situ*) mangrove peat had accumulated on top of about l ft of freshwater calcitic mud. Continued submergence formed Whitewater Bay by destroying the mangrove forest that had deposited the peat. Destruction of the forest is recorded by the deposition of peaty shell debris on top of the peat. Farther to the north, in the Huston Bay complex region of the Ten Thousand Islands area, establishment of the coastal mangrove forest began about 3,500 BP. Mangrove swamps initially developed along stream and river banks as a result of the landward penetration of marine water. With continued submergence the swamps and mangrove forest spread onto inter-channel areas. Eventually, continued marine inundation caused destruction of near-channel portions of the forest, especially in backswamp areas. Killing of mangrove trees and erosion of peat adjacent to drainage channels aided in producing a chain of backswamp bays and connecting channels; the Huston Bay complex forms the northern end of this chain of waterways. The Ten Thousand Islands are chiefly mangrove-crested bars and shoals of shelly quartz sand. This archipelagic portion of the coastal mangrove forest was formed to a large extent by tidal currents and evidently was well developed by 3,000 BP. As emphasized in Part 1 of this work, radiocarbon dates on marine shells and on organic matter of freshwater calcitic mud can be regarded as reliable. 14C dates on the carbonate of calcitic mud, the tests of freshwater gastropods, and fibrous mangrove peat may be too old by about 400 yrs. Dates on these materials should presently be regarded as maximum values. The ages of brackish-water mollusks from the Huston Bay complex of the Ten Thousand Islands area are thought to be of little interpretative value. These shells may have included considerable amounts of "dead" carbon in their shell carbonate and consequently date several thousand years too old.

1964 ◊

Schroeder, R. E. (1964) Ecological studies of the intestinal trematodes of the gray snapper, *Lutjanus griseus* (Linnaeus), in the vicinity of Lower Matecumbe Key, Florida. Ph. D. Dissertation, University of Miami, Coral Gables, FL. 165 pp.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Gray snappers were collected from eight stations comprising four habitats over a nine-month period, and examined for intestinal trematodes. The incidence of each trematode was calculated for each habitat at each time of year. Snails were collected in the vicinity of the various stations, and examined for larval trematode infections. Special attention was given to snails known to harbor snapper trematodes. When possible some index of infection levels and snail population was derived, and the behavior was investigated. It was found that the habitat in which the fish are caught is more important in determining the nature of their trematode population than fish size, sex, or season of the year. The reasons for this probably involve the distribution of intermediate hosts, most especially the snail hosts. *Metadena adglobosa* (Manter, 1947) is most common in fish from shallow Florida Bay *Thalassia* beds, where its snail host, *Cerithium eburneum* (Bruguiere) is most plentiful. Since fish in this area are small, it is found more often in small fish than large fish. *M. adglobosa* is usually found in the pyloric caeca of *L. griseus. Metadens globosa* (Linton, 1910) was most common at the inshore stations. Its distribution suggests that its snail host is different from that of *M. adglobosa. M. globosa* was remarkable for the low incidence of juvenile worms. *Metadena obscura* n. sp. was described from the pyloric caeca and intestine of *L. griseus.* Although superficially similar to *M. adglobosa*. it differs in a number of characters, the most important of which are the enlarged spines of the ventrogenital pit. *Paracryptogonimus neoamericanus* (Siddiqi and Cable, 1960) was most common in fish from the inshore stations. It was usually found in the intestine, but occasionally was in the pyloric caeca of *L. griseus.* Few juveniles were found. In this, and in distribution, it resembled *Metadena globosa. Hamacreadium mutabile* (Linton, 1910) also was most common at the inshore stations. Large populations of the snail hosts, *Aetrea tecta americana* (Solander) were found near the stations having the highest incidences of *H. mutabile. Hamacreadium gulella* (Linton, 1910) was found only briefly until late October, when it began to appear regularly in inshore fish. A possible explanation is that it was brought into the area by another definitive host. One *Astraea tecta americana* that was infected with *H. gulella* was collected. *Helicometrina nimia* (Linton, 1910) was most common in snapper from the offshore stations. It is very rare at other stations. *H. nimia* is not specific for snappers, and is reported from many non-Lutjanid species. The gray snapper probably is not an important definitive host. *Helicometra execta* (Linton, 1910) was found in the gray snapper only rarely, and only at the offshore stations. It is probably an accidental parasite of *L. griseus*, and largely dependent on other hosts. It may not be able to complete its life-cycle in *L. griseus.* Its presence in the gray snapper is a new host record. *Stephanostomum casum* (Linton, 1910) was found at all stations in about the same percentage of gray snappers, suggesting that its intermediate hosts are widely distributed. *Nassarius albus* (Say) or *N. vibex* (Say) may be the snail host. *Nassarius* species are hosts to other *Stephanostomum* species and *N. albus* and *N. vibex* are widely distributed in habitats of the gray snapper. The data indicate that seasonal changes in parasite populations of *L. griseus* near Lower Matecumbe Key are a function of spawning migrations and cold weather movements. Many parasites probably appear in unusual habitats through movements of the host. Migrating fish carry parasites into new habitats. In a new habitat the original parasites gradually are lost, and are replaced by species characteristic of the new environment. Examination of a collection of 178 fish of 41 species other than *L. griseus* indicates that all trematodes of *L.*

griseus except *H. nimia* and *H. execta* are family specific for the Lutjanids. *H. nimia* and *H. execta* have been reported from many families, and are unimportant in *L. griseus.*

1964 ◊

Smith, S. L. (1964) Distribution of Recent foraminifera in lower Florida Bay. M. S. Thesis. University of Wisconsin, Madison, WI.

[NO COPY OF PAPER AVAILABLE.]

1964 ◊

Spackman, W., D. W. Scholl, and W. H. Taft (1964) Field guide to environments of coal formation in southern Florida. Marine Science Press, University of Miami. Geological Society of America pre-convention field guidebook. 67 pp.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] This is a field guide to coal formation in southern Florida.

1964 ◊

Starck, W. A. (1964) A contribution to the biology of the gray snapper *Lutjanus griseus* (Linnaeus), in the vicinity of Lower Matecumbe Key, Florida. Ph. D. Dissertation. University of Miami, Coral Gables, FL, 258 pp.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The family Lutjanidae comprises a large group of generally medium-sized predaceous fishes common in warm seas. For the most part, snappers are shelf species and some are important commercially as food fishes. The family contains an estimated 23 genera, six of which occur in the West Indian Region. *Latjanus* is the largest genus with over 70 species, 14 of which are found in the West Indian Region. (*Lutjanus griseus*) was described as early as 1743 by Catesby and has a synonymy of at least eight names based on Western Atlantic specimens. The most frequently encountered English common names are gray snapper and mangrove snapper. Commercial landings of gray snapper in Florida have varied between about 252,896 to 456,137 pounds, worth $40,078 to $76,140 from 1956 through 1962. Monroe County usually leads the state in production. Limited information on sport fishery landings indicates that the economic value of gray snapper as a sport fish far exceeds its commercial value. *L. griseus* has been recorded from Woods Hole, MA, to Sao Paulo, Brazil. It is common throughout the West Indian faunal region. Several Eastern Atlantic records exist but the systematic status of the Eastern Atlantic species and its synonyms is uncertain. Juvenile gray snapper of 10 - 70 mm standard length are common in shallow water grass beds and often in low salinities. At 70 - 90 mm SL, they begin to congregate around brush, debris and channel edges and are common at such locations from 90 - 210 mm SL. Fish over 170 mm SL, tend to move into channels. Individuals which occupy reef and wreck areas further offshore usually are 200 mm SL or larger. Gray snapper occupy a wider range of habitat than do the other common inshore lutjanids in this region. Records from cold kills of gray snapper indicate a lethal low temperature limit between 11 - 14°C. During cold periods, they move into deeper water and from dense schools. Gray snapper of all sizes have been reported from freshwater with chlorinities as low as 50 ppm. High calcium content is probably important to snapper in freshwater. Barracuda, *Sphyraena barracuda*, and the green moray, *Gymnothorax funebris*, are considered the most important potential predators of gray snapper on the reef. One small gray snapper was taken from the stomach of a cubera snapper, *Lutjanus cyanopterus*. A number of trematodes, an acanthocephalan worm, three nematodes and one cestode have been reported as endoparasites of *L. griseus.* Tumorous growths are seen on 5 - 10% of large snapper at Alligator Reef. A lower incidence was observed in smaller fish. Gray snapper are among the dominant medium sized predators in most areas where they occur. Several thousand are present in two schools at Alligator Reef in summer. The basic color pattern of gray snapper is gray dorsally with white counter-shading. Shade may vary from pale gray to dark reddish brown. Dark shades are found among small juveniles in grass beds and adults from mangrove swamps or estuaries where the water is dark brown. Pale fish are seen in channels around Lower Matecumbe Key and on the reefs. A general reddish color has been reported for gray snapper from deeper water. The color pattern of gray snapper matches in general tone the variety of environments where it is found. Patterns of bars or blotches seen at night match the pattern of areas where they commonly feed. The ocular stripe is displayed when interest is fired upon another organism or when feeding and is believed to function in obliterating the eye. Color pattern of the other inshore snappers is believed to be adapted for blending with their various environments. Gray (*L. griseus* and *L. cyanopterus)* is found in the two species which occupy a wide variety of habitats. Yellow (*L. apodus, L. jocu* and *Ocyurus chrysurus*) is associated with species found in rocky or coral areas where yellowish coral, alcyonarians, sponges and algae are prominent. Pink or reddish hues figure prominently in the pattern of the three species (*L. synagris, L. analis* and *L. mahogoni)* which wander in open areas during the day. Viewed in their natural habitat these pinks appear gray. Selective absorption of various colors, scattering and suspended material alter significantly the underwater appearance of a color pattern. Annulus formation on scales occurs in late fall or early winter after a sudden drop in water temperature. Scales of 1289 snapper were examined and 197 rejected due to replaced centers, and other factors. Estimates of growth based on monthly marginal increment of scales and limited data from tagged fish indicate reduced growth in water and maximum growth in August and September. Back calculations of growth from scale annuli resulted in the following mean SLs at annulus formation: Annulus I, 68 mm SL; II, 123; III, 171; IV, 219; V,252; VI, 287; VII, 324; VIII, 372; IX, 407. Growth rates of 11 tagged fish (256 - 324 mm) at large 72 to 367 days averaged 46.5 mm per year. Nine hundred and twelve gray snapper were tagged and 57 recoveries made. Forty-eight recoveries came from 274 fish tagged at Alligator Light and an additional 30 tagged fish from Alligator Light were estimated to have been brought into local fish market within three weeks of tagging. A high tagging mortality is suspected for small fish. Growth rate of nine snapper released and recovered at Alligator Light averaged 1.7 mm per month after 21 to 367 days at large. Nine other fish released at Alligator Light and recovered 3.4 to 18.7 nautical miles away averaged 7.4 mm growth per month in 19 to 285 days at large. Reduced growth of fish remaining on the reef is attributed to great competition for food in the densely populated reef environment. Gray snapper rarely exceed eight pounds. Most records of greater size are believed to be based on confusion with cubera snapper. *Lutjanus griseus* is intermediate in size and most body proportions to other inshore lutjanids. Only lengths of the paired fins are extreme. Short pelvic fins are associated with a somewhat free swimming mode of life. Short pectoral fins are perhaps an adaptation to moving through mangrove roots, submerged brush, etc. Spination is well-developed in very small individuals and probably serves as a defense mechanism. Small gray snapper have proportionately larger heads, eyes, and mouths than do larger fish, which are more terete of body. These changes are believed to be associated with the early importance of the sense organs of the head and the feeding mechanism resulting in rapid development of these systems in small individuals. Increasing tereteness of body is paralleled by a freer swimming mode of life and increasing tendency by larger snapper to feed on fish. Dentition, especially canine, is best developed in *L. cyanopterus, L. jocu, L. apodus and L. griseus* in that order. All feed extensively on fishes and some crustacea as adults. *Lutjanus analis* has relatively short heavy dentition and feeds largely on crustacea and mollusks. *L. mahogoni* and *L. synagris* have reduced dentition similar in shape to the first group of species. These two feed on small invertebrates and fishes. *Ocyurus chrysurus* has the least developed dentition and eats largely plankton and small midwater fishes and crustacea. One thousand three hundred and thirty-five gray snapper from 10.5 to 489 mm SL were examined for stomach contents. Six hundred and thirty-six, or 48%, contained food. Crustacea, predominantly amphipods and palaemonid shrimp, are the main food (93% of mean food volume) of juvenile snapper from grass beds. Slightly larger snapper from around brush and debris in grass beds had 69.4% crustacea; chiefly *Penaeus duorarum*, xanthid crabs and pertunid crabs. Fish made up 29.1% of food volume and *Opsanus beta* was the commonest fish. Snapper (largely adults) from an inshore channel contained 59.5% crustacea (mainly *Portunus* sp.) and 36.5% fish (*Opsanus beta* again the commonest). Crustacea were chiefly shrimp and portunid crabs. Copepods, amphipods, palaemonid shrimp, penaeid shrimp and portunid crabs successively dominate the crustacea eaten by gray snapper as they increase in size. Fish assume an increasing role in the diet of large snapper. Most food items are swallowed whole and most range in size from eight to 45% of SL though elongate forms such as eels may be eaten even if longer than the snapper. Juvenile gray snapper from grass beds feed in the day while larger snapper are nocturnal feeders. Stomachs examined in later afternoon were almost entirely empty. Schools of gray snapper break up at dusk and disperse into surrounding areas to feed. Large gray snapper may range a mile or more at night from points of diurnal concentration. The feeding habits of gray snapper are not highly selective and are more generalized than those of the other species of snapper. The over-all sex ratio of gray snapper is about equal though mature females predominate in shore channels and males on the reef. The smallest mature female was 195 mm SL and the smallest mature male was 185 mm SL among 722 specimens examined. No significant difference in size of sexes was noted though the four largest fish (430 to 489 mm) were females. Ripe females were common in July and August and spent females common in early September. Spawning occurs more than once and probably around the time of full moon. The occurrence of small juveniles indicates some spawning as early as June. A 315 mm female gray snapper was estimated to have about one half million eggs. Schooling behavior is strongest in adult fish and is greatest in areas of reduced cover. Schools of mixed species including gray snapper are common. Small snapper from inshore areas show no directed seasonal movements other than being driven from certain exposed locations by low temperatures or storms. Adult gray snapper migrate to the offshore reefs to spawn in summer. A much smaller population of gray snapper are year-round residents of the reefs. Tagged snapper moved as much as 40.5 nautical miles in seven days following the fall break-up of the summer schools at Alligator Reef. Gray snapper occasionally submit to removal of ectoparasites by other fishes. The latter include the neon goby (*Elacantinus oceanops*). Spanish hogfish (*Bodianus rufus*) and juvenile porkfish (*Anisotremus virginicus*). The wide geographic and ecologic range of *L. griseus* is attributed to its generalized nature. Restrictive measures for the protection of this species are not needed at present or in the immediate future. Adult populations of gray snapper could probably be substantially increased by proper placement of manmade cover.

1964, 1966 - 1967

Smith, W. G. (1968) Sedimentary environments and environmental change in the peat-forming area of south Florida. Ph. D. Dissertation. Pennsylvania State University, University Park, PA. 254 pp.

The kinds of sediments which occurred in 48 cores which are within or marginal to peat forming areas in South Florida were described. These were subdivided into various types based on ash content, kinds of mineral matter, floral elements, faunal elements, color, texture, and other properties. Comparisons of sulfur content elements from freshwater areas and areas of marine influence were also made. Observations on surface environments and plant communities presently existing in the area were used to relate these sediment types environments of accumulation. The sequences of sediments were described and relate to historical development of the area in the last thousand years. All of this information was used to make inferences about the important processes and controls which exist in the large areas of organic sediment accumulation which exist in the Everglades and in the adjacent tidal plain. Some of the more important conclusions are as follows. Peat forms in six major types of environments in the area, and the peat formed can be differentiated megascopically with varying degrees of certainty. Only three peat types are of common occurrence. There are: a) *Rhizophora* peat, the most abundant type formed in tidal areas; b) Aquatic peat, in basically aquatic conditions; and c) Emergent herbaceous peat, from non-woody plants of the freshwater areas. Peats formed in saline grass or rush marshes may cover wide areas but are thin. Peats formed in bay hammock are of rare occurrence. The peats forming in the tidal area are higher in mineral content than those forming deep within the freshwater regions. This must reflect greater availability and energy for transport of mineral matter in the tidal area. Freshwater peats at depth in the tidal plain were also generally higher in mineral content than peats in the freshwater are indicating possible mineralization after burial. A difference was found to exist in sulfur content of peats in the tidal area and those occurring in freshwater conditions in the Everglades. The freshwater peats ranged from 0.3 to 1.0% sulfur and the saline water peats, with but one exception, always had more than 1.0% sulfur. This was not true, however, of peats of freshwater origin that presently lie within the tidal plain, so an increase in sulfur content possibly occurs at depth in the saline area. All peat types showed a gradual increase in sulfur content in the upper 1-2 ft of the section. Peats of freshwater origin commonly intervene between the mangrove peats of the tidal area and the basal calcitic mud stratum of part of that area. This is contrary to other theories. The sequence previously reported of mangrove peat directly over calcitic mud is encountered only in 7 cores. The oldest Holocene sediments known are peats that are approximately 5500 radiocarbon yrs in age. These reported from beneath Rodriquez Bank off of Key Largo. Basal peats from the northern Everglades date approximately 5000 yrs BP. In the west coast tidal plain and beneath Florida Bay, the ages reported on peats are usually less than 4500 yrs with one exception that is reported here of a *Rhizophora* peat that is approximately 5000 yrs BP in age. The old peats beneath Rodriquez Bank have not been described sufficiently to know their environment of accumulation, but they occur at elevations no lower than those of the west coast that are apparently 500 to 1000 yrs younger. The effects of root intrusion very likely would make these age differences insignificant. It is suggested that the vegetational mosaic pattern of the Everglades is a result of a complex set of factors regulating the production and destruction of organic matter. For any fixed rate of supply of nutrients and water, it is possible for an unvariegated vegetational cover to exist if an equitable distribution of these materials can take place. If inequalities of distribution develop, then differentiation of environments will occur. In an area as large as the Everglades, with variations in rainfall from place to place and variations of inflow from the margins such differentiation seems highly likely. Also, differentiation must have occurred as peat began to accumulate due to variations in bedrock level. When differentiation results in plant communities of basically different life forms, such as the three major communities of the Everglades, the process of differentiation may become self-sustaining from variations in water losses. This may induce an essentially one-way transfer of nutritional substances into the areas of higher water loss. This may produce trends of a serial nature, but changing conditions from time to time apparently reverse the trend as shown by cyclic alternations of the different environments in the cores of this study. Fresh-appearing and probably living roots were noted in cores beneath living *Rhizophora* to depths of about 90 in. Such root intrusions may cause transport of oxygen to some depth and lead to decomposition of earlier formed organic matter. The intruded roots also have compactive effects and may make radiocarbon dates generally younger than the true age. Beneath other types of vegetation, root effect is much less apparent, but may nevertheless be important. A general rise of sea level with respect to the land indicated by the sedimentary record beneath the tidal plain, but locally regressive tendencies are seen and the shoreline has prograded. The view of Davis of generally regressive sequence and general coastal progradation is not supported. The accretionary beach ridges of the three capes of Cape Sable are tentatively dated as having begun to form as early as 2000 yrs BP at Northwest Cape and 1200 yrs BP at East Cape. Shorelines older than the accretion beach ridges also exist in the Cape Sable area. These have not been dated but their prominent surface expression would seem to allow only slight rise of the sea over the land in the time since they were abandoned. The dates on the Beach ridges suggest this was over 2000 yrs. Major trends in mineralogical constituents in carbonate mud cores are not evident. Differences that are seen are usually coincident with other changes that indicate environmental change. There are indications that the peat layers affect carbonate sediments to some extent. Shells near the contacts are soft and decomposed. High magnesia calcite tends to decrease in amount toward the contacts with the peat. Important amounts of non-calcareous clay sized sediment occur in the tidal area but have been little noted in earlier reports. These are most abundantly accumulated in the mangrove swamps. A stiff clayey sand underlies much of the area north of the Shark River and this may be of Pleistocene age. Clays of the Holocene may be partly derived from this and partly from materials transported in from the Gulf of Mexico. The clays are highly organic and are possibly residuals after loss of carbonate originally carried into the swamps. In the freshwater areas clays often occur next to the bedrock in a thin dark organic zone.

1964 - 1965

Beardsley, G. L. (1967) Distribution in the water column of migrating juvenile pink shrimp, *Penaeus duorarum*, Burkenroad in Buttonwood Canal, Everglades National Park, Florida. Ph. D. Dissertation., University of Miami, Coral Gables, FL. 91 pp.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] Distributional studies on migrating pink shrimp showed that they occurred in the Buttonwood Canal at various times. Shrimp were found on the surface of the canal under all conditions based on an analysis of the relation between environmental factors and distributional patterns. However, a greater percentage were observed on the surface during full moon periods. Evidence from Coot Bay also indicated that juveniles respond positively to moonlight during their emigration. No differences in vertical distribution were detected in relation to temperature, salinity, current velocity, changes in water depth, or sex. Changes in lateral distribution, however, occurred in the canal. When moving out with the tide, juveniles commonly cling to drifting vegetation, and their distribution is probably affected by prevailing winds when large amounts of vegetation are present in the water. At other times current patterns showed no features that might contribute to changes in lateral distribution. Mean carapace length and sex ratios were determined.

1964 - 1965

Beardsley, G. L. (1970) Distribution of migrating juvenile pink shrimp, *Penaeus duorarum*, Burkenroad, in Buttonwood Canal, Everglades National Park, Florida. Trans. Am. Fish. Soc., 99(2):401-8.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] The vertical and lateral distribution of migrating pink shrimp, *Penaeus duorarum*, was studied in Buttonwood Canal by thrice monthly sampling with conical nets suspended from a bridge. Vertical and horizontal movements of juveniles correlated with moonlight and tide. During ebb tide, juveniles exhibited a positive response to moonlight, by moving to the surface. During flood tides they stayed on the bottom or at the sides of the canal.

1964 - 1965

Daley, R. J. (1970) Systematics of southern Florida anchovies (Pisces:Engraulidae). Bull. Mar. Sci., 20(1):70-104.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] Samples of southern Florida anchovies were collected around the southern end of the Florida peninsula including the Everglades National Park and were used to analyze variation in gill rakers, vertebrae, and fin rays. Most of the specimens identified belonged to the following five species: *Anchoa lamprotaenia, A. hepsetus, A. nasuta, A. mitchilli*, and *Anchoviella perfasciata*. An identification key is given based on meristic and proportional characters and pigmentation. Observations on their relative abundance and distribution around the tip of Florida are presented.

1964 - 1967

Wood, E. J. F., and N. G. Maynard (1974) Ecology of the micro-algae of the Florida Everglades. Environments of South Florida: Present and Past. Memoir 2. P. J. Gleason (ed.). Miami Geological Society, Coral Gables, FL. 123-45.

This study was centered on the relation between the composition of the micro-algal community, and water level, salinity, seasonal changes and macrophyte population at certain chosen places, which, it is hoped, would represent important habitats from fresh to salt water. The modes of regeneration of micro-algal populations after fire and drought, and the effect of natural changes of the environment on the micro-algal populations were also studied. The investigation was performed in the period 1964 - 1967. The sampling station closest to Florida Bay was in Buttonwood Canal.

1964 - 1968

Cohen, A. D., and W. Spackman (1974) The petrology of peats from the Everglades and coastal swamps of southern Florida. Environments of South Florida: Present and Past. Memoir 2. P. J. Gleason (ed.). Miami Geological Society, Coral Gables, FL. 233-55.

The Everglades and coastal swamps of southern Florida are regions of deposition of significant quantities of peat. Differences in vegetational and depositional environments in which these sediments have been deposited have given them distinctive paleobotanical and petrographic compositions. These differences are best detected by analyses of vertically oriented microtome sections. Nine of the more common peat types of southern Florida and their environments of deposition are described in this paper. These range from mangrove swamp and salt marsh peats, to brackish (transitional) swamp and marsh peats, to freshwater marsh and bay hammock peats.

1964 - 1968

Enos, P. (1989) Islands in the Bay - a key habitat of Florida Bay. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):365-86.

Florida Bay contains 237 muddy islands with areas >100 m^2 that comprise 1.73% of the total area. The geographic distribution of islands is uneven; they are least numerous in the western Bay (0.76% of total area); most common in the central Bay (2.89%) and intermediate in the northeastern Bay (1.88%). Principal island habitats are: (1) red and black mangrove swamps, (2) algal and halophyte marshes, (3) grass "prairies" and (4) hardwood-buttonwood hammocks. A hierarchical classification of islands consists of islands that contain only habitat (1) mangrove swamps, (1) and (2), (1) through (3), and (1) through (4); these represent a developmental sequence. Islands are dynamic: habitats evolve, sometimes catastrophically, and islands migrate through erosion on more exposed margins and lateral accretion on protected margins. Cores from islands showed that some nucleated with transgression of the shoreline and persisted throughout the Holocene flooding of the bay, but others nucleated on mudbanks later in the history of the bay. The stratigraphic history of islands had no obvious relationship to the habitats now present on the islands. Habitats were characterized from field work and aerial photographs taken prior to Hurricane Betsy (1965).

1964 - 1968

Hudson, J. H., D. M. Allen, and T. J. Costello (1970) The flora and fauna of a basin in central Florida Bay. Contribution 263. Spec. Scientific Rep. 604. US Fish and Wildlife Service, Washington, DC. 14 pp.

One hundred ninety-six species of plants and animals were reported from Porpoise Lake, a nursery area for pink shrimp *Penaeus duorarum duorarum* in central Florida Bay. Many of the organisms were benthic and associated with shallow beds of turtle grass, *Thalassia testudinum*. Although abrupt habitat variations may affect species distribution, the general distribution of organisms in the basin and Bay defined environments influenced by different water masses. Sampling took place monthly from April 1964 to January 1968.

1964 - 1973

Davis, G. E., and M. C. Whiting (1977) Loggerhead sea turtle nesting in Everglades National Park, Florida, USA. Herptologica, 33:18-28.

A decade, 1964 - 1973, of investigation of sea turtle nesting in Everglades National Park is reviewed. Virtually all nesting was by loggerhead turtles, *Caretta caretta*. Nesting activity increased from 455 nests to 915 nests per nesting season from 1964 - 1965 to 1973 - 1973. There was roughly twice as much nesting activity in even numbered years as in the following off number years. Individual turtles seemed to nest on a 2-yr cycle, with four or more nests per year. Nesting interval within a season, May through August, was 12 days. Mean clutch size was 100 eggs/nest. This declined steadily through the season from 100 to 79 eggs. Annual predation by raccoons, *Procyon lotor marinus*, on *Caretta* eggs ranged from 49 to 87%. The loggerhead sea turtle nesting beaches are in Cape Sable.

1965

Costello, T. J., and D. M. Allen (1966) Florida Bay ecology project. Circ. No. 246. Bureau of Commercial Fisheries, US Fish and Wildlife Service, Galveston, TX. 15-8.

This citation described activities completed in the study of pink shrimp in Florida Bay during 1965.

1965

Holden, M. W. (1965) Further notes on sea turtle nesting on Cape Sable. Open File Rep. N1415. South Florida Research Center, Everglades National Park, Homestead, FL. 8 pp.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] This paper describes a follow-up study on sea turtle nesting on Cape Sable beaches during the summer of 1965. On-ground and aircraft observations indicated the continued success of nesting (246 observed crawls), however as many as 80% of the nests were thought to have been destroyed by racoons. Artificial nest boxes, used to prevent the racoons from getting at the eggs, resulted in a hatching success of 44%. Recommendations are given to increase the hatching rate, if the artificial nest continues the following year and on racoon removal methodology.

1965 ◊

Idyll, C. P. (1965) Shrimp need freshwater too. Nat. Parks Mag., Oct.:14-5.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] This citation discusses the diminishing supply of water in the Everglades and its effect on shrimp fisheries.

1965 ◊

Lynts, G. W. (1965) Obs···ations on some Florida Bay foraminifera. Cushman Found. Foram. Res. Contr., 16:67-·9.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] *Valvulina oviedoiana* d'Orbigny, *Triloculina bassensis* Parr and *Bolivinita rhomboidalis* (Millet) from Florida Bay and environs are described and discussed. Specimens of *Valvulina oviedoiana* lacking the valvular tooth are quantitatively compared with those with valvular tooth and are presently considered to represent the same species. *Triloculina bassensis* from Florida Bay is compared and considered conspecific with specimens of *Millolina angularis* Flint. *Triloculina bassensis* from Australia and *Triloculina* cf. *T. bassensis* from Bikini. *Triloculina bassensis* Parr is considered to be the valid name of the species at the present time. A specimen previously listed as *Bolivina* sp. from Florida Bay is identified as *Bolivinita rhomboidalis* (Millet).

1965 - 1966

Halpern, J. A. (1970) Growth rate of the tropical sea star *Luidia senegalensis* (Lamarck). Bull. Mar. Sci., 20:626-33.

A recently metamorphosed population of the nine-armed tropical sea star, *Luidia senegalensis,* was found on the southwest coast of Florida in November 1965, and growth was followed for 16 weeks. An analysis of stomach contents was made. It showed the bivalved mollusk, *Abra aequalis* to be the dominant food source. The growth rate of *L. senegalensis* was considerably more rapid than the growth rates of those temperate species of sea stars that have been studied.

1965 - 1967

Costello, T. J., and D. M. Allen (1968) Florida Bay ecology studies. Circ. No. 295. Bureau of Commercial Fisheries, US Fish and Wildlife Service, Galveston, TX. 10-1.

The shallow waters of Florida Bay and the Florida Keys are important nursery grounds for pink shrimp of the Tortugas grounds. Since 1965, biological observations on postlarval and early juvenile pink shrimp were made in these extensive estuaries. Postlarvae were sampled quantitatively once each month on incoming night tides at Whale Harbor Bridge near Islamorada (upper Florida Keys). As part of a cooperative plan similar observations were taken at three additional sites in the lower Keys by biologists of the Florita State Board of Conservation. This work established that large numbers of postlarval shrimp enter Florida Bay from the Atlantic Ocean and that recruitment continues throughout the year. Most postlarvae pass through the Keys into Florida Bay in late spring, summers and early fall. We expanded the sampling of juvenile shrimp in 1967. Quantitative samples have been taken monthly with a modified marsh net at 22 widely distributed shallow-water sites. Earlier samples were taken with the unit-area suction sampler designed by personnel at this station. Examination of samples from Florida Bay revealed that early juveniles increase in abundance during the summer and become most numerous during the fall. This concurs with the observation that postlarvae enter Florida Bay before and during these seasons. The data we have collected on incoming postlarvae and early juveniles indicate that the distribution of early juvenile pink shrink in Florida Bay depends primarily on the degree of postlarval penetration. Maximum concentrations of early juveniles occur in the western and southern portions of the Bay, generally in areas that receive large volumes of waterflow from the Gulf of Mexico and the Atlantic Ocean - a demonstrated source of postlarvae. Conversely, northeastern Florida Bay, which receives little waterflow from these sources, contains few early juveniles. At three stations in the northeastern Bay, we collected no pink shrimp during the first 6 months of sampling. The western and southern portions of the Bay are characterized by more stable salinities and temperatures, lower turbidities, and more extensive seagrass beds than generally occur in northeastern Florida Bay. In certain parts of northeastern Florida Bay, however, environmental conditions suitable for young pink shrimp apparently do exist for extended periods of time. Even at these times, however, few juveniles occur in northeastern Florida Bay. Another important aim of the field work is to accumulate information needed as background for "estuary-seeding" experiments. If production of juvenile shrimp in Florida Bay depends on the availability of postlarvae, it may be feasible to introduce large numbers of young shrimp reared artificially to certain shrimp-deficient areas of the bay and thereby increase production. Sampling has established the usual abundance of pink shrimp and associated organisns at each station. With these background data, we may be able to determine the effect of introducing large numbers of young shrimp at a chosen location.

1965 - 1967

Roessler, M. A., A. C. Jones, and S. L. Monro (1969) Larval and postlarval pink shrimp, *Penaeus duorarum*, in south Florida. FAO Fish. Rep., 57(3):859-66.

[NO COPY OF PAPER AVAILABLE. NARRATIVE SAME AS ROESSLER AND REHRER (1971).]

1965 - 1967

Roessler, M. A. and R. G. Rehrer (1971) Relation of catches of postlarval pink shrimp in Everglades National Park, Florida, to the commercial catches on the Tortugas grounds. Bull. Mar Sci., 21:790-805.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] Postlarval pink shrimp were sampled at Buttonwood Canal and Little Shark River, from July 1965 to December 1967. Environmental effects on postlarval catches were observed and the catches of immigrating *Penaeus* were compared with commercial catches of *Penaeus* on the Grounds. Postlarvae were more abundant at night, during flood tides, in bottom samples, during new and first quarter lunar periods and during the summer. An index of abundance was selected at both stations with which it was possible to predict 61% of the monthly variation in commercial Tortugas catches.

1965 - 1968

Costello, T. J., and D. M. Allen (1969) Ecology of pink shrimp in Florida Bay. Circ. No. 325. Bureau of Commercial Fisheries, US Fish and Wildlife Service, Galveston, TX. 9-10.

Ecological studies in Florida Bay and the Florida Keys have produced a variety of information on young pink shrimp, *Penneus d. duorarum*, not previously available. These shallow waters are the prime nursery grounds for pink shrimp of the Tortugas fishery. Postlarvae of the pink shrimp enter the Florida Bay estuary from the Atlantic Ocean through channels in the Florida keys and love on the bottom of suitable, shallow-water, grassy areas. These shrimp settle in greatest numbers near shorelines, and apparently prefer bottoms with growths of shoal grass, *Diplanthera wrightii.* Quantitative samples of planktopnic postlarval shrimp enterting Florida Bay via Whale Harbor Channel were taken monthly for 30 months. Seasonal peaks of shrimp abundance were in the spring, summer, or fall. The numbers of incoming planktonic postlarvae are reflected by the numbers of benthic postlarvae caught at selected sampling stations in Florida Bay and the Keys. Planktonic and benthic postlarvae were most abundant from June to December in 1967. The numbers of shrimp in samples from 18 selected stations in October 1967 give a general picture of shrimp distribution in Florida Bay and the Florida Keys. Northeastern Florida Bay has little water exchange with the Atlantic Ocean and contains a relatively small number of shrimp. The central Bay, with water circulation somewhat restricted by shallow water mudbanks, has moderate numbers of postlarval and juvenile shrimp, whereas the western Bay, with a large volume of incoming Atlantic water, has an abundance of young pink shrimp. The Lower Keys have moderate numbers of shrimp; the limiting factor here may be the shallow substrates that restrict the growth of seagrasses.

1965 - 1968

Costello, T. J., D. M. Allen, and J. H. Hudson (1986) Distribution, seasonal abundance, and ecology of juvenile northern pink shrimp, *Penaeus duorarum*, in the Florida Bay area. NOAA Tech. Memo. NMFS-SEFC-161. NOAA/NMFS, Miami, FL. 84 pp.

The Florida Bay area of south Florida contains important nursery grounds used by juveniles of the northern pink shrimp, *Penaeus duorarum*, before their migration to the offshore Grounds. Early juvenile shrimp were sampled in the Bay area from 1965 to 1968; maximum concentrations of early juveniles were in the western Bay; few occurred in the eastern Bay. They occurred year-round and were most abundant from late summer to early winter in seagrasses. Initial distribution of the early juveniles in the Bay is effected by the flooding tide, which transports planktonic postlarval shrimp into the shallow nursery grounds where they settle as epibenthic postlarvae. The movement of postlarvae into the Bay is apparently facilitated by the rise in sea level from about April to October. Variations in sea level control the aereal extent of the shallow nursery grounds and may determine the abundance of early juveniles in the Bay, and the subsequent commercial production of adult shrimp on the offshore Tortugas Grounds. The postlarvae probably actively select areas of shoal grass, *Halodule wrightii*, for initial benthic settling. The early juveniles are closely associated with shoal grass as the primary habitat and may depend upon this species for survival. Optimum habitat for early juveniles is characterized by (1) relatively open marine water circulation with daily tidal exchange, and (2) broad intertidal or subtidal beds of shoal grass with high blade densities. Shoal grass, often favored by environmental disturbances, may be a critical factor in recruitment success of pink shrimp.

1966 ◊

Berner, R. A. (1966) Diagenesis of carbonate sediments: interaction of magnesium in seawater with mineral grains. Science, 153:188-191.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Samples of natural fine-grained carbonate sediment from Florida Bay, underwent mole-for-mole cation exchange with aqueous solutions of $MgCl_2$ and $CaCl_2$ in the laboratory. The exchange reaction, which involves the surface of the grains of sediments, can be essentially described by a simple mass action-law equation. Enrichment of Mg^{2+} beyond the amounts found within particle interiors should take place on the surface of $CaCO_3$ sediments immersed in seawater; it may be on both exchangeable and unexchangeable sites.

1966

Klukas, R. W. (1967) Factors affecting nesting success of loggerhead turtles at Cape Sable, Everglades National Park. Open File Rept. No. N1415. 58 P. South Florida Research Center, Everglades National Park, Homestead, FL.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] Efforts were initiated in spring 1966 to reduce the racoon population at Cape Sable by trapping in one area and setting aside another area in the rookery as a control area where no trapping was conducted. A comparison of the nesting success in the two areas indicated that live-trapping can be a very effective technique in controlling and reducing the amount of nest predation by racoons. Additional notes on the nesting success and behavior of loggerhead turtles nesting there, and data on the natural history of racoons near the rookery are provided.

1966 ◊

Kontrovitz, M. (1966) A study of some Ostracoda of the Vaca Key, Florida Bay area. M. S. Thesis. University of Florida, Gainesville, FL.

[NO COPY OF PAPER AVAILABLE.]

1966

Lee, C. C. (1969) The decomposition of organic matter in some shallow water, calcareous sediments of Little Blackwater Sound, Florida Bay. Ph.D. Dissertation, University of Miami, Miami, FL. 106 pp + appendix.

Nine cores from Little Black Water Sound (LBWS), Florida Bay, were sectioned and analyzed for pH, Eh, moisture, carbonate carbon, TOC, lipid carbon, as well as free fatty acids and glyceride fatty acids. Surface sediments between 0 and 4 cm deep were collected for laboratory degradation studies over a ten-week interval and TOC, lipid carbon, glyceride fatty acids and free fatty acids were analyzed at the end of each incubation period. The results of these analyses were correlated with measurements of the corresponding environmental parameters observed within the sediments (e.g. sediment composition, particle size, depth of sediment layer, moisture content, pH and Eh). The results from laboratory incubated sediments were also correlated with total bacterial counts. LBWS sediments showed two distinct distributions of organic carbon; values varied between 0.5 and 1.4% in shelly muds and between 1.9 and 13% in peaty sections. Concentrations of organic carbon increased with sediment depth; minimal amounts occurred within surface sections. Absolute concentrations of lipids for shelly muds were generally below 600 μg lipid C g^{-1} sediment dry weight, but this amount constituted upwards of 8% of the total organic-carbon fraction. The distribution of lipids for peats, on the other hand, contained between 600 μg to 2.7 mg lipid C g^{-1} sediment dry weight. However, peat lipids accounted for only 3% of the TOC content. As for TOC, lipid carbon levels increased with sediment depth. Minimal amounts were also found within the surface layers. Free, normal-fatty acids and normal-fatty acids from hydrolyzed triglycerides with carbon chain lengths of C_{10} to C_{20} were tentatively identified. C_{16} and C_{18} acids were the dominant acids detected. Although C_{16} acid levels decreased with sediment depth and C_{18} acid concentrations increased with sediment depth, no consistent patterns of distribution for the other acids were observed. An inverse-relationship of C_{16} to C_{18} acids was apparent and suggested an inter-dependence of the two acids resulting from selective utilization and production of one or the other acid is suspected and discussed. Degradation studies of incubated surface sediments indicated that the processes of organic matter degradation were cyclic and microbial in nature. The cycle begins with initial breakdown of readily usable substrates, synthesis of secondary products with depletion of usable substrate and the adaptation of either the same organisms to new substrates and environmental conditions or the development of new organisms to cope with the new conditions, followed by continued organic substrate utilization. Sampling was done in 1966.

1966 ◊

Scholl, D. W. (1966) Florida Bay: site of recent limestone formation. In: Encyclopedia of Oceanography. R. W. Fairbridge (ed.) Reinholt, NY. 85-93.

[NO COPY OF PAPER AVAILABLE.]

1966 ◊

Tabb, D. C. (1966) The estuary as a habitat for spotted seatrout (*Cynoscion nebulous*). A symposium on estuarine fisheries. Suppl. to Trans., Amer. Fish. Soc., Spec. Pub. No. 3. 95(4):59-67.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The spotted seatrout is one of the most valuable fish of the southeastern United States. It is one of the few species that depends on the changeable habitats of estuaries and lagoons, even spawning there. Both young and adults are tolerant of the normal environmental extremes of estuaries, which are too rigorous for most marine fishes. This enables the spotted seatrout to reproduce, and grow almost unhindered by predation and competition. Spotted seatrout populations of more northern estuaries apparently make seaward movements to escape winter cold but southern populations do not exhibit a strong offshore movement. They are nearly non migratory in Florida; tagging studies show that they seldom move more than 30 mi from the point of tagging. Since most of the favored estuarine areas are separated by long stretches of exposed seashore there is little exchange of stocks between estuary systems. The non migratory character of the species, when combined with differences in habitat, has resulted in spotted seatrout populations having different growth rates. Unfavorable conditions for feeding or spawning in any given estuary, which cause declines in abundance, are likely to be left for long periods since the region will not likely receive large numbers of immigrants from other estuaries.

1966 - 1967

Allen, D. M., and J. H. Hudson (1970) A sled-mounted suction sampler for benthic organisms. Spec. Sci. Rep., Fish. No. 614. US Fish and Wildlife Service, Washington, DC. 5 pp.

The sampler is an underwater vacuum device mounted on a sled; a venturi-type water dredge provides suction. This equipment collects quantitative samples of young pink shrimp, *Penaeus duorarum*, and is effective in capturing other small benthic organisms. Shrimp catching efficiency was compared with that of a benthic sled net in Florida Bay.

1966 - 1967

Idyll, C. P., E. S. Iversen, and B. J. Yokel (1968) Variations in abundance of juvenile pink shrimp emigrating from the Everglades National Park, in relation to the commercial catch. Circ. No. 295. Bureau of Commercial Fisheries, US Fish and Wildlife Service, Galveston, TX. 13-14.

This citation describes variations in abundance of juvenile pink shrimp emigrating from the Everglades National Park, in relation to the commercial catch.

1966 - 1968

Allen, D. M., J. H. Hudson, and T. J. Costello (1980) Postlarval shrimp (*Penaeus*) in the Florida Keys: species, size, and seasonal abundance. Bull. Mar. Sci., 30:21-33.

Postlarval shrimp of the genus *Penaeus* were sampled for 32 months (January 1966 to August 1968) at Whale Harbor Channel in the Florida Keys. Most of the postlarvae were pink shrimp *Penaeus duorarum;* the majority had three dorsal rostral spines and were approximately 7.5 mm total length. *P. duorarum* postlarvae occurred year-round but were generally most abundant from April to September. The seasonal high in postlarval abundance was probably related to the annual increase in water temperature on the offshore spawning grounds and to the annual rise in sea level in the Florida Bay area. Seasonal abundances of postlarvae at Whale Harbor Channel were closely related to abundances of early juvenile *P. duorarum* on the Florida Bay nursery grounds. The juveniles are recruits to the offshore Tortugas shrimp fishery located west of Key West, Florida.

1966 - 1981

Browder, J. A. (1985) Relationship between pink shrimp production on the Tortugas grounds and water flow patterns in the Florida Everglades. Bull. Mar. Sci., 37(3):839-56.

Regression analysis indicated a relationship between landings of pink shrimp on the Tortugas grounds and freshwater runoff to the estuarine areas of Everglades National Park, as indexed by water levels in the Park. Landings, catch per unit effort (pounds per hour fished), and effort (vessel-hours fished) from 1966 to 1981 are displayed graphically in the paper. A strong positive relationship between quarterly (3-month landings and the average water level of the previous quarter was found for three quarters of the year. October through December water levels, followed by July through September water levels, may have had the greatest influence on annual landings. An inverse relationship between landings and water levels from April through June was not precluded. Information of this type is needed in order that the freshwater needs of estuarine-dependent marine organisms can be taken into account in water management planning.

1967 ◊

Berner, R. A. (1967) Comparative dissolution characteristics of carbonate minerals in the presence and absence of aqueous magnesium ion. Am. J. Sci., 265(1):45-70.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Short term (5-25 hrs) steady state pH has been measured for the dissolution of reagent grade calcite, Deep Spring Lake dolomite, and Florida Bay sediment (aragonite plus 14 mode mole percent Mg calcite) in distilled water and 0.1 m $MgCl_2$ solution at 25°C and constant P_{CO_2} (1 and 10-2.51 atm). Results indicate that calcite and dolomite can each show a constant ion activity product in the presence and absence of high concentrations of dissolved Mg^{+2} if unground samples are used and steady state approached from undersaturation. Measured ion activity product values are: calcite, 10 - 8.87; dolomite, 10 - 17.0. Unground Florida Bay sediment does not show simple reversible behavior in either solution. The solubility in distilled water is partly controlled by the rate of recrystallization of high-Mg calcite to more stable forms of $CaCO_3$ and is affected by the amount of surface area exposed to the solution. Dissolved Mg^{+2} causes a definite depression in the steady state pH and ion activity product of Florida Bay sediment below values predicted from the measure pH in distilled water at the same P_{CO_2}. The lowered pH is probably due in part to decreased rates of solution and loss of Mg from high-Mg calcite. Inhibition of low-Mg calcite nucleation may also result in a reversible equilibrium involving Mg ions and the grain surfaces. Experiments with mixed $CaCl_2$ - $MgCl_2$ solution demonstrate that this hypothetical Mg-enriched surface is not simply dolomite (non-exchangeable) or ideal, exchangeable $CaCO_3$ - $MgCO_3$.

1967

Costello, T. J., and D. M. Allen (1968) Florida Bay ecology studies. Circ. No. 268. Bureau of Commercial Fisheries, US Fish and Wildlife Service, Galveston, TX. 9-11.

[ABSTRACT FROM SCHMIDT (1991).] The first year of an on-going benthic ecology study on post larval and juvenile pink shrimp in eastern Florida Bay was completed. Variations in abundance of postlarvae collected at Whale Harbor Channel and other Keys bridges by plankton nets were compared to juvenile shrimp densities on the nursery grounds. Associated organisms collected in suction dredge samples were used to determine habitat types preferred by pink shrimp. Peaks of abundance for small shrimp and associated organisms appeared in August and November and followed postlarvae abundance peaks on bridge sites by one month.

1967 ◊

Hoffmeister, J. E., K. W. Stockman, and H. G. Multer (1967) Miami limestone of Florida and its recent Bahamian counterpart. Geol. Soc. Amer. Bull., 78:175-90.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The Miami Oolite, named by Sanford for the oolitic limestone of Pleistocene age which covers a large part of the southern tip of Florida, has been found to consist of two separate units: an upper unit, herein designated the oolitic facies; and a lower unit, called here the bryozoan facies. In this paper the two units are combined as the Miami Limestone, a formational name which now seems more appropriate than the Miami Oolite. The bryozoan facies, the dominant constituents of which are massive compound colonies of the cheilostome bryozoan *Schizoporella floridana* Osburn surrounded by ooids and pellets, covers the greater part of Dade County and extends in places into adjoining counties, a total area of about 2000 square miles. It averages 10 ft in thickness in southeastern Florida and thins to 1 ft or so westward to the Gulf of Mexico. It is the surface rock of the southern Everglades and is one of the most extensive bryozoan limestones in the country. In southeastern Florida, it is covered by an elongated mound of crossbedded oolitic limestone, the upper unit or oolitic facies. This is the rock of the southern end of the Atlantic Coastal Ridge, with a maximum thickness of 35 ft under the Ridge summit thinning westward toward the low-lying Everglades as it encroaches over the bryozoan fancies. Interest in the origin of the two units has been heightened recently by the recognition of similar deposits that are being actively produced in a nearby area. Immediately east of Miami on the western edge of the Great Bahama Bank, strung in a north south line, are the islands of Bimini, Cat Cay, Sandy Cay, etc., the region described by Newell and others. East of the Cays and parallel to them, large underwater mound of unstable oolite is forming, and east of the mound in the shallow lagoon massive, tubular bryozoans (*Schizoporella floridana* Osburn) are growing. The oolite from the mound is slowly encroaching over the bryozoan beds. The bathymetric and ecologic conditions now extant in this area are probably similar to those which existed during the Pleistocene to form the units of the Miami Limestone. The eastern slope of the unstable oolite mound of the Cat Cay and Sandy Cay area is cut by tidal channels which run normal to the direction of the mound itself. Narrow valleys, similar to these channels, can be found in the indurated rock of the oolitic facies of the Atlantic Coastal Ridge. The valleys probably had their origin as channels produced by tidal currents at the time the oolite mound of the Ridge was in an unstable condition. It is also believed that the shape and orientation of the Lower Keys of Florida originated in a similar fashion.

1967

Idyll, C. P., and M. Roessler (1968) Relation of variations in abundance of juvenile pink shrimp emigrating from the Everglades National Park estuary to the commercial catch. Circ. No. 268. Bureau of Commercial Fisheries, US Fish and Wildlife Service, Galveston, TX. 11-2.

This citation describes variations in abundance of juvenile pink shrimp emigrating from the Everglades National Park to the commercial catch.

1967

Idyll, C. P., and M. Roeslerr (1968) Seasonal changes in relative abundance of postlarvae of pink shrimp entering the Everglades estuary. Circ. No. 268. Bureau of Commercial Fisheries, US Fish and Wildlife Service, Galveston, TX. 12.

This citation describes seasonal changes in relative abundance of postlarvae of pink shrimp entering the Everglades estuary during 1967.

1967 ◊

Muller, G., and J. Muller (1967) Mineralogisch-Sedimentpetrographische Und Chemische Unterschungen An Einem Bank-Sediment (Cross-Bank) der Florida Bay, U.S.A. N. jb. Miner. Abh. 106(3):257-86.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] The sediments of a core of 1.6 m in length taken on the windward side of Cross Bank, Florida Bay, are divided into two portions, as shown by grain size analysis. A description of each portion is given, along with sediment composition based on changing grain size. Based on a thin layer of sand, a catastrophic event is indicated in the Florida Bay region.

1967 ◊

Price, W. A. (1967) Development of the basin - basin honeycomb of Florida Bay and the northern Cuban Lagoon. Trans. Gulf Coast Assoc. Geol. Soc., 17:368-99.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] A geomorphological synthesis of geological and ecological data on Florida Bay is provided by the author as follows: Florida Bay, a triangular 1,000-sq mile, bimodally windy, sub-tropical lagoon is a honey comb of closely spaced, interconnecting, sub-oval, pan-shaped basins individually upwards of 10 miles long and 12 ft deep. It lies north-south between mangrove swamp belts along the mainland of of the Everglades Ntional Park and the emergent barrier reef of the Florida Keys. Basin walls of Holocene marl made stable by alterations of mangrove swamp bands and marine grasses form a honeycomb pattern trough the lagoon. Basin areas and depths increase irregularly southward. No process of accumulation adequate by itself to form such honeycombs is known. The genetic process was the drowning and embayment of oriented lakes formed in drowned marsh rills.

1967 ◊

Scholl, D. W., and F. C. Craighead (1967) Recent geological history of the west coast of Florida; coastal mangrove swamps, and Florida Bay. Trans., Gulf Coast Assoc. Geol. Soc., 17:481.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The Recent (last 10,000 — 11,000 yrs) geologic history of the northeastern corner of the Gulf of Mexico, i.e., western and southern continental shelves of peninsular Florida, is recorded by the character and stratigraphy of outer-shelf and nearshore deposits. These deposits chiefly reflect the interplay of a generally rising sea level and the proximity of sources of terrigenous detritus, especially detrital quartz. For example, seaward of west-central Florida the outer shelf is essentially a bedrock surface overlain by a thin veneer of bioclastic sediment and biogenic reef growths that initially formed in a shallow nearshore environment. In contrast, the inner part of the shelf is flooded with shelly quartz sand or silt. Some of this detrital debris has been transferred to the shore to form prisms of quartzose beach sand, tracks of prograding beach ridges, and high coastal dunes. The quartz is chiefly derived from reworking of residual shelf and terrace deposits and drowned coastal plain sediments of Pleistocene age. Sources of detrital quartz disappear to the south, consequently the inner belt of quartzose deposits narrows and becomes increasingly mixed with shell debris and finer calcilutaceous components in this direction. As an important constituent of shelf sediments, detrital quartz essentially vanishes by the latitude of Cape Sable. Attesting to this, the carbonate content of unconsolidated sediment in Florida Bay (immediately south of the Cape) averages close to 90%. This sediment is primarily composed of comminuted molluscan, foraminiferal, and algal debris, 80-85% of which consists of "metastable" aragonite and high-magnesian calcite. The calcarenitic and calcilutaceous deposits of Florida Bay are as much as 4 m thick and overlie a thin stratum of freshwater peaty and calcareous sediment resting on a karsed bedrock surface of Pleistocene age. The basal freshwater deposits have a radiocarbon age of approximately 4000 yrs, which implies that sea level at this time was about 4 m lower than its present position. Also beginning about 4000 yrs ago marine water slowly inundated the western margin of the freshwater swamps of the Everglades, thereby providing the necessary paralic environment for the growth of the magnificent coastal mangrove forest and swamps of southwestern Florida. Strata underlying submerged waterways, intra-forest bays and tidal channels of the swamps form a simple transgressive sequence consisting of a basal freshwater unit of peat and calcite mud, a middle unit of paralic and brackish-water peat, and an upper marine unit of organic-rich quartzose sediment or shell debris. Deposits underlying the floor of the mangrove forest, or associated salt-grass marshes, range from peaty and calcareous quartzose sand and silt to compact, fibrous autochthonous peat. These organic rich units also attest to approximately 4 m of marine submergence during the last 4000 yrs. Concomitant with this submergence a rather complicated sequence of peaty and calcareous sediments accumulated along the western margin of the Everglades. If lithified, the modern shelf and coastal deposits of the northeastern corner of the Gulf of Mexico would be mapped as a somewhat discontinuous and slightly time-transgressive stratigraphic sequence consisting of a variety of shallow-water facies composed of mixtures of three lithologic end members: (1) calcarenite and calcilutite, (2) quartzose sandstone and siltstone, and (3) coal. These facies, and their stratigraphic relationships, duplicate some of the essential aspects of Paleozoic cyclotherms.

1967 ◊

Scholl, D. W., and M. Stuiver (1967) Recent submergence of southern Florida: A comparison with adjacent coasts and other eustatic data. Geol. Soc. Amer. Bull., 78:437-54.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Submergence data gathered in southern Florida indicate that approximately 4400 yrs ago (in terms of radiocarbon years) sea level was about 4 m lower than today's level. Between 4400 and 3500 BP, sea level rose at a rate close to 30 cm 100 yr^{-1} (1.0 ft $century^{-1}$). About 3500 BP, when sea level stood below its contemporary position, the rate of rise diminished by a factor of five; since 1700 BP, the rate of rise has averaged only about 3 cm 100 yr^{-1} (0.1 ft $century^{-1}$). Because a consirable body of evidence points to the probable tectonic stability of southern Florida in Recent time, the recorded submergence us regarded as a measure of an eustatic change in sea level. The Florida submergence curve shows that sea level has risen more or less steadily to its present level during the last 4400 yrs. This differs significantly from the hypothesis that sea level rose 2 - 4 m above its present position during this time. The Florida submergence data also do not support a strict interpretation of the stable sea-level hypothesis, *i.e.,* that sea level reached its present position (and maintained it) sometime between 3000 and 5000 yrs ago. This citation mainly discusses the Whitewater Bay region. [See Smith and Coleman (1967) and Scholl and Stuiver (1967) for comments and reply on this paper.]

1967 ◊

Smith, W. G., and J. M. Coleman (1967) Recent submergence of southern Florida: Discussion. Geol. Soc. Amer. Bull., 78:1191-4.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Many of the dated samples reported by Scholl and Stuiver (1967) probably cannot be as closely related to past sea level as their small margins of error would suggest. More evidence of the true nature of the materials dated and the environments in which they accumulated must be provided. In the low-relief area of the Everglades and adjacent swamps, the materials used probably generally reflect the last phase of sea-level rise. More precise determinations seem necessary, however, before acceptance of the area as a standard of comparison for other coasts.

1967 ◊

Scholl, D. W., and M. Stuiver (1967) Recent submergence of southern Florida: reply. Geol. Soc. Am. Bull., 78(9):1195-8.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] This is a reply to the comments by Smith and Coleman (1967) of the authors' paper on submergence (Scholl and Stuiver, 1967).

1967

Tabb, D. C., T. R. Alexander, T. T. Thomas, and N. Maynard (1967) The physical, biological, and geological character of the area south of C-111 Canal in extreme southeastern Everglades National Park. Final Report for Contract 14-10-1-160-11. Rosenstiel School of Marine and Atmospheric Science, University of Miami, Miami, FL. 55 pp.

A topographic map of the region was constructed using the elevation of the periphyton (fibrous algal growth) on plant stems as an indication of the depth of seasonal flooding. These depths were, in turn, converted to elevations (i.e., the deepest flooding represented topographic lows and the shallowest flooding indicated topographic highs. Variations in these measurements from station to station represented approximate contours. Maximum ground-level variation observed in the area was 8.5 in. Salinity observations show that the freshwater (0.0 to 5.0 ‰) zone extends completely across the study area from east to west and covers 35.6% of the 45.5 square mile land area studied. They also showed that salinity of 20 ‰ and higher exist in the canal below the plug at Highway 1 while the water immediately above the plug has no measurable salinity. Studies of animal distribution indicate that freshwater animals were found over 60.0% of the total land area. Studies of flowering plants indicate that freshwater species cover 42.4% of the land area. Mature hammock growth formed by these species indicate long-term freshwater conditions. Studies of unicellular plants of the periphyton show that freshwater forms cover 36.0% of the area under the observed dry season conditions. The nature of the sediments was determined by x-ray diffraction techniques and show that 68.2% of the study area was covered by pure calcite marl, thus indicating a long period of freshwater conditions. It is concluded that these studies, which were arrived at separately by different investigators, offer convincing proof of the freshwater character of soils, plants and animals of about 50% of the total land area within the study area. The study of the topography suggests that should saline spillover occur from C-111 canal, there would be a southwestward spread of the effects of this spill. This would be reflected most rapidly by the unicellular algae of the periphyton, then by salt-sensitive higher plants, and shortly thereafter by a disappearance of freshwater fishes and invertebrates. It is also concluded that although hurricanes such as Betsy of September 1965 occasionally push seawater onto the study area, the salt is rapidly flushed back into the sea by the accompanying heavy rains that normally accompany such storms, and effects other than by outright destruction by winds is transient.

1967 ◊

Taft, W. H. (1967) Modern carbonate sediments. Carbonate Rocks: Origin, Occurrence and Classification. G. V. Chilingar, H. J. Bissell, and R. W. Fairbridge (eds.) Developments in Sedimentology 9A. Elsevier, New York. 29-50.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Modern carbonate sediments are accumulating in almost all depositional environments except for the very deep oceans. Chemical and physical conditions, however, govern preservation and abundance of carbonate relative to non-carbonate material. Most modern marine carbonate sediments owe their origin to accumulation of bioclastic debris. Rarely can inorganic precipitation be actually proven. Mineralogical analysis of these sediments has shown that deep cold-water carbonates are predominantly low-magnesium calcites; whereas shallow, warm-water shelf deposits are composed predominantly of metastable carbonates (aragonite and high-magnesium calcite) with minor amounts of low-magnesium calcite. Significant quantities of supratidal dolomite has been reported in modern sediments. Diagenesis is taking place in modern sediments; however, only rarely can mineralogical or chemical changes be demonstrated in sediments that have not been exposed to freshwater. If modern shelf sediments are good examples of ancient sediments, almost all limestones have recrystallized. Florida Bay is one of the areas discussed.

1967 ◊

Wickham, D. A. (1967) Observations on the activity patterns in juveniles of the pink shrimp, *Penaeus duorarum*. Bull. Mar. Sci., 17(4):769-86.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The daily pattern of locomotor and burrowing activity of juveniles of *Penaeus duorarum* was observed in the laboratory under constant conditions of light intensity, water current, and water level. A bimodal pattern of nocturnal activity with a period of diurnal burrowing was observed near the times of the new and the full moon. A daily progression in the times of nocturnal activity peaks was observed which appeared to correspond with the normal daily tide progression in the area of capture. The rhythmic pattern in the behavior of *P. duorarum* was persistent, but could be modified by experimentally changing light regimes and water levels. This study indicated that activity of pink shrimp at any given time in the field is probably a resultant of the interaction of the environmental stimuli which are present and the rhythmic patterns of the previously experienced stimuli.

1967 ◊

Yokel, B. J., M. A. Roessler and E. S. Iversen (1967) Fishes and juvenile stages of pink shrimp (*Penaeus duorarum*) collected in Buttonwood Canal, Florida, December 1962 to June 1965. Data Rep. Serv. No. 22. US Fish and Wildlife Service, Washington, DC. 58 pp.

[NO COPY OF THE PAPER AVAILABLE.]

1967 - 1968

Chuensri, C. (1968) A morphometric and meristic study of postlarval brown shrimp, *Penaeus aztecus* Ives, pink shrimp, *Penaeus duorarum* Burkenroad, and white shrimp, *P. setiferus* (Linneaus). M. S. Thesis. University of Miami., Coral Gables, FL. 108 pp.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] A morphometric and meristic study of postlarval brown shrimp, *Penaeus aztecus* Ives, pink shrimp, *P. duorarum Burkenroad*, and white shrimp, *P. setiferus* (Linnaeus) was conducted at the Institute of Marine Sciences during 1967 and 1968. The purposes of the study were to develop a simple method of distinguishing the three species and to quantitatively analyze the various characteristics used. A total of 2,201 collected specimens were examined. Collection sites included Buttonwood Canal and Little Shark River in Everglades National Park, the Dry Tortugas area near Key West, and Upper Matecumbe in Florida; Barataria Bay and Vermilion Bay in Louisiana; Mississippi Sound in Mississippi; Bogue Inlet in North Carolina; the North Edisto River and Prince Inlet in South Carolina; and Galveston Bay in Texas. Twenty one laboratory reared *P. aztecus* and 3 laboratory reared *P. duorarum* were also examined. The collected specimens ranged from 2.60 mm in total length with 1 dorsal rostral spine to 18.45 mm in total length with 10 dorsal and 2 ventral rostral spines. The maximum number of dorsal and ventral rostral spines of one postlarva was 11 and 3 respectively. A new morphological character, the connection between the anterior edge of the carapace at the orbit and the lateral side of the rostrum, was used to distinguish postlarval *P. setiferus* from *P. aztecus* and *P. duorarum*. In the former species, the connection is described as abrupt, and in the latter two species, it is described as gradually closing. All of the *P. setiferus* and 95% of the *P. duorarum* could be distinguished from *P. aztecus* by the relationship between the carapace length and sixth abdominal segment length at the 95% level of confidence. The calculations are as follows:

$$Y_c = b + m X_o$$

Variation of Y_o would fall between Y_c - 1.96 $S_{y,x}$ and Y_c + 1.96 $S_{y,x}$ at the 95% level of confidence, where Y is the sixth abdominal segment length (0.05 mm); x is the carapace length (0.05 mm); b is the Y intercept; m is the slope of regression line; c is the subscript for "calculated"; o is the subscript for "observed"; and $S_{y,x}$ is the standard error of estimate for linear correlation. The sixth abdominal segment was greater than 2.65 mm in 92% of the *P. aztecus* postlarvae, but only in one of the *P. duorarum* postlarvae. All postlarval *P. aztecus* could be distinguished from *P. duorarum* by averaging the deviation of individuals regressions between 7 pairs of morphometric characters: carapace length and sixth abdominal segment length, carapace length and rostrum length, carapace length and eyestalk length, carapace length and antennal scale length, carapace length and antennal spine length, rostrum length and eyestalk length, and antennal scale length and antennal spine length. The individual was assigned to the species from whose 7 regression lines showed the least average deviation. The calculations for average deviation from regression lines are as follows:

$$Y_c = b + m X_o$$

$$Z = \frac{|Y_c - Y_o|}{S_{y,x}}$$

$$\overline{Z} = \frac{\Sigma Z}{7}$$

where Z is the deviation from regression line; and $\overline{Z}$ the average deviation from regression lines. The values of b, m and $S_{y,x}$ for each species according to the number of dorsal rostral spines present are given in the citation. The laboratory reared specimens confirmed that the absence of dorsal carina spines on the sixth abdominal segment of *P. setiferus* can be used to segregate it from *P. aztecus* and *P. duorarum* only if the shrimp has more than 5 dorsal rostral spines. Approximately 49% of the *P. aztecus* had the lateral spine longer than the tip of the antennal scale, and 2% of them had the lateral spine equal to the tip of the antennal scale. The third pereiod in 75% of all specimens examined in the present study was found to extend beyond the eye. Four out of 962 postlarval shrimp from Florida waters were morphometrically similar to *P. aztecus*. The remaining 958 specimens were morphometrically identified as *P. duorarum*.

1967 - 1968

Manker, J. P. (1969) Origin and distribution of silicate minerals in a carbonate environment, Florida Bay. M. S. Thesis. University of South Florida, Tampa, FL. 49 pp.

Chlorite, montmorillonite, illite, and kaolinite have been found in the clay-size insoluble residue or Recent carbonate sediments of Florida Bay. Clay mineral distributions in the study area can be described in terms of two end-member assemblages. They are characterized by: (1) chlorite, which is dominant in the eastern portion of the Bay; and (2) montmorillonite, which is dominant in the western bay region. The distribution of these two end-members is apparently related to source area (e.g., Gulf of Mexico for the Western bay area and the Atlantic coastal currents for the eastern Bay region). Illite is a minor component and is distributed in a manner parallel to chlorite. Kaolinite is also present in small quantities, but its areal distribution could not be delineated accurately. A restricted areal distribution of the two end-members exists due to the inhibiting action of many near-surface, carbonate mud banks on the exchange of water between eastern and western portions of Florida Bay. Samples were collected in 1967 and 1968.

1967 - 1969

Green, M. A. (1975) Survey of endolithic organisms from the Northeast Bering Sea, Jamaica, and Florida Bay. M. S. Thesis, Duke University.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] A comparative analysis of endolithic organisms within carbonate substrates from polar and tropical regions was undertaken to determine to what extent these microboring assemblages differ and what microboring organisms are present in each regime. Substrates were retrieved from Jamaica and from sites in Swash Keys Basin and Long Sound, Florida Bay. Assemblages observed in Florida Bay samples were composed primarily of blue-green algae (*Mastigocoleus testarum, Plectonema* sp., *Hyella caespitosa*) and green algae (*Ostreobium brantium*). Little distinction could be made between endolithic assemblages from Jamaica and Florida Bay.

1967 - 1968

Heald, E. J. (1969) The production of organic detritus in a south Florida estuary. Ph. D. Dissertation. University of Miami, Coral Gables, FL. 110 pp.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] [Also publ. as: Sea Grant Tech. Bull. No. 6, Univ. of Miami Sea Grant Prog., Miami, Fl. 1-110 p. (1971).] During 1967 and 1968 in the North River, the annual production of organic debris by red mangrove, *Juncus*, and sawgrass was studied. The rate of decomposition and the manner of degradation were determined, as well as the total contribution by each producer to the detrital load of the river. It was found that annual production exceeded 3 metric tons acre^{-1}, of this, 90% was produced by red mangrove. Degradation of red mangrove leaves was most rapid in brackish water as opposed to freshwater and the terrestrial environs. Two species of amphipods and a xanthid crab were consumers in brackish water. Seasonally the quantity of detritus was highest in the river from November - February; mangrove detritus accounted for 35-60% of the total suspended material month^{-1}. The nutritive value of mangrove detritus, its significance as an energy source in the estuarine ecosystem, and the importance of the mangrove community to adjoining bays are considered.

1968 ◊

Hughes, D. A. (1968) Factors controlling emergence of pink shrimp (*Penaeus duorarum*) from the substrate. Biol. Bull. 134:48-59.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] A close relationship exists between the day-night cycle and the times of activity of pink shrimp. The shrimp bury beneath the substrate during the day but emerge at the time of sunset and are active at night. Emergence from the substrate is markedly synchronized in all members of the population. This study elucidates the mechanisms whereby this synchrony is maintained. The persistence of the pattern of nocturnal activity for several days under conditions of constant low light intensity confirmed that emergence and subsequent activity were under rhythmic control. Resynchronization of the phase of the rhythm controlling emergence to a shift in the light-dark cycle indicated that the light-dark cycle itself, or some component of it, is responsible for maintaining the relationship between emergence and the day-night regime. The close association between emergence and the time of light-dark transition indicated the possibility that the latter was the important component of the Zeitgeber responsible for the control of the time of emergence. This was supported by experiments in which a changing responsiveness was shown to light-dark transitions imposed at various times during the light period. Maximum response (in terms of the rate and degree of emergence from the substrate) occurred when a light-dark transition was imposed at a time (18:00) to which the shrimp had previously been entrained to receive the onset of the dark period. Experiments in which shrimp, which had been fed 24 hr previously, emerged from the substrate and carried out food-searching movements, in the absence of food and despite high intensity illumination, which would normally suppress emergence, indicated the presence of a feeding rhythm with an approximate 24-hr periodicity. The feeding rhythm probably accounts for the fact that the phase of the rhythm of emergency was resynchronized to a shifted light-dark cycle in three days among shrimp fed immediately following the shifted cycle, as opposed to six days in those deprived of food during this time of entrainment. The phases of the two rhythms, being almost identical, probably supplement each other. Shrimp smaller than 4 cm (total length) emerged significantly earlier than larger individuals. This possibly reflects the lesser dependence of the early juveniles on inherent rhythms and consequently their greater receptivity to exogenous stimuli. The most obvious advantage of the circadian rhythm controlling emergence and subsequent activity is to confine the times of activity of shrimp to the hours of darkness when predation by fish is minimal. The proximity of the phase of the 24-hr feeding rhythm to the circadian rhythm of emergence and activity probably serves to strengthen the entrainment properties of the latter such that the time of emergence is further synchronized between all members of the population. The synchrony of the time of emergence is probably important for the maintenance of cohesion between aggregations of shrimp.

1968 ◊

Multer, H. G., and J. E. Hoffmeister (1968) Subaerial laminated crusts of the Florida Keys. Geol. Soc. Amer. Bull., 79:183-92.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Exposed Pleistocene marine limestones of the Florida Keys are often coated with laminated 1-to-6-cm-thick calcitic crusts. Heretofore these crusts have locally been identified as indurated marine algal stromatolites similar to the soft, marine, living algal stromatolitic mats of the Florida Keys, which border and occasionally coat the encrusted bedrock; such juxtaposition is now considered merely coincidental. ^{14}C dating of five different crust samples reveals a time of formation (within the last 4395 ± 90 yrs) during which the land surface was above sea level. Field relationships and laboratory evidence also indicate subaerial origin. Three general types of crusts are: (1) microcrystalline rind, (2) dense laminated, and (3) porous laminated. Similar laminated crusts found in subsurface cores suggest emergence followed by submergence of the Key Largo reef in late Pleistocene time. Proper identification of such subaerially formed laminated crusts, to distinguish them from similar-appearing crusts formed in marine environments, is necessary for correct interpretation of paleoenvironments and former sea level fluctuations. Thin crusts may be the only evidence in recognizing some ancient unconformities.

1968 - 1974

Ogden, J. C. (1975) Effects of bald eagle territoriality on nesting ospreys. Wilson Bull., 87(4):496-505.

Interspecific territoriality has been defined as aggressive territorial behavior persistently performed by individuals of a species against individuals of different species. Little attention has been given to documenting the effects of this behavior on nesting success of conflicting species. This paper is a study of the productivity and factors affecting nesting success in ospreys (*Pandion haliaetus*). It was found that osprey nesting success in the study area was affected by territorial behavior of bald eagles (*Haliaeetus leucocephalus*). It was also noted that the interspecific relationship between the ospreys and bald eagles differed in some aspects from forms of interspecific territoriality previously described. This paper describes the interspecific erritoriality exhibited by bald eagles toward ospreys, and quantifies the effect of this behavior on osprey nesting success and nest-site selection. This study took place from 1968 to 1974 in Florida Bay.

1968 - 1975

Ogden, J. C. (1978) Status and nesting biology of the American crocodile, *Crocodylus acutus*, (Reptilia, Crocodilidae) in Florida. J. Herpetol., 12(2):183-96.

This project was designed to determine the status of the American Crocodile in Florida and the factors regulating that population. Estimates of the historical and present range show that the nesting range has been considerably reduced during the 20th Century, including continued reduction in Florida Bay since that region became a part of Everglades National Park in 1950. Crocodiles in Florida Bay and on Key Largo are mound nesters, utilizing well-drained beaches, creek banks and abandoned canal levees as nesting sites. Females usually maintain primary and secondary mounds that are repeatedly used through many years. Average clutch size is 44; about 48% of the eggs hatch in successful nests, while the annual average number of successful nests is 65%. Most nesting failures are due to raccoon predation or failure of eggs to hatch, the latter probably a temperature problem in certain types of nests. The total number of crocodiles in south Florida early in the 20th century may have been between 1,000 and 2,000 animals, but that total has steadily declined to the present. Based on an estimated 20 breeding females per year and an average 275 hatchling crocodiles produced annually, the 1970s population is estimated to be between 100 and 400 animals. Factors that regulate the population, including low nesting success, human disturbance, and hurricanes, are discussed.

1968 - 1984

Fleming, D. M., N. C. Kline, and W. B. Robertson (1989) A comparison of osprey nesting distribution, abundance and success in Florida Bay from 1968 to 1984. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):517.

[ABSTRACT ONLY.] Declines in the Florida Bay osprey population have been documented. A 58% decrease in the number of nesting ospreys *(Pandion halliaetus)* occurred from 1970 to 1980. This decrease was believed related to reduced productivity caused by lower food supplies. Objectives of this study were to: (1) assess the current status and trend of nesting ospreys in Florida Bay, (2) analyze the spatial distribution of osprey productivity throughout the Bay in relation to selected environmental factors; (3) examine possible hypotheses concerning the Bay osprey population decline, and (4) evaluate osprey population status and trend as indicators of habitat change in the Bay. Current osprey nesting distribution, abundance and success were compared to that reported in previous studies. The spatial distribution of osprey productivity throughout the Bay was investigated by factor and discriminate analyses of environmental variables. Although the number of nesting ospreys remained relatively low and productivity was variable, the population appeared to have stabilized in recent years. Osprey productivity occurred primarily on islands adjacent to the mainland coastline of northern Florida Bay. Within this region, areas with islands of high osprey productivity were characterized by high relative abundances of fish prey species in close proximity to bank and/or shallow water habitats, and relatively low occurrences of mammalian predators (i.e., raccoons). An apparent relationship was also noted between annual rainfall and salinity variability, the relative abundance of important fish prey species, and subsequent osprey productivity. No such relationship appears to exist with the number of breeding pairs. Excluding the adverse effects of unseasonal weather events, osprey productivity appears to be a good indicator of macrohabitat changes that may occur in Florida Bay each year as a result of annual stochastic environmental variability. However, the usefulness of osprey population trends as an indicator of long term changes in Florida Bay ecosystem processes remains unclear. Until additional information is obtained on the loss of adults, and subadult dispersal and recruitment rates to the breeding population, osprey population trends as Indicators of habitat change in Florida Bay could not be substantiated.

1969 ◊

Hughes, D. A. (1969) On the mechanisms underlying tide-associated movements of *Penaeus duorarum*. FAO Fish. Rep., 57(3):867-74.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Postlarval shrimp move inshore on flood tides while juveniles move offshore on ebb tides. The mechanism whereby this discrimination between the tides is effected appears to be based on the respective response of postlarvae and juveniles to changes in salinity. Juveniles are positively rheotactic within a current of water. However, when the salinity of that water is decreased downstream swimming ensues. This ensures that juveniles will, in nature, resist displacement in an inshore direction by the flood tide but will swim and be placed in an offshore direction by the ebb tide. When the salinity increases (flood tide), they become active in the water column and are displaced inshore. The apparent dependence of tide associated movements on changes in salinity points to an explanation for the positive correlations that have been found between the extent of rainfall in the vicinity of "nursery" areas and the commercial catch of the following year.

1969 ◊

Hughes, D. A. (1969) Evidence for the endogenous control of swimming in pink shrimp, *Penaeus duorarum*. Biol. Bull., 136:398-404.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Evidence that the swimming of migrating juvenile pink shrimp is under some measure of endogenous control was derived from experiments which indicated (1) that the pattern of swimming exhibited by a group of shrimp, maintained under constant conditions within a current of water, was similar over each of the two nights following their collection from nature, and (2) that the swimming of two such groups, collected together, but maintained in separate current chambers within the laboratory, was similar during the night following their capture. Endogenous control over swimming extended to the sign of rheotaxis which, during certain nights, in the absence of change in external conditions, would reverse in all shrimp at approximately the same time. A predictable relationship occurred between the tide cycle to which shrimp were exposed prior to capture and their subsequent swimming in the laboratory. The adaptive nature of this relationship is suggested from the fact that downstream swimming, which in nature occurs only during ebb tides, and facilitates the offshore movements of juveniles, occurred in the laboratory only at the time of ebb tides in nature. It did not, however, occur at the time of all ebb tides but only during those occurring early in the evening. It is suggested that the cohesion of the aggregations of migrating shrimp may largely be maintained by means of the synchrony imposed on the activities of all individuals by endogenous timing mechanisms.

1969 ◊

Hughes, D. A. (1969) Responses to salinity change as the tidal transport mechanism of pink shrimp, *Penaeus duorarum*. Biol. Bull., 136:43-53.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The inshore movements of postlarval pink shrimp and the subsequent offshore movements of the juveniles are facilitated by flood and ebb tides respectively. This investigation concerns the behavioral mechanisms involved in the selective use of one tide and the evasion of the other. Salinity changes, similar to those occurring with change in tide in the inshore environment usually occupied by pink shrimp, were imposed on both postlarvae and juveniles in a constant-current apparatus. Juvenile shrimp were almost invariably positively rheotactic. However, with a decrease in salinity the sign of the response was reversed, resulting in active downstream swimming. This often gave way to passive drifting. Under conditions of low light intensity postlarvae were active in the water column, and being unable to withstand even slow currents were easily displaced. With a decrease in salinity they sank to the substrate or remained low in the water column where they were better able to maintain position. Responses of postlarvae at a discontinuity barrier between bodies of water differing in salinity indicated their ability to perceive differences as small as 1 °/oo. There was an "aversion" to penetrating such a barrier into water of lower salinity. Smaller postlarvae were more "averse" to the barrier than others approximately a week older. If similar responses are elicited in nature during the flood tides, juveniles would orientate and swim against the current in an offshore direction, while postlarvae, by being active in the water column, would be displaced shoreward. Following the decrease in salinity which accompanies the ebb tide the juveniles would swim, or be passively displaced, with the current, again in an offshore direction, and the postlarvae would sink low in the water column or settle on the substrate from where they are better able to resist displacement.

1969 ◊

Manker, J. P., and G. M. Griffin (1969) Distribution of silicate minerals in Florida Bay. Geology of the American Mediterranean. Gulf Coast Assoc. Geol. Soc. Trans., 19:505.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The dominantly carbonate sediments within Florida Bay contain small percentages of insoluble silicate minerals, ranging in our samples from 1.25 to 14.91% by weight. Quartz chlorite, and montmorillonite compose most of the silicate fraction. with very minor amounts of illite and kaolinite. Clay mineral distribution can be described by concentration gradients based on two end member assemblages: A chlorite assemblage dominates in the eastern part of the Bay, but declines westward. In a reciprocal manner, a montmorillonitic assemblage dominates the western bay and declines eastward. The two clay mineral assemblages reflect different sources-chlorite from the Atlantic province, and montmorillonite from the Gulf of Mexico province. Shallow and subaerial carbonate mud banks and intervening basins inhibit mixing of waters bearing the two clay assemblages; this has caused the relatively rapid transition from one clay suite to another in the 30-40 mile span of Florida Bay. The clay mineral fractions of similar ancient carbonate reef trends would be expected to show analogous concentration gradients in the back-reef area.

1969 ◊

Scholl, D. W., F. C. Craighead and M. Stuiver (1969) Florida submergence curve revised: Its relation to coastal sedimentation rates. Science, 163:562-4.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] New data substantiate as well as modify the south Florida submergence curve, which indicates that eustatic sea level has risen continuously, although at a generally decreasing rate, during the last 6500 to 7000 sidereal yrs (5500 standard radiocarbon yrs) to reach its present position. Accumulation rates of coastal deposits are similar to the rate of sea-level rise, thus supporting the generalization that submergence rates largely determine as well as limit rates of coastal sedimentation in lagoonal and estuarine areas.

1969, 1971

Russel, R. J. (1971) Beaches and ground water of Cape Sable, Florida, during extreme drought. Tech. Rep. No 103. Coastal Studies Institute, Louisiana State University, Baton Rouge, LA. 18 pp.

In October 1969 beaches and water tables were investigated after 5 months of adequate rainfall in the Cape Sable complex. In April 1971 a similar study was made after 5 months of extreme drought in the Florida Everglades, when water tables were lowered and flattened enough to permit widespread saltwater intrusion. Much of the beach rock and cemented water-table rock under the beaches had been eroded by high-energy waves, probably of Hurricane Laurie (1969) or various local storms. Slabs of the eroded beach rock were tossed up on the beaches, and if sufficiently indurated, became incorporated into the deposits. No evidence of subsequent cementation was observed. On East and Northwest Capes the ground water had been replaced by stagnant seawater. On Middle Cape the water table was lowered, but a salinity gradient and some potable ground water were present in 1971. The Cape Sable region is isolated from mainland surface runoff by extensive areas of lakes and waterways with seawater salinities, and from subsurface flow of ground water by a thick section of compact marl and compressed peat. Accumulation of ground water depends on local rainfall, and its volume varies with size and permeability of catchment areas. The conclusions of this study are applicable to many other coastal areas and may be useful in assessing their population and survival potentialities.

1969 - 1971

Charlton, D. S. (1981) The characterization and evolution of carbonate tidal deltas, upper Florida Keys. Ph. D. Dissertation. University of Wisconsin, Madison, WI. 421 pp.

South Florida was inundated by the last sea-level rise, initiating tidal exchange between Florida Bay and the open ocean at bedrock lows along the Florida Keys. Carbonate tidal deltas, composed of mangrove peat and carbonate sediments, formed during the last 5000 yrs seaward and bayward of tidal channels at Snake Creek, Whale Harbor and Tavernier Creek. The carbonate tidal delta system at Snake Creek was the focus of this study. Six surface depositional zones of the Snake Creek bayside delta and their diagnostic elements recognized in cores, representing environmental gradients from most restricted circulation to more open marine conditions, are: (1) BLACK MANGROVE ZONE (*Cerithidea scalariformis,* dolomitic crusts); (2) RED MANGROVE ZONE (peat); (3) RESTRICTED POND ZONE (*Anomalocardia auberiana*); (4) OPEN MUD FLATS ZONE (*Anomalocardia auberiana*); (5) TIDAL DELTA FRONT ZONE (*Turbo castaneus*, *Tegula fasciata*, *Porites*); and (6) FLORIDA BAY ZONE (*Codakia orbicularis*, coarse molluscan packstone). Cutting across these zones is the (7) MAJOR CHANNELS ZONE. Snake Creek delta provides a microcosm of regional gradients from the Everglades, across Florida Bay, to Hawk Channel. This zonation and a similar approach for ocean-side tidal deltas were used to interpret Holocene cores along nine cross sections at Snake Creek, Whale Harbor and Tavernier Creek. Cores within the proximal bay-side tidal delta plain commonly show deepening-upward, transgressive, sequences (subaerial erosional surface -> basal peat -> marine carbonates with *Thalassia*) followed by a shallowing-upward, regressive, sequence (carbonates with *Thalassia* -> peat and red mangroves -> carbonates and black mangroves). Mangrove peats are present in proximal cores only. Distal bay-side delta cores, composed entirely of carbonates, show a deepening-upward, transgressive, sequence (subaerial erosional surface -> coarse basal marine carbonates) followed by a shallowing-upward, regressive, sequence (Florida Bay Zone -> Delta Front Zone -> Open Mud Flats Zone) representing progradation. Bay-side deltas differ from ocean-side deltas because of restricted circulation, greater turbidity and lower energy conditions. Ocean-side tidal deltas underwent transgression followed by regression. Distal ocean-side cores coarsen upward with decreases in *Thalassia* roots and increases in *Porites* and *Goniolithon* due to rising sea level, increasing energy, plus upward growth and progradation. Proximal ocean-side cores exhibit fining-upward sequences with upward increases in *Thalassia* roots as buildup and progradation cause progressive sheltering of the inner delta. Both bay-side and ocean-side tidal deltas record two-phase transgressive/regressive sequences similar to those interpreted for

Rodriguez Bank and described for Florida Bay islands. A decrease in the rate of sea level rise about 3000 BP probably caused local changes from transgression to regression. The presence of basal transgressive peat, common to all bay-side deltas and under Florida Bay islands, Hawk Channel banks and ocean-side deltas indicates its early burial history and permanence of overlying sediments. Four conceptual models of tidal delta genesis were developed that usefully: (1) describe the feedback of dominant tidal delta processes and parameters; (2) relate delta size changes to competition between the rates of sedimentation and sea level rise; (3) place Tavernier delta in an earlier stage and Matecumbe delta in a later stage of ontogenetic development, with Snake Creek and Whale Harbor in intermediate stages; and (4) extrapolate the sedimentary history from rising sea level to falling sea level. An index of restriction, FM/AC ratio, was formulated to compare grain constituents at Snake Creek to adjacent areas. It appears to have wide application for regional carbonate facies studies. It is calculated as:

$$\text{FM/AC} = \frac{\text{\% Benthic foraminifera + \% Mollusks}}{\text{\% Algae + \% Coral}}.$$

Using the data of Gindburg and others, regional FM/AC values varied from very low (< 0.4) for the outer Florida reef track, to very high (> 50) for Florida Bay, with intermediate FM/AC values between.

1970 ◊

Costello, T. J., D. M. Allen (1970) Synopsis of biological data on pink shrimp, *Penaeus duorarum*, Burkenroad, 1939. FAO Fish. Rep., 57(4):1499-537.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] This citation is a species profile of the pink shrimp. It covers taxonomy, identification, life history, fisheries, ecological role, and environmental requirements.

1970 - 1974

McPherson, B. F., G. Y. Hendrix, H. Klein, and H. M. Tyus (1976) The environment of south Florida, a summary report. Geol. Surv. Prof. Pap. 1011. 81 pp.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] This report summarizes the scientific information database collected on the south Florida environment as a result of a variety of governmental (NPS, USGS, EPA, BSF&W, NMFS BOR, etc.) and private (University of Florida) studies undertaken during the early 1970's to determine the effects of a proposed international jetport on the ecosystem of the Everglades National Park. This report concludes phase one of the phase two project, South Florida Environmental Study, which described and identified the natural ecosystems of south Florida as they functioned before man began to have major impacts on these systems. The study also encompassed the agricultural and urban developments of south Florida and their impacts on the ecosystems. Topics covered as they pertain to the coastal and estuarine environments of the Park include: mangroves and salt marshes, shallow estuaries and bays, marine fisheries, water quality and pesticide effects. The authors conclude that by developing a thorough knowledge of the south Florida environmental system and the flow of energy through that system, planning and development can occur and permit full use and enjoyment of south Florida's natural resources without destroying those resources.

1970 ◊

Morelock, J. (1970) Consolidation of marine carbonate mud. Geol. Soc. Amer. Abs., :861.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] In this study, 34 sediment samples from the Gulf of Mexico, Florida Bay, and the Bahama Banks were analyzed to determine their consolidation characteristics. The results were similar to those found by testing noncarbonate silty clay. The carbonate sediments did not compact to as low a porosity as the noncarbonates which could be due to differences in particle shape and strength of the individual particle. Age and incipient cementation must play a part because the Holocene carbonate sediments did not show this characteristic.

1970 ◊

Rouse, W. (1970) Littoral crustacea from southwest Florida. Quart. Jour. Fla. Aca. Sci., 32(2):127-152.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] This paper is an annotated checklist of decapods, stomatopods, and isopods collected in Florida Bay, the Ten Thousand Islands, Whitewater Bay, and Buttonwood Canal.

1970 ◊

Yokel, B. J. (1970) The relationship of the pink shrimp emigrating from the Everglades National Park to commercial catches on the Grounds. Proc. Gulf and Caribb. Fish. Inst., 22:65.

[NO COPY OF THE PAPER AVAILABLE.]

1970 - 1982

Mazzotti, F. J. (1989) Factors affecting nesting success of the American crocodile, *Crocodylus acutus*, in Florida Bay. Bull. Mar. Sci., 44:220-28.

Approximately two-thirds of the nests of the American crocodile (*Crocodylus acutus*) in Florida occur in Everglades National Park along sandy shorelines and marl creek banks, in northeastern Florida Bay. Seventy-four percent of 104 crocodile nests examined between 1970 and 1982 produced at least one hatchling. Fifty-eight percent of eggs in such successful nests hatched, while 43% of all eggs laid produced hatchlings. Egg mortality was caused by predation (13% of 104 nests), and embryonic mortality (13% of 104 nests), resulting from flooding and desiccation. Nest temperatures apparently did not kill developing embryos, but deformed hatchlings were observed from hot (>36.5°C) nests. Disturbance to nesting females may result in abandonment of nests during incubation and relocation of nesting effort in subsequent years. The timing of nesting seems to be rigidly scheduled, with the developmental period bracketed by desiccating and flooding conditions, and periods of low and high temperatures. The success of this strategy is shown by the relatively low rate of nest failure in most years.

1971 ◊

Ginsburg, R. N. (1971) Landward movement of carbonate mud: a new model for regressive cycles in carbonates. Am. Assoc. Petrol. Geol. Bull., 55:340. (Abs.).

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] The Florida Bay lagoon and the tidal flats of the Bahamas and the Persian Gulf are traps for fine sediments produced on the large adjacent open platforms or shelves. The extensive source areas produce carbonate mud by precipitation and by the disintegration of organic skeletons. The carbonate mud moves shoreward by wind-driven, tidal or estuarine-like circulation, and deposition is accelerated and stabilized by marine plants and animals. Because the open marine source areas are many times larger than the nearshore traps, seaward progression of the wedge of sediments is inevitable. As the shoreline progrades seaward, the size of the open marine source area decreases, eventually reduced progradation of mud no longer exceeds slow continuous subsidence and a new transgression begins. When the source area expands so that production again exceeds subsidence a new regressive cycle starts. These results suggested by the model should be observable in ancient deposits.

1971 ◊

Given, P. H. (1971) Distribution of forms of sulfur in peats from saline environments in the Florida Everglades. Geol. Soc. Amer. Abstr., 3:580.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Peat deposits influenced by marine waters have higher pyrite and organic sulfur contents compared with freshwater deposits. The principal source of sulfur in saline conditions is the sulfate ion. As a first step in seeking to understand the sequence of changes by which sulfate is converted to the various other sulfur forms, a peat core in a mangrove swamp environment in the Florida Everglades has been analyzed at various depths for H_2S, acid-soluble sulfides, pyrite, elementary sulfur, organic sulfur and sulfate ion. Measurements at two depths have been made in a second core where conditions are brackish for part of the year. Concentrations tend to fluctuate with depth rather than show progressive trends. Ferrous sulfide, the presumed precursor of pyrite, is very low at all levels. Free sulfur, perhaps involved in the formation of pyrite, is found, though at rather low concentrations. It is difficult to see any other means of production of reduced forms of sulfur than the activities of sulfate-reducing bacteria. Yet Eh values, measured *in situ* with a pyrolytic graphite electrode, are in the range (100-450 mv), commonly described as "oxidizing." Clearly the oxidizable and reducible species in peat do not constitute an equilibrium system, the rate of reaction being slow.

1971

Harriss, R. C., H. Mattraw, G. J. Horvath, and A. Andren (1971) Input, cycling, and fate of heavy metal and pesticides pollutants in estuaries of the western Everglades. Final Rep. to the National Park Service from the Marine Laboratory, Florida State University, Tallahassee, FL.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] This report contains the results of the first phase of an investigation of the sources, dispersion mechanisms, and ecological impact of heavy metals and chlorinated hydrocarbon pesticides on the estuaries of the western section of Everglades National Park. The most important findings of the study are: (1) Agricultural activities located north of the park are a source of heavy metals and chlorinated hydrocarbon pesticides to the Park estuaries. Heavy applications of chemicals for plant nutrition and pest control have produced soils with average Fe, Cu, Mn, Zn, and Pb concentrations up to six times greater than presently uncontaminated estuarine soils and sediments; (2) The measured gradients for Fe, Cu, Mn, Zn, and lead suggest that migration of these metals into the estuarine environment is occurring; (3) Suspended sediments from drainage canals contain the highest Cu, Ni, Zn, and Cd values measured; (4) The cation exchange capacity of the soils and sediments studied increases with increasing organic content; and (5) Concentrations of mercury up to 1.8 µg/g have been measured in sediments with no likely source of artificial contamination. A very strong correlation was found between cation exchange capacity and Hg content in the sediments.

1971 ◊

Manker, J. P., and G. M. Griffin (1971) Source and mixing of insoluble clay minerals in a shallow water carbonate environment - Florida Bay. J. Sediment. Petrol., 41(1):302-6.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Chlorite and smectite dominate the clay-size insoluble residue of Recent carbonate sediments of Florida Bay illite and kaolinite also occur in very small quantities. Chlorite is derived from the Atlantic Coast and eastern Everglades provinces and is introduced by stream and by tidal channels through the northern Florida Keys. Smectite is derived from the Gulf of Mexico province to the west. In the northern part of Florida Bay, water flow is greatly impeded by a complex bank and base system, and the clay mineral suites remain relatively segregated near their respective sources. However, in the southern part of the Bay, banks are less frequent, water flow is less impeded, and the clay mineral suites mix gradually across the area.

1971 ◊

Slack, J. F., and R. S. Sites (1971) Analytical study of Caribbean carbonate sediments. The Compass, 49(1):9-24.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Carbonate sediments, representing various depositional environments from the Florida Coast, Keys, and Bay area, were analyzed by x-ray, infrared, and atomic absorption methods. Aragonite and high-magnesium calcite were found to be the dominant minerals formed in shallow water environments, whereas calcite was the predominant mineral phase in deep sea carbonate sediments. Spectrochemical analyses for Sr and Pb, at the trace element level, tended to reflect the amount of aragonite present. With an increase of aragonite, there was an increase of Sr^{+2} and Pb^{+2}, and also an increase in the pH of the environment. An infrared method, based upon frequency change with changing composition, is correlated with the standard x-ray diffraction procedure for the determination of the Ca/Mg ratio within sample of "protodolomite."

1971 - 1972

Collins, L A., and J. H. Finucane (1984) Ichthyoplankton survey of the estuarine and inshore waters of the Florida Everglades May 1971 to February 1972. NOAA Tech. Rep. NMFS 6. PB84-235829. NOAA/NMFS, Panama City, FL. 76 pp.

Quarterly ichthyoplankton sampling was conducted at 16 estuarine and 24 inshore stations along the Florida Everglades from May 1971 to February 1972. The area is one of the most pristine along the Florida coast. The survey provided the first comprehensive information on seasonal occurrence, abundance (under 10 m^2 of surface area) and distribution of fish eggs and larvae in the area. A total of 209,462 fish eggs and 78,865 larvae was collected. Eggs were identified only as fish eggs, but among the larvae, 37 families, 47 genera, and 37 species were identified. Abundance of eggs and larvae, and diversity of larvae, were greatest in the inshore zone. The 10 most abundant fish families which together made up 90.7% of all larvae from the study area were in descending order of abundance: Clupeidae, Engraulidae, Gobiidae, Sciaenidae, Carangidae, Pomadasyidae, Cynoglossidae, Gerreidae, Triglidae, and Soleidae. Clupeidae, Engraulidae, and Gobiidae made up 59.9% of all larvae. The inshore zone (to a depth of about 10 m) was a spawning ground and nursery for many fishes important to fisheries. The catch of small larvae ($\leq$ 3.5 mm SL) indicated that most fishes identified from the 10 most abundant families spawned throughout the inshore zone at depths of $\leq$ 10 m, but *Orthopristis chrysoptera*, Gerreidae, and *Prionotus* spp. spawned at depths of $\geq$ 10 m, with offshore to inshore (eastward) larval transport. Salinity was one of several environmental factors that probably limited the numbers of eggs and larvae in the estuarine zone. Abundance of eggs and larvae at inshore stations was usually as great as, and sometimes greater than, the abundance of eggs and larvae at offshore stations due west of the Everglades.

1971 - 1972

Lindall, W. N., J. R. Hall, W. A. Fable, and L. A. Collins (1974) Fishes and commercial invertebrates of the nearshore and estuarine zone between Cape Romano and Cape Sable, Florida. NTIS PB235-215. NTIS, Washington, DC.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] This study was designed to acquire baseline data on fishes and commercial invertebrates inhabitating the estuarine and nearshore waters between Cape Romano and Cape Sable. An annotated list of fishes with environmental data where each species was collected is provided. Results show that nearly 32,000 finfishes representing 114 species were collected, quarterly, between May 1971 and February 1972. The most abundant species, in decreasing order of abundance, were the striped anchovy, *Anchoa hepsetus*; bay anchovy, *Anchoa mitchilli*; silver jenny, *Eucinostomus gula*; fantail mullet, *Mugil trichodon*; and pinfish, *Lagodon rhomboides*. Of the six species of commercial invertebrates collected, pink shrimp, *Penaeus duorarum*, comprised nearly 91% of the total numbers of individuals taken (2,800). The number of organisms offshore increased with proximity to the shoreline. Generalized locations of isohalines for each quarter are also provided.

1971 - 1973

Grady, W. C. (1978) Sediments of Florida Bay near Islamorada, Florida. M. S. Thesis. West Virginia University, Morgantown, WV. 242 pp.

It is the purpose of this study to examine the sediments of the Florida Bay region, and to relate them to modern sedimentary environments with the aim of forming analogies to ancient environments of carbonate deposition. The study area may be subdivided into regions on the basis of biota, hydrologic factors such as water depth or current velocity, sediment size and sediment constituents. Petrographic study of the constituents in the sand and gravel size fractions allowed sediment facies to be ascertained for each fraction based on constituent composition. These facies were closely tied to variations in size, sorting, and skewness of the sediments. Q-mode factor analysis was employed to determine the facies of the sand and gravel size fractions, and the entire sediment. Three facies of the entire sediment resulted: (1) sediments of the muddy regions of Florida Bay, (2) sediments of the back reef, and (3) lag deposit sediments of the bay. Sediments of the study area consist predominantly of peloids of unknown origin, mollusk fragments, *Halimeda* fragments, and foraminifera. Quartz, which is found in most Bay sediments, originates in the underlying Pleistocene bedrock. Nearly one half of the skeletal grains in the study area are micritized, though only slightly. Also, an inverse relationship was recognized between mud content of the sediment and the amount of micritization of the grains. The bedrock surface beneath the recent sediments is a karst surface superimposed on a drainage pattern topography. This surface has no single control on the location of sediment build-up since its flooding. Sediments retrieved from 27 cores on the mangrove islands and shoals of the study area reveal eleven different sediment types within these islands and shoals. Cross sections based on these cores show that each island has had a history independent of each other island, and that sea level rise has been more-or-less continuous for the last 3300 yrs. Crane and East Keys, because of their proximity, developed into similar mangrove islands, but had vastly differing histories. Crane Key has always existed where it is now located since the initial flooding of the Bay. It first formed as a mangrove swamp, depositing peat, but as sea level rose, it developed into the mangrove island of today. East Key began as a sand shoal, which developed into a mangrove island. Cotton Key developed on the lake floor from sediments carried through Whale Harbor channel during storms. The portion of Shell Key studied initiated as sediments accumulating within a sinkhole. These sediments allowed the growth of mangroves, which have since formed the island. Shoal "78A" was initially a mud bank, but developed into a sand shoal midway through its history. The same appears to have happened to shoal "84". Sampling took place from 1971 to 1973.

1971 - 1973

Ogden, J. C., W. B. Robertson, G. E. Davis and T. W. Schmidt. (1974) Pesticides, polychlorinated biphenyls and heavy metals in upper food chain levels, Everglades National Park and vicinity. NTIS Rep. No. DI SFEP-74-16. 27 pp.

A general concern over possible environmental pollution in southern Florida by man-made poisons prompted this extensive survey of chlorinated insecticides, polychlorinated biphenyls, and metals in upper trophic level samples. The resulting analyses provide a baseline for future analyses, and clues for particular poisons or particular species in need of more study. These data revealed that DDT, DDE, DDD, dieldrin, and PCBs appear to exist in concentrations well below amounts known to have either acute or chronic effects on local species. Less is known of the significance of the various metal concentrations reported here, although levels of Hg in fresh water vertebrates, and As in marine species are great enough to deserve more intensive study. Collections were made between 1971 and 1973. The samples were eggs, and/or tissue of ospreys, pelicans, common egrets, white ibis, cormorants, sooty terns, cattle egrets, red shouldered hawk, alligators, crocodiles, pinfish, stone crabs, sea catfish, crevalle jacks, silver mullet, spiny lobsters, gray snappers, pink shrimp, blue crabs, bluegills, Florida gar, largemouth bass, leopard frogs, mosquito fish, and crayfish collected in Florida Bay or the Everglades. The samples were analyzed for DDT and metabolites, dieldrin, As, Hg, Cd, Zn, Pb, and Cu.

1972

Davies, T. D. (1980) Peat formation in Florida Bay and its significance in interpreting the Recent vegetational and geological history of the Bay area. Ph. D. Dissertation. Pennsylvania State University, University Park, PA. 338 pp.

[DATE OF SAMPLING PRIOR TO 1980 BUT UNKNOWN.] Florida Bay, a large shallow water embayment, occupies approximately 600 square miles between the South Florida mainland and the coralline Florida Keys. Bay sediments developed on the surface of the gently sloping (0.3 ft mi^{-1}) Pleistocene Miami Formation. The Miami Formation beneath the Bay is a karst limestone similar to that exposed in many areas of the Everglades to the north. Sediments covering the Bay floor are composed almost entirely of calcareous mud with occasional occurrences of peat. These sediments are young when compared to the 100,000-yr-old Miami limestone bedrock. Radiocarbon dates of basal peats indicate that peat accumulation began in south and southwestern sectors of the Bay about 5,500 radiocarbon yrs ago. Paleobotanical evidence from buried peats reveals that flora once occupying the Bay area was significantly different from today's. It was similar to flora presently growing on the mainland to the north in the freshwater Everglades. The purpose of the research was to develop an understanding of early vegetational and geological history of Florida Bay, and to relate the history of the Bay to the development and/or destruction of the South Florida coastline. There were five integrated parts: (1) determination of lateral and vertical extent or peat in Florida Bay; (2) determination of peat types contained in Bay sediments; (3) interpretation or environments responsible for formation of the various peat types encountered; (4) establishment of modes of occurrence of sulfur in peat sediments; and (5) interpretation or role peat sediment plays in island formation. Initial data were gathered at 547 grid sampling stations and 74 additional sites. Peat was found more widespread over the Bay than previously recorded. Sediment isopach and bedrock contour maps were produced. At 15 sites, 22 3-in piston cores were obtained representing the full thickness of peat present at each site. Peat and carbonate samples were processed for analyses of peat constituents and pollen stratigraphy. Peat thin sections were prepared at 3-in intervals. Environments of deposition were determined. Some important conclusions resulting from this study are the following. Autochthonous peat is more widespread over the Bay than previously recorded. Peat commonly occurs as basal sediment beneath numerous islands and banks, but is absent in open basin areas. Erosion of the peat "body" has played a role in the geomorphology of the Bay. Peat sedimentation began at least 5,500 radiocarbon yrs ago in south and southwestern parts of the Bay where the bottom of the Bay is lowest in elevation. Petrographic and palynologic data indicate freshwater marsh and swamp vegetation grew in the area in the past. Florida Bay peats are chiefly root peats and contain only minor amounts of stem wood. Thirteen peat types are identified from the Bay including three marine, two brackish, and eight freshwater types. Many of these peats are indistinguishable from peats from the mainland Florida. A concept of "secondary" peat types is presented for peats extensively intruded from above by roots of plants growing in differing overlying environments. Freshwater marsh peats are more fine-grained than the fibrous, rocky, marine peats present in the Bay. Charcoal is consistently more abundant in freshwater, marsh peat types, especially those comprised chiefly of *Mariscus jamaicensis* and *Acrostichum* spp. remains, than in brackish and marine swamp peats. Foraminiferal remains are common in many marine peats. Siliceous sponge spicules are present only in the younger marine sediments. Microscopically identifiable plant fragments, palynomorphs, charcoal, sponge spicules, foraminiferal remains, and radiolaria are useful in paleoenvironmental reconstruction. The sedimentary record of peat in Florida Bay is a cycle consisting of a clearly defined transgressive sequence. The cycle beginning at the base includes: (a) freshwater carbonate mud; (b) freshwater marsh and swamp peat; (c) brackish water peat; and (d) marine peat. The cycle is not always complete, but the sequence is always the same.

1972 ◊

Friedmann, E. I., W. C. Roth, J. B. Turner, and R. S. McEwen (1972) Calcium oxalate crystals in the aragonite-producing green alga Penicillus and related genera. Science, 177(4052):891-3.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Calcium oxalate crystals occur in the marine green algae *Penicillus*, *Rhipocephalus*, and *Udotea*, known as producers of sedimentary aragonite needles. In contrast to the externally deposited aragonite crystals which are generally < 15 µm long, the oxalate crystals are larger (up to 150 µm) and are located in the vacuolar system of the plant. No calcium oxalate was found in the related but noncalcifying genera *Avrainvillea* and *Cladocephalus*. Algae specimens were collected in Florida Bay.

1972 ◊

Gebelein, C. (1972) Sedimentology and ecology of a Recent carbonate facies mosaic, Cape Sable, Florida. Ph. D. Dissertation. Brown University, Providence, RI. 237 pp.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] A study of the sedimentary processes encountered in the recent, shallow marine intertidal carbonate deposits in and around Lake Ingrahm, Cape Sable was conducted to describe the nature of facies changes, sedimentation products, and organism - sediment interactions. The following sedimentary environments were described: mud flats, subtidal muds, mangrove flats, marl prairies, and inland lagoons including zonational characteristics, organism abundance and diversity, sedimentation rates and mechanics. A total sedimentation budget was estimated by comparing recent marine deposits accumulated since the opening of the canals in 1922 which drastically changed sedimentation style from fresh-brackish water conditions to a fully marine complex. A lack of diagenesis in Lake Ingrahm was explained by the youthfulness of deposits found at Cape Sable. Cape Sable deposits were compared with recent tidal flats in the Bahamas, Persian Gulf, and ancient tidal flat sediments. [Also published as Dynamics of recent carbonate sedimentation and ecology - Cape Sable, Florida (1977), Inter. Sed. Petro. Ser., Leiden & Brill., Vol. 16., 115 pp.]

1972 ◊

Ginsburg, R. N. (ed.). (1972) South Florida carbonate sediments. Sedimenta II. Comparative Sedimentology Laboratory, University of Miami, Fisher Island Station, Miami Beach, FL. 72 pp.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] This citation is a field guide to the geology of South Florida and covers Florida Bay and the Reef Tract. Subjects discussed include water circulation, molluscan fauna, isotope record of circulation gradients and texture and composition of sediments. This is a reprint of the Guidebook for Field Trip 1, Geological Society of America (1964).

1972 ◊

Hughes, D. A. (1972) On the endogenous control of tide-associated displacements of pink shrimp, *Penaeus duorarum* Burkenroad. Biol. Bull., 142:271-80.

[DATE OF SAMPLING NOT AVAILABLE.] Swimming of both postlarval and juvenile pink shrimp was recorded in current chambers in the laboratory for three days following collection from Buttonwood Canal. In the apparent absence of environmental cues the animals maintained various forms of phase relationship with the tidal and diurnal cycles. Postlarvae manifested a pattern of swimming, markedly in phase with the semi-diurnal tide cycle. Upstream swimming took place during flood tides and downstream swimming during ebb tides. No circadian periodicity was found and the confining of their activity in nature to night-time is considered a direct response to prevailing light intensity. The patterns of swimming evidenced by juveniles differ depending, apparently, on some as yet undetermined aspect of the tide cycle to which they are exposed prior to collection. Individuals collected at times of new and full moon, when ebb tides occur early in the evening, exhibit a different pattern of swimming from those of individuals collected at times of quarter moons when ebb tides occur late at night. The patterns obtained are clearly endogenous although their adaptive phasing with the tidal and diurnal cycles is not always evident.

1972 ◊

Kerr, S. D. (1972) Patterns of coastal sedimentation: carbonate muds of Florida Bay. Am. Assoc. Petrol. Geol. Bull., 56(3):632.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Muddy carbonate sediments of Florida Bay have accumulated in response to hydraulic process characteristic of coastal environments. These processes are reflected in faunal distribution as well as physiography of the accumulations. The frequently encountered coastal sedimentary pattern of "banks," "lakes," and mainland veneer is expanded laterally in Florida Bay because of topography of the underlying Pleistocene rock surface. In Florida Bay the dominant physiographic pattern consists of circular "lakes" of deeper water surrounded by curvilinear banks and islands. The banks, composed predominantly of mud sediment, reach within a foot or so of mean sea level and are largest in the western bay nearest the open Gulf of Mexico. The northeastern or "interior" segment of the Bay is characterized by narrower banks, in many places exposed subaerially as islands. Spitlike accretion is apparent from growth lines on islands and some banks. This indicates locally directed currents; however, overall randomness of orientation and circular patterns of sediment distribution suggest that significant currents develop in all directions. The larger submerged banks of the "outer" Bay display prominent accretion lines and are in addition elaborately channeled. The channeling follows a distinctive cycle of establishment and decline that seems closely related to bank growth. Current control of deposition of muddy sediments is reflected also in the ancient sedimentary record, notably the Pennsylvanian Virgil "mounds" near Alamogordo, NM, and Pennsylvanian Lansing "mounds" in southeastern Kansas. Sediment-baffle processes previously proposed for the construction of mound-topography appear unneeded in as much as current processes may achieve similar results.

1972

Lindberg, E., and C. Harris (197-. Mercury enrichment in estuarine plant detritus. .ar. Pollut. Bull., 5/6:93-5.

Relative Hg concentrations were enriched by a factor of 10 in decomposition products of the red mangrove, *Rhizophora mangle*, compared with living plant tissue. The Hg content of mangrove detritus is 3 to 30 times higher than values reported for marine phytoplankton. Detritus formation represents a natural mechanism for Hg enrichment in estuarine food chains. Sampling for this study took place in 1972.

1972 ◊

McCallum, J. S., and K. W. Stockman (1972) Water Circulation. Sedimenta II. South Florida Carbonate Sediments. R. N. Ginsburg (ed.) Univ. of Miami Rosenstiel School of Marine and Atmospheric Science, Miami, FL. 11-4.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] This paper provides a summary review of the restricted exchange of water in Florida Bay based on topography and the effect of variations in rainfall on Florida Bay salinity and water levels. A north-south gradient in salinity was found in Florida Bay as a result of runoff produced by mainland and Bay water levels, and by the excess of rainfall over evaporation. The authors suggest that the general salinity level of northern Florida Bay has fluctuated from brackish to hypersaline in a period of 5 to 7 years. Hydrographic zones of Florida Bay are presented.

1972 ◊

McNulty, J. K., W. N. Lindall, and J. E. Sykes (1972) Cooperative Gulf of Mexico estuarine inventory and study, Florida: Phase I, Area Description. NOAA Tech. Rep. NMFS. Circ-368. NOAA/NMFS, Seattle, WA. 126 pp.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Newly-developed tables and maps depict the dimensions, submerged vegetation, tidal marshes, mangrove swamps, commercial oyster beds, leased oyster-rearing areas, sources of pollution, drained tidal marshes, and filled areas of Florida's west coast estuaries. Published and unpublished information on temperature, salinity, geology, artificial fishing reefs, stream discharge, human population, commercial fishing, and economic development is presented in new form. If the total area of estuaries (3,003,312 acres = 1,215,440 ha) is considered to be the area of open water (2,081,525 acres = 842,393 ha) plus the area of mangrove swamps (393,160 acres = 159,112 ha) and tidal marshes (528,528 acres = 213,895 ha), then roughly one-half of the total area of estuaries is unvegetated; the remaining half is about equally divided among mangroves, tidal marshes, and submerged vegetation. Human population in coastal counties increased from 614,616 persons in 1930 to 3,320,226 persons in 1970, resulting in adverse effects from pollution to 43% of estuarine areas, filling of 23,521 acres (9,519 ha) mainly for residential and industrial development, and draining of 26,676 acres (10,796 ha) of tidal marshes for mosquito control. Increasing population correlates directly with the number of sources of pollution, filled area, and the area closed to shellfishing by public health authorities; thus, failure to control the adverse effects of population growth will clearly result in continued rapid degradation of estuarine habitat on Florida's west coast. This document includes coverage of Florida Bay.

1972

Odell, D. K., E. D. Asper, J. Baucom and L. H. Cornell (1980) A recurrent mass stranding of the false killer whale, *Pseudorca crassidens*, in Florida. Fish. Bull. US. 78:171-77.

The false killer whale, *Pseudorca crassidens*, is one of the several species of odontocetes known primarily through its relatively frequent mass strandings. These strandings offer a large amount of natural history data but, in most cases, investigators have been unable, for various reasons to thoroughly study these events. The series *P. crassidens* mass strandings described is the third in Florida in recent years and occurred outside Florida Bay. An unreported stranding occurred on July 1972 on the northeast end of Sawyer Key in Florida Bay is briefly mentioned in the paper. Nineteen animals were involved.

1972 ◊

Perkins, R. D., M. D. McKenzie, and P. L. Blackwelder (1972) Aragonite crystals within codiacean algae: distinctive morphology and sedimentary implications. Science, 175(4022):624-26.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Morphologic studies of single crystals of aragonite within Codiacean algae reveal characteristic crystal forms produced by two distinctly different modes of calcification. Diagnostic serrated crystals (1 µm in length) of aragonite originating within the extracellular sheaths of capitular filaments are incorporated into modern lime sediments and may serve as effective tracers for particles of algal origin. Intercellular calcification within *Penicillus dumetosus*, previously unreported, is represented by doubly terminated aragonite crystals ranging in size from 48 to 160 µm. Specimens for this study were collected in Florida Bay.

1972, 1987, 1989

Thompson, M. J., and M. B. Robblee (1989) Remote monitoring of seagrass die off in Florida Bay, Everglades National Park, Florida. Abs., 10th Biennial Estuarine Research Conf., Baltimore, MD. 82.

[ABSTRACT ONLY. NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] Extensive dying of seagrasses within climax *Thalassia testudinum* seagrass beds was first reported from Florida Bay, in the fall of 1987. Dying of seagrass beds in that area has continued and the phenomena appears to be spreading beyond the confines of Florida Bay. Aerial imagery from 1972, 1987, and 1989, and SPOT satellite imagery from 1987 through 1989 has been used to map the extent and the rate of spread of seagrass destruction. Remotely monitored signatures indicative of die-off are identified and possibilities for future, larger scale remote monitoring are discussed.

1973 ◊

Andren, A. W. (1973) The geochemistry of mercury in three estuaries from the Gulf of Mexico. Ph. D. Dissertation. Florida State University, Tallahassee, FL. 140 pp.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The distribution of Hg in three Gulf of Mexico estuaries of varying physical characteristics has been observed. In the Mississippi River approximately 100 kg Hg settles in the three main tributaries annually while 1.24×10^5 kg Hg reaches the Gulf, 78% in suspended form and 22% in dissolved form. In Mobile Bay 4.5×10^3 kg Hg settles in the estuary while 4.8×10^3 kg Hg enters the Gulf, 58% on suspended matter and 42% in dissolved form. This data indicates that estuaries with high sedimentation rates serve as efficient traps for mercury laden sediments. The Hg budget for the Everglades was not calculated but this area was utilized to illustrate that high levels of Hg can be encountered despite the fact that no Hg discharge sources are present in its vicinity. In order to study the nature of dissolved Hg the dissolved organic matter in the Mississippi River and the Everglades was fractionated into six different molecular weight ranges and Hg determined in each fraction. Data reveals that in the Mississippi River approximately 90% of both dissolved Hg and dissolved organic carbon are associated with the <500 molecular weight fraction. Identical measurements in the Everglades reveal that up to 40% of both dissolved Hg and dissolved organic matter exist in the >5OO molecular weight fraction. Additional evidence strongly suggests that Hg is strongly associated with the dissolved organic matter in the <500 molecular weight fraction. If dissolved methyl Hg exists measurements indicate that its concentration is less than 1 ng L^{-1}. Between 60-80% of methyl Hg in water is associated with the particulate phase, the highest association occurring in the Mississippi River and the lowest in the Everglades. This relatively constant phase separation indicates that suspended particulate matter is very important in determining the low dissolved Hg concentrations. If any adsorption-desorption effects of Hg exist at the zone of salt water mixing they are effectively masked by dilution phenomena. Alkyl Hg concentrations in sediments constitute only about 0.04% of the total Hg present. The observed organic matter-mercury associations are rather of the humic and fulvic type. The chelating ability of these organic materials are mainly due to their carboxyl content, which increases with decreasing molecular weight. Laboratory experiments show in addition that the fulvic acid-mercury association is only partially reversible as higher salinity water is reached, indicating that a very strong complex is formed. Measurements of Hg in interstitial waters presumably of anoxic character show that this element does not become immobilized by the formation of insoluble sulfides. Theoretical considerations show that this observation can be explained by the formation of soluble polysulfide species as well as by organic matter-mercury complexes.

1973

Brook, I. M. (1978) Comparative macrofaunal abundance in turtlegrass (*Thalassia testudinum*) communities in South Florida characterized by high blade density. Bull. Mar. Sci., 28(1):212-17.

Five *Thalassia* communities with high blade density (~3,000 blades m^{-2}) were sampled by suction dredge in April 1973. Four sites were in south Biscayne Bay, and one was at Murray Key in the Everglades National Park on the southwest coast of Florida. Macrofaunal abundance ranged from 292 to 10,728 individuals m^{-2}. It is postulated that a high standing crop of seagrass may not be the primary determining factor in faunal abundance.

1973 ◊

Caldwell, D. K., and M. C. Caldwell (1973) Marine mammals of the eastern Gulf of Mexico. A Summary of Knowledge of the Eastern Gulf of Mexico: 1973. J. I. Jones, M. E. Ring, M. O. Rinkel, and R. E. Smith (eds.). State University System of Florida, Florida Institute of Technoloy, Melbourne, FL. III-I-1 - 23.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Positive records of marine mammals from the eastern Gulf of Mexico are listed with annotations, and maps are included to show the location of the records. The species listed in Florida Bay and Florida Keys are *Balaenoptera acutorostrata* (Minke whale), *Globicephala macrorhyncha* (short-finned pilot whale), *Physeter catadon* (sperm whale), *Trichechus manatus latirostris* (manatee), *Tursiops truncatus* (bottlenose dolphin), and *Ziphius cavirostris* (Cuvier's beaked whale). It is not possible to determine in the maps whether records for the Florida Keys are for the Bay or ocean side of the reef track.

1973 ◊

Carballo, J. D. (1985) Holocene dolomitization of supratidal sediments, Sugarloaf Key, Florida. M. S. Thesis. University of Texas, Austin, TX. 130 pp.

[NO COPY OF PAPER AVAILABLE.]

1973 ◊

Chase, T. L. (1973) The variation in growth habits and ecology of the stony corals from Don Quixote Bank, Florida Bay. M. S. Thesis, University of Michigan,

[NO COPY OF PAPER AVAILABLE.]

1973 ◊

Craighead, F. C. (1973) The effects of natural forces on the development and maintenance of the Everglades, Florida. Research Reports - National Geographic Society, 1966:49-66.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The author first visited the Florida Everglades in 1917 in connection with a study of Paradise Key made under the auspices of the Smithsonian Institution. At that time he visited Lake Okeechobee and boated down the Caloosahatchee River to Fort Myers. Although the destruction of native vegetation was even then well under way, much was still preserved and made a lasting impression that motivated him to return to Homestead on his retirement in 1949. His work with the US Department of Agriculture from 1911 to 1949 frequently brought him into the forests of the state and increased his interests in its ecological problems. Since 1953, he collaborated with the Everglades National Park, and from 1961 the Park contributed to the expenses pertaining to these studies. In 1966 a research grant from the National Geographic Society allowed him to continue and expand the studies of this ecologically critical region. Preliminary studies have shown that natural forces, such as the rising sea, recent sedimentation (5,000 yrs or less), hurricanes, changing water levels, drought and resulting fires, and even the alligator can have catastrophic effects on the life and death of plant communities in south Florida and can profoundly affect the wildlife. Several investigators during the past four decades have called attention to the worsening conditions in the natural environments of south Florida. The present studies have attempted to throw more light on the natural processes of change, to point out their intensification by man, and to offer suggestions toward better management of this complex environment.

1973 ◊

Roberts, A. A., J. G. Palacas and I. C. Frost (1973) Determination of organic carbon in modern carbonate sediments. J. Sed. Petrol., 43(4):1157-9.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] In the routine analysis for organic carbon in modern unconsolidated sediments the initial step commonly is to remove the carbonate carbon by acid treatment and to analyze directly the organic carbon in the residue. As much as 44% of the organic carbon in modern carbonate sediments from Florida Bay is solubilized and lost during the acid treatment. Therefore, the amount of carbon in these, and in similar modern sediments, must also be included in the analysis for an accurate determination of the percentage of total organic carbon in the sample.

1973 ◊

Jones, J. I., R. E. Ring, M. O. Rinkel, and R. E. Smith (eds.) (1973) A summary of knowledge of the eastern Gulf of Mexico. State University System of Florida, Institute of Oceanography (SUSIO), Gainesville, FL.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] This report represents a compilation and evaluation of selected studies of the significant natural and artificial environmental characteristics of the eastern Gulf of Mexico and provides an overview of the current status of knowledge and information on past and on-going studies which are significant for a more complete understanding of the environment and ecology of the area. An extensive geological literature has been developed in this region since it is one of the major petroleum producing regions of the world and since a number of major commercial fisheries are located in this region there is an extensive literature regarding this aspect as well. Some of the more general statements made on the major topics addressed in this report are briefly summarized as follows: the climate of the report area is characterized by a subtropical high-pressure belt, with the period from March to September characterized by a clockwise atmospheric circulation pattern; wind and waves respond to seasonal changes in circulation patterns. Effects of hurricanes, tropical storms, and winter cold fronts are also discussed. Sections discussed as they pertain to the Everglades region include extensive chemical data on nearshore and estuarine waters including water quality, nutrients, minor elements and their hydrology are presented. A discussion of the biological environment is presented relative to both the environment and organism including salt marshes, mangroves, seagrass beds, plankton, major benthic invertebrate groups, fishes, marine mammals and birds. The Ten Thousand Islands - Florida Bay area is considered as one of the most complex coastal areas in the United States.

1973 ◊

University of Georgia Marine Institute and The Skidaway Institute of Oceanography (1973) The geological inventory of Cumberland Island, Everglades National Park, Gulf Islands National Seashores, and Biscayne National Monument. Final Rep. to the NPS. Contr. CX001-3-0052. National Park Service, Washington, DC.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] All available information and data concerning geology, geological history and development, and geological processes of the subject areas were gathered, evaluated and reduced, whenever possible, to a format appropriate for computer storage and retrieval. The information and data topics included ground water, tides, currents, waves, hydrography, shoreline erosion and accretion, and shallow water structure and stratography. An annotated bibliography was prepared. Aerial photographs (USGS, US C&GS/ESSA/NOAA and other sources), maps and charts and foundation borings and other engineering data were catalogued. Despite delays in obtaining equipment, maps, charts and air photos and developing the capability of time-lapse motion picture photography, the objectives were reasonably accomplished. The collation of existing information is essentially completed except for keeping up with current publications. Site visits by all the project personnel have provided a good insight and working knowledge of the geology and physical condition, in the subject areas and the basic processes that affect these areas. Because of a prolonged but apparently unavoidable delay in receiving the smooth sheets and topographic charts for NOAA, work on the historical trends of shoreline change and, hence, the forecast of future trends is still underway. Along with the time-lapse photography this important study will be given first priority in the proposed continuation of the project.

1973 - 1974

Davis, G. E., and C. A. Hilsenbeck (1974) The effects of watershed management on the Shark Slough Whitewater Bay estuary of Everglades National Park, Florida. Final Report RSP-EVER-N-65. South Florida Research Center, Everglades National Park, Homestead, FL. 16 pp.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] A study on the effects of upstream environmental conditions on the epibenthic community structure in the Whitewater Bay - Shark River estuary was conducted during 1973 - 1974. It was found that runoff, as it affected water levels in the water shed and the reduction of annual rainfall and increase in saltwater intrusion from Florida Bay, determined the seasonality and magnitude of salinity flux in the estuary, resulting in the replacement of the estuarine nursery area by a coastal marine system. The authors suggest that although the system will remain productive, its loss will cause reduction of fisheries as supported by larval recruitment. Salinity and substrate significantly affected the amount of total benthic biomass. Authors suggest salinity most important since substrate does not change seasonally.

1973 - 1974

Manker, J. P. (1975) Distribution and concentration of mercury, lead, cobalt, zinc, and chromium in suspended particulates and bottom sediments - upper Florida keys, Florida Bay and Biscayne Bay. Ph. D. Dissertation. Rice University, Houston, TX. 125 pp.

- Concentration of Pb, Hg, Cr, Co, and Zn have been determined in bottom sediments, the 4-μ fraction of bottom sediments, and in suspended particulates from the Upper Florida Keys/Biscayne Bay area. Highest concentrations are found in the 4-μ and suspended fraction and may be related to more surface area being provided by fine particulates for adsorption/absorption of toxic metals. Organics associated with fine particulates also allow additional toxic metals, especially Hg, to be chelated or taken up in organic combinations. Toxic metal concentrations in suspended versus 4-μm fractions are similar as are their particle assemblages indicating the possible existence of chemical and physical equilibrium conditions between these fractions. Such equilibrium conditions could be disrupted by increased wave and/or current conditions which would place large volumes or bottom-derived material (4 μ to 20 μ) into suspension with associated toxic metals. A great potential exists during high winds for dispersal of this mobile fraction of bottom sediments concentrated in toxic metals to areas of low concentration. Because lagoonal environments contain large amounts of fine material, this process could take place to a greater extent. Even under normal wind conditions (~5 kts), two to three times as much fine material is in suspension in bay areas as compared to the reef tract areas. The mineralogy/chemistry of finer particles may play a role in toxic metal concentrations and distribution. In Biscayne Bay, which is mainly a sand-size quartz environment, high metal concentrations were predicted but low values were obtained. Immediately outside the quartz environment (i.e., on the reef tract) where $CaCO_3$ dominates, sediments high in concentrations of toxic metals were recorded. Such a discrepancy may be caused by calcium carbonate particles allowing toxic metals to be absorbed into the carbonate structure, where as the SiO_2 structure does not permit such substitution. Other reasons for low concentration of these metals in Biscayne Bay may be caused by the lack of fine particulates in this dominantly sand-size quartz environment for adsorption or absorption of metals, or perhaps most of these metals originate from outside the Bay. In general, toxic metal concentration in the study area can be correlated with areas of dense population with associated high automobile and boat traffic and improperly monitored and maintained sewage disposal systems. In addition, the Turkey Point nuclear/fossil fuel power plant may be linked with some metal concentrations. Pollutants (sewage and toxic metals) introduced in northern portions of the study area are able to move southward toward less populated areas by means of longshore drift and counter-currents present at the shelf margin. Highest toxic metal concentrations come from sediments receiving effluent from a storm sewer system in Tavernier Key, a marina on Key Largo, and a lagoonal area in Florida Bay. The latter two locations should be expected to yield high toxic metal concentrations because they are restricted basins in populated areas where these metals could accumulate. Metal concentrations are also noted near the Turkey Point generating facility for Hg, Zn, Cr, and Co. Build up of toxic metals in the outer reef tract area can be correlated with adjacent regions of maximum population and development. Carbon-12 enrichment in outer reef corals may indicate that sewage, which also carries toxic metals, is reaching the reef environment in the study area. It is considered that concentration of Pb and Hg in bottom sediments is reaching sufficient levels above background in certain areas of the Upper Keys to be of environmental concern. Such areas are those proximal to sewage outfalls (i.e. Tavernier Key) and in restricted basins (i.e. Pennekamp marina). Values are also high in bottom sediments for Cr, Co, and Zn, but little research has been done on the environmental impact of these metals. Therefore, predictions cannot be made for the study area ecosystem concerning the adverse effects of these metals. A previously indicated, toxic metals are more concentrated in suspended particulates and in the 4-μ fraction of bottom sediments. The influences of such concentrations on the environment are unknown. However, adverse effects may be expected in bottom-dwelling organisms that feed on silt and clay fractions of sediments where toxic metal concentrations are high. Organisms that ingest suspended particulates including plankton in areas of elevated metal concentrations may be subject to the adverse effects of these toxins. Obvious detrimental effects of toxic metals in the study area are elusive and difficult to define. A reduction in seagrass and green algae has been reported in areas of high toxic metal concentration in this paper and by other workers. Reefs which displayed highest concentrations of toxic metals have undergone serious deterioration which may be caused primarily from influx of cold water during extreme temperature conditions during winter months and secondarily by toxic metal contamination. Such concentrations of metals may serve to forewarn of continuing toxic metal accumulation commensurate with rapid development within the study area.

1973 - 1974

Odell, D. K. (1975) Status and aspects of the life history of the bottlenose dolphin, *Tursiops truncatus*, in Florida. J. Fish. Res. Bd. Can., 32(7):1055-58.

Aerial censuses of the bottlenose dolphin, *Tursiops truncatus*, in waters of the Everglades National Park carried out every 1 - 2 months during 1973 and 1974 resulted in sightings of a minimum of five and a maximum of 79 animals. Seasonal variation in numbers apparently occurs. The survey covered Florida Bay, Whitewater Bay, the Gulf of Mexico coast within Park boundaries and western inland waters.

1973 - 1974

Schmidt, T. W. (1986) Food of young juvenile lemon sharks, *Negaprion brevirostris* (Poey), near Sandy Key, western Florida Bay. Florida Scientist, 49(1):7-9.

The food habits of the lemon shark, *Negaprion brevirostris*, were investigated by examining the stomach contents of juveniles between 58 and 100 cm in total length from shallow grass flats near Sandy Key in western Florida Bay. Sharks were obtained from monthly seine collections of fishes made at three sites in the Bay from May 1973 to June 1974. Small demersal fish, mainly *Opsanus beta* and *Lagodon rhomboides*, and the commercially important pink shrimp, *Penaeus duorarum*, were the most common dietary items of *N. brevirostris* in the coastal marine waters. Small, fast-moving pelagic fishes were also found in the shark's diet.

1973 - 1974

Schmidt, T. W. (1979) Seasonal biomass estimates of marine and estuarine fishes within the western Florida Bay portion of Everglades National Park, May 1973 to July 1974. Proc., First Conf. on Scientific Research in the National Parks, Vol. I. New Orleans, LA. November 9 -12, 1976. R. M. Linn (ed.). National Park Service Trans. and Proc. Series, 5:665-72.

Trawls were used to sample the demersal fish inhabiting channels and basins of depth in excess of 1 m while beach seines were used to sample the entire water column (<1 m) over nearshore grass beds and intertidal sand and mudflats. Sampling took place in 1973 and 1974. The objectives of these fishery investigations were established in part to provide data for the first time on the seasonal, relative abundance, and biomass of the estuarine and marine fish fauna by habitat and their relationship with various environmental parameters. The results were used to assist in the evaluation of sport and commercial fisheires resource management program within the Florida Bay portion of the Everglades National Park.

1973 - 1975

Odell, D. K. (1976) Distribution and abundance of marine mammals in south Florida: preliminary results. Biscayne Bay: Past/Present/Future. A. Thorhaug and A. Volkes (eds). Symp. No. 1, Spec. Rep. 5, Info. Serv., University of Miami, Sea Grant Program, Coral Gables, FL. 203-12.

The preliminary results of aerial surveys to study the distribution and abundance of the bottlenose dolphin (*Tursiops truncatus*) and the manatee (*Trichechus manatus*) in South Florida are reported. Light aircraft were used to survey the waters of the Everglades National Park from September 1973 through December 1975 and the waters of Biscayne Bay and vicinity from July 1974 through June 1975. Flights were made approximately every two weeks and the same flight path was followed on each flight in both the Everglades National Park and Biscayne Bay. Forty flights (100 survey hours) were completed in the Park and twenty flights (40 survey hours) in Biscayne Bay. Three hundred eighty-five (385) dolphin herds totaling 1137 individuals were counted in the Park. Sighting rate was 11.37 animals per survey hour. Herd size ranged from 1 to 25 with a mean of 2.95 animals per herd. Six dolphin herds totaling 50 individuals were seen during the Biscayne Bay surveys. Sighting rate was 1.25 animals per survey hour. Herd size ranged from 3 to 13 with a mean of 8 animals per herd. Previous data of this type is not available for either area. Possible reasons for the difference in dolphin abundance in the two are given. These include geographic differences, food distribution and abundance, and direct and indirect human-related factors. Little information is available on the natural history of the bottlenose dolphin in the survey areas and a research program is outlined. No manatees were seen on the Biscayne Bay survey transects. A total of 575 manatees was seen during the 100 survey hours in the Park (5.75 per hour). The number of manatees seen per flight ranged from 0 to 75 with a mean of 14.38 per flight. In the cases of both the dolphins and the manatees, some of the same individuals were probably seen on successive flights. Little information is available about the natural history of the manatee and the research program outline for the dolphin could apply to this animal as well.

1973 - 1976

Getter, C. D. (1976) The systematics and biology of the poeciliid fish, *Gambusia rhizophorae*, with an account of its hybridization with *Gambusia affinis*, and *Gambusia punctata*. M. S. Thesis. University of Miami., Coral Gables, FL. 129 pp.

The systematics and biology of the mangrove gambusia, *Gambusia rhizophorac* Rivas (1969) (mangrove gambusia), were studied. Particular attention was paid to its intrageneric relationships, especially with *G. punctata* and *G. affinis*, with which it shares part of its range. *G. punctata,* a closely related species, is sympatric with *G. rhizophorae* in Cuba; a possible case of hybridization between the two species is reported, and the species status of *G. rhizophorae* reaffirmed. Coloration in life is described. *G. rhizophorae* is a tropical species with a distjunct range, which is native to marine and brackish waters of southeast Florida and northwest Cuba. It is typically a resident of sheltered mangrove areas. In Florida, the species is distributed from Fort Lauderdale, south along the mainland coast to Key Largo, throughout the Florida Keys to Key West; the Florida range appears to be correlated to the 16.7°C winter isotherm. *G. rhizophorae* appears to have differentiated from *G. punctata* in Cuba and to have been dispersed to Florida by currents. An integral part of the mangrove ecosystem, *G. rhizophorae* feeds on terrestrial insects, and is in turn fed upon by fish-eating birds and fishes. Maximum size for females is 50.8 mm SL, and 38.9 mm SL for males. Females begin to mature at about five months, becoming gravid by the eighth month. Senility begins after ten months. Few females survive over thirteen months. Males have a shorter lifespan. The species thus lives one year or less in nature. Males cease growing at maturity, which begins at 15 mm; 50% of the males mature by 28 mm. Maturity in males is seasonal, with close correlation to the percentage of gravid females. Fewer, larger mature males are present during the reproductive peak, determined by fertility indices to occur during March, April and May. From 12 to 25 mm SL, sex ratios are approximately 60:40, males to females, becoming 50:50 between 25 and 26 mm SL. The number of males then begins a steady decline with increasing size. Brood size ranged from 2 to 65 embryos with an average of 13.4. *G. rhizophorae* becomes sexually inactive in late summer until the end of winter, followed by a three-month spring reproductive peak. A specialized courtship occurs before copulation which closely resembles that described for *G. punctata*. Hybridization with *G. affinis* is demonstrated to occur naturally in Florida, and the nature of this cross was examined. Fertile hybrids were described between these two subgenerically distinct species, and implications discussed in terms of the speciation and systematics of *Gambusia*. This study was based on collections made by various scientists over a period of decades. The specimens from Florida bay were collected from 1973 to 1976.

1973 - 1976

Odell, D. K. (1976) Distribution and abundance of marine mammals in the waters of Everglades National Park. Proc., First Conf. on Scientific Res. in the National Parks. R. M. Linn (ed.). Trans. and Proc. Ser. 5. US Department of the Interior, Washington, DC. 673-81.

Aerial surveys were conducted from 1973 through 1976 to assess the populations of dolphins and Manatees in waters of the Everglades National Park. Bottlenose dolphins were observed in all but one of the 48 flights. Five hundred seventy three (573) dolphin herds were sighted totaling 1651 individuals. Mean herd size was 2.88 animals. Only 56 of the dolphins were calves. This count may be low as the calves stay very close to the mother and may be difficult to observe from the air. Fifty percent of the herds were feeding. The distribution of the dolphin sightings were: Florida Bay, 11%; Whitewater Bay, 33%; Gulf of Mexico, 36%; and inland waters, 20%. Dolphins appeared to be less abundant in the Park during September, October and November. Manatees were not observed as frequently as dolphins. These animals can stay submerged for 20 min and only need to raise the tip of the nose to breathe so aerial sightings may be difficult. Three hundred two (302) manatee herds totaling 772 individuals were sighted. Mean herd size was 2.55 animals. The distribution of the manatee sightings were: Florida Bay, 1%; Whitewater Bay, 46%; Gulf of Mexico, 20%; and inland waters, 23%. The low abundance of manatees in Florida Bay may be shallow water or lack of freshwater to drink.

1973 - 1976

Schmidt, T. W. (1979) Ecological study of fishes and the water quality characteristics of Florida Bay, Everglades National Park, Florida. Final Rept. RSP-EVER N-36. South Florida Research Center, Everglades National Park, Homestead, FL. 144 pp.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] An ecological study of the fishes of Florida Bay was directed toward acquiring baseline information on their relative abundance by number and biomass, habitat types, and the effect of environmental conditions on their distribution. A total of 182,530 fishes representing 128 species and 50 families were collected throughout Florida Bay. Their total biomass was 764.9 kg. An additional 21 species were identified from supplemental observations. In general the greatest numbers and biomass of the fishes occurred during the wet season (summer and fall months) whereas the lowest numbers and biomass occurred during the dry season (winter and spring months). The greatest abundance and diversity of fishes was found in western Florida Bay followed by eastern and central Bay regions, respectively. The sampled areas of Florida Bay was found to support seagrass and macroalgal communities composed primarily of *Thalassia testudinum, Halodule wrightii*, and green algae, *Pencillus* sp. Salinity appeared to be the most important factor measured affecting fish distribution.

1973 - 1976

Schmidt, T. W. (1989) Food habits, length-weight relationships and condition factor of young great barracuda, *Syphraena barracuda* (Walbaum), from Florida Bay, Everglades National Park, Florida. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):163-70.

The food habits of the great barracuda, *Syphyraena barracuda,* were investigated by examining the stomach contents of fish between 36 and 441 mm TL from the shallow grassbeds of Florida Bay. Juvenile barracuda less than 333 mm fed on small epibenthic fish. Goldspotted killifish, *Floridichthys carpio,* and rainwater killifish, *Lucania parva,* were the most common dietary items of juvenile *S. barracuda.* Food habits of juveniles were relatively constant with season and location within the estuary. Larger food organisms were consumed by adult barracuda. The calculated length - weight relationship for 97 barracuda (33 142 mm TL) was $\log_{10}W = -5.0148 + 2.8663 \log_{10}L$, and the mean condition factor was 0.497. This study was based on 106 specimens collected during ichthyofaunal surveys from 1973 to 1976.

1973 - 1976, 1982 - 1985

Rutherford, E. S., T. W. Schmidt, and J. T. Tilmant (1986) Early life history of spotted seatrout, red drum, gray snapper, and snook in Everglades National Park, Florida. Rep. 86/07. South Florida Research Center, Everglades National Park, Homestead, FL. 99 pp.

We present results of recent studies on distribution, habitat, and relative abundance of larvae and juveniles of the four most popular gamefish species in Everglades National Park, (spotted seatrout, red drum, gray snapper, snook). The National Park Service and NOAA/NMFS personnel sampled larvae from 1982 to 1985 in passes and creeks bordering the park and sampled juveniles from 1973 to 1976 and from 1982 to 1985 in mangrove creeks, channels, shorelines, banks, basins, and bays. We collected larvae of spotted seatrout and red drum and juveniles of four species. Spotted seatrout were found to spawn in park waters, predominantly in western Florida Bay. We caught spotted seatrout larvae in mesohaline and marine salinities during every month but January with peaks in June to September. Catches (larvae 100 m^{-3}) varied by station and year but approximated those taken 20 yrs ago. We collected juvenile spotted seatrout in euryhaline seagrass beds of mixed species composition (*Thalassia testudinum, Halodule wrightii,* and *Syringodium filiforme*). Juveniles were most abundant in western Florida Bay mixed species seagrass beds of 1,000-4,000 shoots m^{-2}, where the percent organic matter and density and biomass of *S. filiforme* were higher than in areas without spotted seatrout. Red drum and gray snapper were found to spawn outside of park waters. Red drum entered the park from September to January as larvae and inhabited shallow brackish waters near mangrove shorelines and in creeks. Larval drum catches were lower than those taken 20 yrs ago. Gray snapper entered park waters as post larvae and small juveniles, inhabiting euryhaline seagrass beds in banks, basins and channels, and mangrove roots. Juvenile gray snapper were most abundant in Florida Bay mixed seagrass beds with 1,000 - 4,000 shoots m^{-2} of higher densities and biomass *Halodule wrightii* and *Syringodium filiforme* than other areas sampled. Adult spawning areas and habitat of young snook remain unknown as few young-of-year were collected. Juvenile snook 1 - 2 yrs old were present in euryhaline mangrove shorelines and creeks. We estimated monthly mortality rates of juvenile spotted seatrout 16 - 144 SL (A = 34.7%) and juvenile gray snapper 72 - 116 mm SL (A = 39.5%) using catch curve analysis.

1973 - 1976, 1982 - 1985

Rutherford, E. S., T. W. Schmidt, and J. T. Tilmant (1989) Early life history of spotted seatrout (*Cynoscion nebulosus*) and gray snapper (*Lutjanus griseus*) in Florida Bay, Everglades National Park, Florida. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):49-64.

This report describes information on distribution, habitat, and relative abundance of spotted seatrout and gray snapper in Florida Bay. Larvae were sampled from 1982 to 1984 in channels, passes and creeks bordering Florida Bay and juveniles were sampled from 1973 to 1976 and from 1982 to 1985 in mangrove creeks, channels, shorelines, banks, basins, and bays. Spotted seatrout were found to spawn predominantly in western Florida Bay. Spotted seatrout larvae were caught in marine salinities during every month but October and January with peaks in June to September. Juvenile spotted seatrout were collected mainly in mixed species of seagrass beds *(Thalassia testudinum. Halodule wrightii,* and *Syringodium filiforme).* Juveniles were most abundant in western Florida Bay mixed species seagrass beds of 1,000 - 4,000 shoots m^{-2}, where the percent organic matter and density and biomass of *S. filiforme* were higher than in areas without spotted seatrout. Gray snapper spawn outside of park waters. They enter Florida Bay as post larvae and small juveniles, inhabiting seagrass beds in banks, basins and channels, and mangrove prop roots. Juvenile gray snapper were most abundant in Florida Bay mixed species seagrass beds of higher densities of *Halodule* and *Syringodium* than other areas sampled. Monthly mortality rates of juvenile spotted seatrout 16 - 144 mm SL (A = 34.7%) and juvenile gray snapper 72 - 116 mm SL (A = 39.5%) were estimated using catch curve analysis of length frequencies.

1973 - 1980

Getter, C. D. (1981) Ecology and survival of the key silverside, *Menidia conchorum*, an antherinid fish endemic to the Florida Keys. Ph.D. Dissertation, University of Miami, Coral Gables, FL. 405 pp.

The key silverside, *Menidia conchorum*, was studied as an indicator of adaptations to environmental conditions in lagoonal and ponded water habitats of Florida Bay and the lower Florida Keys. Evidence is presented to support the current view of ichthyologists that *M. conchorum* is a valid species. It occurs in lagoons from Grassy Key to Key West. This lagoonal habitat is shared by a distinct community. Such lagoons are characterized by rapid fluctuations and broad ranges of physico-chemical parameters. *M. conchorum* feeds on planktonic crustaceans and terrestrial insects. Maximum size for females is about 58 mm (SL) and 50.1 mm for males. Maturation appears to take place at about 40 mm. The species appears to live one year or less in nature. Reproduction continues year-round with peaks in fertility in the spring and fall. Its population size is seasonal, with a low point in late summer and fall. Nearly all populations inhabit lagoons altered by man and the species is judged as threatened with extinction.

1973 - 1980

Getter, C. D. (1982) Temperature limitations to the distribution of mangrove mosquitofish in Florida. Fla. Sci., 45:196-200.

An extensive survey of southern Florida revealed a limited, coastal distribution of the mangrove mosquitofish (*Gambusia rhizophorae*). However, discovery of the species in collections from Cuban freshwaters indicates that it is not salinity-limited. Laboratory studies determined the low-temperature tolerance of the species to be 17°C. The winter, low-temperature isotherm for southern Florida at this temperature intersects all furthest-known points north and west of the species distribution. Temperature limitations to distribution may be controlled by fertility which, for the mangrove, mosquitofish, is known to be correlated with temperature. This study was based on an extensive field survey conducted from 1973 to 1980.

1974

DeFelice, D. R. (1975) Model studies of epiphytic diatoms of upper Florida Bay and associated sounds. M.S. Thesis, Duke University. Durham, NC. 193 pp.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] The diatom flora of northeastern Florida Bay and adjoining sounds, primarily within the boundaries of Everglades National Park, was modeled using factor-vector analysis and species diversity indices. Of the four distinct floras identified, two were epipelic floras inhabitating the carbonate mud substratum. One hundred and sixty-two species were identified from 30 stations, 34 of which were restricted to the epiphytic habitat and 18 species were limited to the epipelic habitat. It was found that the epipelic flora was significantly more diverse than the epiphytic flora and the diversity of floras of both habitats increased away from land areas. Factors affecting the distribution of both floral types are hypothesized.

1974

DeFelice, D. R., and G. W. Lynts (1978) Benthic marine diatom associations: upper Florida Bay (Florida) and associated sounds. J. Phycol., 14(1):25-33.

Models of the diatom associations found in upper Florida Bay and adjoining sounds have been constructed utilizing Q modal factor-vector analysis and ecologic diversity indices (Shannon index, number of species, eveness). Four distinct associations were defined using Q-mode factor-vector analysis. Two associations were epiphytic, occurring on *Thalassia testudinum* König: Association I was characterized by *Cocconeis placentula* (Ehr.); and Association III by *Cylindrotheca closterium* (Ehr.) Reim & Lewin and *Cocconeis placentula* Ehr. The other two associations were epipelic, occurring on the carbonate mud substratum: Association II was characterized by *Cyclotella striata* (Kütz.) Grun., *Rhopalodia gibberula* (Ehr.) O. Müller and *Surirella fastuosa* (Ehr.) Kütz.; and Association IV by *Fragilaria crotonensis* Kitton and *Cyclotella striata* (Kütz.) Grun. The majority of the 161 species identified were present in both the epiphytic and epipelic assemblages. Only 33 species were restricted to the epiphyton and 18 species restricted to the epipelon. The epipelic assemblage was significantly more diverse than was the epiphytic assemblage. A general trend of increased diversity away from terrestrial environs toward more open areas of water in both the epipelon and epiphyton was also found.

1974 ◊

DuBar, J. R. (1974) Summary of the Neogene stratigraphy of southern Florida. Post-Miocene Stratigraphy, Central and Southern Atlantic Coastal Plain. R. Q. Oaks and J. R. DuBar (eds.). Utah University Press, Logan, UT. 206-65.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] This report summarizes the present status of Neogene (post-Oligocene) stratigraphic studies in southern Florida. With some exceptions, general accord prevails concerning application of Neogene formational terminology; however, there exists little general agreement regarding the correlation or ages of formations. Diversity of opinion is partly a by-product of inadequate stratigraphic control due to thinness and sparsity of exposures, and to a paucity of subsurface data; it is also, in part, a function of differing stratigraphic philosophies of the principal investigators. The maximum thickness of Neogene formations in southern Florida is measured in tens of feet, and collectively their thickness probably does not exceed 600 ft. The formations discussed in this report are: (1) Tamiami (upper and lower members), (2) Caloosahatchee, (3) Bermont, (4) Ft. Thompson, (5) Anastasia, (6) Miami Limestone, (7) Key Largo Limestone, and (8) Lake Flirt. "Terrace-plain formations" recognized by various authors are not discussed. With the exception of the Lake Flirt, a freshwater deposit, all the formations are predominantly of nearshore-marine origin. On the basis of stratigraphic relationships, radiometric dating, paleoecological analyses, and comparative faunal studies the following age assignments have been made: (1) Lower Tamiami (medial Miocene to medial Pliocene); (2) Upper Tamiami (medial to late Pliocene); (3) Caloosahatchee (early to medial Pleistocene, 400,000 yrs BP); (4) Bermont (medial Pleistocene); (5) Ft. Thompson (late Pleistocene, 120,000 to 140,000 yrs BP); (6) Anastasia (late Pleistocene); (7) Miami Limestone (late Pleistocene, 120,000 to 130,000 yrs BP); (8) Key Largo Limestone (late Pleistocene, 95,000 yrs BP); and (9) Lake Flirt (Wisconsin, 7000 to 21,000 yrs BP).

1974 ◊

Gentry, R. C. (1974) Hurricanes in South Florida. Environments of South Florida: Present and Past. Memoir 2. P. J. Gleason (ed.). Miami Geological Society, Coral Gables, FL. 73-80.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Hurricanes or tropical storms have struck South Florida half of the years during the past century and the frequency of hurricanes is greater in South Florida than in any other place in the United States. The winds and the storm surge of the hurricane do great damage to property, to trees, other plants and to the coasts of the area as well as cause much loss of life. The rains can bring either much needed water or unwelcome floods depending on the circumstance. This section discusses the frequency of hurricanes, damaging forces of the storms, and a few of the famous hurricanes that have ravaged South Florida.

1974 ◊.

Gleason, P. J., A. D. Cohen, H. K. Brooks, P. Stone, R. Goodrick, W. G. Smith, and W. Spackman (1974) The environmental significance of Holocene sediments from the Everglades and saline tidal plain. Environments of South Florida: Present and Past. Memoir 2. P. J. Gleason (ed.). Miami Geological Society, Coral Gables, FL. 287-341.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The distribution, age, composition, rates of deposition, and depositional environments of macroscopically identifiable organic and inorganic Holocene sediments of interior and marginal areas of South Florida are reviewed and discussed. Four topics are selectively treated: 1) Tree island formation and the petrographically-determined peat stratigraphy of three hammocks in the northern Everglades; 2) Sedimentation changes which have occurred in the peats and with respect to freshwater calcitic muds within Taylor Slough; 3) Transgression and regression of the sea along segments of the South Florida coast; and 4) Evidence for climatic change in South Florida during the Holocene.

1974 ◊

Hoffmeister, J. E. (1974) Land from the Sea. University of Miami Press, Coral Gables, FL. 143 pp.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] This citation is a review of the geologic history of South Florida including Florida Bay.

1974 ◊

O'Brien, N. R., K. Tompkins, and S. Bryson (1974) Clues in recent carbonate sediment and limestone revealed by electron microscopy. Earth Sci. 27(4):217-21.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] This paper describes the use of electron microscopy in the study of carbonate sediments including those of Florida Bay.

1974 ◊

Parker, G. (1974) Hydrology of the pre-drainage system of the Everglades in Southern Florida. Environments of South Florida: Present and Past II. P. J. Gleason (ed.). Miami Geological Society, Coral Gables, FL. 22-7.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The Everglades, covering an area of about 3,900 square mi, is the lower segment of a large naturally integrated drainage system of about 9,000 square miles. Lake Okeechobee occupies a 730 square mi basin with its floor at sea level almost in the middle of this system. In pre-drainage days as now, drainage began in the northern-most part of the Kissimmee River basin, near Orlando, and flowed southeast into the lake. During these pre-drainage times, most of the KLOE (Kissimmee - Lake Okeechobee - Everglades) drainage system was inundated much of the time and during flood periods when the Lake's level rose to heights of about 14.6 ft MSL (mean sea level), two separate segments of the Lake's southern shore, totaling about 19 mi, overflowed into the Everglades. When lake levels reached about 18 ft MSL, the entire southern shore for a length of about 32 mi poured a sheet flood into the upper glades. Sheet flow continued from there on south to the Bay of Florida with notable discharge to the Atlantic Ocean through such streams as New and Miami Rivers, and through transverse glades across the coastal ridge. During extended droughts, the sawgrass plains dried out and at times fierce fires swept the glades burning the muck and peat down to the lowered water table. Buried ash layers incorporated into the body of the peat deposits give mute testimony to these prehistoric fires and the severe droughts that allowed them to burn the dried-out peat.

1974 ◊

Stephens, J. C. (1974) Subsidence of organic soils in the Florida Everglades - a review and update. Environments of South Florida: Present and Past. Memoir 2. P. J. Gleason (ed.). Miami Geological Society, Coral Gables, FL. 352-361.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The Everglades contains the largest single tract of organic soils in the world, over 3,100 square miles. Formed under marshy conditions, they subsided when drained by compaction, biochemical oxidation or burning. Biochemical oxidation has accounted for approximately two-thirds of the total loss of the arable soils in the Everglades. Subsidence has had serious environmental effects on agriculture, water supplies, and wildlife. Flooding the land in Conservation Areas will halt subsidence, and losses on arable lands can be ameliorated by maintaining water tables as high as feasible, making productive use of drained lands as soon as possible, and increasing research.

1974 ◊

Thomas, T. M. (1974) A detailed analysis of climatological and hydrological records of South Florida with reference to man's influence upon ecosystem evolution. Environments of South Florida: Present and Past. Memoir 2. P. J. Gleason (ed.). Miami Geological Society, Coral Gables, FL. 82-122.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] An attempt has been made to summarize the historical climatological records of southern Florida south of latitude 29° N. Rainfall and temperature records were obtained for 157 stations within this region. Calculations determined that a minimum of seven years data per station was required to obtain statistically valid monthly and annual averages, but that the 10 - 15 yrs, suggested by Sass (1967) were more suitable. Using monthly and annual averages calculated for 119 station many of which dated prior to 1900, synoptic maps were constructed displaying the geographical distribution of these two climatic variables. From statistical inference, i.e. averages, standard deviations and coefficients of variation, areas with similar characteristics were isolated and reduced to a single monthly time series record varying from 50 to 70 yrs in length and analyzed for evidence of long term changes as well as cyclical behavior. This analysis suggests that no long term changes have occurred when independently considering all the Januarys, Februarys, Marches, etc. but that from a standpoint of a linear record by month, by years a bi-annual component appears as well as one in the proximity of five years. This five year component seems to be most pronounced in the area along the eastern coastal ridge, disappearing in areas west and north-west of it. The results of this analysis are considered with respect to changes in the elevation of freshwater table due to man's influence, the natural rise in sea level due to deglaciation, and the mechanism effecting changes in estuarine and near shore salinities.

1974 ◊

Wanless, H. R. (1974) Mangrove sedimentation in geologic perspective. Environments of South Florida: Present and Past. Memoir 2. P. J. Gleason (ed.). Miami Geological Society, Coral Gables, FL. 190-200.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Coastal mangrove swamps are a passive sedimentary environment, offering some resistance to erosion in which peat accumulates predominate if the area is protected from strong physical agitation and detrital sediment influx. Coastal swamps have produced transgressive, regressive, oscillating and equilibrium (non-migrating) accumulates on the South Florida and Bahama Platforms during the postglacial, Holocene, sea-level rise. The varied patterns of coastal swamp sedimentation are related to the complex pre-existing and evolving co-existing topography through its influence on wave and current patterns, detrital sediment influx and freshwater drainage. Physical and chemical attributions of mangrove swamps can strongly influence the character of adjacent sedimentary environments.

1974 - 1975

Kushlan, J. , and D. White (1977) Nesting wading bird populations in southern Florida. Fla. Sci., 40:65-72.

Wading birds, including ibises, herons, and storks, which once nested in southern Florida by the millions have decreased because of habitat destruction. A 1974 - 1975 survey located 41 colonies and 129,800 wading birds nesting in southern Florida. White ibis and cattle egret were most abundant: populations of great egrets, little blue herons, Louisiana herons and snowy egrets were lower than expected. Wading birds nested year round but individual species had more circumscribed nesting seasons which differed seasonally and between inland and coastal colonies.

1974 - 1980

Iverson, R. L., and H. F. Bittaker (1986) Seagrass distribution and abundance in eastern Gulf of Mexico coastal waters. Est. Coastal Shelf Sci., 22:577-602.

The marine angiosperms *Thalassia testudinum, Syringodium filiforme,* and *Halodule wrightii* form two of the largest reported seagrass beds along the northwest and southern coasts of Florida where they cover about 3000 square km in the Big Bend area and about 5500 square km in Florida Bay, respectively. Samples were taken from 1974 to 1980. Most of the leaf biomass in the Big Bend area and outer Florida Bay was composed of *T. testudinum* and *S. filiforme* which were distributed throughout the beds but which were more abundant in shallow depths. A short-leaved form of *Halodule wrightii* grew in monotypic stands in shallow water near the inner edges of the beds, while *Halophila decipiens* and a longer-leaved variety of *H. wrightii* grew scattered throughout the beds, in monotypic stands near the outer edges of the beds, and in deeper water outside the beds. *Halophila engelmanni* was observed scattered at various depths throughout the seagrass beds and in monospecific patches in deep water outside the northern bed. *Ruppia maritima* grew primarily in brackish water around river mouths. The cross-shelf limits of the two major seagrass beds are controlled nearshore by increased water turbidity and lower salinity around river mouths and offshore by light penetration to depths which receive 10% or more of sea surface photosynthetically active radiation. Seagrasses form large beds only along low energy reaches of the coast. The Florida Bay seagrass bed contained about twice the short-shoot density of both *T. testudinum* and *S. filiforme* for data averaged over all depths, and about four times the average short-shoot density of both species in shallow water compared with the Big Bend seagrass bed. The differences in average seagrass abundance between Florida Bay and the Big Bend area may be a consequence of the effects of greater seasonal solar radiation and water temperature fluctuations experienced by plants in the northern bed, which lies at the northern distribution limit for American Tropical seagrasses.

1975 ◊

DeFelice, D. R. (1975) Model studies of epiphytic and epipelic diatoms. Geol. Soc. Amer. Abs., 7(7):1048.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] Studies on the diatoms of northeast Florida Bay resulted in the construction of models utilizing factor-vector analysis and species diversity indices which identified four distinct floras. Two of these were epiphytic floras living on *Thalassia* which were characterized by the dominant species *Cocconeis placentula, Mastigloia crucicula, M. ovata*, and *Nitzschia closterium*. The other two were epipelic floras living on the carbonate mud substratum which were characterized by the dominant species *Cyclotella striata, Rhopalodia gibberula, Nitzschia panduriformis, Amphora actiuscula, A. coffeaiformis*, and *Fragilaria crotonensis*. The majority of the 162 diatom species were identified in both the epiphytic and epipelic floras. The epipelic flora were significantly more diverse and a general trend was found of increased diversity in both the epipelic and epiphytic habitats, away from the Everglades and the Florida Keys.

1975 ◊

Multer, H. G. (ed.). (1975) Field guide to some carbonate rock environments; Florida Keys and western Bahamas. Contrib. No. 40. Dept. of Earth Science, Fairleigh Dickinson University, Madison, NJ. 175 pp.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] This is a field guide to the carbonate environments of the Florida Keys and the Bahamas Bank. Aereal and underwater photographs are included in the citation.

1975 - 1979

Davis, G. E., and J. W. Dodrill (1980) Marine parks and sanctuaries for spiny lobster fisheries management. Proc. Gulf Carib. Fish. Inst., 32:194-207.

[ABSTRACT IN SPANISH. SUMMARY PAPER BASED ON PREVIOUS STUDIES.] Los parques maritimos podrían proveer servicios valiosos para los científicos y administradores pesqueros si estuvieran libres de los impactos de la captura. Los estudios de la langosta espinosa en cuatro parques nacionales de los Estados Unidos se utilizan para describir beneficios potenciales por repoblacion, conservación de la variabilidad genética; proveen oportunidades educacionales, deportivas y estéticas; actúan como base para el estudio y evaluacion de programas de administracion; y proveen poblaciones vírgenes para los estimados de la producción sostenida. En la Florida, tres parques nacionales contienen amplios recursos de langosta espinosa principalmente *Panulirus argus.* El Monumento Nacional Fort Jefferson en las Dry Tortugas cubre 190 km^2 de arrecifes de corales y placeres de grama marina que mantienen langostas espinosas adultas y juveniles. El Monumento Nacional Biscayne, al sur de Miami en la parte norte de los cayos de la Florida, incluye 190 km^2 de laguna tropical en el sur de la Bahía Biscayne y 200 km^2 de arrecifes de corales y placeres al este de los cayos. Juveniles de langosta espinosa ocupan cerca de 1,000 km^2 de grama marina y del fondo dominado por octocorales en la Bahía de la Florida dentro del Parque Nacional de los Everglades. En el Parque Nacional de las Islas Virgenes, cerca de 230 km^2 de arrecifes de coral costeros y de bahías costeras alrededor de la isla St. John, mantienen langostas espinosas adultas y juveniles. Las observaciones de mas de 15,000 ejemplares de *P. argus* marcados en las poblaciones de estos parques, están resumidos para proveer información del desarrollo, mortalidad, reproduccion y movimiento. Los factores que se encontraron afectaban más el desarrollo, fueron las estaciones y daños a los juveniles, y el sexo de los adultos. Las poblaciones vírgenes proporcionaron estimados directos de mortalidad natural. El tamaño de la madurez primaria en las problaciones vírgenes fué mayor que en las poblaciones mas explotadas. Juveniles de *P. argus* demostraron movimientos direccionales extensivo hasta de 200 km, mientras los adultos demostraron movimientos restringidos por aproximadamente dos años. Las devoluciones de las placas de identificación durante la temporada de 1977 - 1978 en la Florida se dividieron igualmente entre pescadores deportivos (49%) y comerciales (51%). Sin embargo, las devoluciones de las placas de identificación que fueron situadas directamente en las nasas o trampas comerciales demostraron que solamente 11% de las placas de identificación en las nasas fueron reportadas. Estas devoluciones demuestran que la captura deportiva fue 9% del total en la parte norte de los cayos de la Florida si todas la placas fueron reportadas. El escape promedio de la langosta de nasas no recobradas fué de 1.2% diario durente los 14 dias de caladas.

1975 - 1988

Halley, R. B., P. K. Swart, R. E. Dodge, and J. H. Hudson (1994) Decade-scale trend in seawater salinity revealed through $\delta^{18}O$ analysis of *Montastraea annularis* annual growth bands. Bull. Mar. Sci., 54(3):670-8.

Stable oxygen isotope ratios ($\delta^{18}O$) of coral skeletons are influenced by ambient water temperature and by the oxygen isotope ratio in the surrounding seawater, which. in turn, is linked to evaporation (salinity) and precipitation. To investigate this relationship more thoroughly, we collected hourly temperature data from the Hens and Chickens Reef in the Florida Keys between 1975 and 1988 and compared them to the $\delta^{18}O$ of *Montastraea annularis* skeleton that grew during the same interval. To ensure that we obtained the correct oxygen isotopic range in the skeleton we typically sampled the coral at a resolution of 20 - 30 samples in one year; in one year we sampled the coral at a resolution of 70 samples yr^{-1}. Despite our high-resolution sampling, we were unable to obtain the full temperature-induced $\delta^{18}O$ range in the skeleton. Our data suggest that, during the summer, evaporation causes isotopic enrichment in the water, partially masking the temperature-induced signal. Our data also show that oxygen isotopic composition of seawater at the reef has increased since 1981. This increase indicates that salinity has increased slightly during the past decade, perhaps as a result of increased evaporation in waters of Florida Bay and the Keys. This phenomenon is probably not caused by a decrease in the outflow of freshwater into Florida Bay from the Everglades but may be related to the measured deficit in precipitation that has occurred over the past decade.

1976

Halley, R. B., and R. P. Steinen (1979) Ground water observations on small carbonate islands in southern Florida. Guide to Sedimentation for the Dry Tortugas. R. B. Halley (compiler). Southeastern Geol. Soc. Publ. 21. 82-9.

The ground water of Loggerhead and Cluett Key differs significantly from surrounding seawater despite the relatively small size (a few hundred m) of these islands. Climate alone does not determine the character of these ground waters; for example, Loggerhead Key is underlain by less saline ground water than Cluett Key despite the fact that it receives less rainfall. Ground water under small islands such as these is formed from a complex variety of variables that affect the hydrology of the islands. These variables include topography, sediment character, vegetation, and many more parameters that are themselves interrelated. They conspire to form island ground water that not only differs from seawater but also can react with the island sediments to change the character of ground water. In this manner, island ground waters serve as geologic agents, hastening the alteration of marine carbonate sediments to limestone and dolomite. This study was done in 1976.

1976 ◊

Hovorka, S. D., P. E. Luttrell, and T. D. Murphy (1976) Facies relationships and depositional history of south Florida carbonate mud banks. Geol. Soc. Amer. Abs., 8:23-24.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Interior Florida Bay consists of shallow 1-3 m deep semicircular basins separated by a network of elongate shoals (banks). Low mangrove islands (keys) are developed along the bank crests. Geometry of Holocene carbonate sediments is based on data from probes and cores taken along profiles across several banks and keys. Comparison with surficial sediment characteristics permits recognition of facies in the cores. Facies relationships have been used to interpret depositional history and evolution of the banks and their associated keys. Mangrove peats developed on the irregular Pleistocene surface during post-Pleistocene sea level rise. As flooding continued subtidal *Thalassia* meadows became established on minor topographic highs. The dense grass trapped carbonate muds resulting in vertical accretion and development of the bank system variations in intertidal facies are associated with bank crests. Where tidal circulation is adequate and salinities are near normal marine the branching finger coral *Porites divaricata* forms dense mats. These corals are absent in the bay interior where salinities are lower and more variable. In these areas, mangrove seedlings become established along bank crests contributing to island development. Island margins may be characterized by shell berms and mangrove peats. Island interiors have marshes developed on supertidal storm washovers and shallow central ponds. These ephemeral ponds are filled with muds and have thin surficial blue-green algal mats. Facies evolution of Florida Bay banks provides an excellent model for shallow, low energy, humid climate carbonate platform sedimentation.

1976

Layman, J. W. (1977) Acid insoluble residues of the carbonate sediments of Northwest Florida Bay, South Florida. M. S. Thesis. University of Toledo, Toledo, OH. 78 pp.

Sixty-seven surface grab and core samples, collected from the carbonate sediment forming environment of northwest Florida Bay, were analyzed to determine the amounts, composition, textures and sedimentation patterns of acid insoluble residues. The characteristics of the acid insoluble residues and their sedimentation patterns were then related to ten depositional sub-environments which were determined and classified according to what are believed to be the dominant physical environmental controls: depth of water, tidal current activity and exposure to wave action. The tidal channels were divided into the outer, central and inner sub-environments. The mud banks were divided into the outer, Middle Ground, central and inner sub-environments, and the mainland shore face was divided into the Gulf exposed, outer and central sub-environments. The weighted average amounts of acid insoluble residue coarser than 8.0 ϕ ranged from 1.5% on the Gulf exposed shore face to 9.5% on the Middle Ground banks. The amount of sand-sized acid insoluble residue decreased eastward from 2.3% on the higher energy Middle Ground banks, which are exposed to the Gulf of Mexico, to 0.8% in the lower energy inner tidal channel sub-environment of Florida Bay. Silt-sized acid insoluble residues were highest on the banks and averaged approximately 5.5% for the outer, central and inner banks. The Middle Ground banks contained 7.2% silt-sized acid insoluble residue. Quartz was the dominant constituent of the acid insoluble residues and ranged in size from 0.0 to 8.0 ϕ. Sponge spicules occurred as whole and fragmented megascleres and microscleres and ranged in size from 1.5 ϕ (350 μm) to 8.0 ϕ (4 μm) long. Radiolaria were present in minor amounts and ranged in size from approximately 3.0 to 6.0 ϕ. Quartz is transported from, the north, along the Gulf of Mexico nearshore zone and Cape Sable beaches, into northwest Florida Bay by longshore and flood tidal currents. Transport of quartz and other acid insoluble residue within the study area is primarily by tidal currents of which ebb tidal currents are more dominant. Sponge spicules and radiolaria are derived primarily from within the study area. However, some spicules and radiolaria could be derived from outside the study area and transported into the area by flood tidal currents from the west and ebb tidal currents from the east and southeast. A minor source of quartz, sponge spicules and radiolaria may be the Miami Oolite which forms the bedrock of Florida Bay. Sampling from Flamingo to East Cape Sable took place in 1976.

1976 ◊

McPherson, B. F., G. Y. Hendrix, H. Klein, and H. M. Tyus (1976) The environment of south Florida, a summary report. Geol. Surv. Prof. Pap. 1011. 81 pp.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] After 1900 men came in increasing numbers to south Florida and began extensive modification of the vast wilderness of swamps, forests, marshes, prairies, and bays. The original south Florida ecosystem that evolved over thousands of years gave way to a new three-part ecosystem which incorporated an agricultural component, an urban component, and a component of the original ecosystem that is largely undeveloped but still has been affected by man. These components are interrelated through the flow of energy and resources. The remaining natural component of the south Florida ecosystem includes freshwater and terrestrial systems such as ponds and sloughs, sawgrass marshes, wet prairies, hammock forests, bay heads, cypress forests, pine forests, mixed swamp forests, and dry prairies; and coastal systems such as bays, coral reefs, mangroves and saline marshes, and beaches and dunes. Fire, tropical storms, frost and cold weather, saltwater intrusion, and man also affect systems. Freshwater is a key environmental factor in that it not only affects a system directly but that it also affects other controlling environmental factors such as fire, soil, temperature, and saltwater intrusion. The coastal systems of south Florida are dependent on currents, tides, waves, and in most cases freshwater runoff to circulate and transport salts, nutrients, and other essential products. Freshwater runoff also dilutes seawater. Mangrove forests usually grow where freshwater runoff is greatest and salinity is seasonally reduced, whereas coral reefs occur in areas of little or no runoff and normal seawater salinity. In estuaries and bays, salinity varies during the year depending on the amount of runoff and evaporation, and is a major controlling factor on the distribution of organisms. The coastal systems are also affected by other environmental factors such as cold weather, water turbidity, and tropical storms. Tropical storms often alter coastal systems and are the major natural force that changes the distribution of mangrove forests. Juveniles of many marine species derive food and protection in estuaries and bays and thus require these habitats to complete their life cycles. Man has been altering the ecosystem of south Florida extensively for 70 yrs. Wetlands originally occupied about 75% of south Florida, but through the years much of this land has been drained. In southeast Florida, drainage has lowered water levels as much as 1.5 to 1.8 m (5 to 6 ft) below the 1900 level and has disrupted the natural systems. Drainage reduces productive wetlands, promotes organic soil oxidation and damaging fires, and has permitted seawater intrusion in some areas of excessive water-table lowering.

1976

Odell, D. K., and E. D. Asper (1977) A summary of information derived from the recurrent mass stranding of a herd of *Pseudorca crassidens* (Cetacea: Delphinidae). Marine Mammal Stranding Workshop, Athens, GA, 10 - 12 August, 1977. 207-222.

A herd of at least 29 false killer whales (*Pseudorca crassidens*) entered shallow water on the southwest coast of Florida on 22 July 1976. One died, 4 were taken into captivity after stranding and later died, and 24 returned to sea. On July 25, a herd of 30 *Pseudorca* stranded on Loggerhead Key, Dry Tortugas, about 325 km south of the first site. At least some of the animals from the two strandings were identical based on dorsal fin photographs. One of the Loggerhead Key animals died and the rest were forced back to sea. Three were found dead near Cape Sable, Everglades National Park, on 2 August. Twenty skeletons were recovered in the same area on August 28. Cape Sable is about 190 km ENE of the Dry . These animals were probably the same animals that were forced off Loggerhead Key. Body measurements, organ weights and reproductive data were collected from 6 animals that were necropsied. Blood data from 34 animals indicate stress but were, in general, comparable to normal values for other small cetaceans. The cause(s) of the strandings were not determined.

1976 ◊

Smith, W. G., and H. H. Roberts (1976) Coastal change at Cape Sable, Monroe County, Florida. Louisiana State University Coastal Studies Institute.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] A report on shoreline change in the Everglades National Park indicates that the three points of Cape Sable are littoral accumulative forms of successively accumulated beach ridges consisting of predominantly molluscan shell debris. According to radiocarbon analysis, these ridges have been in their present position 1200 - 2000 yrs. Results reveal that older phases of coastal change exist inland from the three capes in the form of low carbonate mud ridges similar to those found along the present Florida Bay shoreline.

1976

Videlock, S. L. (1983) The stratigraphy and sedimentation of Cluett Key, Florida Bay. M. S. Thesis. University of Connecticut, Storrs, CT. 161 pp.

Cluett Key began developing very soon after sea level flooded the floor of Florida Bay some 4000 yrs ago. The island grew from a nucleus of supratidal sediment. Sediment accumulation was rapid in the west and northwest and slower in the east and southeast. Deposition has been fairly continuous since the island began. Cluett Key may still be accreting (migrating?) to the southeast today. Sediments of Cluett Key are composed largely of unstable phases of calcium carbonate, aragonite and magnesium calcite. The stable phases, calcite and dolomite, are responsible, on an average, for less than 15% of the mineralogic composition. This suggests that under present Florida Bay environmental conditions aragonite and magnesium calcite are "stable." The mineralogic composition of offshore sediments differs from that of onshore sediments. Offshore sediments contain a greater amount of aragonite and almost no dolomite. This could be due to either differences in the fauna and flora between the two locations and/or diagenetic changes that may be occurring. Aragonite needles are not responsible for the bulk of lime mud sediment on Cluett Key. Sediment here is mostly molluscan and foraminiferal in origin. For the most part, magnesium calcite/calcite ratios remain fairly constant with depth. However, many cores exhibit a sudden increase in the ratio at an average depth range of 120 - 150 cm. The reason for this increase may be related to grain size. This horizon may be coarser and have a higher permeability than the surrounding sediment. Consequently, water may circulate too rapidly for diagenetic changes to take place. Fauna present in sediments taken some distance from the island is similar yet larger in size than offshore fauna located closer to Cluett Key. This may affect the grain size of the sediment at each particular location and could eventually effect diagenesis. Porosity of island cores is just slightly less than the porosity of offshore cores. Permeability increases, on Cluett Key, from the east side to the west side. Salinity values increase from west to east. Likewise, concentrations of magnesium and calcium in subsurface water increase from the west side to the east. The formation of dolomite on Cluett Key is apparently related to some island controlled processes. These exact processes have yet to be discovered. Whether dolomite is still being formed today or was formed some time in the past and has now stopped is not known. Sampling took place during 1976.

1976 ◊

Woelkerling, W. J. (1976) South Florida benthic marine algae. Sedimenta V. Comparative Sedimentology Laboratory, University of Miami, Coral Gables, FL.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] This paper provides illustrated keys to the genera of green, brown, and red algae and to the genera and species of blue-green algae commonly found in marine benthic communities of Florida with emphasis on those forms found in the Florida Bay portion. A glossary of morphological terms used in the keys, the literature pertaining to Florida marine algae, brief comments on marine algae habitats and communities and instructions for the collection, preservation, and examination of algae material were included.

1976 ◊

Zieman, J. C. (1976) The ecological effects of physical damage from motorboats. Aquatic Bot., 2:127-39.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Observation has shown that beds of turtle grass, *Thalassia testudinum*, although highly productive, do not recover rapidly following physical disturbance of the rhizome system. In shallow waters the most common form of rhizome disturbance is from the propellers of motor boats. In turtle grass beds which are otherwise thriving, tracks resulting from propellers have been observed to persist from 2 to 5 years. The proportion of fine sediment components is reduced in the sediments from the boat tracks, and the pH and Eh are reduced in comparison to the surrounding grass bed. Damage of this type is most likely to occur in the shallow passes between islands and keys. These areas are also the slowest to recover due to the rapid tidal currents present in the shallow passes.

1976 - 1977, 1979 - 1981

Walker, N. D. (1982) Physical responses of southern Florida and northern Bahama lagoon waters to severe cold air outbreaks and effects on hermatypic coral reefs. M. S. Thesis. Louisiana State University, Baton Rouge, LA. 114 pp.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] Major mortalities of southern Florida and northern Bahama reef corals during recent winters suggest that chilled water masses may influence their development. This research was undertaken to investigate the regional extent, duration, and frequency of water mass chilling and preferential routes for offshore water movement. Temperature infrared satellite data (NOAA-5 and NOAA-6), *in situ* water temperatures from eastern Florida Bay, local meteorological data, and a numerical heat flux model were incorporated in the analyses. Study results indicated that southern Florida and northern Bahama lagoons provide less than optimal environmental conditions during winter for reef growth and development. Shallow bays of southern Florida chill below the 16°C thermal stress threshold for reef corals several times each winter. The longest observed residence time for sub-16°C water in Florida Bay was 12 days during January 1981. The present distribution of reef corals can be attributed to cold air outbreak chilling of shallow lagoon waters and their offshelf transport routes.

1976 - 1979

Thue, E. B., E. S. Rutherford, and D. G. Buker (1983) Age, growth, and mortality of the common snook, *Centropomus undecimalis*, in Everglades National Park, Florida. Rep. T-683. South Florida Research Center, Everglades National Park, Homestead, FL. 33 pp.

A study was made of age, growth and mortality of 325 snook, *Centropomus undecimalis* (Bloch), collected from sport fishermen in Everglades National Park from May 1976 through December 1979. Fish sampled ranged in length from 284 - 940 mm FL ($\bar{x}$ = 643 ± 11 mm) and in weight from 0.7 - 11.6 kg ($\bar{x}$ = 3.03 ± 0.17 kg). Females ranged in length from 464 - 940 mm ($\bar{x}$ = 680 ± 25 mm) and in weight from 1.0 - 11.6 kg ($\bar{x}$ = 3.64 ± 0.49 kg). Males ranged in length from 284 - 889 mm ($\bar{x}$ = 632 ± 14 mm) and in weight from 0.7 - 7.2 kg ($\bar{x}$ = 2.84 ± 0.18 kg). Mean lengths of fish were largest in spring and smallest in winter. There were no differences in mean length among areas of capture. Snook were aged by scale annuli. Annulus formation occurred in spring (March - May). Ages of fish were mainly four- and five-yr olds. Recruitment to the fishery began at age two and was completed by age six. The oldest fish sampled was eight years old. The overall sex ratio favored males 3/1, but the ratio decreased steadily with age. The mean age of females was significantly greater than the mean age of males. There were no differences in mean age of fish among areas of capture. Mean calculated growth of all snook was 375 mm FL in the first year and 57 - 90 mm FL thereafter. Females were significantly larger than males in calculated mean lengths at ages one through four. Calculated fish lengths at age differed among areas of capture. Fish taken from the Whitewater Bay - Coot Bay area were larger at ages one through four than fish of the same age taken from the north Florida Bay - Cape Sable area. Sexual differences in length-weight relationship were noted. Females weighed more at a given length then males. Annual mortality rate of all fully recruited fish for the period 1976 - 1979 was 78%. Female mortality was lower than male mortality. Conditional fishing mortality was twice as high as conditional natural mortality for males but was the same for females. Conditional natural mortality and exploitation ratio was higher for males than for females.

1976 - 1981

Dunson, W. A., and F. J. Mazzotti (1989) Salinity as a limiting factor in the distribution of reptiles in Florida Bay: a theory for the estuarine origin of marine snakes and turtles. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):229-44.

Salinity is hypothesized to be the major abiotic factor limiting the colonization of Florida Bay by estuarine reptiles. This premise is supported by the small number of species of reptiles found in the bay in comparison with freshwater, the distinct osmoregulatory specializations of the few estuarine specialists that occur there, and a remarkable cline in the ability to tolerate seawater found among modern-day estuarine and coastal reptiles. This latter cline in osmoregulatory abilities is believed to represent a model of the evolutionary stages through which pelagic snakes and turtles have passed in developing adaptations for life in the open sea. Florida Bay is an especially useful site for the study of such adaptations since it is the only known location in this hemisphere where three specialized estuarine reptiles are sympatric: the American crocodile *(Crocodylus acutus)*, the diamondback terrapin *(Malaclemys terrapin)*, and the mangrove snake *(Nerodia clarkii compressicauda)*. Small populations of freshwater turtles and the alligator also occur in tidal creeks along the northern shore. Recent advances in the study of turtles suggest that the single most important factor in determining tolerance to high salinity is the amount of seawater swallowed incidentally with food ingestion. This finding needs to be extended to other reptiles to test the hypothesis that fish eaters, such as snakes, that do not crush or bite chunks from their food have reduced incidental drinking. This could explain how the mangrove snake can survive in estuaries without a salt gland, whereas the sympatric terrapin possesses a sizable lachrymal salt gland. We hypothesize that the following represent major transitional stages in the gradual evolution of marine snakes and turtles from freshwater ancestors: (1) utilization of behavioral osmoregulation to avoid salinities that cannot be directly tolerated; (2) a reduction in net salt uptake and water loss and in incidental drinking of seawater while feeding; (3) the first appearance of rudimentary salt-excreting glands; (4) hypertrophy of salt glands as dictated by rates of salt uptake, in concert with the development of a specialized external morphology suited for a pelagic life.

1976 - 1982

Frohring, P. C., and J. A. Kushlan (1986) Nesting status and colony site variability of laughing gulls in southern Florida. Fla. Field Naturalist, 14(1):1-28.

Laughing gulls (*Larus atricilla*) used twenty-six nesting sites in Florida Bay, from 1976 through 1982, breeding from mid-April to August. Colony site use and nesting numbers were highly variable, and nesting success appeared to be poor. Fewer than half of the known nesting sites were used in any year. Limiting factors included flooding and food availability. We hypothesize that the southern Florida nesting population may be of relatively recent origin resulting from repeated colonization by birds from further north. It appears to be supported primarily by the availability of sanitary landfills and agricultural fields, and so may be affected as these types of land uses are scaled back in southern Florida.

1976 - 1982

Kushlan, J. A., and P. C. Frohring (1985) Decreases in the brown pelican population in southern Florida. Colonial Waterbirds, 8(2):83-95.

Since 1970, the population of the brown pelican (*Pelecanus occidentalis*) in Florida has been thought to be stable. However, one local population, in extreme southern Florida, experienced a 40% decrease from 1977 through 1981. An evaluation of the precision of the long-term statewide aerial pelican survey showed that even the complete loss of this local population would not be statistically recognizable on a statewide basis. We also found that censuses conducted in other than the month of peak nesting have a 40-60% error. We hypothesize that a decrease in food availability in Florida Bay precipitated this decrease in pelican numbers. The status of brown pelican populations has been evaluated on geopolitical rather than biological boundaries. The conservation of sensitive species requires consideration of local population trends, especially those that may represent special genetic stocks. This study was based on monthly aerial censuses conducted from 1976 to 1982.

1977 ◊

Lidz, B. H., and P. R. Rose (1989) Diagnostic foraminiferal assemblages of Florida Bay and adjacent shallow waters: a comparison. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):399-418.

[PAPER BASED ON WORK PUBLISHED IN 1977.] This paper describes foraminiferal data that distinguish Florida Bay from the nearby open-circulation platform margin and shows general trends in a foraminiferal population across a platform. Results of this study of benthic foraminifera in the Bay indicated that: the bay is a specialized restricted platform interior environment; its fauna was divisible into three subfaunas: nearshore, mudbank, and "lake"; substrate, currents, wave intensity, and wave direction affected local distribution but do not alter regional patterns; and faunal assemblages rather than individual species of foraminifera were diagnostic environmental indicators as many species range over several faunal zones. Samples were collected by hand from the upper few centimeters of bottom sediment from 46 locations selected along traverses which cross the various types of depositional environments within Florida Bay. Three traverses (39 samples) transect the Bay; and one traverse (7 samples) crosses the platform margin. Foraminifera greater than 62 µm were identified under the binocular microscope from approximately 10 cc of washed material, and their abundance was estimated. This paper was excerpted, with modifications, from an earlier publication by the authors in 1977.

1977 ◊

Mitterer, R. N., and P. W. Carter (1977) Some analytical and experimental data on organic-carbonate interaction. Proc., 3rd Internatl. Coral Reef Symp., Miami, FL. 2(Geology): 541-48.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] There are basic differences, in general, between the organic matter of carbonate and non-carbonate sediments. Analyses of sediments from the Flower Garden Reef, offshore Texas, show that the carbonate fraction is characterized by (1) coarse size, (2) less total organic matter, (3) a greater proportion of the organic matter as amino acids, and (4) a predominance of aspartic acid compared to the noncarbonate fraction. The non-carbonate fine fraction has a lesser proportion of amino acids with glycine and alanine predominant. This contrast is consistent with the suggestion that an aspartic acid-rich proteinaceous fraction plays an influential role in calcification. To further elucidate this role, soluble fulvic acid extracted from the <62 µm fraction of Florida Bay sediment was titrated with Ca solutions in the presence of pH and calcium-specific ion electrodes. The organic matter, which has an aspartic acid content of about 40%, was able to bind Ca. Additional experiments confirmed the metal binding capability of the organic matter. The characteristic occurrence of aspartic acid-rich organic matter in carbonate sediments of various types (skeletal and non-skeletal), the selective absorption of this organic matter to carbonate surfaces, ant the ability of the organic matter to bind Ca suggest that it exerts a strong influence on carbonate geochemistry in the marine environment.

1977 ◊

Perkins, R. D. (1977) Quaternary sedimentation in south Florida. Part II. Depositional framework of Pleistocene rocks in south Florida. US Geol. Surv. Mem., 147:131-97.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Detailed stratigraphic analysis of the Pleistocene of South Florida, based on 56 measured sections, indicates that these deposits are divisible into five marine units separated by regional discontinuity surfaces. Marine units are correlated with eustatic high sea-level stands and discontinuity surfaces with subaerial exposure during low stands. Criteria for recognizing discontinuity surfaces include: (1) vadose sediment, (2) land-plant root structures, (3) laminated crusts, (4) diagenetic soilstones, (5) soils and soil breccias, (6) solution surfaces, (7) bored surfaces, and (8) freshwater limestones. Discontinuity surfaces are often found to be intraformational when related to formal stratigraphic designations presently in use. The Fort Thompson and Anastasia Formations contain four such surfaces, the Key Largo Limestone contains two, and the Miami Limestone contains two. When considered in detail, discontinuity surfaces in South Florida are found to vary in the amount of time they represent and the degree to which they are developed and preserved. The five marine units recognized in this study have been informally termed from oldest to youngest, Q1 through Q5 (Q for Quaternary). Each stratigraphic unit is analyzed from the following viewpoints: (1) role of pre-unit topography, (2) isopach patterns, (3) lithofacies patterns, (4) ecologic facies patterns, and (5) interpretation of depositional environments. Pre-unit paleotopography strongly influenced isopach thicknesses and lithofacies patterns within individual Pleistocene units, although to a lesser degree upward in the section as paleotopography became more subdued. A marine embayment, occupied by the present position of Lake Okeechobee and the Florida Everglades, was bounded by topographically higher areas to the north and west. These topographic highs, mantled with older Pliocene and Miocene elastic sediments, served as sources for detritus throughout Pleistocene deposition. During Q1 deposition, quartz sandstones with admixtures of molluscan debris clearly reflect the proximity of these topographic highs. More open marine conditions persisted in the embayment between the highs where arenaceous, mollusk fragment packstones are found interbedded with fossiliferous quartz sandstones. Important faunal elements within these embayment sediments include: *Chione cancellata,* miliolids, peneroplids, *Manicina, Porites,* and *Schizoporella.* In the northeastern portion of the study area, Q1 sediments are represented by arenaceous, mollusk-fragment grainstones deposited as barrier-beach and beach-dune sediments, and fine-grained quartz sands (lagoonal sediments). Lithofacies patterns within the Q2 unit are essentially the same as those found in the Q1 unit, except that molluscan packstone increases in the northern part of the embayment to the exclusion of quartz sandstone. Generally, the fauna of the Q2 unit is similar to that of the Q1 unit. However, more open shelf conditions are suggested by scattered occurrences of the coral, *Montastrea,* along the southern margin of the study area. The proportion of carbonates to terrigenous sediments increased markedly during deposition of the Q3 unit. Arenaceous, mollusk-fragment packstone deposited in the northern portion of the embayment grades southward into foraminiferal, mollusk-fragment packstone and grainstone that are relatively free of quartz. Fossiliferous quartz sandstones persisted in proximity to the topographic highs. A highly coralline facies composed of grainstone and packstone was deposited along the southern margin of the study area and marks the first appearance of large numbers of the hermatypic corals, *Montastrea, Diploria, Porites astreoides,* and *Porites porites* in association with encrusting red algae and *Halimeda* plates. Barrier-beach and lagoonal sedimentation persisted in the northeastern portion of the study area where mollusk-fragment grainstone, quartz sand, and sandstone were deposited. The upper contact of the Q3 unit represents one of the most pronounced of all the Pleistocene discontinuity surfaces. Pre-unit topography prior to Q4 deposition was greatly subdued as a result of Q3 sedimentation, especially along the southern margin of the study area where coral growth resulted in appreciable constructional topography. Maximum relief prior to Q3 deposition was greater than 120 ft (37 m), as contrasted with approximately 30 ft (9 m) prior to Q4 deposition. During Q4 deposition, detrital influx was greatly reduced in the western part of the study area, but continued to persist in the northeastern part in the form of quartz sand and sandstone deposited as a broad, arcuate shoal. To the east of this shoal, barrier-beach and lagoonal sedimentation prevailed. Within the embayment, mollusk-fragment packstone, wackestone, and quartz sandstone grade southward into highly burrowed peneroplid, miliolid, pellet packstone and grainstone, which locally contain abundant bryozoans *(Schizoporella).* This pelletal facies grades along the southern edge of the study area into a highly coralline, red algal packstone and grainstone facies that is characterized by *Montastrea, Diploria, Porites, Halimeda,* and encrusting red algae. Paleotopography developed on the upper surface of the Q4 unit gave rise to a relatively featureless, gently seaward dipping platform on which Q5 sediments were deposited. In the northeastern part of the study area, arenaceous, mollusk fragment grainstone, fossiliferous sandstone, and fine-grained quartz sand were deposited as barrier-beach-lagoonal sediments that grade westward into quartz sandstones derived from terrigenous sediments shed off the nearby topographic high. During Q5 time, the area now occupied by Lake Okeechobee was the site of deposition of mollusk-fragment wackestone in what is believed to have been a restricted marine bay as suggested by local occurrences of *Rangia cuniata* and oysters. Southward along the present-day Atlantic coastal ridge, the barrier-beach-lagoonal complex gives way to an oolitic facies composed of arenaceous, oolith, pellet grainstone and packstone, believed to represent tidal-bar deposits. Another discrete oolitic tidal-bar belt was formed in the area now occupied by the lower Florida Keys. In contrast to the northern tidal-bar belt, these oolitic deposits are essentially quartz free and contain less mud (predominantly grainstone). In the area between the two tidal-bar belts of Q5 age, a highly coraline facies is found similar to those developed during Q3 and Q4 deposition. The environment of deposition favored for this coralline facies, as well as those of Q3 and Q4 age, is that of a migrating sand-shoal-patch-reef complex. This migrating shoal may have been initiated at a paleotopographic break in slope on the outer shelf margin and does not require a seaward barrier reef for its inception. Pelletal packstone and grainstone accumulated in sheltered water behind the sand-shoal-patch-reef complex and the oolite bars. These sediments are usually highly burrowed and contain miliolids, peneroplids and *Schizoporella.* Considered as a whole, the Pleistocene record of South Florida may be thought of as simple infilling of pre-Pleistocene paleotopography during repeated marine transgressions, modified by subaerial exposure and the production of discontinuity surfaces during low sea-level stands.

1977 ◊

Rosenfeld, J. K. (1977) Nitrogen diagenesis in nearshore anoxic sediments. Ph. D. Dissertation. Yale University, New Haven, CT. 200 pp.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Nitrogen is the limiting nutrient in the marine coastal environment and one of the major processes affecting its distribution is exchange across the sediment-water interface. Therefore, it is important to understand the chemistry of hydrogen compounds in sediments. In anoxic sediments, the most important processes of nitrogen diagenesis are the decomposition of nitrogen-containing organic compounds and the subsequent production of ammonium. Changes in the distribution and nature of ammonium and organic nitrogen occur with depth in the sediment column and the extent of the change is controlled by the geochemical environment of the sediments. In order to better understand the anoxic portion of the sedimentary nitrogen cycle, diagenetic changes have been studied in different sediment systems (clays vs. carbonates, organic-rich vs. organic poor) and in sediments of similar mineralogy, which exhibit different chemical properties (for example, different amounts of sulfate reduction). Sediment cores were taken in Long Island Sound, Florida Bay, and Pettaquamscutt River, RI, and changes in the nitrogen chemistry, of both the intertidal water and the sediment solids, were measured. Ammonium production was found to be related to sulfate production, although once all the sulfate is reduced, ammonium is still produced by other process of organic matter decomposition. In addition, in Long Island Sound sediments, nitrate reduction is generally complete by a depth of 3 cm. Organic nitrogen decreases with depth in the sediment column and is utilized preferentially relative to organic carbon. Similarly, amino acids and amino sugars are utilized preferentially during diagenesis relative to total organic nitrogen. However, the individual acidic and neutral amino acids appear to be utilized equally during this stage of organic matter decomposition. Comparison of the results from the different cores has pointed out the important role bioturbation plays in controlling the chemistry of both the interstitial water and the sediment solids. In the laboratory, the processes of ammonium and amino acid adsorption, organic matter decomposition, and ammonium diffusion in natural sediments have been studied. There appears to be a "dynamic equilibrium" between the amounts of dissolved, exchangeable, and fixed ammonium found in sediments. In Long Island Sound sediments, more than half of the ammonium produced by organic matter decomposition is adsorbed by the sediment, while the rest is dissolved in the interstitial water. The proportion of amino acids adsorbed by sediments is greater than the proportion of ammonium adsorbed and in clay sediments, the organic matter, rather than the clay minerals, is responsible for most of the ammonium and amino acid adsorption. The organic matter decomposition experiments have shown that the rates of sulfate reduction and ammonium and phosphate production decrease with decreasing temperature and increasing depth in the sediment column. The diffusion experiments confirmed that the ammonium diffusion coefficient in the fine-grained sediments is approximately twice as great as the sulfate diffusion coefficient. Stoichiometry and kinetic diagenetic models have been used to predict the C/N ratio of the decomposing organic matter, the rates of ammonium production and the loss of organic nitrogen in the sediment column. These models only utilize changes in the interstitial water chemistry and it has been shown that the values predicted by the models agree well with the values actually measured in sediment cores and laboratory experiments.

1977

Roberts, H. H., L. J. Rouse, N. D. Walker, and J. H. Hudson (1982) Cold-water stress in Florida Bay and northern Bahamas: a product of winter cold-air outbreaks. J. Sed. Petrol., 52(1):145-55.

During January 1977, three consecutive cold fronts crossed south Florida and the northern Bahamas which depressed shallow-water temperatures below the lethal limit for most reef corals. Digital thermal infrared data acquired by the NOAA-5 meteorological satellite, in situ water temperatures, and meteorological data were used to study the thermal evolution of Florida Bay and Bahama Bank waters. The third and most important frontal system depressed Florida Bay water below 16°C, a thermal stress threshold for most reef corals, for 8 days. The minimum water temperature recorded in situ was 12.6°C. Satellite data suggest that some Florida Bay coastal waters were at least 1°C cooler than water at this site. Cold-water plumes detected on satellite imagery suggests that offshelf or offbank movement of cold, dense water follows bathymetry-controlled routes. Absence of viable shelf reefs opposite tidal passes supports this contention. Coral mortality at Dry Tortugas was up to 91% during the 1977 event. Coral and fish kills were also reported from other parts of the Florida Reef Tract and northern Bahamas. Study results show that cold-water stress conditions can exist over vast shallow-water areas and have residence times of several days These observations suggest that aperiodic chilling processes have a limiting influence on reef community development throughout the Florida Reef Tract and northern Bahamas.

1977

Roberts, H. H., L. J. Rouse, and N. D. Walker (1983) Evolution of cold water-stress conditions in high-altitude reef systems: Florida Reef Tract and the Bahama Banks. Carib. J. Sci., 19(1-2):55-60.

Thermal depression of shallow bank and bay waters accompanying the passage of severe cold fronts can stress high latitude coral reef systems, such as those of the Florida Reef Tract and northern Bahama Banks. Laboratory and field experiments suggest that sustained temperatures below 16°C are detrimental to most reef-building corals. Time-series satellite imagery provides a data base for assessing the thermal variability of waters interfacing with reef systems. Digital thermal infrared data acquired by the NOAA-5 meteorological satellite were used to study thermal evolution of Florida Bay and Bahama Bank waters during a succession of three cold-air outbreaks (January 1977). Effects from the third and most important of these frontal systems persisted from 19 to 26 January. Northerly winds (to 15 m s^{-1}) accompanied by cold, dry air caused extreme losses of sensible and latent heat from these shallow waters of limited heat capacity. As a result of this process, Florida Bay, Little Bahama Bank, and Great Bahama Bank experienced water temperatures blow 16°C for 5 days. Florida Bay waters reached a temperature minimum of 12.9°C, as determined from satellite data and confirmed by *in situ* field measurements. Water temperatures in the Bay remained under the 16°C lethal limit for corals for 8 days. At Dry Tortugas 91% of the shallow

Acropora cervicornis community was reported killed during this abnormally cold event. These studies indicate that the temperature of subtropical bank and Bay waters is subjected to depression below 16°C accompanying the outbreak of unusually cold air. This superchilled water can have a residence time of days. The cooling process creates water masses that are out of density equilibrium with warmer ocean water. Offshelf movement of the cold, dense water occurs at particular sites, as shown by time-series satellite data. The absence of coral reefs opposite tidal passes in the Florida Keys is attributed to this process, which has probably limited development of the entire reef tract.

1977 ◊

Roberts, H. H., T. Whelan, and W. G. Smith (1977) Holocene sedimentation at Cape Sable, South Florida. Sedimentary Petrol., 18:25-60.

A regionally distinct mosaic of sedimentary environments including beaches and beach ridges which formed under relatively high-energy conditions through low energy, tide-dominated environments to quiescent inland lakes and ponds, exists at Cape Sable, south Florida. Environments of deposition from the sandy capes inland are: (1) shell beaches and beach ridges; (2) black mangrove mudflats; (3) ponded mudflats; (4) exposed mudflats; (5) Lake Ingraham; (6) coastal levees and supratidal plain; and (7) ephemeral ponds. With exception of the beaches and beach ridges, sediments of the other environments are dominantly calcareous muds and silts and represent a depositional history related to frequency of tidal inundation and storms. Of the three capes exposed roughly from northwest to southeast at Cape Sable, radiocarbon dating shows that Northwest Cape formed in the present position or possibly migrated to it 1980 ± 100 years BP, while Middle Cape and East Cape data from 1610 ± 100 BP and 1230 ± 95 years BP. Relict shorelines features, coastal levees, on the supratidal plain indicate an episode of coastal progradation which started 2280 ± 100 years BP and apparently ended about 1560 ± 80 years BP. The entire column of Holocene carbonate sediments in the cape area rests on a thin, intermittent basal peat which dates 4950 ± 120 years BP. Cores through the supratidal plain reveal a basal carbonate-mud sequence much like subtidal sediments of modern Florida Bay. This unit has a typical marine carbonate mineral suite, numerous shallow-marine mollusks, and an abundance of *Thalassia* root burrows. An intermediate unit characterized by marine-brackish carbonate sediments with algal laminations is overlain by massive aragonitic supratidal silts and silty clays. The entire sequence is capped by a dark, highly organic zone representative of the coastal levee and intervening algal-flat sediments. Trace quantities of dolomite and substantial amounts of low-Mg calcite found throughout the cores are considered to be of detrital origin. Localized surface concentrations of dolomite associated with the coastal levees may have a mixed in-situ and detrital origin. Investigation of the extractable organic matter in the intertidal facies of cores through the three prominent coastal levees indicates that diagenesis of organic matter has systematically occurred from the youngest to the oldest levee. Fatty alcohols and total hydrocarbons increase with time while fatty acids decrease. Partial decarboxylation and chemical reduction of fatty acids can occur within the time interval of 750 yrs between the oldest and youngest coastal levees. Geochemistry of interstitial water from the supratidal-plain cores indicated a general increase in chlorinity from the youngest to the oldest coastal levee. Chlorinity levels drop at the base of all three cores analyzed which may be related to fresher ground water influence from the Miami limestone. Ratios of Ca, Mg, and Sr to chloride are remarkably constant throughout the cores. Higher relative Sr ion concentration in the core from the intermediate coastal levees may indicate a subtle dissolution of aragonite. In general, evidence of diagenesis in these carbonate sediments is not readily apparent.

1977 ◊

Schold, G. P. (1977) Analysis of a indigenous foraminiferal biocenosis from Buttonwood Sound, Florida Bay. M. S. Thesis. Duke University, Durham, NC. 87 pp.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Samples of *Thalassia testudinum* (Konig) and short cores of sediment were collected over short lateral and vertical distances in Buttonwood Sound to study distribution patterns of the indigenous foraminiferal biocenosis. A rope cross, consisting of rays 50 meters in length, was staked to the bottom. Samples were collected at intervals of 5, 50, 500, and 5,000 cm from the center of the cross along each ray. Very few foraminifera were found to be living on *T. testudinum* and consequently the quantitative analysis was essentially restricted to those foraminifera that were living either on or within the sediment. Species diversity indices and factor-vector analysis were used to analyze the foraminiferal biocenosis. Factor-vector analysis is a mathematical model used to determine causal relationships existing between species (R-mode analysis) and between samples (Q-mode analysis). Ten vectors were selected in the R-mode factor-vector analysis that accounted for approximately 94% of the total information contained in the data matrix. The average Shannon-Wiener species diversity index accounting for the foraminifera living in the upper 2 cm of the sediment cores was 2.48, whereas the average species diversity index in the next lower 14 cm of sediment from the same cores was 2.12. *Archaias angulatus* (Fichtel and Moll) was the only numerically dominant species in the study area. Species diversity indices suggest that the environment of the study area was relatively unstable, resulting in broad niches populated by a few abundant species. Variations in species diversity were attributable to the distribution of a large number of rare species. The growth density of *T. testudinum* might have been in part responsible for the rather uniform pattern of species diversity. *Thalassia testudinum* traps sedimentary particles of a size that depends on its density, thus producing a somewhat homogenous substrate. Because the rope cross was positioned in an area characterized by a fairly constant growth density of *T. testudinum,* distribution of the various sizes of sediment was very similar throughout the study area to account for the variation in biotic/abiotic response that was by both R-mode and Q-mode factor-vector analysis.

1977 ◊

Steinen, R. P., R. B. Halley and S. L. Videlock (1977) Holocene dolomite locality in Florida Bay. Am. Assoc. Petrol. Geol. Bull., 61(5):833.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Dolomitic mud has been identified in the unlithified subsurface Holocene sediments recovered from Cluett Key, Florida Bay. The dolomite is in the lower one third to one-half of the slightly greater than 3-m thick carbonate mud, sand, and peat accumulation. In this interval the dolomite is estimated to comprise up to 40% of the sediment and is present as dolomite grains and rhombs smaller than 2 μ. The dolomite is poorly ordered and calcium-rich ($Ca_{0.56\text{-}0.60}\ Mg_{0.400.44}CO_3$). A second type of dolomite is stoichiometric and is in small amounts (less than 50%) in some samples. This type of dolomite is believed to be similar to the detrital dolomite identified by earlier workers in Florida Bay. Dolomite is common in cores from Cluett Key, but is absent or in insignificant amounts in the adjacent subtidal mudbanks that surround the inland. The dolomitic island mud is underlain by peat with a ^{14}C age of 3879 ± 70 yrs BP. The dolomite is completely unlithified and lacks cementation features associated with supratidal dolomites from elsewhere in South Florida and the Bahamas. It appears in both supratidal and subtidal (subaqueous). The origin of this dolomite is currently under investigation. Its distribution suggests a relation with some island process, most likely the formation and trapping of brackish and hypersaline ground waters in the low-permeability (10 md average) island muds. Brackish ground water (0 to 30 ‰ total dissolved solids) is present beneath the topographic highs (up to 0.5 m above sea level) of the island. This water supports a variety of hardwoods and grasses. Hypersaline ground water (90 to 130 ‰) is present beneath low elevations (within 0.1 m of sea level) where water is ponded intermittently. Bay water ranges between 30 and 50 ‰ during the year. The areal distribution, stratigraphy, abundance, chemistry, and grain size suggest this dolomite to be of Holocene age. Although the complex hydrochemical setting requires further study, the presence of this dolomite mud may offer an alternative to dolomitization models requiring high permeabilities and rapid water movement.

1977 ◊

Steinker, D. C. (1977) Foraminiferal studies in tropical carbonate environments: South Florida and Bahamas. Fla. Sci., 40(1):46-61.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Those who seek to understand ancient carbonate rocks must first pursue knowledge of modern carbonate depositional environments. Those who study modern carbonates in tropical areas quickly learn that plants and animals exert significant influences upon the depositional environment, affecting the sedimentary framework. The foraminifera are important both as members of the biota and as skeletal constituents of carbonate sediments in areas such as South Florida and the Bahamas. Most studies of modern foraminifers from the South Florida-Bahama region have concentrated on distributions among sediment samples, with living and dead populations distinguished on the basis of rose bengal stain. Rose bengal is found to be an unreliable indicator of living specimens and methods of direct observation are suggested for the recognition of live foraminifers. Generally, a larger living population is found on marine vegetation than in the sediments of those areas. The assemblage among the bottom sediments commonly is sorted by waves and currents and does not necessarily accurately reflect the biocoenosis of an area. Attempts must be made to discriminate between those factors of the environment that influence the distribution of living populations and those that determine the thanatocoenosis in the sediments. More biologically oriented investigations are necessary for a better understanding of the foraminifera in their natural habitats. Such investigations should include both field studies and laboratory cultures.

1977 ◊

Vander Kooi, V. (1977) Paleoenvironmental history of eastern Florida Bay based on foraminiferida. M. S. Thesis. University of Akron, Akron, OH. 172 pp.

[NO COPY OF THE PAPER AVAILABLE.]

1977 - 1978

Davis, G. E., D. S. Baughman, J. D. Chapman, D. MacArthur, and A. H. Pierce (1978) Mortality associated with declawing stone crabs, *Menippe mercenaria*. Rep. T-522. South Florida Research Center, Everglades National Park, Homestead, FL. 23 pp.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] This study was designed to measure the mortality of declawing stone crabs, *Menippe mercenaria*, using standard commercial techniques under laboratory conditions, as a precursor to a field investigation. From 1977 to 1978, 201 stone crabs were collected by traps in Florida Bay, returned to the lab and maintained in aquaria. Of 101 crabs that had both claws removed, 47 died and 28 of 100 single claw amputees died. Declawing wound width was significantly correlated with survival. Instantaneous crab mortality from declawing wounds of commercial fishermen ranged from 23 to 51%.

1977 - 1978

Hall, R. J., T. E. Kaiser, W. B. Robertson, and P. C. Patty (1979) Organochlorine residues in eggs of the endangered American crocodile (*Crocodylus acutus*). Bull. Environ. Contam. Toxicol., 23:87-90.

Most of the 27 species and subspecies of surviving crocodilians have declining populations and 22 of them are considered to be severely endangered. The US population of the American crocodile is no exception; it probably numbers between 100 and 300 individuals. Nests of the species have been regularly surveyed by the staff of the Everglades National Park. Our sample consists of eggs that remained in nests after the hatching of broods and of one clutch laid in captivity by an unmated female. Analysis of the 1977 samples for organochlorine contaminants has permitted a detailed examination of their contaminant loads and has allowed comparisons with a small sample analyzed in 1972.

1977 - 1980

Kushlan, J. A., and F. J. Mazzotti (1989) Historic and present distribution of the American crocodile in Florida. J. Herpetology, 23(1):1-7.

The historic and recent distribution of the American crocodile (*Crocodylus acutus*) in Florida is from Vero Beach and Tampa south to the lower Florida Keys. Surveys covered the entire coastal zone, concentrating in Florida Bay from Key Largo to Cape Sable. Standardized surveys from power boat, canoe, fixed wing aircraft and helicopter took place from July 1977 to September 1980. The nesting distribution is southern Biscayne Bay and northeastern Florida Bay. Both distributions reflect winter temperature. Nesting sites and non-nesting habitat have been lost to development on Miami Beach and the upper Florida Keys, but this loss has been compensated by the creation of artificial nesting sites on spoil banks along southern Biscayne Bay and a westward addition to the nesting range in Florida bay. Except for the shift in nesting away from developed areas, the general distribution of the American crocodile in Florida is the same as that historically documentable.

1977 - 1981

Kushlan, J. A., S. A. Voorhees, W. F. Loftus, and P. C. Frohring (1986) Length, mass, and calorific relationships of Everglades animals. Fla. Sci., 49(2):65-79.

Meristic and calorific relationships were determined for aquatic animals from southern Florida. The relationships derived included wet mass to length (52 species, 2 families), dry mass to length (17 species), dry mass to wet mass (17 species), and calorific value (44 taxa). These analyses were the first available for most of the species. Such relationships can be used in estimating standing stock and energy flow in aquatic systems. Samples were obtained during routine sampling programs from 1977 to 1981.

1977 - 1981

Ledder, D. A. (1987) Food habits of the West Indian Manatee, *Trichechus manatus* Latirostris, in south Florida. M. S. Thesis, University of Miami, Coral Gables, FL. 114 pp.

Gut contents were collected from 84 animals over a five year period, from 1977 to 1981, in order to describe the diet of *Trichechus manatus latirostris* in South Florida. Microhistological analysis was used to identify plant species sampled from the stomach, duodenum, and cecum. A gross analysis was also carried out to estimate the ratio of surface to subsurface portions of the plants consumed. The manatees sampled fed in both fresh and salt water. The seagrass *Halodule wriqhtii* comprised the largest portion of the diet (24.4% by percent composition), followed by the freshwater species *Hydrilla verticillata* (12.-7%). Significant contributions were also made by the seagrass *Syringodium filiforme* (9.1%), and the euryhaline species *Ruppia maritima* (7.4%). Algae were found in large amounts in five of the animals, resulting in a total contribution of 6.0% to the diet of the sample population. The most common plant species in the diet were equally represented in males and females. Adult and juvenile animals differed only with respect to the consumption of *Syringodium filiforme*, *Panicum hemitomon*, and algae. Seagrass made large contributions to the diets of animals on the coasts, while *Hydrilla verticillata* and *Panicum hemitomon* made the largest contributions to the diets of animals in Central Florida. *Halodule wrightii* contributed the greatest percentage to the diet by percent composition in summer and winter, while *Syringodium filiforme* and *Thalassia testudinum* values were highest in the winter and spring, and spring respectively. The terrestrial grass *Panicum hemitomon*, and freshwater plant species contributed the most to the diets of the animals during the fall. Subsurface portions of plants contributed more to the diet for salt water species (mean ratio of surface/subsurface portions = 46/54) than for freshwater species (86/14). Ratios of surface/subsurface portions of plants were essentially equal for males and females, and for juveniles and adults. Manatees collected on the coasts consumed more subsurface portions of plants than those collected from Central Florida. More subsurface portions of plants were consumed in winter and summer than in the spring and fall.

1977 - 1981

Mazzotti, F. J. (1983) The ecology of *Crocodylus acutus* in Florida. Ph. D. Dissertation. The Pennsylvania State University, University Park, PA. 161 pp.

Crocodylus acutus formerly occupied a much broader range in southeastern Florida. Aerial and boat surveys showed that the current core distribution of *C. acutus* is the extreme southern Florida mainland and northern Key Largo. Most sightings were in bays, ponds, rivers, and canals in mangrove swamps. All known nesting sites are within this area. Approximately 50% of the sightings and captures of non-hatchling crocodiles were of immature animals. Thus recruitment into the breeding population appears to be occurring. Seventy-four percent of the known crocodile mortalities that occurred between 1971 and 1981 were related to human activities such as shooting or collision with automobiles. Preservation of the crocodile population will require increasing attention to reducing the adverse effects of man and protection of remaining habitats from disturbance. Crocodiles nest on exposed shoreline beaches, creek banks, and canal banks. The substrate may be composed of marl, peat, or sand. Failure of eggs to hatch is primarily caused by desiccation and flooding, and the nesting period is timed to avoid the driest and wettest periods of the year. Approximately 200 hatchlings are produced each year in Everglades National Park. Hatchlings usually disperse rapidly from their nests, and it was not possible to distinguish between death and dispersal. However, some hatchling crocodiles survived for at least a year in Everglades National Park, on northern Key Largo and at the Turkey Point power plant site. Turkey Point hatchling crocodiles were found in the cooling canal system. Here, as in other parts of southern Florida, hatchlings not only tolerated saline water but gained mass under hypersaline conditions. They grow to the size (200 g) at which they show increased tolerance to seawater by the onset of the dry season in October. Hatchling *C. acutus* have rates of body sodium and water turnovers similar to those of hatchling *Alligator mississippiensis*. Both species appear less specialized for life in saline water than *C. porosus*. In the laboratory, *C. acutus* held in seawater can osmoregulate behaviorally by drinking brackish water made available by simulating rainfall. The drinking of brackish water combined with rapid growth to a more salt tolerant size seems to be one of the primary specializations of *C. acutus* for life in saline water.

1977 - 1982

Kushlan, J. A., and F. J. Mazzotti (1982) Population biology and status of the American crocodile in south Florida. In: Crocodiles. D. Dietz and F.W. King (eds.). Gland, Switzerland IUCN. 188-94.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] The population biology and status of the American crocodile was studied in Florida Bay during 1977 - 1982. In this paper the authors briefly abstract some new findings concerning various hypotheses previously suggested to account for presumed population decreases. Data is summarized on historic population status, current population size and structure, nesting biology, habitat, mortality as well as management needs which suggest that current population is not decreasing, although its historic range has decreased somewhat. The authors see no need for any drastic manipulative management of the south Florida crocodile population.

1977 - 1982

Kushlan, J. A., and F. J. Mazzotti (1989) Population biology of the American crocodile. J. Herpetology, 23(1):7-21.

The population biology of the American crocodile (*Crocodylus acutus*) was studied in southern Florida during 1977 - 1982. Crocodiles were located on monthly surveys using boat, canoe, fixed wing airplane and helicopter. An extensive capture/mark/release program was conducted using boats at night. Crocodiles occur primarily in inland mangrove swamps protected from wave action. Females use the open waters of Florida Bay only for access to nesting sites. Individuals have large (86-262 ha) overlapping activity areas. Nesting occurs in spring and summer avoiding the cold and the wet seasons either of which can affect incubation. Clutches averaging 38 eggs were laid both in mounts and in holes in the ground either singly or communally. Available data cannot support the view that the number of nests has decreased in recent years. Hatching failure occurred as a result of infertility, predation, and embryonic mortality from desiccation and flooding. Hole and creek nests were most susceptible to embryonic mortality. Seventy-eight percent of nests hatched some young. No evidence was found of adults defending nests or young but nest opening by adults was essential for hatching. Disturbance at nest sites caused females to abandon the site. All expected age classes occurred in the population. Size at maturity was 2.25 m TL for females. Documented mortality of adult and subadult of approximately 2 crocodiles per year was predominantly human-caused. At least 45 crocodiles have been released into southern Florida in 17 yrs. We estimate the southern Florida population to be about 220 ± 78 adults and subadults.

1977 - 1982

Mazzotti, F. J. (1988) Science, politics, and management of crocodilians in the Everglades. Wildlife in the Everglades and Latin America Wetlands. Wildlife in the Everglades and Latin America Wetlands, 1985. G. W. Dalrymple, W. F. Loftus, and F. S. Bernardino (eds.). Florida International University, Miami, FL. 5-6.

This citation discusses various aspects of the management of crocodile populations in the Everglades National Park.

1977 - 1992

Bohnsack, J. A., D. E. Harper, and D. B. McClellan (1994) Fisheries trends from Monroe County, Florida. Bull. Mar. Sci., 54(3):982-1018.

Fishing is an important activity in the Florida Keys National Marine Sanctuary (FKNMS). Concern exists that excessive fishing could be deleterious to individual species, disrupt marine ecosystems, and damage the overall economy of the Florida Keys. We examined data from commercial, recreational, and marine life fisheries in Monroe County.

invertebrates comprised the majority of commercial landings. In 1992, the total reported commercial landings were composed of 52% invertebrates (4.09 x 106 kg), 28% reef fishes (2.19 x 106 kg), and 21% non-reef fishes (1.62 x 106 kg). In the recreational headboat fishery, reef fishes accounted for 92% of 0.107 x 106 kg average total annual landings from the Dry Tortugas and 86% of 0.201 x 106 kg landed from the Florida Keys since 1981. Average annual landings for other recreational fisheries were estimated at 1.79 x 106 kg for reef fishes (45%) and 2.17 x 106 kg for non-reef fishes (55%) from 1980 through 1992. Finer resolution of catch and effort data are needed, especially for recreational fisheries. Landings for some species varied greatly over time. The most conspicuous declines were for pink shrimp, combined grouper, and king mackerel while the most conspicuous increases were for amberjack, stone crab, blue crab, and yellowtail snapper. Landings of spiny lobster have generally remained constant. Fisheries closed to harvest included queen conch, Nassau grouper, jewfish, and stony corals. Effective fishing effort has increased over time with more participants and more effective fishing technology. Since 1965, the number of registered private recreational vessels has increased over six times, while the number of commercial and headboat vessels has remained stable. The number of management actions have continually increased and become more restrictive with increased fishing effort. Comparison of fisheries was complicated because different fisheries targeted different species and different sized organisms. Also, landings were sometimes reported by numbers and sometimes by weight. Measures of reproductive value and spawning potential are suggested as useful parameters for comparing effects of different fisheries. The new FKNMS provides a unique opportunity to shift management emphasis from a species approach to an ecosystem and habitat based approach.

1978 ◊

Crapon de Caprona, A. (1978) Foraminiferes et microfaunes associees de l'ilot de Murray Key, Baie de Floride (Foraminifera and associated microfauna of Murray Key, Florida Bay). Univ. Geneve, Lab. Paleontol., Geneva. Notes du Laboratoire de Paleontologie, 2(1-13):37-43 (In French).

[NO COPY OF PAPER AVAILABLE.]

1978 ◊

Carter, P. W., and R. N. Mitterer (1978) Amino acid composition of organic matter associated with carbonate and non-carbonate sediments. Geochim. Cosmochim. Acta, 42(8):1231-8.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] Studies on carbonate sediment samples from the Florida Keys and Florida Bay (Cross Key Bank) and noncarbonate samples from Mexico Beach, Florida, indicate that amino acids comprise 15-36% by wt of humic substances from these sediments. Humic and fulvic acids extracted from carbonate sediments are characterized primarily by the acidic amino acids aspartic and glutamic acid. From these sediments it was found that lower mol wt fractions have appreciably higher relative abundances of the acidic amino acids compared to higher mol wt fractions. Based on typical values for carboxyl group content in humic substances, acidic amino acids may be a significant contributor of these functional groups. Carbonate surfaces selectively adsorb aspartic acid-enriched organic matter while noncarbonates do not.

1978 ◊

Davies, T. D., and W. Spackman (1978) The nature, occurrence, and significance of peat in Florida Bay. Geol. Soc. Amer. Abs., 10(7):386.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The sporadic occurrence of a buried peat layer has been reported by most researchers concerned with the sediments of Florida Bay. However, sampling on a one-mile square grid pattern has revealed the presence of a sub-marl autochthonous peat over a much larger area than previously shown. At one site several miles south of mainland Florida, peat forms the entire sedimentary sequence. Eleven cores from the islands and "banks" were analyzed petrographically, palynologically, and chemically and a limited number of age determinations were made. Petrographic and palynological studies of the peats show that a terrestrial vegetation occupied a large portion of the Bay in the recent past. Basal peat sediments indicate that much of the area involved was covered with freshwater marsh and swamp environments with the saline mangrove environment which now characterizes the Bay gradually encroaching from the south and west. Fresh-water peat types encountered include water lily peat, saw grass-arrowhead peat, and buttonbush peat. The environments associated with these peats became progressively more saline. Fresh-water peats are overlain by brackish buttonwood peat which is, in turn, overlain by saline mangrove peats. In most places the transgressive sequence is completed by several feet of marine carbonate mud. The now discontinuous occurrences of peat appear to represent remnants of more extensive peat layers, some of which may have been continuous with those of mainland Florida. The peats display unexpectedly low pyrite concentrations as well as total S contents. Evidence suggests that this is the result of the lack of available iron and hence a failure to fix the available S in the sulfide form.

1978 ◊

DeBellevue, E., H. T. Odum, J. Browder, and G. Gardner (1978) Energy analysis of the Everglades National Park. Rep. T-527. South Florida Research Center, Everglades National Park, Homestead, FL. 34 pp.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] This report presents the first attempt, using an energy analysis, to show a National Park as an integral part of a larger system. The most important components and interactions with the model are shown using energy circuit diagrams representing subsystems such as mangrove, saltwater, sawgrass, marine meadows, etc. Pathways are evaluated numerically using available data and comparative values are given by the energy analysis. An analysis of the park fishery based on commercial and recreational catches at Flamingo was made using the retail price of fish as their value to the economy. A ratio of fossil fuel energy input using coal equivalents was made and related to increased water supply on the parks value to the regional system. Results included a land use map of park subsystems, an evaluated Everglades National Park model and summary diagrams. A floodway, from Lake Okeechobee to Conservation Area III, was proposed by the authors to restore natural flow to the park, and to serve agriculture and urban development.

1978 ◊

Gilbert, C. R. (ed.) (1978) Rare and endangered biota of Florida. Vol. 4. Fishes. University Press of Florida, Gainesville, FL. 58 pp.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] A classification and description of Florida's aquatic ecosystems was provided along with definitions of status categories and a list of included species of fish. Those rare/endangered/threatened species known to occur in the coastal areas of the Everglades National Park include key silverside, *Menidia conchorum*, Rivulus *Rivulus marmoratus*, mangrove mosquitofish *Gambusia rhizophorae*.

1978 ◊

Ogden, J. C. (1978) American crocodile. Rare and Endangered Biota of Florida. Vol. 3, Amphibians and Reptiles. R. W. McDiarmid (ed.). University of Florida Press, Gainesville, FL. 21-2.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] This is a short description of the ecology, range, habitat and status of the American crocodile.

1978

Poole, A. (1979) Sibling aggression among nestling ospreys in Florida Bay. The Auk, 96(2):415-7.

Nestling activity was monitored during 1978 at two Florida Bay osprey nests as part of a study of osprey feeding ecology for the region. One nestling was consistently aggressive towards its only nestmate. The aggression produced no physical damage but was sufficient to reduce the food intake of the intimidated sibling significantly.

1978 ◊

Wanless, H. R. (1978) Storm generated stratigraphy of carbonate mud banks, South Florida. Geol. Soc. Amer. Abs., 10(7):512.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Southward migration and expansion of east-west trending carbonate mudbanks within Biscayne Bay and Florida Bay have generated sedimentary sequences composed of four lithologies. These lithologies are produced by an interaction of hurricane and repetitive winter storm sedimentation. A molluscan-foraminiferal grainstone to packstone forms the basal 0 - 15 cm over Pleistocene bedrock. This is a winter storm winnowed lag of sediment produced in bays adjacent to banks and/or carried into the bays during hurricanes. The overlying 0.2 - 1 m is a crudely layered molluscan foraminiferal packstone thought to represent hurricane layers. These are deposited as widespread layers in the bays but are only preserved where covered by migrating or expanding mudbank flanks. The bulk of the mudbanks is a pelleted mudstone (2 - 3 m in thickness) formed by lee side accretion of fine sediment during winter storms. Hurricanes may also add mud to lee flanks. Winter storm waves will strip any hurricane mud layers from north facing flanks. North facing flanks of banks contain a surficial molluscan grainstone to packstone. Shell is derived from winnowing of eroding north facing flanks as well as from southward transport from adjacent bays. Winter storm waves move lobes of this grainstone onto the bank flat. These anastomosing mudbanks of biogenic sediment record a dynamic history of physical sedimentation caused by accretion and erosion during minor and major storm events and probably also by evolving stability of subcircular bay patterns during late stages of the Holocene rise of sea level.

1978 - 1979

Lyons, W. G., D. G. Barber, S. M. Foster, F. S. Kennedy, and G. R. Milano (1981) The spiny lobster, *Panulirus argus*, in the Middle and Upper Florida Keys: Population structure, seasonal dynamics, and reproduction. Rep. No. 38. Florida Department of Natural Resources, St. Petersburg, FL. 45 pp.

Data on abundance, distribution, size, sex, mating, spawning, molting, incidence of fouling organisms, and injury rates were obtained from 19,180 lobsters at nine stations in the upper and middle Keys fishery area during April 1978 through March 1979. Mean and modal carapace length (CL) sizes were approximately 73 mm, slightly below legal size (76 mm). Lobsters at deep reef (30 m) stations averaged 80.1 mm CL; size decreased gradually to an average of 65.6 mm CL at shallow (3 m) Bay stations. Distribution of lobsters was age- and habitat-related; immature, principally sublegal lobsters in year class 2+ occupied southern Florida Bay stations, then moved gradually to nearshore oceanside Keys stations; lobsters in year class 3+ migrated seaward in response to onset of maturity or declining late fall-early winter temperatures. Stations on the north sides of Keys were within the Florida Bay nursery area, where fishery-induced damage to sublegal lobsters probably exceeded legal catch from the area. Legal-sized lobster constituted 43.7% of total catch; 90% were captured at oceanside stations, and nearly half were from the deep reef. Greatest mean sizes at all but one station occurred during the closed season or the first month of the open season and represented growth among lobsters at each station. Upper Keys stations were more productive (average +67%) than were comparable middle Keys stations. Marked declines in average size at all stations during winter are attributed to depletion by the fishery to legal-sized lobsters and to seaward emigration of relatively larger lobsters from shoreward subpopulations. Mean total number of lobsters per trap per week was 0.84, constituting 0.70 at bay stations and 0.91 oceanside. Legal catch averaged 0.37 lobsters per trap week, constituting 0.12 at bay stations, 0.50 oceanside. Poundage of legal catch during the open season seldom averaged 1 lb per trap per week except at deep reef stations, indicating weekly catch rates less than one third of those two decades previous. Female:male ratio (1.2:1) was strongly influenced by significantly more females than males at seaward reef stations. Virtually all mating, evidenced by external spermatophores on females, occurred among oceanside lobsters, and 88% of all activity was found at two deep reef and one shallow (10 m) reef station. Principal mating season was from April through June. Spawning, evidenced by externally carried eggs, occurred only at oceanside stations; 31.1% of females at two deep reef and one shallow reef station were spawning during peak months of May and June. Size of the smallest spawning female was 65 mm CL, but greatest spawning contribution (24.5%) was in the 81-85 mm size class. Nearly 60% of all eggs were produced by lobsters ≤ 85 mm CL. Spawning contribution by the Keys population was only 12% of that expected from a comparably sized, unharvested population of larger lobsters. Fouling by various sessile invertebrates was slight or absent on most lobsters. No correlation was found between fouled lobsters and capture location. Indications of molting averaged only 1% in the total population, but was significantly more frequent at nearshore (3 - 6 m) than at seaward (9 - 30 m) stations. Maximum molting frequency (2.7%) during April may have been in response to temperature increases. Greatest rates of injury occurred at the ends of the 1977 - 78 and 1978 - 79 fishing seasons; injuries declined rapidly due to growth and regeneration during the closed season. Unexplainably low previous-injury rate of sublegal-sized lobsters during the open season suggests they may have experienced considerable mortality due to fishery practices. The sampling sites in Florida Bay were at Vaca Key and Matecumbe Key.

1978 - 1979

Dunson, W. A. (1980) Osmoregulation of crocodiles in Everglades National Park. Rep. T-599. South Florida Research Center, Everglades National Park, Homestead, FL. 29 pp.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] The physiological effects of high salinity on young crocodiles, *Crocodylus acutus*, was examined in Florida Bay using measurements of electrolyte composition of plasma and cloacal fluid and of possible hatchling food. No final answer can be given to the hypothesis that a major portion of crocodile mortality in Florida Bay is associated with osmoregulatory problems caused by high salinities. Small *C. acutus* show few physiological specializations for life in saline waters although results indicate that the vicinity of many nest sites are saline enough that difficulties could be encountered in water and salt balance. The author suggests additional studies are needed to establish their mortality under the most stringent salinity regime ever likely naturally to be encountered.

1978 - 1979

Dunson, W. A. (1982) Salinity relations of crocodiles in Florida Bay. Copeia, 1982(2):374-85.

Studies were carried out to determine the importance of high salinity as a limiting factor to the Florida Bay population of *Crocodylus acutus,* since hatchlings in captivity are unable to survive in seawater. Sodium, K, Cl and osmotic pressure were measured in samples of plasma and cloacal fluid. The ion and uric acid content of solid cloacal excretions was also determined. Sodium influx and efflux of small crocodiles submerged in seawater and of isolated skin keratin were measured. The relationships between snout-vent length, body mass and surface area were estimated. It was found that the head-neck, tail, legs and body regions each account for about one-fourth of the total area. Studies were conducted on hatchling crocodiles of evaporative water loss, behavioral osmoregulation and on the water and ion content of possible food items. Wild hatchlings have a plasma osmotic pressure near 330 mOsm, a level typical of vertebrates. Body Na influx and efflux are quite low; there is a net uptake in seawater of about 9 μmoles 100 g^{-1} body mass hr. The skin is probably very low in Na permeability. There is a substantial loss of water from fasting hatchling crocodiles submerged in seawater (35 ‰) or held in moist air. Feeding is an important means of balancing these water losses. When fed fish ad lib. and kept in an aquarium divided into land and water portions, most small (100 - 480 g) crocodiles maintained body mass at salinities up to 17.5 ‰. Some even gained mass at 26 ‰. Field data from Florida Bay tend to confirm that *C. acutus* hatchlings are intolerant of 35 ‰ seawater. This study was conducted during 1978 and 1979.

1978 - 1979

Poole, A. (1982) Brood reduction in temperate and sub-tropical ospreys. Oecologia, 53(1):111-9.

In an effort to understand patterns and causes of nestling loss in ospreys (*Pandion haliaetus*), the brood reduction in three eastern osprey colonies was studied during 1978 and 1979. The colonies, located in Florida Bay (1) and on coastal Long Island, NY (2), differed in the average daily amount of food delivered to nestlings; Florida nests received 43% and 11% less fish per day than nests in the two NY colonies, largely because latitude and season restricted day length and thus foraging time for the winter-breeding Florida ospreys. Increased distance from stable food sources accounted for the lower rate of feeding at one of the NY colonies. Variation in clutch size in the three colonies reflected differences in latitude more than in food availability; average clutch sizes in Long Island were larger than Florida clutches by 0.5 of an egg, but were similar to each other and to those in other northeastern US osprey populations. Increased nestling loss coincided with reduced food delivery rates and, in food stressed colonies, this loss was 2-3 times greater than any recorded for ospreys. Starvation was the primary cause of nestling death, with mortality concentrated on third chicks, which hatched on average 3.9 days later and from eggs 5.6% smaller than chicks hatching first. Sibling aggression accounted for the preferential feeding of older nestmates, but only in colonies or nests where food was limited. Aggressive chicks nearly always stopped fighting after being fed. This behavior provided a reversible mechanism for controlling brood reduction that was based on nutrition. Growth rates of young measured during the first half of the growth period were more variable between colonies than within nests. This is interpreted as reflecting both the differences in colony food delivery rates as well as the evolutionary pressures of sibling competition to equalize the growth of nestmates.

1978 - 1980

Davis, G. E., and J. W. Dodrill (1989) Recreational fishery and population dynamics of spiny lobsters, *Panulirus argus*, in Florida Bay, Everglades National Park, 1977-1980. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):78-88.

Florida spiny lobsters, *Panulirus argus,* are found in the southern two-thirds of Florida Bay. Field studies of 3,570 tagged lobsters revealed that they pass through Florida Bay, using it for less than three years as juveniles, between their planktonic larval stages in the open ocean and adulthood on coral reefs. The field studies took place in 1978 through 1979. Lobsters from the Bay supported commercial and recreational fisheries outside of Everglades National Park from Dry Tortugas to Pacific Reef near Miami. Growth rates of juvenile lobsters in Florida Bay were found to be the highest on record, which may reflect optimum habitat with abundant food and shelter. Reportedly, the average-sized lobster taken by commercial bully netters in the Bay prior to 1965 was 90-95 mm carapace length. The Everglades National Park recreational harvest in 1978 - 1979 was about 20,000 lobsters with a mean size of 83 mm CL., and about 44,000 lobsters (x 88 mm CL) in the 1979-1980 season. The fishery also provided 7,500 to 8,000 person-days of recreation each year for about 1,000 persons. In 1980, a lobster nursery sanctuary was created in the Everglades National Park portion of Florida Bay to restore the natural conditions of the bay and provide more lobsters for harvest in adjacent fisheries.

1978 - 1980

Morrison, D. (1984) Seasonality of *Batophora oerstedi* (Chlorophyta), a tropical macroalga. Mar. Ecol. Prog. Ser., 14:235-44.

The seasonality of *Batophora oerstedi,* a benthic tropical macroalga, was studied in Florida Bay at Key Largo. Abundance, measured by biomass and coverage sampling varied seasonally with standing crop highest in summer and fall and lowest in winter. Reproductive activity, expressed as percentage of reproductive individuals, varied seasonally with greatest activity in fall. It is hypothesized that the fall reproductive pulse may be triggered by a drop in water temperature caused by the passage of the first fall cold front or, infrequently, a late summer-early fall hurricane. Net photosynthesis (P_N) exhibited a unimodal seasonal pattern with highest rates in summer and lowest rates in winter. Net photosynthesis was positively correlated with water temperature, but not significantly correlated with any other environmental parameter. Respiration (R), constant throughout much of the year, was elevated in fall during the period of maximal reproductive activity. The daily (24 hr) P/R ratio was always greater than unity suggesting that *Batophora is* capable of year-round growth. This study took place from 1978 to 1980.

1978 - 1980

Olmstead, I. C., L. L. Loope, and R. P. Russell. (1981) Vegetation of the southern coastal region of Everglades National Park between Flamingo and Joe Bay. Rep. T-620. South Florida Research Center, Everglades National Park, Homestead, FL. 18 pp.

Much of the early mangrove literature for southern Florida has emphasized the land building role of mangroves. Succession beyond the mangrove stage depends on the deposition of sediments during storms. Mangrove ecosystems are true "steady-state" ecosystems in the sense that they are self-maintaining in spite of cyclic perturbations, as long as environmental tolerances of salinity and moisture fall within their optimal tolerance range. We are comfortable with this view, although we find it convenient to speak of the process of mangrove ecosystem recovery from hurricanes as succession. The hurricane of 1960 killed most of the mangrove vegetation within the mapped area. However, re-establishment of mangrove vegetation was rapid in many areas. Red, black and white mangrove, as well as buttonwood normally have ripe propagules during the hurricane season, and the current vegetation pattern suggests that all except buttonwood were able to establish immediately following the 1960 hurricane. Soil moisture and salinity, as well as propagule availability, probably determined which species established in a given locality. Though we do not know the alteration of species composition between most stands killed by the hurricane, and new stands becoming established, the maps tell us much about certain other stands. Buttonwood and hammock vegetation, located on higher ground, largely escaped severe destruction by the last hurricanes. Even though mechanical damage from the hurricane was considerable for these "upland" types, numerous trees survived. In many cases, buttonwoods which were uprooted later produced new shoots along the fallen trunks. In fact, vegetative reproduction seems to have been the prime mode of reproduction for buttonwood. Buttonwood seedlings and saplings are very rare. The presence of scattered tall, old mangroves towering above a dense canopy of young white mangroves in the area north of Snake Bight and Garfield Bight shows clearly that white mangrove has colonized the area since the 1960 hurricane. The current vegetation mosaic frequently has a band of halophytic herbaceous vegetation located between mangrove and buttonwood or buttonwood-hammock vegetation. These saline flats have increased substantially in the area since the early 1930s. Large areas of saline flats occur with skeletons of dead trees, usually *Conocarpus*. Little or no reproduction is evident in what was formerly a forest. Reasons for the lack of mangrove or buttonwood reproduction here are not clear presumably changes in substrate, salinity and/or water table are involved.

1978 - 1980

Rutherford, E. S. (1982) Age, growth and mortality of the spotted seatrout, *Cynoscion nebulosus*, in Everglades National Park, Florida. M. S. Thesis. University of Miami, Coral Gables, FL, 65 pp.

Age, growth and mortality were studied in 570 spotted seatrout taken from sportfishermen catches in Everglades National Park from 1978 to 1980. Fish ranged in length from 220 - 680 mm and in weight from 0.10 - 2.24 kg. Ages of the catch, determined from scale readings, were mainly 3 and 4 yrs. Males lived to at least six years, females to at least seven years. The sex ratio favored females (1.67/1). Fish lengths at age were back calculated from scale annuli. Fish length varied between sexes and among areas of capture. Males were larger than females at age 1 but smaller at ages 3 - 6. Calculated fish length and length at capture were largest in seasonally brackish areas and smallest in a hypersaline area of the Park. There was no significant difference in length-weight relationship between sexes or among areas of capture. Annual mortality rate of all fish was 77%. Male spotted seatrout had higher annual mortality and conditional fishing mortality than females. Conditional natural mortalities were the same for both sexes. Exploitation ratio was higher for males than for females. Yield per recruit for both male and female spotted seatrout was at or near maximum given the 12 in. minimum size limit. Comparison of the results of this study with an earlier study of Park spotted seatrout showed apparent changes in age distribution, age at full recruitment and mortality since 1959, although yield per recruit and mean sizes at age of fish have not changed. Dominant ages shifted from 2- and 3-yr old, to 3- and 4-yr old fish. Age at full recruitment shifted from age 3 to age 4. Annual mortality of all fish increased slightly since 1959.

1978 - 1980

Rutherford, E. S., E. B. Thue, and D. G. Buker (1983) Population structure, food habits, and spawning activity of gray snapper, *Lutjanus griseus*, in Everglades National Park. Rep. SFRC-83/02. South Florida Research Center, Everglades National Park, Homestead, FL. 41 pp.

Population structure, food habits, and spawning activity of 1026 gray snapper *Lutjanus griseus* were studied in Everglades National Park from November 1978 through January 1980. Fish were sampled from sportfishermen catches and ranged in length from 111 - 451 mm FL (x = 257 ± 3.2 mm) and in weight from 0.05 - 1.6 kg (x = 0.33 ± .02 kg). There was no difference in mean length between sexes. Fish aged from scale annuli ranged from one to seven years. Two- and three-yr old fish dominated the catch. Recruitment was complete by age three. The mean age of all fish was 3.0 ± 0.1 yrs. There was no difference in mean age between the sexes. Fish taken from the Cape Sable area were significantly older than fish taken from other areas. Calculated growth of gray snapper was greatest in the first year and relatively linear before increasing in the fifth year. Calculated growth varied between sexes and among areas of capture. Females were significantly larger than males at one and two. Fish taken from hypersaline areas near the Gulf of Mexico were larger at ages one through four than fish taken from seasonally brackish waters. Males in the Shark River area did not show as great an increase in weight length as did all fish in other areas. Females in the Coot Bay and Whitewater area were heavier at a given length than all fish in other areas. Annual survival rate of all fully recruited fish was s = 0.28 ± .03. Survival of males was higher than females. Gray snapper survival was higher in hypersaline waters near the Gulf than in other areas. Spawning activity probably occurs outside of park waters. Only four of 668 examined inside park waters were ripe. Park gray snapper diet consisted mainly of fish, shrimp, and crabs. Species composition of the diet varied with age and among seasons and areas of capture. Comparison of this study with an earlier study of Park gray snapper showed increases in survival and longevity since 1960. No changes in diet, spawning activity, or growth rate were noted.

1979

Anonymous (1980) Pesticide use observations, Monroe County, Florida, March - June 1979. USEPA, National Enforcement Investigations Center (NEIC), Denver, CO. 36 pp.

From June 3 to 14, 1979, a pesticide use observation study was conducted by the National Enforcement Investigations Center (NEIC) in Monroe County. During the study, an EPA team evaluated the environmental effects resulting from the aerial application of Naled (Dibrom-14) and ground application of Baytex for the control of mosquitoes. A reconnaissance survey in March of the marine environment in the Everglades National Park revealed no pesticide residues were detected prior to the initiation of the mosquito control program by Monroe County. Lack of precipitation in the spring reduced mosquito breeding activities and consequently the necessity for intensified pesticide applications. Records indicate only three aerial and two ground application occurred from June 3 to 14, 1979. Of the 37 surface water samples collected from the Everglades National Park marine environment, two contained detectable amounts of pesticide. At Station 10 on June 5, Naled was found at a concentration of 0.02 mg/L. On June 14 at Station 04, Naled appeared at a concentration of 0.06 µg/L. No Baytex was found in the water samples. Pesticide drift into the area adjacent to the Park was confirmed by the use of Hi-Vol air samplers at Station 12 (Ranger Station) on three occasions. On June 4, filter paper in the Hi-Vol samplers captured 0.18 µg of Baytex sprayed via ground applications. June 5 and 12 the air monitoring filters revealed a capture of 0.06 µg and 0.02 µg respectively. Uptake by exposed marine organisms of the applied pesticide was negligible. The only observed instance of uptake occurred at Station 05 (Manatee Creek) where the oysters accumulated an average of 0.007 µg/g of Naled. Baytex was not found in detectable amounts. Field analyses of hydrographic conditions were made daily throughout the 11-day study to determine if the aquatic environment affected the survival rate of the test animals. From June 3 to 14, records revealed that conditions were at a seasonal norm and as such appeared to have had no direct influence on test organism survival during the exposure studies. The test to relate the presence of an oily film on the water surface to a pesticide incursion into a non-target area proved inconclusive. Two filter paper samples of a surface film were obtained and neither contained measurable amounts of Naled nor Baytex. The Monroe County Mosquito Control District supervises the disposal of used containers at a local sanitary landfill which operates a drum crusher. The Safety Director was advised that because Naled and Baytex are kept in Group II containers, it is recommended that each empty container be triple rinsed and crushed prior to disposal in a landfill.

1979 ◊

Centaur Associates, Inc. (1979) Socioeconomic assessment for fishery management, Everglades National Park. Rep. T-543. South Florida Research Center, Everglades National Park, Homestead, FL. 105 pp.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] This report presents the socioeconomic impact assessments and adverse effects from restrictions on commercial and recreational fishing activities in the Everglades National Park. The Park is unique with respect to fishery resources and fishery management. Florida Bay has been subject to a considerable degree of commercial and recreational pressure. The issuance of commercial fishing permits are nearly equally divided between Florida Bay and the Everglades City area while recreational and guide and charterboat fishing is an important attraction primarily in the Flamingo - Florida Bay area. Although all commercial and recreational fishing is done in accordance with state regulations, intense competition exists between both factions with the result that the NPS explore alternative management options for the park's fishery resources. These actions which require consideration as they affect three South Florida counties and in relation to 24 fishery management alternatives, are assessed as follows: prohibition of net fishing, bag limits and harvest sizes of major gamefish species, prohibited harvest of stone crabs and spiny lobster and commercial permits, boat and motor restrictions, and financial and non-financial impacts are given for each management action.

1979 ◊

Davies, T. D. (1979) The use of peat petrography in reconstructing shoreline migration in the area of Florida Bay. Geol. Soc. Amer. Abs., 11(7):410.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] New data gathered in Florida Bay substantiates an earlier hypothesis that the sea level rise, to its present level, has been continuous during the last 5,500 radiocarbon yrs. It has been determined that thirteen peat types occur in Florida Bay ranging from freshwater to marine. The non-marine peats are situated at the base of the sediment sequence either directly on the Pleistocene bedrock or on a thin layer of freshwater, calcitic mud. Radiocarbon dates of the basal freshwater peats from the Bay suggest that sedimentation of the freshwater peats took place in the southwestern part of the Bay prior to 5,000 yrs BP. This strongly suggests that the position of the shoreline, at this time, was a considerable distance to the west and south. The sea probably did not begin to influence the vegetation of the Bay area until sometime after 5,000 yrs ago. This is particularly well documented by the freshwater tree island peat underlying Ninemile Bank dated to be 5190 ± 100 yrs BP. Although these freshwater peats megascopically resemble the fibrous coastal, mangrove peats, microscopic examination revealed that they are freshwater in origin. Their "fibrous" nature results from intruded roots of brackish and marine plants which grew in overlying environments. Recognition of this fact together with knowledge of the age of the various peat types results in the conclusion that the shoreline initiated its migration into the Bay area later than previously recognized and its eastern movement has been slower than heretofore thought.

1979 ◊

Davies, T. D. (1979) The carbonaceous sediments of Florida Bay and their anomalous sulfur content. Proc., IX Inter. Congr. of Carbon. Strat. and Geol., May 1979, Urbana, IL. 49.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Systematic sampling on a one-mile square grid pattern has revealed that a sub-marl, autochtonous peat is more widespread over Florida Bay then heretofore recorded. Cores from islands and banks were analyzed petrographically and palynologically and the peats were classified according to their source environment. The areal extent of the peat suggests that the vegetation of the Bay was more widespread in the past. The petrographic and palynologic studies, in all instances, demonstrated a clearly defined transgressive sequence. The basal peats represent freshwater environments of both marsh and forest types. These are overlain by brackish water, and then by marine peat, unless the peat sequence is truncated by an unconformity. Typically the peat is overlain by a marine carbonate mud, but in one case it makes up the entire sedimentary sequence of 3.53 m (or 139 in). Sixty-three peat samples from fifteen cores taken from Florida Bay were analyzed for sulfur forms. Despite its position below marine strata, the peat displayed unexpectedly low pyrite concentrations. Pyrite values ranged from 0.03% to 1.06% (d. b.) with the highest concentrations occurring at a site in the northeastern part of the Bay adjacent to the mainland. Evidence suggests that the low pyrite concentrations are the result of the lack of available Fe and hence a failure to fix the available S in the sulfide form. Total S concentrations in freshwater peats are typically below 1.0% for the chase of the basal freshwater peats in the Bay, the total S concentration appears to be affected by the type of overlying sediment. When the freshwater peat was overlain by brackish peat, it was found that the S content was consistently higher than when overlain by marine carbonate muds.

1979 ◊

Davis, G. E. (1979) An assessment of fishery management options in Everglades National Park, Florida. Rep. T-541. South Florida Research Center, Everglades National Park, Homestead, FL.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] This report presents an assessment which considers the biological and socio-economic impacts of several alternative fishery management actions for the Everglades National Park. The ultimate goal of this process is to provide the information upon which decisions can be made to produce regulations to effectively manage park fisheries in accordance with existing guidelines. Fish mortality must be compensated by natural reproduction and commercial and recreational fishing will be managed to maintain traditional age and size structure of fish populations. A conflict between both fisheries has intensified concerning the use of nets and unlimited harvest of gamefish species in the park. Alternative management options include prohibition of net fishing in all or certain parts of Florida Bay; establish specific bag limits for red drum, snook, sea trout, and gray snapper and/or a combination of species; prohibit harvest of lobster, stone crab and limit or restructure commercial fishing permits; and limit powerboat use and prohibit snook harvest in summer. Major socio-economic positive and negative impacts are given for each option.

1979 ◊

DeFelice, D. R. and G. W. Lynts (1979) Biotic and abiotic parameters affecting diversity in modern and ancient benthic diatom assemblages of Florida. Fla. Sci. 42. (Suppl.):44.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Study of benthic diatom communities in Florida Bay reveals that diversity in living diatom populations is a function of several biotic and abiotic parameters. Among the most important of these parameters is substrate, light quality, sediment particle size, and distance from land. Examination of a core recovered from Florida Bay shows that although diatoms are quite common in surface sediment, they are absent immediately below the surface horizon, leaving sponge spicules as the only siliceous biogenic components in the sediment. Florida Bay, as a shallow water carbonate environment, is extremely undersaturated with respect to silica in the water column and at the sediment-water interface. It is believed that diatoms dissolve almost immediately after death, allowing for quick recycling and reutilization of silica in a silica starved environment. Rapid dissolution and recycling would subsequently impede any accumulation of dissolved silica in interstitial pore waters.

1979 ◊

Enos, P., and R. D. Perkins (1979) Evolution of Florida Bay from island stratigraphy. Geol. Soc. Amer. Bull., 90:58-83.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] The sedimentary record of most Florida Bay islands is an asymmetric cycle consisting of a transgressive sequence followed by a regressive sequence, both formed during a continuous Holocene rise in sea level. The principal sedimentary environments of Florida Bay and the south Florida mainland are represented in the cycle by an upward succession of freshwater pond, coastal mangrove swamp, shallow bay ("lake"), mud bank, and island. Some parts of the cycle may be missing, but the sequence is always the same. Supratidal carbonate sedimentation on islands may develop from coastal mangrove swamp or by mangrove colonization of mud banks. Islands have developed from mud banks at many different times during the rise of sea level into Florida Bay, indicating that mud banks must have existed through out much of the Bay's history. Florida Bay probably will evolve into a coastal carbonate plain with inland mangrove swamps and freshwater ponds, very similar to the present southwest Florida mainland.

1979

Irvine, A. B., J. E. Caffin, and H. I. Kochman (1981) Aerial surveys for manatees and dolphins in western peninsular Florida. US Fish and Wildlife Service, Bureau of Land Management, Washington, DC. FWS/OBS-80/50. 21 pp.

Low altitude aerial surveys were conducted at approximately monthly intervals from July to December 1979 to count West Indian manatees (*Trichechus manatus*) and bottlenose dolphins (*Tursiops truncatus*) in western peninsular Florida. Sightings of sea turtles, turtle tracks, and a crocodile were also noted. A total of 554 manatees was observed in 297 groups. Fifty-eight percent of the manatees were sighted in the CollierMonroe Counties area in shallow, brackish inshore areas. A total of 1,383 bottlenose dolphins was observed in 431 herds, including 700 (in 146 herds) in the Gulf of Mexico, 491 (in 185 herds) in bays, and 192 (in 100 herds) in marsh-river habitats. Fifty-eight sea turtles (including 45 loggerheads, *Caretta caretta*) and 30 sets of turtle tracks were counted. One crocodile, probably *Crocodilus acutus* was sighted in the Everglades National Park.

1979 ◊

May, J. A., and R. D. Perkins (1979) Endolithic infestation of carbonate substrates below the sediment-water interface. J. Sediment. Petrol., 49(2):357-78.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Carbonate substrates prepared from conch shells and inorganic cleaved calcite were planted both at and below the sediment-water interface in a back barrier sound of North Carolina, within a mudbank of Florida Bay, and along a barrier reef transect in Belize. Scanning electron microscope (SEM) examination of plastic casts of microboring networks formed the primary basis of study, supplemented by light microscopy of isolated endolithic organisms and transmission electron microscope (TEM) examination of doubly embedded material. A diverse assemblage of endolithic forms was detected in substrates planted at the sediment-water interface. In contrast, a less diverse and distinctly different assemblage of endolithic forms was found within substrates planted as much as 160 cm below the sediment-water interface. This is the first known report of such activity within buried marine sediments. The most abundant subsurface endoliths were two coccoid forms, separated on the basis of size, surficial texture, and morphology. Each type had several growth variants believed to be stages of binary, cellular fission. Other endolithic forms detected include a filamentous, irregular, polygonal network; an irregular flattened mass; and a regular, crenulate, flattened disc. TEM examination of one of the coccoid forms suggests a procaryonic blue-green algal or bacterial origin. The affinities of the other forms were unknown, but resemble endolithic traces attributed to fungi, bacteria, and *Actinomycetes*. The regular discoids and irregular flattened masses were found only in association with the filamentous form and may be reproductive bodies. Subsurface endoliths appear to be restricted to finer-grained, reducing sediments, and may be utilizing the more abundant interstitial nutrient supply as well as, or instead of, organic matrices within the mollusk substrates. Endolithic activity within buried marine carbonate sediments has important consequences in that it broadens the environmental conditions under which microborings may form. It also suggests that endolithic heterotrophs may significantly affect the surrounding microenvironment within sediments, and may result in porosity development during early sediment burial.

1979 ◊

Odell, D. K., E. D. Asper, J. Baucom, and L. H. Cornell (1979) A summary of information derived from the recent mass stranding of a herd of false killer whales, *Pseudorca crassidens* (Cetacea:Delphinidae). Biology of Marine Mammals: Insights Through Strandings. J. R. Geraci and D. J. St. Aubin (eds.). NTIS Rept. PB293-380. 207-22.

[NO COPY OF PAPER AVAILABLE.] [Same narrative as Odell *et al.* 1980).]

1979 ◊

Raymond, R. J., and T. D. Davies (1979) Content and form of sulfur in coal: A reflection of peat depositional environments. Geol. Soc. Amer. Abs., 11(7):501.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Chemical, optical, and electron microprobe techniques were used to study content and form of S in recent peat from Florida Bay and low volatile bituminous coal of Middle Pennsylvanian age from western Pennsylvania (Lower Kittanning seam). The results reveal three discernible periods of sulfur emplacement in the peat/coal cycle. The first and second occur during early stages of peat deposition when compaction is minor and water circulation is unrestricted. During this time the entire organic sulfur constituent will be emplaced, and depending upon the available sources of Fe and S, small euhedral crystals (0.5 - 15 µm) and framboids (5 - 50 µm) of pyrite may be incorporated within peats. The first period of S emplacement reflects the peat depositional environment. If deposition occurs in freshwater, organic S will be low and pyrite may be entirely absent in marine water, the peat will have high organic S content and may have high pyrite content depending upon available iron. The second period occurs after peat deposition, but prior to coalification. If marine waters permeate a previously deposited peat, both the pyritic and organic S content will be increased. Due to high permeability of peat, S enhancement is greater in freshwater if it is overlain by marine peat marine rather than marine carbonate mud. The third period occurs after coalification, when permeability is mostly restricted to joint or cleat fractures. At this stage organic S content is not altered. If Fe and S are present in ground water, pyrite may be deposited, but only as fillings in fractures or pores. The massive form of this pyrite can be distinguished from the euhedral crystals and framboids typical of marine depositional environments.

1979 ◊

Rosenfeld, J. K. (1979) Ammonium adsorption in nearshore anoxic sediments. Limnol. Oceanogr., 24(2):356-64.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The distributions of dissolved, exchangeable, and fixed ammonium were measured in sediment cores from Long Island Sound, Florida Bay, and Pettaquamscutt River, RI, and in laboratory experiments to determine the importance of ammonium adsorption in anoxic sediments. Two sites were sampled in Florida Bay, at Ramshorn and Mangrove, north of Tavernier. Apparently, a dynamic equilibrium exists between dissolved, exchangeable and fixed ammonium in sediments. The concentration of exchangeable ammonium increased linearly with increasing concentrations of dissolved ammonium. Exchangeable ammonium adsorption was rapid, reversible, and predominantly associated with the organic matter rather than the clay minerals. The concentration of fixed ammonium also increased with increasing concentrations of dissolved ammonium, but this change, due to diagenesis, is small compared to the total fixed ammonium in sediments and is also smaller than the corresponding increase in exchangeable ammonium. The ammonium adsorption coefficient for Long Island Sound sediment was between one and two: of the ammonium produced by organic matter decomposition, as much or twice as much is associated with the sediment as is dissolved in the interstitial water. Therefore, ammonium adsorption by sediments is an important process in the diagenesis of nitrogen in nearshore anoxic sediments.

1979 ◊

Rosenfeld, J. K. (1979) Interstitial water and sediment chemistry of two cores from Florida Bay. J. Sediment. Petrol., 49(3):989-94.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The interstitial water and sediment chemistry of cores from two different environments in Florida Bay, mangrove swamp and submerged mudbank, were analyzed. The interstitial water profiles showed that sulfate reduction, along with the resulting ammonium, phosphate, and alkalinity production, was occurring in Florida Bay sediments. However, the sulfate concentration profile was not typical of other anoxic environments, in that the sulfate concentration increases below a depth of approximately 20 cm. The ammonium, phosphate, and alkalinity concentrations all decrease below this depth. It is suggested that these interstitial water profiles might be explained in terms of a balance between the mixing of the interstitial water with the overlying seawater and decreasing rates of organic matter decomposition with depth. The rates of organic matter decomposition were measured in laboratory experiments, which indicated that sulfate reduction and ammonium generation were much faster (a factor of 3 to 9 times) between 0 and 10 cm than between 10 and 20 cm. Organic carbon, organic nitrogen, and amino acid profiles showed decreases as large as a factor of 2 in the organic content of Florida Bay sediments in the top 60 cm of the sediment column.

1979 ◊

Rosenfeld, J. K. (1979) Amino acid diagenesis and adsorption in nearshore anoxic sediments. Limnol. Oceanogr., 24(6):1014-21.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Amino acid diagenesis and free amino acid adsorption by sediments were studied in cores of nearshore anoxic sediments from Long Island Sound, Florida Bay, and Pettaquamscutt River, RI. Two sites were sampled in Florida Bay, at Ramshorn and Mangrove Keys, north of Tavernier. Both organic nitrogen and amino acid content decreased by a factor of about two in the top meter of the sediment. Individual amino acid profiles showed that the acidic and neutral amino acids, despite their different chemical composition, appeared to be equally u ized in both clastic and carbonate sediments. This result differs from the preferentia utilization of certain amino acids generally found in deep-sea sediments. The results of laboratory adsorption experiments suggest that in clay sediments, free amino acids are predominantly adsorbed by the organic matter in the sediment rather than by the clay minerals. However, in the carbonate sediments, the organic matter seems to inhibit the adsorption of free amino acids on the carbonate grains.

1979

Schmidt, T. W. (1979) Preliminary observations on fish predator-prey interactions in the Shark River estuary, Everglades National Park. Second Conf. on Natl. Parks, San Francisco, CA. November, 1979. 63.

[ABSTRACT ONLY.] In this paper, preliminary results are reported on a fish food habits study currently in progress in the Shark River estuary, Everglades National Park. The purposes of the study were to obtain quantitative information on the energy pathways and trophic interrelationships of dominant, non-game, epibenthic fish, shrimp, and crabs. It is part of a larger project to identify the driving variables on the biotic resources within the coastal ecosystems of South Florida National Park Service areas. These data are essential in our understanding of how these estuaries respond to external parameters, fishing pressure, and natural or man-made environmental variation. The selection of study sites and standard sampling techniques focused on the principal prey items of pinfish *Lagodon rhomboides,* silver jenny *Eucinostomus gula*, silver perch *Bairdiella chrysura*, lane snapper *Lutjanus synagris*, pigfish *Orthopristis chrysoptera*, blue crab *Callinectes sapidus*, and pink shrimp *Penaeus duorarum*. Types of sampling gear employed, the design, fabrication, and installation of mechanical hardware required to accommodate the samplers, and the procedures used, including water quality parameters measured, sampling frequency and intervals, are discussed. A literature search on potential predator-prey organisms was conducted through park and university libraries. A rapid, standardized approach for laboratory procedures was developed utilizing the same methods to measure the food organisms and those taken in concurrent biotic surveys. Required information on the individual- predators included numbers, length, weight, sex, reproductive condition, and species of food organisms being eaten. A data manipulation and processing system was developed on a Wang 2200 minicomputer to store and retrieve stomach contents data sets and to compute and display the statistical summaries of the prey organisms including numerical and percent composition (frequency of occurrence), abundance and biomass of the food items. In addition, the storage of important life history information on other predator characteristics was facilitated. Prey organism collected between March and June, 1979, indicated that most of the diet items fell into three categories: mussels *Brachidontes exustus*; polychate fragments; and gammarid or caprellid amphipods. Future work plans are to determine if feeding preferences are due to differences in prey availability resulting from natural or man-made environmental variation. With this information in hand the park managers who are responsible for managing natural resources can direct their interests towards understanding what regulates the stability of these ecosystems.

1979 ◊

Tisserand Delclos, L. (1979) Foraminiferes de deux localites de la baie de Floride et des environs; Joe Kemp Key et Key Biscayne. (Foraminifera from two localities in Florida and vicinity; Joe Kemp Key and Key Biscayne) Notes du Laboratoire de Paleontologie, 4(2):19-25.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE. CITATION IN FRENCH.] This citation discusses foraminifera from Joe Kemp Key and Key Biscayne.

1979 ◊

Wanless, H. R. (1979) Role of physical sedimentation in carbonate-bank growth. Am. Assoc. Petrol. Geol. Bull., 63(3):547.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Carbonate mudbanks of central Florida Bay contain three types of sediment wedges which provide evidence that pulses of rapid physical sedimentation are a dominant cause for bank growth and migration. Most dramatic are layered to laminated wedges of carbonate mudstone flanking eastern, southern, or western bank margins . Depositional units are .5 to 1.5 m thick and compose up to 70% of the existing bank. Units have erosional basal contacts: basal shelly sand grades upward to a layered laminated mudstone containing no pellets, no burrowing, no seagrass rootlets, and few sand size skeletal grains. Three features suggest rapid disposition: vertical escape burrows extending upward from the basal sand, vertical smooth-walled water escape fractures in the lower part, and abundant seagrass blades incorporated into the layers. The second type of wedge is a layered, pelleted mudstone to packstone otherwise similar to that described above. The third type of wedge is a bioturbated, soft-pellet wackestone to packstone as much as 1 m thick and flanking only southern bank margins. It contains horizontal to inclined seagrass rhizomes throughout and has minor autochthonous mollusks. The layered wedges are interpreted to record rapid sudtidal sedimentation during rare super storms (extreme hurricanes), the first type from storms of sufficient violence to destroy most pellets. The third wedge type records persistent lee-side accumulation from lesser hurricanes and winter storms. This deposition, although rapid, is slow enough to be in continuous association with a seagrass-community influence.

1979, 1983 - 1984

Zieman, J. C., J. W. Fourqurean, and R. L. Iverson (1989) Distribution, abundance and productivity of seagrasses and macroalgae in Florida Bay. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):292-311.

The distribution, abundance, and productivity of submerged macrophytes were measured in Florida Bay to determine the total productivity and seagrass habitat distribution throughout the region using aerial photography and ground verification, benthic community characterization, ^{14}C uptake studies, drift material sampling and other techniques. The field work took place during 1983 and 1984 except for the drift material sampling which took place in 1979. The sediment, water level and water temperature at these locations was described by Holmquist *et al.* (1989) and the decapod and stomatopod communities by Holmquist *et al.* (1989). *Thalassia testudinum* was widely distributed and was the dominant macrophyte species in the 1,660 km^2 of seagrass beds contained in the bay. *Halodule wrightii* was also common, but had standing crop significantly less than *Thalassia* at all sample locations. *Syringodium filiforme* grew mainly in areas with strong oceanic influence, especially along the south and west margins of the Bay. Macroalgae were a small percentage of the total macrophyte biomass. Gradients in environmental and biological variables extended from southwest to northeast Florida Bay. Water clarity, water exchange, and sediment depth were all greatest in the south and west portion of the bay and decreased towards the northeast corner of the bay. The seagrass standing crop varied from between 60 and 125 g dw m^{-2} in the southwest to between 0 and 30 g dw m^{-2} in the northeast. Total seagrass leaf standing crop was 8 x 10^{10} g dw in Florida Bay, 90% of which was *Thalassia* leaf material. *Thalassia* mean leaf productivity was 0.97 g dw m^{-2} d^{-1}, with higher values in the southwest and lower values in the northeast portions of the bay. Approximately I .7 x 10^{9} g dw d^{-1} of *Thalassia* leaf tissue was produced in Florida Bay during the summer. *Thalassia* had about the same leaf productivity on a per gram leaf dry weight basis throughout the different environments of Florida Bay, therefore variations in areal leaf productivity were caused by variations in leaf standing crop and not by variations in leaf specific productivity. Distribution, abundance, and productivity data were used to divide the bay into six community types.

1979 - 1980

Bert, T. M., J. T. Tilmant, J. W. Dodrill and G. E. Davis (1986) Aspects of the population dynamics and biology of the stone crab (*Menippe mercenaria*) in Everglades and Biscayne National Parks as determined by trapping. Rep. SFRC-86/04. South Florida Research Center, Everglades National Park, Homestead, FL. 77 pp.

Stone crabs (*Menippe mercenaria*) were trapped on a lunar cycle (full moon) from June 1979 to June 1980 to investigate the population biology and life history of the organism in South Florida marine waters managed by the National Park Service. Seventeen stations, located throughout the coastal regions of Everglades National Park and Biscayne National Park, were fished for an entire year. Five additional stations were fished the last nine months of the study. An array of morphometric and biological data was taken on each crab captured. Salinity, temperature, water clarity, principal fouling biota, and bottom type were recorded at each station during sampling. Relative abundance, proportion of females, and number of juveniles were highest in Everglades National Park marine waters from Lostmans River northward. Also, mean size of both sexes was generally smallest in that region. Progressing southward along the Gulf of Mexico and east into Florida Bay, relative abundance of both adults and juveniles decreased, proportion of males increased, and mean size of both sexes became larger. Juveniles were never found at most stations sampled in Florida Bay. Biscayne National Park resembled Florida Bay in number and size of adults, proportion of males, and lack of juveniles. Juvenile distribution and abundance was directly correlated with relative abundance of adults and proportion of females in the trapped population. The primary source of adults in Florida Bay appears to be a very slow movement of crabs from the Gulf of Mexico progressively farther into Florida Bay. The stone crab population in Biscayne National Park may be dispersing from farther north along the Atlantic coast of Florida. Temporal changes in relative abundance, sex ratio, and size class frequency of female stone crabs captured were strongly correlated to various aspects of reproductive activity. Changes in values of these parameters for males were related to changes in water temperature and female reproductive activity. Differences in relative abundance and mean size of both sexes also corresponded to commercial fishing season near the seaward limits of Everglades National Park in the Gulf of Mexico, and to the number, proportion, and mean size of males in commercially fished areas of Florida Bay. Because of the simultaneous occurrence of natural and artificial factors affecting the trapped population over time, it is difficult to attribute observed variations to any particular factor. As determined by trapping, changes in the population biology of stone crabs in Everglades and Biscayne National Parks occurring during the year are cyclic, and the population recovers to its initial state by the onset of the next year. Female stone crabs produce eggs throughout the summer. Younger females peak in egg production in late summer and older females in late spring. Young females molt and possibly mate more frequently than older females, but egg production of the young segment of the female population is reduced. By age three, all females have apparently reached sexual maturity. Molting occurs from fall through spring in young females and molt frequency declines with increasing age until, at age four, females molt annually in the fall. Females increase in carapace width about 10 mm with each molt and can live to about age seven.

1979 - 1980

Evink, G. L. (1981) Hydrological study in the area of Cross Key, Florida. Rep. FL-ER-16-81. Florida State Dept. of Transportation, Bureau of Environment, Tallahassee, FL.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] This study is designed to evaluate the need for additional openings through the causeways in the area of Cross Key, from the Florida mainland to Key Largo. Information on this area is needed to develop plans for four-laning this section of US 1 in relation to current and past water management practices involving circulation, hypersalinity, and changes in freshwater flow. It was found that salinities on either side of Cross Key may be high during the dry season and under drought conditions. It was recommended that no further structures were needed to obtain relief from hypersaline conditions in the Cross Key area.

1979 - 1980

Gruber, S. H. (1982) Role of the lemon shark, *Negaprion brevirostris* (Poey), as a predator in the tropical marine environment: a multidisciplinary study. Florida Sci., 45:46-75.

Sharks are numerically important members of many marine communities, yet little is known of their role in these ecosystems. Recent technical developments in laboratory and field have facilitated investigation of the autecology of the lemon shark *Negaprion brevirostris* (Poey). This littoral shark is abundant, lives well in captivity and is ideally suited for investigation. During 1979 and 1980, 984 young sharks were marked and released during a study of population dynamics. Each was injected with tetracycline for age validation. We tracked individual sharks for hundreds of kilometers via ultrasonic telemetry thus determining activity rates, movements, home range and diel periods. We evaluated blood gas parameters, food intake, digestion, growth, resting and routine metabolism in the laboratory. These data provide estimates of the energy budget of the lemon shark and form a basis for understanding the flow of energy from environment to shark. Our tentative conclusion is that an adult lemon shark must remove nearly 1500 g of fish daily (1.6×10^6 calories) to account for its vital activities.

1979 - 1980

Lutz, P. L., and A. C. Dunbar-Cooper (1982) The nest environment of the American crocodile, *Crocodylus acutus*. Rep. T-671. South Florida Research Center, Everglades National Park, Homestead, FL. 38 pp.

In the nesting seasons of 1979 and 1980 selected crocodile nests from Florida Bay were studied to examine the nest environment throughout incubation. Nest temperatures ranged from 29.0 - 35.5°C, the higher temperatures more associated with the latter part of the season. A small diurnal fluctuation was recorded over 25 days of monitoring a normal sand nest. Nest soil water values varied considerably (4.89 - 36.14%). Marl tended have higher amounts of water throughout the incubation period. All eggs lost water over the incubation period. The greatest loss appeared to occur towards the end of the season. The amount of water loss is determined by the egg shell permeability and the water vapor gradient across the egg shell, the latter being dependent on the hydration of the soil. In the most complete set of data the average water loss found was very similar to that found for birds (15%). The average birth weight of the hatchlings was 0.64 of the initial egg mass, also very similar to that found for birds. The oxygen diffusivity of sand was much greater than that of marl. In marl the diffusivity was strongly influenced by water content. In all nests there was a decline in oxygen and rise in CO_2 over incubation, i.e. developing embryos will naturally experience hypoxic, hypercapnic conditions. The changes were very variable between nests, though they appeared to be greater in mud nests. It appears that in several cases minimum nest oxygen levels were reached before the end of incubation. It is suggested that the metabolic rate of the nest clutch of *Crocodilus acutus* regulated by oxygen and carbon dioxide levels in the nest. This allows *C. acutus* to use soils of quite different and varying gas permeabilities for nesting sites.

1979 - 1980

Lutz, P. L., and A. C. Dunbar-Cooper (1984) Nest environment of the American crocodile, *Crocodylus acutus*. Copeia, 1984(1):153-61.

In the southern tip of the Everglades, Florida, a small population of the American crocodile, *Crocodylus acutus* builds nests in two quite different substrates, sand/shell and marl. Changes in temperature, soil, water and gaseous composition were monitored in selected nests throughout incubation, and the gaseous resistance of the soils measured. Temperatures increased from approximately 30°C to a maximum of 34°C over incubation and no differences were found between the two nest types. The marl nests had a higher water content than the sand/shell nests and had a significantly higher resistance to gaseous diffusion. In both nest types there was a decline in PO_2 and an increase in PCO_2 over incubation, with greater extremes reached in the marl nests. In sand/shell nests, eggs lost 15% of initial wet weight over incubation. It is suggested that the crocodile embryo adapts to the characteristics of the different substrates by matching its metabolic rate to the gaseous environment of the nest. Important similarities in bird and crocodilian egg development suggest that the birds have been highly conservative in this feature of their biology.

1979 - 1980

Schmidt, T. W. (1993) Community characteristics of dominant forage fishes and decapods in the Whitewater Bay/Shark River estuary, Everglades National Park, Florida. Rep. NPS/SEREVER/NRTR-93/12. South Florida Research Center, Everglades National Park, Homestead, FL. 67 pp.

This report presents the results of studies on the community characteristics (relative abundance, seasonal occurrence, size, reproductive activity, and food habitats) of the following dominant epibenthic forage fish and decapod crustacean species: pink shrimp *(Penaeus duorarum),* blue crab *(Callinectes sapidus),* pinfish *(Lagodon rhomboides),* silver jenny *(Eucinostomus gula),* pigfish *(Orthopristis chrysoptera),* and silver perch *(Bairdiella chrysura).* Juveniles and adults were collected with trawl and gill nets from five sites among open water bay habitats in the Whitewater Bay-Shark River system, March 1979 through May 1980. Macrobenthos sampling was usually conducted at each site on the day fish collections were made. Silver jenny, silver perch, and blue crab were classified as residents in the estuary while pink shrimp, pinfish, and pigfish were seasonal visitors which spawn offshore. Juvenile pink shrimp, the most abundant animal studied, occurred year-around, most abundantly during summer, fall, and winter, while pigfish showed abundance maxima in spring/summer. Blue crab and silver perch occurred most often in winter-spring while nearly equal numbers of silver jenny and pinfish occurred year-around. All species, except for silver jenny, occurred in greatest numbers at the Clearwater Pass site in mid-Whitewater Bay. This site, reflecting potential food sources for these species, had: (1) the greatest macrobenthic diversity, and abundance maximas of crustaceans (amphipoda), polychaetes, and mollusks (bivalves), and (2) the most dense vegetative cover of all sites sampled. Spatial and temporal variations in abundance of the dominant epibenthic species were explained, in part, by spatial and temporal patterns of food availability and habitat quality (i.e. sediment, vegetative cover). Salinity and temperature may only be autocorrelates with spawning activities and recruitment, and were not shown to be important limiting factors for these species. In this study, catches of small juveniles of pink shrimp and pigfish suggests post-larval settlement at Clearwater Pass, whereas catches of young silver jenny and pinfish indicates post-larval settlement in eastern Whitewater Bay for these species. Except for blue crab, catches of larger specimens of all species studied occurred at the deep water, high salinity Oyster Bay site. Diets of seasonal visitors (pink shrimp, pinfish and pigfish) suggested omnivory, with feeding primarily on crustaceans (amphipods and isopods) and vegetation (marine alga/seagrasses), whereas resident species exhibited carnivorous feeding habits, consuming mainly crustaceans (amphipods and shrimp), polychaetes, and mollusks (bivalves). Spatial, temporal, and ontogenetic variations in foods habits were found among the species sampled. Shrimp exhibited dramatic differences in diet with predator size, site, and season; highest feeding activity was found in the fall-winter period while feeding diversity was lowest at the inner-most sampling site (Tarpon Bay). Silver jenny diet varied with season and site, while pinfish varied by season and size and pigfish by predator size. Variations in diet with site and season were attributed to food availability and habitat structure while trophic ontogeny was related to fish/shrimp morphogenesis. These species were sufficiently opportunistic in their food habits to take advantage of the availability of major prey groups found at the sampled sites. In summary, variations in abundance of the dominant species among sites were related to feeding habits as a reflection of prey availability and vegetative cover, while recruitment and reproductive activity were associated with season effects. It may be that patterns of estuarine abundance, as reported in this study, are influenced by long-term evolutionary adaption than by short-term ecological or behavioral response to environmental parameters.

1979 - 1981

Brown, J. W. (1987) Studies of humic and fulvic acid dynamics in coastal marine waters of South Florida. Mar. Environ. Res., 21:163-74.

Humic (HA) and fulvic (FA) acid concentrations (HA + FA) were monitored over a two-year period in different areas of Florida and Biscayne Bays. The Florida Bay sampling site was north of Islamorada. These studies were undertaken in an effort to determine fluctuations in the quantity and chemical nature of humic substances in productive coastal environments in South Florida and, retrospectively, to discern the extent of potential terrestrial influences. Additional studies were undertaken with material from a South Florida mangrove environment and material isolated from offshore Gulf Stream waters. Dramatic fluctuations in humic substances were observed in all coastal areas. In east-central Florida Bay, for example, humic materials (HA + FA, collectively) were found to fluctuate as much as eleven fold. In both Biscayne Bay and Florida Bay, these fluctuations appeared to follow the artificially-controlled input to water from the South Florida mainland. The ratios of FA to HA varied dramatically between terrestrially-influenced and oligotrophic marine environments (i.e. a progressive increase of the FA/HA ratio with this transition). In all marine locations studied, coarse particulate humic substances were low in comparison to the dissolved component of this chemical class. The sampling sites were monitored at 6 - 8 week intervals during 1979 to 1981.

1980 ◊

Aisner, J. A. (1980) Origin and development of Arsenic Bank, a Holocene biotherm in southwestern Florida Bay. Geol. Soc. Amer. Abs., 12(4):169.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Arsenic Bank is a Holocene biotherm located in southwestern Florida Bay, approximately 9 km north-northwest of Long Key. Fourteen cores were analyzed to determine the stratigraphy and depositional process of the shoal. Sediment samples from the shoal surface were also analyzed to determine recent modes of sedimentation and biotic communities. Arsenic Bank is composed of alternating beds of coarse coral, algal and molluscan sediments with subordinate plant, foraminiferal and ostracode debris. A thick carpet of *Thalassia, Porites, Halimeda* and sponges blankets the shoal and allows for sediment entrapment, shoal growth and stability. These current and wave resistant organisms form a loose, interlocking framework where coarse-grained molluscan and *Halimeda* sediment is entrapped. Sediment texture suggests that the various modes of sedimentation setting on Arsenic Bank throughout Holocene time have not changed significantly. These modes of sedimentation include *in situ* accumulation of wave-generated skeletal debris and allochthonous debris, including Pleistocene rock fragments, from adjacent areas. The presence of large Pleistocene rock fragments indicates that storms account for significant episodic deposition on the bioherm. Vertical and lateral accretion of the bank is the result of the framework organisms adapting to areas subject to high wave and current energy.

1980 ◊

Aisner, J. A. (1980) Origin and development of Arsenic Bank, a Holocene biotherm in southwestern Florida Bay. Fla. Sci., 43(suppl. 1):43-4.

[NO COPY OF PAPER AVAILABLE. Narrative same as in Aisner (1980).]

1980 ◊

Davies, T. D., and W. Spackman (1980) The palynology of the peats of Florida Bay. Palynology, 4:238.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Five hundred and seventy-three sites were probed in Florida Bay to establish the thickness and areal extent of Recent sub-marl peat. Cores were taken from Ninemile Bank, Spy Key-Panhandle Key Bank, Joe Kemp Key, Cluett Key, Jim Foot Key, Samphire Key, Man-of-War Key, Shell Key, Panhandle Key, Spy Key, Russell Key, Eagle Key, Crane Key, and Pigeon Key. The peat is more extensive than heretofore recorded and commonly occurs as the basal sediment beneath numerous islands and "banks." Normally, the peat is overlain by a marine carbonate but in one case it forms the entire sedimentary sequence of 11 ft 5 in. Six cores were investigated petrographically and palynologically. In all, a clearly defined transgressive sequence was encountered with the basal peats representing freshwater environments of both marsh and hammock types. The freshwater peats are overlain by brackish and then by "marine" peats, unless the peat sequence is truncated by an unconformity, in which case the overlying sediment is a marine carbonate. The latter may contain one or more lenses of *Rhizophora* or *Avicennia* peat. In many instances, the initially-formed peat had been extensively intruded by roots of younger plants growing in overlying environments, which were substantially different from the environments responsible for the original peat. This usually results in considerable degradation of the original peat and this, compounded with the addition of new plant material, produces a new "secondary" peat type. Hence, proper interpretation of the true ecological sequence represented by the peat sediment becomes difficult. Study of the pollen content of each peat type enables the accurate recognition of the environment responsible for formation of the "primary" peat type and thus complements the petrographic approach to the study of phytogenic sediments.

1980 ◊

Davis, G. E. (1980) Juvenile spiny lobster management or how to make the most of what you get. Fisheries, 5(2):57-62.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] Larval production and survival, equitable allocation and efficient harvest among fishermen, and maximization of yield per postlarval recruit are identified as the major elements amenable to management actions in spiny lobster fisheries. A step down diagram is provided which illustrates the logical relationship among the three elements, the overall fishery objective of an optimum yield and a description of the relationship between the factors involved in improving the yield per postlarval recruit. The factors discussed in the paper are: minimum harvest size, growth values, mortality rates and nursery sanctuaries. National Parks' provide protection for about 1/3 of the juvenile spiny lobster habitat in south Florida.

1980 ◊

DeFelice, D. R. and G. W. Lynts (1980) Epiphytic diatoms as r-selectors in Florida Bay, Florida. Fla. Sci., 43 (Suppl.):23.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Examination of epiphytic diatom populations of Florida Bay provides an excellent opportunity to test the applicability of r selection to low trophic level organisms. *Cocconeis placentula* Ehrenberg, the dominant epiphyte, exemplifies many of the characteristics attributed to the theoretical "r" endpoint species. Specimens of this species are small, considered degenerate, and live in an unpredictable and ephemeral environment (*Thalassia testudinum* grass blades). The epiphytic assemblage is characterized by high productivity and low equitability. Recolonization is periodically necessary due to short lived nature of the grass blade substratum. Strategy for *Cocconeis placentula* is to put all possible matter and energy into reproduction with the smallest practicable amount into each individual offspring. The r endpoint represents an ecologic vacuum with no competition. Production is regulated solely by maximum intrinsic rate of natural increase (r max).

1980 ◊

Dunson, W. A. (1980) The relation of sodium and water balance to survival in seawater of estuarine and fresh-water races of the snakes *Nerodia fasciata, N. sipedon* and *N. valida*. Copeia, 1980(2):268-80.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Subspecies of the Florida banded water snake (*Negroid fascinate*) vary markedly in their tolerance to seawater. The freshwater race *N. f. pictiventris* differs physiologically from the estuarine races *N. f. compressicauda* and *N. f. clarki* in several, important ways. When placed in seawater, it has a higher body water influx and efflux, a higher body sodium influx, and its skin is more permeable to water and sodium. It is likely that the high rate of sodium influx, immediately after placement in seawater, is the primary factor leading to drinking of seawater and subsequent death. Thus the distinction between freshwater and estuarine races is not simply behavioral, as was previously believed, but is dependent also on physiological differences. Other freshwater snakes studied (*N. sipedon, Regina septemvittata*) also had greater rates of water influx than found in marine or estuarine species. The queen snake (*R. septernvittata*) has the highest rates of sodium influx and water exchange. Immediately after immersion in seawater, water exchange is primarily through the skin and sodium uptake through the mouth. Interbreeds between *N. f. pictiventris* and *N. f. compressicauda* had the seawater tolerance of the estuarine race. It appears that these estuarine subspecies are in the process of evolving into true marine species. They may not have a salt gland, but they are capable of surviving long penods in saline habitats. A similar evolutionary development may be occurring among coastal populations of the Mexican water snake *N. valida.* Some specimens of *N. f. compressicauda* were collected in Florida Bay.

1980 ◊

Enos, P. (1980) Stratigraphic sequences in a shelf lagoon: Florida Bay. Geol. Soc. Amer. Abs., 12(2):33.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] A carbonate facies mosaic is being deposited in Florida Bay, which is characterized by variable salinity, low energy and compartmentalizatlon by mudbanks. Lithofacies are: (1) calcite "mudstone" of freshwater ponds; (2) peat from coastal mangrove swamps; (3) aragonitic skeletal packstone lag from intrabank basins; (4) skeletal-pelletal wackestone, laminated mudstone, and packstone from mudbanks; and (5) stromatolitic wackestone from supratidal islands. Some or all of these components are stacked in the order named into an asymmetric sequence, transgressive through elements 1-3 and regressive through thicker mudbank and supratidal phases. Predominately vertical accretion forms banks and islands which then act as nuclei for lateral accretion. The resultant facies mosaic is complicated in detail but coherent in overall aspect because of the predictable sequence. This sequence is accumulating over a microkarstic disconformity surface. The semi-restricted setting originates primarily from depositional topography of the previous (Pleistocene) cycle but is influenced by evolving depositional topography of the present regime. Small-scale depositional relief producing diverse and compartmentalized environment was probably as commonplace in ancient semi-restricted carbonate settings as in modern examples, but could only be detected in the record with extremely detailed stratigraphic control. Depositional regimes similar to Florida Bay will apparently be perpetuated in south Florida by incremental compartmentalization and filling of the shallow inner shelf of the Gulf of Mexico. On the small scale of mudbank accretion as well as on the larger scale of incremental shelf filling, deposition is more episodic than continuous.

1980

Hunt, J. H., W. G. Lyons, and F. S. Kennedy (1986) Effects of exposure and confinement on spiny lobsters, *Panulirus argus*, used as attractants in the Florida trap fishery. US NMFS. Fish. Bull., 84(1):69-76.

Traps in the south Florida spiny lobster fishery were baited with live sublegal-sized lobsters (shorts), many of which are exposed for considerable periods aboard vessels before being placed in traps and returned to the sea. Average mortality rate of lobsters exposed 0.5 1, 2, and 4 hr in controlled field tests was 26.3% after 4 weeks of confinement. About 42% of observed mortality occurred within 1 week after exposure, indicating exposure to be a primary cause of death. Neither air temperature during exposure nor periodic dampening with seawater had significant effects on mortality rate. Mortality among confined lobsters increased markedly in the Atlantic ocean side but not in Florida Bay during the fourth week of confinement following exposure, probably because more natural food organisms entering traps from nearby seagrass beds delayed starvation at the latter site. Mortality caused by baiting traps with shorts may produce economic losses in dockside landings estimated to range from $1.5 to $9.0 million annually. Mortality studies were conducted four times during 1980 in Florida Bay, and six times during 1981 and 1982 in the Atlantic reefs.

1980 ◊

Mitchell-Tapping, H. J. (1980) Depositional history of the oolite of the Miami limestone formation. Fla. Sci., 43(2):116-25.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The Pleistocene Miami Limestone Formation presently consists of the Miami Oolite and Key Largo Reef facies. It is proposed here that the Miami Oolite facies be considered as two separate units within the Miami Limestone Formation and penecontemporaneous to the Key Largo Reef limestone. The lower unit is called the Key West Oolite and the upper is called the Fort Dallas Oolite. The Fort Dallas unit is considered an eolian dune field formed by the breakdown of various oolitic marine bars across the mouth of Florida Bay, while the Key West unit is the remnants of some of these bars formed behind the Key Largo Reef in Sangamon time. This new division of the Miami Limestone Formation was based on field outcrops, above and below the water, the fossils, well cuttings, and an SEM study of the ooids.

1980

Stoneburner, D. L., and J. A. Kushlan (1984) Heavy metal burdens in American crocodile eggs from Florida Bay, Florida, USA. J. Herpetol., 18(2):192-3.

Nine unhatched eggs of the American crocodile (*Crocodylus acutus)* were collected in Florida Bay in 1980 and the levels of heavy metals determined. The egg samples were partitioned into shell and albumin-yolk mass. These two samples were lyophilized and metal level determinations, with the exception of Hg, were made after HNO_3/H_2O_2 digestion of the lyophilized material using inductively coupled plasma spectrometer. NIST SRM 1577, Bovine Liver, was used as part of the quality assurance protocol. The elements determined were Al, Cr, Co, Ni, Cu, Sr, Mo, Cd, Hg, and Pb.

1980

Ullman, W. J., and R. C. Aller (1985) The geochemistry of iodine in near-shore carbonate sediments. Geochim. Cosmochim. A., 49(4):967-78.

The total concentration of I is commonly higher in surface terrigenous sediments relative to more deeply buried material. Diagenetic release, loss of dissolved I during burial, and back-reaction of I with the solid phase under oxidizing conditions contribute to I enrichment near the sediment/water interface. In order to differentiate between scavenging of dissolved I by organic matter or metal oxides, the diagenetic behavior of I was examined in the Fe-poor carbonate sediments of Florida Bay. In this environment, I is released by organic decomposition at I/C ratios similar to terrigenous environments (~0.5 mmole $mole^{-1}$), transported to the oxygenated sediment/water interface, and lost to the overlying water. The dissolved I flux from these deposits is roughly equivalent to the production rate within the deposit (~10 μmole m^{-2} day^{-1} at 28°C). No significant enrichment was observed in the solid phase. Dissolved iodine transport within the sediment column may also be controlled by non-steady-state lateral diffusion into burrows. These observations, together with laboratory experiments which demonstrate IO^{3-} scavenging by Fe-oxyhydroxides at pH $\leq$ 8, imply that enrichment of I in terrigenous surface sediments results predominantly from the initial oxidation of I^- to IO^{3-} by microorganisms, followed by sorption on Fe oxides. Upon burial and reduction during anaerobic decomposition, this metal-associated I is released to solution, in a manner similar to phosphate. Sampling took place at Crab Key Bank and Captain's Key Bank in 1980.

1980 - 1981

Mazzotti, F. J., J. A. Kushlan, and A. C. Dunbar-Cooper (1988) Desiccation and cryptic nest flooding as probable causes of egg mortality in the American crocodile, *Crocodylus acutus*, in Everglades National Park, Florida. Fla. Sci., 51(2):65-71.

Flooding and desiccation probably caused mortality of eggs of the American Crocodile (*Crocodylus acutus*) in Everglades National Park. Flooding was subterranean with no sign evident above ground. Apparent desiccation occurred in a year (1981) of abnormally low rainfall. The timing of nesting seems to be rigidly scheduled, with the developmental period bracketed by possibly desiccating and flooding conditions. The success of this strategy is shown by the relatively low rate of embryonic mortality in most years.

1980 - 1983

Merriam, D. F., C. E. Sorensen and R. V. Jenkins (1987) Modern carbonate sediments in Shell Key Basin, Florida Bay. Symp. on the Geology of South Florida. Miami Geol. Soc. Mem., 3:73-90.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] Shell Key Basin, bordered on the east by Upper Matecumbe Key and mangrove islands on the west within the boundaries of the Everglades National Park in Florida Bay was studied through a period of two years. Water and sediment samples were collected from 13 stations in the Basin; additional sites were sampled in north central Florida Bay for comparative purposes. It was found through sonic depth profiles and sediment cores that the same microkarst features are under the basin as are exposed farther north on the mainland. Analysis of results indicate that sediments accumulating in the basin has a bimodal size distribution from Penicillus secretions and abraded bioclastic debris. Storm-driven currents are responsible for sediment distribution and composition. In general, the salinity and CO_2 of the water decrease as pH and turbidity increase; salinity changes are the result of dilution and circulation; CO_2 changes result from vegetation, light, and temperature; pH is affected by CO_2 production and circulation; and turbidity is due to depth, agitation, and availability of loose material. It was suggested that there is a topographical low area parallel to the present keys and extending north seemingly an extension with present-day drainage.

1980 - 1985

Harriss, R. C., D. I. Sebacher, K. B. Bartlett, D. S. Bartlett, and P. M. Crill (1988) Sources of atmospheric methane in the south Florida environment. Global Biogeochem. Cycles, 2(3):231-43.

Direct measurement of methane (CH_4) flux from wetland ecosystems of South Florida demonstrates that freshwater wet prairies and inundated sawgrass marsh are the dominant sources of atmospheric CH_4 in the region. Fluctuations in soil moisture are an important environmental factor controlling both seasonal and interannual fluctuations in CH_4 emissions from undistrubed wetlands. Land use estimates from 1900 to 1973 were used to calculate regional CH_4 flux. Human settlement in South Florida has modified wetland sources of CH_4, reducing the natural prairies and marsh sources by 37%. During the same period, impoundments and disturbed wetlands were created which produce CH_4 at rates approximately 50% higher than the natural wetlands they replaced. Preliminary estimates of urban and ruminant sources of CH_4 based on extrapolation from literature data indicate these sources may now contribute approximately 23% of the total regional source. We estimate that the integrated effects of urban and agricultural development in South Florida between 1900 and 1973 resulted in a 26% enhancement in CH_4 flux to the troposphere. This citation reports the results of CH_4 flux studies conducted from 1980 to 1985.

1981 ◊

Aisner, J. A., and S. B. Upchurch (1981) Genesis of a skeletal mound, Arsenic Bank, Florida Bay. Geol. Soc. Amer. Abs., 13(7):394.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Arsenic Bank is a series of Holocene carbonate mounds located in southwestern Florida Bay. Surficial sediment samples and fourteen cores were taken from a mound in the middle of the Arsenic Bank chain to determine bank history, modes of sedimentation and biotic composition. The depositional history of the mound is, in ascending order, deposition of: (1) a basal, polyhaline facies; (2) an upper, normal marine facies; and (3) a storm facies within the normal marine facies. These facies document the Flandrian transgression in southwestern Florida Bay. The basal, polyhaline facies consists of muddy sand which accumulated in bedrock depressions about 3,200 yrs ago. This sediment was colonized by *Thalassia* and contains a brackish-water tolerant fauna. The normal marine facies is composed of beds of coral, algal and molluscan sediment with subordinant plants, foraminifera and sponges. Growths of *Thalassia*, *Porites* and sponges allowed for baffling of waves and currents and formed a loose, interlocking framework in which sediments were trapped. They also provided a substrate for a diverse fauna of sediment contributors. Episodic storms account for significant concentrations of very coarse-grained sediment within the normal marine facies. These concentrations resemble modern "blowout" deposits caused by major storms. Sediment textures suggests that modes of sedimentation on the mound have not changed significantly throughout most of its depositional history. These modes of sedimentation include autochthonous accumulations of skeletal debris and bedrock fragments. Vertical accretion of the mound is the result of growth of framework-organisms and sediment entrapment in a high wave- and current-energy environment. Episodic storms yield lag concentrations of corals and other coarse skeletal debris.

1981 ◊

Kick, R. M. (1981) Carbonate sediments from Peterson Key Bank, Florida Bay. M. S. Thesis, University of South Florida, Tampa, FL.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] A study of carbonate sediments at Petersen Key Bank demonstrated that all sediments are of biological origin, produced predominantly by mollusks, *Halimeda*, and foraminifera. Difference in sediment texture was attributed to the mode of sedimentary breakdown by organisms. These organisms and the type of sediment they produce are summarized. The distribution of sediment type was used to determine the recent history of two channels in the bank.

1981 ◊

Davis, G. E. (1981) On the role of underwater parks and sanctuaries in the management of coastal resources in the southeastern United States. Environ. Conser., 8(1):67-70.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Aquatic resources in parks and reserves are not as adequately protected as comparable terrestrial resources. Thus the values of protected aquatic ecosystems as standards for comparison, reservoirs of genetic material, and "emotional" reserves, are apt to be greatly diminished. Even seemingly static ecosystems such as coral reefs are dynamic, changing dramatically in response to natural short-term environmental variations. Such ecosystems require protected natural areas as dynamic standards that will allow distinctions to be drawn between effects of exploitation or pollution and normal variation. Furthermore, fisheries harvests may reduce the size at which exploited species mature, and reduce the amount and variability of genetic material produced by exploited populations. The seven underwater parks or sanctuaries established since 1935 in Florida and the US Virgin Islands exhibit wide variations in the degree of protection accorded to aquatic resources, a range being apparent from nearly complete protection in the first parks to be established to virtually no protection at all in the recently-established parks. The consequences of permitting consumptive uses of aquatic resources in parks and reserves need to be objectively evaluated. Unless these consumptive uses are severely curtailed or eliminated, the primary values of the parks and reserves may never be realized.

1981 ◊

Morrison, D. (1981) Macroalgal seasonality in *Batophora*-dominated communities in the Florida Keys. M. S. Thesis. Rosentiel School of Marine and Atmospheric Science, University of Miami, Miami, FL. 118 pp.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] This study investigates macroalgal seasonality in *Batophora*-dominated communities in Florida Bay at Hammer Point, Key Largo. The objectives of this research were: (1) to determine if the macrophyte community varies seasonally in respect to species richness, diversity, and abundances of species; (2) the description of the annual pattern of productivity, abundance, and reproduction of *Batophora oerstedi*; and (3) to determine if observed biological patterns are correlated with seasonal changes in environmental parameters. All measured abiotic patterns fluctuated over the course of a year; however, only a few exhibited seasonal patterns. Water temperature had an obvious seasonal pattern of considerable amplitude. A maximum temperature of 36°C was recorded in summer and a minimum of 12°C in winter. Nitrite and nitrate had no apparent seasonal pattern. However, orthophosphate levels were greatest in spring and summer and ammonia concentrations were generally greatest in the summer and fall. These patterns could be due to terrestrial runoff from heavy summer rains and fall turnover in the canal. Mid-day irradiance at the study site did not exhibit much seasonality. Macrophyte associations in three habitats - bay flat, canal ledge, and canal slope - were investigated. Dominant species on the bay flat were *Batophora oerstedi* and *Acetabularia crenulata*. In the canal, the dominants were *Batophora* and *Laurencia* spp. (*L. poitei* and *L.obtusa*). In all habitats, seasonality occurred at the community and population levels. The macroalgal associations can be subdivided into winter and summer communities, with significant seasonal differences in at least two of the following community characteristics: species richness, species diversity, total vegetational abundance, and the abundances of species. The seasonal pattern differed with habitat; species diversity increased on the bay flat, decreased on the canal slope, and remained the same on the canal ledge from summer to winter. The different patterns are in part due to differences in species composition and relative abundance among habitats. Community seasonality was due primarily to fluctuations in the abundances of species present in both periods rather than changes in species composition. Ten species varied seasonally in population abundance. These include the dominants of each habitat except the canal slope. *Batophora* abundance was highest in the summer and fall. *Schizothrix* sp. also was more abundant in summer. The other species, *Acetabularia*, *Laurencia* spp, *Chondria tenissuma, Heterosiphonia* sp., *Polysiphonia* sp., *Jania rubens,* and *Griffithsia tenius* were more abundant in winter. These results support the hypothesis of the presence of winter- and summer-optimum plants in the Florida Keys. *Batophora* was reproductive throughout the year; however, the reproductive activity varied seasonally. Reproduction was greatest in fall (mid-October to mid-December). The fall reproductive pulse may be triggered mainly by the abrupt drop in water temperature with the passage of the first fall cold front, or occasionally a late summer hurricane. Net photosynthesis and respiration varied seasonally but with different patterns. Net photosynthesis was highest in summer and lowest in winter. It was positively correlated with temperature, but not correlated with any other parameter. Respiration was greatest in fall when reproductive activity was maximal. Respiration was not correlated with any environmental parameter. Whereas seasonality in net photosynthesis is influenced by an environmental factor, temperature, seasonal variation in respiration appears to be the result of a biological phenomena, reproductive activity, and not directly influenced by abiotic factors within the ranges observed here. The P/R ratio was always greater than one, thus *Batophora* metabolism was not energy limited. Batophora's apparent capacity for year-round growth and reproduction could explain its ability to rapidly colonize and dominate newly exposed substrate. I believe temperature is the major abiotic causal factor in the seasonality observed in this study. Seasonal patterns in *Batophora* photosynthesis, reproduction, and abundance, and the abundances of other species closely follow that of temperature. Photoperiod, irradiance, and wave action, which could explain why *Batophora* abundance on the canal slope did not vary seasonally, probably play a secondary role to temperature.

1981

Powell, G. V. N. (1983) Food availability and reproduction by great white herons, *Ardea herodias*: a food addition study. Colonial Waterbirds, 6:139-47.

The impact of food on reproduction in great white herons was measured by comparing timing of nesting, clutch size, and fledging success of naturally foraging herons with herons that received supplemental food during the 1981 breeding season. The timing of nest initiation was not significantly different between food-supplemented and unsupplemented herons. Supplemented herons laid larger clutches and raised more young than did unsupplemented birds. Clutch sizes of supplemented herons were not significantly different from clutches laid by herons in Florida Bay in the 1923 when the habitat was relatively pristine. These results provide evidence that food availability can influence clutch size and fledging success in great white herons However, the similarity in size of clutches produced by supplemented herons and 1923 herons also suggests that unsupplemented herons had depressed clutches. The response to food supplementation is therefore interpreted as evidence that herons decrease clutch size when food is scarce. It was not possible to determine from this study whether food abundance could be increased sufficiently to trigger herons to increase clutch size above levels considered typical for the species.

1981 ◊

Raymond, R., and T. D. Davies (1981) Mangrove root intrusion; a means for enriching sulfur in underlying peats. Scanning Electron Microscopy, 1981(1):651-56

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] Electron probe microanalysis has shown that Lower Kittanning coal samples (a seam in Western Pennsylvania) with freshwater overburden contain the least organic S, while those with marine overburden contain the most organic S. The organic S contents of freshwater coals are greater than those of marine coals conformably overlying them. Chemical analyses performed on Florida Bay peats deposited in freshwater environments and later affected by marine waters permeate a previously deposited low S peat, the organic S content will be increased. A mechanism must be present that increases permeability of the underlying peats and provides avenues along which marine waters travel downward. From scanning electron microscopy and petrographic data root intrusion by *R. mangle L.* (red mangrove) trees that grow in a marine environment appear to be a mechanism for emplacement of fin-grained pyrite in underlying freshwater peats. Root intrusion may provide a means for enriching organic S in freshwater peats overlain by marine conditions.

1981 ◊

Tyson, R. (1981) Sediments of a Florida Bay basin. M. S. Thesis. University of South Florida, Tampa, FL.

In a southeastern Florida Bay basin, 44 surface sediment samples exhibited variations in texture, mineralogy, and molluscan assemblages. Sediment grain size analysis separated the samples into three major groups. Aragonite averaged approximately 51% in the silt and clay sized fractions. Bivalves were shown to prefer small grain sized sediments. A direct correlation between bivalve and *Thalassia* distribution was associated with the trapping of fine grained sediments by seagrass beds. Epifaunal gastropods exhibited uniform distribution. Correlations among sand, depth, rock fragments, foraminifera, *Cerithium, Halimeda*, and calcite content are identified for sand environments; correlations among other variables are also cited for silt environments.

1981 ◊

Walker, N. D. (1981) January water temperatures kill Florida fauna. Coast. Oceanogr. Climatol. News, 3(3):30.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] Seven cold fronts reached southern Florida during January 1981, depressing air and water temperatures below normal for most of the month. Intense frontal systems moved into the area Jan 10 and 16, causing air temperature minima over Florida Bay of 2.2 and 5.3°C, respectively, and wind speeds in excess of 15 m sec^{-1} at Key West. Florida Bay water reached temperatures of 9.0°C. The effects of the January 16 frontal passage on shallow bank and Bay environments is shown on a NOAA-6 satellite image.

1981

Walker, N. D., H. H. Roberts, L. J. Rouse, and O. K. Huh (1982) Thermal history of reef-associated environments during a record cold-air outbreak event. Coral Reefs, 1:83-7.

Several polar continental air masses intruding into the south Florida/northern Bahama Bank region during January 1981 caused record low air temperatures and rapid chilling of extensive shallow-water carbonate systems. Numerous "coral kills" along the Florida reef tract and massive fish mortalities in Florida Bay were attributable to unusually cold waters generated at this time. Thermal evolution of Florida Bay/Florida reef tract and northern Bahama Bank waters from 8 to 21 January was assessed from thermal infrared data acquired by the NOAA-6 environmental satellite, *in situ* water temperatures, local meteorological data, and a computerized heat flux model. Field observations and laboratory experiments identify 16°C as a thermal stress threshold for most reef corals. Temperature corrected digital satellite data indicated that water temperatures below 16°C were generated in Florida Bay and on Little and Great Bahama Banks during a 10-day period in January. Lowest temperatures on the Florida reef tract resulted from offshelf transport of Florida Bay water through major tidal channels. Offshelf movement of bay water is driven primarily by strong northerly winds, density gradients, and tidal pumping. Absence of reef development opposite major tidal passes along the Florida reef tract and aperiodic coral kills along bank margins can be attributed to this process, which has probably had a limiting influence on Holocene reef development in these areas.

1981 ◊

Woodroffe, C. D. (1981) Mangrove swamp stratigraphy and Holocene transgression, Grand Cayman Island, West Indies. Mar. Geol., 41(3/4):271-94.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The island of Grand Cayman, in the western Caribbean, has an extensive mangrove swamp vegetation. Numerous cores have been taken in and adjacent to these swamplands, and these reveal that the swamps are generally underlain by a transgressive sequence of sediments. The basal unit of this sequence consists of a laminated or non-laminated crust, formed in a subaerial environment. Locally, these crusts are overlain by plastic mud, deposited in seasonally-flooded environments. Mangrove peat forms the upper unit of the transgression within most of the swamplands, overlying the other units where these are found, and reaching thicknesses of more than 4 m. The final stage of marine incursion is recorded to the east of North Sound, where, in water depths of 10 - 200 cm, shelly mud occurs overlying mangrove peat. In contrast to this, to the west of North Sound, there is a regressive sequence in which shelly marl underlies a localized sea grass peat and mangrove peat. This regressive sequence records local progradation of mangroves into marine environments. The transgressive sedimentary sequence on Grand Cayman is similar to transgressive sedimentary sequences described from the Florida Everglades-mangrove complex, Florida Bay and the Belize Shelf. On Grand Cayman, however, the stratigraphy is less complex because there are not extensive freshwater peat-forming environments, or intertidal and supratidal carbonate environments. Samples of mangrove peat were collected from the peat/bedrock interface along a surveyed profile across Barkers Peninsula on Grand Cayman. Radiometric dating of these implies that sea level was approximately 185 cm below the present level at least 2100 yrs BP. Comparison of these dates with dates on mangrove peat from elsewhere suggests that submergence on Grand Cayman has taken place at a similar rate to that in Florida.

1981 - 1983

Dunson, W. A., and M. Seidel (1986) Salinity tolerance of estuarine and insular Emydid turtles (*Pseudemys nelsoni* and *Trachemys decussata*). J. Herptol., 20(2):237-45.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] *Pseudemys nelsoni* and *Trachemys decussata* inhabit brackish water in mainland areas of extreme southern Florida and on Grand Cayman Island. They appear to be intermediate in their salinity tolerance between truly freshwater forms and the highly specialized estuarine terrapin (*Malaclemys*). Unfed *P. nelsoni* (730 - 1240 g) had especially low rates of mass loss (primarily net water loss) in 100% seawater (about 0.4% initial mass day^{-1}). Smaller *T. decussata* (200 - 240 g) had higher values (about 0.8%/day), yet these rates were still lower than four values obtained on typical freshwater species (1.8 - 7.6%/day) held in 100% seawater. Mean whole body water effluxes in 100% seawater of adult *P. nelsoni* and *T. decussata* larger than 60 g were low (0.24 - 0.47 mL 100 g^{-1} h^{-1}). Hatchling *T. decussata* had much higher rates of water efflux (1.0 mL 100 g^{-1} h^{-1}). Sodium effluxes in 100% seawater were low (less than 100 μmol 100 g^{-1} h^{-1}) in all size classes. There was no stimulation in sodium efflux after salt loading in *P. nelsoni*, nor in *T. decussata* after dehydration in saline solutions. This implies the lack of salt glands in these species. Sodium influx in 100% seawater was very low in adult *P. nelsoni* and in *T. decussata* larger than 200 g. There was a progressive increase in sodium influx with declining size in *T. decussata*, so that hatchlings underwent a considerable net uptake of sodium in seawater. Hatchling *T. decussata* fed fish ad libitum were unable to maintain mass or grow when the salinity exceeded 41% seawater. Juveniles of about 80 g grew at salinities up to 59% seawater, representing a significantly increase in tolerance above that of the hatchlings. Additionally, 80 g turtles grew significantly faster in 25% seawater than in freshwater. Large individuals (>200 g) of both species tolerated immersion in 100% seawater for prolonged periods (at least 10 - 24 days). Their natural habitats vary seasonally in salinity, but remain on average quite dilute due to rainfall.

1981 - 1986

Robblee, M. B., and J. T. Tilmant (1989) Distribution, abundance and recruitment of the pink shrimp (*Penaeus duorarum*) within Florida Bay. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):522.

[ABSTRACT ONLY] The Tortugas shrimping grounds were first exploited commercially in 1950 prompting intensive study of the early life history of the pink shrimp in the shallow near shore waters of South Florida, the primary nursery ground for the species. Within the Bay, the pink shrimp is an important source of food for gamefish species and wading birds. This paper reports the use of sled net and throw traps to study the seasonal and spatial distribution of the pink shrimp in Florida Bay from 1981 to 1986. Seasonal observations and recruitment studies were concentrated in Johnson Key Basin, a high density shrimp area in western Florida Bay. Largest abundance was found between fall and winter with peak abundance between September and December. The pink shrimp was present throughout the year in Johnson Key Basin and was most abundant during fall and winter with peak abundance between September and December. During this study, average shrimp size varied seasonally, but was higher in 1986 when compared to 1985. During the fall and winter, pink shrimp were most abundant in near-key habitats in Johnson Key Basin when compared to bank and basin. While very small shrimp <9 mm CL were most abundant in near-key habitats, the distribution of shrimp size during the winter was similar among habitats. Based on sampling in January 1986, pink shrimp generally were most abundant in the west when compared with central and eastern Florida Bay. Over the whole bay, where shrimp are present, they appear to be most abundant in shallow water, either near-key or bank habitat.

1982

Bert, T. M. (1985) Geographic variation, population biology, and hybridization in *Menippe mercenaria* and evolution in the genus *Menippe* in the southwestern North Atlantic Ocean. Ph.D. Dissertation. Yale University, New Haven, CT. 305 pp.

Electrophoretically detectable variation in 40 proteins, color morphology, and field studies involving trapping and SCUBA diving were used to determine the evolutionary relationships of crabs of the genus *Menippe* (Xanthidae) in the south eastern United States. Correlation of the patterns of geographic variation in genotype and phenotype with the geological record and estimated times of divergence indicated that the observed patterns are the product of the influence of Late Cenozoic changes in climate and geology. Both allele frequencies (= genotype) and color morphology (= phenotype) showed that one of the species, *M. mercenaria*, is actually a taxonomic supergroup, composed of two taxa (designated semispecies). One (the western Gulf form) is distributed from northwest Florida westward through Texas. The second ranges, in its pure form, through the Florida peninsula from northwest to east central Florida, and in North Carolina. The taxa hybridize in two discrete regions - in the Gulf of Mexico (northwest Florida) and in the Atlantic Ocean (east central Florida to South Carolina). The Atlantic hybrid zone was formed prior to the closure of the seaway across north Florida connecting the Gulf of Mexico and the Atlantic, and the northwest Florida zone at some time subsequent to that closure. The northwest Florida hybrid zone is narrow, exhibits a strong concurrent clinal shift in both allele frequencies (= genotype) and color pattern (= phenotype). The zone has definable deficits of hybrids in general, and of particular hybrid phenotype-genotype combinations. The structure and dynamics of the zone can be attributed to (1) its location in an ecological transition zone, and at the parapatric junction of the ranges of the two parent taxa, (2) partial assortative mating due to different habitat preferences of the two taxa, and (3) post-mating selection against particular genotype-phenotype forms. The northwest Florida hybrid zone is characteristic of hybrid zones that persist through evolutionary long periods of time with relatively little change. The Atlantic hybrid zone is broad and has a unique geographical pattern of allele frequencies and color morphology. The greatest variation in color pattern is seen where the zone is thought to have originated (Georgia), and no animals within the zone are phenotypically identical to either parental form. Allele frequencies never completely shift from one parental type to the other but remain close to those of the form inhabiting peninsular Florida. The strongest shifts in allele frequencies occur in east central Florida and South Carolina, to the south and north or the origin of the zone. The structure and dynamics of the Atlantic hybrid zone can be attributed to: (1) its ancient age; (2) the absence of a pronounced ecotone throughout the zone; (3) greater habitat overlap than is seen between the two taxa in the northwest Florida hybrid zone; (4) location of the hybrid zone in relation to the range of the two parental taxa; and (5) numerical and genetic swamping of the western Gulf taxon by the peninsular Florida taxon. Hybridization in *Menippe* illustrates that multiple instances of hybridization between the same two species can result in very different morphological configurations of the zones themselves, and possibly even in different resolutions of the hybridization event, depending upon the environmental context in which hybridization occurs and stage of divergence of the two hybridizing taxa. Sampling in Florida Bay took place in 1982 north of Marathon.

1982 ◊

Beccasio, A. D., N. Fotheringham, A. E. Redfield, and *et al.* (1982) Gulf coast ecological inventory: user's guide and information base. Biological Services Program, US Fish and Wildlife Service, Washington, DC. 191 pp.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] This report provides an inventory of important ecological resources along the Gulf coast, including the Everglades National Park. It is intended to provide government and industry decision-makers with ecological information to assist them in the determination of impacts from the coastal sitings of oil- and energy-related facilities. Major goals of the inventory include review and analysis of coastal fish and wildlife data and habitats, development of data formats compatible with 1:250,000 mapping scale, and the preparation of a report narrative keyed to resource inventory graphics. Ecological resources are summarized by geographic zone and descriptions and locations of species with special status and species of high commercial, recreational and aesthetic value are included.

1982 ◊

DeFelice, D. R. (1982) Applicability of the r-selection concept to modern diatom communities. Geol. Soc. Amer. Abs., 14(7):473.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Analysis of diatomaceous sediments from two widely separated and different environments indicates that the concept of r selection may be applied to diatom communities. Diatom populations sampled from the shallow benthic environment of Florida Bay (biacoenose) and from the deep sea planktic environment of the southeast Atlantic (thanatocoenose) share similarities in diversity and ecologic succession that conform strongly to the hypothetical r and K selectors defined by MacArthur and Wilson. Diversity in both areas is strongly regulated by the stability and predictability of the environment. Low diversity assemblages in Florida Bay and the southeast Atlantic are almost monospecific and involve periodic recolonization. *Cocconeis placentula* occurs in insignificant numbers on the sediment substrate in Florida Bay but is ubiquitous on the grass blades of *Thalassia testudinum* whose short residence time on the plant makes the substrate ephemeral, unstable and unpredictable. Although *Nitzschia kerguelensis* forms a major portion of the diatom assemblage in the diatom ooze belt between the Polar Front and northern sea ice boundary, it is overwhelmingly dominant in the portion of the Weddell Basin affected by fluctuating ice conditions. It acts as an epontic species within the sea ice, recolonizing the open ocean in the summer following sea ice recession. Both species explode into an ecologic vacuum following a strategy defined for r selectors of producing as many progeny as possible into an environment with minimal competition. Production is regulated solely by maximum intrinsic rate of natural increase (r max).

1982 ◊

Caughey, M. E. (1982) A study of the dissolved organic matter in the pore waters of carbonate-rich sediment cores from Florida Bay. M. S. Thesis. University of Texas at Dallas, Richardson, TX. 69 pp.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Interstitial fluids extracted from segments of cores collected from mudbanks and islands in Florida Bay were analyzed to determine the types and amounts of dissolved free and combined amino acids present. Both protein and nonprotein amino acids were found in concentrations as high as 263 μM for free, and up to 353 μM for the total following acid hydrolysis. The five most abundant amino acids, both in the free and combined forms, were glutamic acid, alanine, aspartic acid, serine and glycine. The total concentration of glutamic acid usually exceeds that of aspartic acid, in contrast with many other types of sedimentary organic matter. The ratio of total aspartic acid to total serine in the pore waters of the upper core segments tended to be less than one at stations located in central areas of the Bay, but greater than one at stations nearer the Keys and the mainland. The total hydrolysate amino acid concentration in the uppermost segment pore waters generally increased away from the mainland toward the Keys and the Gulf. Trends in the free/combined ratios of averaged amino acid concentrations at selected depths indicate that free amino acids may be incorporated into soluble polymers in the interval between 12 and 60 cm. Overall, total amino acid and total carbohydrate concentrations decreased progressively with increasing depth in the sediment column. Beta-aminoglutaric acid was tentatively identified in 53 out of 62 core segments. Its concentration decreased with depth in all cores but one. The amino acid composition of organic matter dissolved in pore water and adsorbed to mineral surfaces in carbonate sediments differs significantly from the amino acid composition of organic matter in non-carbonate sediments.

1982 ◊

Manker, J. P., A. R. Hill, and C. S. Johnston (1982) Toxic metal concentrations and distribution in Tavernier and Tarpon Basin - Florida Bay. 59th Ann. Mtg. of the Georgia Acad. Science, Columbus, GA, April 23 - 24, 1982. Ga. J. Sci., 40(1-2):21.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Sediment* toxic metal distribution studies have been completed in two backwater basins of Florida Bay. Although the natural environmental setting for each basin was similar, the concentrations of Pb and Zn were found to be greater in the basin adjacent to Tavernier Key as compared to Tarpon Basin adjacent to Key Largo. Chromium and Co concentrations were not appreciably different in the two basins. Lead concentrations ranged from 12 to 150 µg/g and from 10 to 24 µg/g in Tavernier and Tarpon Basin respectively. Zinc was found to have a maximum concentration of 38 µg/g in Tavernier Basin and 24 µg/g in Tarpon Basin. The major source of Pb contamination in Tavernier Basin is from marine and automotive internal combustion engine emissions. A storm sewage drainage system, which drains the major highway in that part of the Florida Keys, empties into the basins via a single pipe. Tavernier Basin is also a high use marina area. In conjunction with the toxic metal investigation a survey of bottom flora and fauna populations was carried out in both basins. No benthic fauna exists in the Tavernier basin, and little difference was found in number and variety of plant species between basins.

1982 ◊

Odum, W. E., C. C. McIvor, and T. J. Smith (1982) The ecology of the mangroves of South Florida: A community profile. FWS/OBS-81/24. Fish and Wildlife Service, Bureau of Land Management, New Orleans, LA. 144 pp.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] This citation is a description of the ecology of mangrove communities of South Florida. The subjects covered include mangroves, microorganisms, plants other than mangroves, invertebrates, fishes, amphibians, reptiles, birds, mammals, economic value of ecosystem, and management. No abstract or summary is available.

1982 ◊

Parks, J. M., P. J. Lagas, M. A. Cable, R. D. Becker, S. I. Michelson, C. Lensch, and E. B. Evenson (1982) Florida Bay carbonate mud banks: possible additional factor in mode of deposition exemplified by Ramshorn Spit. Geol. Soc. Am., Abstr., 14(7):58.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] Holocene carbonate mudbanks in Florida Bay have been attributed to the turtle grass, *Thalassia testudinum*, which traps fine sediment on contact with slime coating on its leaves, acts as a baffle to promote the deposition of suspended sediment by slowing current flow, and prevents sediment erosion with its rhizomes. However, Ramshorn Spit is

* **Sediment samples were collected and analyzed in this study. This is not mentioned in the published abstract. Personal communication, J. P. Manker, Georgia Southwestern College, Americus, GA.**

accumulating without benefit of a grass cover. Older portions of the spit that have built up to sea level acquire a grass cover which stabilizes the mudbank. Results indicate that sediment comes to rest on the growing mudspit as organically-bound agglomerates. Undispersed samples are unimodal at 4.50, have a lower density than solid particles of that size, and therefore settle more slowly. Most previous size analysis of Florida Bay sediments were made on mechanically and/or chemically disaggregated samples; this may have obscured the observation that Ramshorn Spit sediment is deposited as aggregates of fine particles bound with organic matter.-Adapted from authors' abstract.

1982 ◊

Rich, J., D. Kuehn, and T. D. Davies (1982) The paleoecological significance of *ovoidites*. Palynology, 6:19-26.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] *Ovoidites* is an ovoid zygospore or aplanospore of the Zygnemataceae which is found in sediments of the Cretaceous to Holocene age. Spores typically exhibit a prominent line of dehiscence that allows them to split in half lengthwise. The variety of sizes, shapes, and sculpturing suggests that several natural species may be included within *Ovoidites*. Studies of sediment cores from marine, brackish, and freshwater sequences beneath islands in Florida Bay and at the mouth of the Harney River in Everglades National Park demonstrate the close association which the spores have with freshwater peats and related pollen assemblages. Palynological study of freshwater peats from the Okefenokee Swamp in Georgia shows additionally that *Ovoidites* occurs preferentially with open-water marsh peat and pollen assemblages. The spores typically are not found in tree- or shrub-dominated areas, and, therefore, are not associated with tree and shrub peats. The apparently narrow range of habitat preferences which the algae display suggests that *Ovoidites* may be a valuable indicator of ancient freshwater coal deposits.

1982 ◊

Schomer, N. S., and R. D. Drew (1982) An ecological characterization of the Lower Everglades, Florida Bay and the Florida Keys. US Fish and Wildlife Service, Office of Biological Services, Washington, DC. FWS/OBS-82/58.1. 246 pp.

A conceptual model of the study area identified four major ecological zones: (1) terrestrial and freshwater wetlands, (2) estuarine and saltwater wetlands, (3) Florida Bay and mangrove islands, and (4) the Florida Keys. These are geographically delineated from one another by a combination of elevation gradient and positioning relative to one another and to major outside influences such as upstream watersheds, the continental shelf and major ocean current systems. These zones are delineated by differences in basic physical-chemical background factors such as substrate, climate, hydrology and water chemistry which in turn promote characteristic ecological communities. Many of these communities are similar between zones but localized differences do exist, as do significant shifts in relative abundance of community types. The terrestrial and freshwater wetlands support pinelands, sawgrass marshes, wet prairies, sloughs and occasional tree islands on freshwater peat, marl, and limestone soils. The estuarine and saltwater wetlands support mangrove forests, salt marshes and oscillating salinity systems on mangrove peat, marine marl, sand or "liver mud" substrates. Florida Bay exhibits oscillating meso - to hypersaline waters over grassbeds on marine lime mud sediments. These mud banks form an anastomosing pattern surrounding deeper "lake" areas having only a thin veneer of sediment. The exposed tips of the mud banks frequently support mangrove and salt prairie vegetation. The Florida Keys support almost all of the above communities to some small degree but are more prominently characterized by extensive offshore coral reefs. The upper Keys are themselves a relict reef exposed by global lowering of sea level. The lower keys are composed of rock hardened Miami oolite, a limestone formed via chemical precipitation rather than biological deposition. The productivity of these communities with regard to fish and wildlife reflects: (1) the diversity and type of habitats available to species that are potentially capable of exploiting them, (2) the degree of alteration of these habitats by man and natural forces, and (3) historical, biogeographic and random factors that restrict organisms to specific environments or prohibit them from exploiting a potential habitat.

1982

Sorensen, C. E. (1985) Quantitative analysis of the carbonate sediments in Shell Key Basin, Florida Bay. The Compass, 62(2):97-105.

Sediment and water samples were collected from a small basin in Florida Bay to elucidate the process of carbonate sediment genesis. At each sample station various environmental parameters were measured: depth, temperature, salinity, dissolved carbon dioxide, dissolved oxygen, and pH. Grain-size analysis was conducted on the sediment samples. The resultant data set was subjected to various statistical analyses, principal-component analysis, and a regression analysis. The factor and regression analysis indicated that the strongest predictive variables for the dominant grain-size class are salinity, concentration of dissolved carbon dioxide, and concentration of dissolved oxygen. The stronger predictive relationship exhibited between dissolved oxygen and the dominant grain-size class suggests that algae play a larger role in sediment production than mollusks in Shell Key Basin. The strong inverse relationship displayed between depth and pH suggests that the shallow marine mudbanks maintain their relief by higher organic activity than the deeper parts of the Basin. Temperature may play a larger role than previously hypothesized in the distribution of grain sizes in Shell Key Basin.

1982

Sorensen, C. E. (1985) A study of active processes affecting grain-size and chemical distribution in three selected basins of Florida Bay, Florida. M. S. Thesis. Wichita State University, Wichita, KS. 146 pp.

Sediment and water samples were collected and analyzed in three basins of Florida Bay to determine whether biological or physical processes control grain size. The sediments were analyzed for weight percent of Ca, Mg, Ti, Si, Al, Sr, Fe, and K using x-ray fluorescence. Water samples were analyzed in situ by a portable chemical analysis kit for pH, temperature, dissolved oxygen, dissolved carbon dioxide, salinity, and turbidity. Populations of benthonic flora and fauna were estimated at the 45 sampling stations. X-ray diffractometry determined mineralogical content present for each sediment sample. Statistical parameters were calculated to elucidate any relationships. Parameters indicated that physical processes controlled grain-size distributions in Shell Key and Crab Key Basins, but biological processes controlled grain-size distributions in the northernmost basin: Madeira Bay. Interpretation of the Sr analyses inferred that most of the sediment in the basins was derived from mollusks, rather than algae as previously believed. Chemical conditions above the sediment-water interface were not favorable for inorganic, physicochemical precipitation of calcium carbonate at the time the measurements were taken. The expected significant negative correlation between *Thalassia* density and the percentage of coarse grains was present in only one basin. Sampling took place in 1982.

1982 ◊

Ullman, W. J., and R. C. Aller (1982) Diffusion coefficients in nearshore marine sediments. Limnol. Oceanogr., 27(3):552-6.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The formation resistivity factor, F, necessary to calculate bulk sediment diffusion coefficients of interstitial solutes from free solution diffusion coefficients, can be estimated from f, the sediment porosity. Empirical relationships between F and ¢^{2} indicate that F ~ ¢$^{-2}$ for unlithified marine sands or muds when ¢ $\leq$ 0.7 and F ~ ¢$^{-2.5}$ to ¢$^{-3}$ for high porosity muds when ¢ $\geq$ 0.7. Cores were collected from Captain Key Bank, Florida Bay, as well as from other locations.

1982 ◊

Walker, N. D., H. H. Roberts, L. J. Rouse, and O. K. Huh (1982) Evolution of "thermal stress" in high altitude reef systems. EOS Trans., 63(3):83.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Intrusions of polar continental air into the south Florida/northern Bahama Banks region cause rapid and extensive chilling of shallow reef, associated bay and bank waters. "Coral kills" observed during the 1969 - 1970, 1976 - 1977, and 1980 - 1981 winters were attributed to cold-water induced stress. Thermal evolution of Florida Bay and northern Bahama Banks waters was assessed for critical times during these winters with temperature-corrected thermal infrared data acquired by the NOAA-5 and NOAA-6 environmental satellites, in-situ water temperatures, and a computerized heat-flux model. Laboratory and field experiments identify 16°C as a thermal stress threshold for most reef corals. Sub-16°C waters were generated in shallow bay and bank areas during January of each winter. Offshore movement of super chilled waters interrupted warmer conditions along bank margins, subjecting corals to stressful waters. Strong northerly winds are the primary initiator of this offbank flux; however, density gradients and tidal pumping may increase the transport rate. Absence of reef development opposite major tidal passes connecting Florida Bay and the reef tract, as well as coral moralities observed, is attributable to this process, which has probably limited Holocene reef growth in these areas.

1982 ◊

Zieman, J. C. (1982) The ecology of the seagrasses of south Florida: a community profile. FWS/OBS-82/25. US Fish and Wildlife Service, Washington, DC. 158 pp.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] This report provides a detailed description of the community structure and ecosystem process of the seagrass ecosystems of south Florida including Florida Bay, one of the two major areas of seagrass distribution in Florida. This description is based upon a compilation of information from numerous published and unpublished sources. The material covered includes distribution, systematics, physiology, and growth of the plants, as well as succession and community development. The role of seagrass ecosystems in providing both food and shelter for juveniles as well as foraging grounds for larger organisms is treated in detail. Emphasis is given to the functional role of seagrass communities in the overall coastal marine system. The final section considers the impacts of human development on seagrass ecosystems and their value to both man and the natural system. Because seagrass systems are fully submerged and less visibly obvious, recognition of their value as a natural resource has been slower than that of the emergent coastal communities. They must, however be treated as a valuable natural resource and preserved from further degradation.

1982 ◊

Zieman, J. C., S. D. Goodwin, and M. L. Robertson (1982) Surface transport of particulate matter from Florida Bay. EOS Trans., 63(3):83.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The surface transport of macro-particulate matter provides a mechanism for the exchange of organic material between the near shore shallow-water environment and the coastal shelf zone. In the fall of 1979, surface drift material was collected from 42 stations encompassing 14000 km^2 west of Florida Bay. Two seagrasses, *Thalassia testudinum* and *Syringodium filiforme*, accounted for 90% of the drift material. Surface drift averaged 9.4 g dry weight m^{-2} adjacent to the source seagrass beds, and decreased with distance from these beds. The total standing stock of drift material in the study area was 5000 metric tons dry weight. Samples from smaller studies in 1978 and 1980 show that the transport of material is highly variable. The exchange of material between the inshore grass beds and to coastal shelf region is governed largely by wind speed and direction, with the majority of material being transported westward from Florida Bay and the lower Keys. A turnover time of approximately 20 days is estimated for the floating seagrasses, which could represent an annual input of 7.2 g m^{-2} to the offshore sediments using the 1979 data.

1982, 1985 - 1987

Brasier, M. D., and O. R. Green (1993) Winners and losers: stable isotopes and microhabitats of living Archaiadae and Eocene *Nummulites* (larger forminifera). Mar. Micropaleontol., 20(3-4):267-76.

This paper discusses isotopes in larger foraminiferal calcite from two contrasting settings: modern Florida Bay, dominated by Archaiadae (the "winners"); and the Upper Eocene Banon Clay of England, locally dominated by *Nummulites* ("the losers"). The archaiads (plus peneroplids and soritids) were mainly collected from *Thalassia* leaves. They yield signatures that closely reflect strong isotopic gradients in seawater across Florida Bay and the outer patch reefs. Isotopic signatures of eurytopic *Androsina lucasi* record extreme conditions to the north of the Bay, which includes $\delta^{13}C$ evidence for much nutrient-regeneration. Such tolerance of relatively eutrophic conditions may explain the capacity of Archaiadae for survival in the Caribbean region during the Neogene. Isotopes of *Nummuliles prestwichianus* from the basal Bartonian compare more closely with data from living nummulite *Heterostegina*. $\delta^{18}0$ indicates a yearly growth cycle under tropical bottom water temperatures with an annual range of approximately 2.5°C. Carbon isotopes show a trend towards heavier values with growth, here related to decelerating rates of calcification and, perhaps, the additional effects of test-thickening on carbon isotope fractionation by endosymbionts. The nummulitic data indicate a much more stable carbon and nutrient cycle in the basal Barton Clay than seen in the Florida Bay mud mound assemblage. This is consistent with their presumed stenotopic and oligotrophic life habit. It could well explain their vulnerability to extinction after the mid-Eocene, and the post-Aquitanian decline of larger rotaliids and reefs in the Caribbean region. Sampling took placed August to September during 1982, and 1985 to 1987 at various locations in Florida Bay.

1982 - 1984

Wilson, K. A. (1989) Ecology of mangrove crabs: predation, physical factors and refuges. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):263-73.

The relative importance and interactions of biological and physical factors as influences on microhabitat utilization of crabs in mangrove forests in Florida Bay was examined. Two experimental approaches were taken: (1) Estimation of the relative risk of predation among microhabitats in the mangrove on a tidal, seasonal, and annual basis; and (2) Measurement of responses of crabs to exposure in microhabitats in the field. Florida Bay mangroves are intertidal soft-sediment habitats in which four species of mangrove crabs broadly overlap in habitat utilization and share periodic shifts in microhabitat selection. *Aratus pisonii* is an arboreal crab; *Eurytium limosum, Sesarma curacaoense,* and *Uca thayeri* live in burrows and holes on the mud surface and occasionally climb mangrove prop roots. Field predation tethering experiments found a differential risk of predation among microhabitats and strong tidal and seasonal differences in predation rates. In field experiments that tested tolerance to exposure in various microhabitats species exhibited different responses to temperature and relative humidity conditions in each microhabitat. The unique physiognomy and characteristics of mangroves provide a habitat that ameliorates environmental conditions and provides varied structural refuge from predation for crabs. The differential physiological suitability of refuges and risk of predation among microhabitats means that crabs must balance the constraints of physiological tolerances and the avoidance of predation in a system that has a seasonally variable risk of predation and environmental conditions. This study took place from 1982 through 1984.

1982 - 1984

Wilson, K. A. (1985) Physical and biological interactions that influence habitat use of mangrove crabs. Ph. D. Dissertation, University of Pennsylvania, Philadelphia, PA. 167 pp.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] This study examines the relative importance of biological and physical factors in the microhabitat use and distribution of four species of crabs in mangrove forests in south Florida including Florida Bay. Three aspects were investigated: (1) Estimation of risk of predation among microhabitats in the mangrove; (2) Evaluations of competitive interactions for refuges; and (3) Definition of suitable physiological microhabitats and measurements of responses to exposure in microhabitats in the field. The four species of mangrove crabs, *Aratus pisonii, Eurytium limosum, Sesarma curacaoense*, and *Uca thayeri* broadly overlap in habitat use and share periodic shifts in microhabitat locations. Field experiments show a differential risk of predation among microhabitats by tide levels and show that a change in predation intensity and predator type results in strong tidal and seasonal components of refuges. Crabs must balance the constraints of physiological tolerances with the avoidance of predation. No single physiological factor can be labeled as the cause of distributional patterns.

1982 - 1986

Parsons, G. R. (1993) Geographic variation in reproduction between two populations of the bonnethead shark, *Sphyrna tiburo*. Environ. Biol. Fishes, 38(1-3):25-35.

A study of two populations of the bonnethead shark, *Sphyrna tiburo,* was conducted in Florida Bay and Tampa Bay, Florida from September 1982 to December 1986. The maintenance of sharks in captivity at the Marine Science and Conservation Center in the Florida Keys, and the collection of sharks from widely separated geographical areas allowed the examination of latitudinal variation in reproduction. Several reproductive parameters were found to differ: (1) size at maturation, (2) age at maturation, (3) time of fertilization, (4) rate of embryonic development, (5) size at birth, (6) the energetic investment in producing offspring, (7) gestation period, and (8) the incidence of infertility. Average litter size and maximum age of females was not different between the two populations. These contrasting life history parameters are not easily explained. Food limitation and seasonal differences between the two areas are considered as factors controlling reproduction in these populations. It is noteworthy that the average size of adult females in Tampa Bay is significantly greater than that of Florida Keys sharks. This size difference may be important in explaining the observed differences in reproduction.

1982 - 1986

Parsons, G. R. (1993) Age determination and growth of the bonnethead shark *Sphyrna tiburo*: A comparison of two populations. Mar. Biol. (Berlin), 117 (1):23-31.

From July 1982 to December 1986, a study of the age and growth of the bonnethead shark *Sphyrna tiburo* was conducted in Tampa and Florida Bays. Tetracycline-injected sharks held in captivity and, to a lesser extent, tagged, released and recaptured, were utilized for validating the annual nature of the rings (herein defined as the narrow, translucent regions) appearing on vertebral centra. The technique was validated for all age groups (0 to 6 + yr) included in the study. Marginal increment analysis likewise suggested annual ring formation. The rings formed during the winter, when water temperatures were lowest. Using the vertebral ring aging-technique, von Bertalanffy growth curves for males and females from both Tampa and Florida Bays were constructed. Growth of sharks born and held in captivity demonstrated that the male and female growth curves diverge after ~1 yr and that mean sizes at age are statistically distinct after ~2 yr. In both populations, females grew to larger sizes than males and apparently are longer-lived. Reproductively mature females from Tampa Bay were significantly larger than those from Florida Bay.

1983 ◊

Bert, T. M., J. W. Dodrill, G. E. Davis, and J. T. Tilmant (1983) The population dynamics of the stone crab (*Menippe mercenaria*) in Everglades and Biscayne Parks. Fla. Sci., 46 (Suppl. 1):24.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Temporal and spatial variations in the distribution, relative abundance, sex ratio, size class frequency, and reproductive effort of stone crabs were assessed for one year throughout South Florida nearshore national park waters using traps. The data indicate that a major nursery area for stone crabs exists offshore from southwest Florida's two major terrestrial drainage-systems, the Big Cypress and Everglades estuaries Stone crabs apparently disperse from that area southward toward the Florida Keys and into Florida Bay. The stone crabs in Biscayne National Park are apparently not locally recruited and may be dispersing from farther north along the east coast of Florida.

1983 ◊

Bielsa, L. M., H. Murdich and R. F. Labisky (1983) Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (south Florida) - pink shrimp. US Fish Wildlife Service FWS/OBS-82/11.17. US Army Corps of Engineers, TR EL-82-4. 21 pp.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] This citation is a species profile of the pink shrimp. It covers taxonomy, identification, life history, fisheries, ecological role, and environmental requirements.

1983

Harrigan, P., J. C. Zieman, and S. A. Macko (1989) The base of nutritional support for the gray snapper: an evaluation based on a combined stomach content and stable isotope analysis. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):65-77.

A combined stomach content and stable isotope analysis was used to determine if seagrass provided a base of nutritional support to the gray snapper, *Lutjanus griseus*. The work was done from June to September 1983. The results provided a quantitative evaluation of the relative contribution of carbon and nitrogen from various primary organic sources to gray snapper taken from a mangrove site (southeast Whitewater Bay) and a seagrass dominated location (near Schooner Bank). Stomach content analysis revealed that gray snapper from the two areas had similar diets which were primarily composed of penaeid shrimp (>60%). Isotopic results provided a distinction between food webs on the basis of carbon values. The $\delta^{13}C$ of components from the seagrass location were greater than -17 ‰ in contrast to values of less than -19 ‰ for those from the mangrove area. Quantitative estimates indicated that gray snapper from the seagrass area derived more than 90 °/oo of their carbon and nitrogen from sediment or water column particulate organic matter. Gray snapper from the mangrove area were supplied by carbon and nitrogen from these sources in addition to detritus. The main contributors appeared to be particulate organic matter from the water column and the brackish water grass, *Ruppia maritima*. Together, these sources accounted for 35 to 100% of the ultimate source of prey item dietary carbon and nitrogen. These results suggest that within both food webs carbon and nitrogen are transferred from a detrital base by similar mechanisms and emphasize the use of multiple isotopes as a tool for quantitatively evaluating food webs.

1983 ◊

Hendrix, G. Y., and J. M. Morehead (1983) Everglades National Park: Imperiled wetland. AMBIO, 20(3-4):153-7.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] This paper reports on the present status of the Everglades National Park, a wetland under fire from various developmental and recreational interests. A brief historical resume of the Park is presented including water delivery alterations, declines in wading bird populations and of park fisheries, endangered species protection, and invasions of exotic species were discussed as well as the mission of the park's South Florida Research Center - to monitor the effects of water management upon the ecology of the Everglades.

1983 ◊

Jenkins, R. V. (1983) A comparison of Florida Bay marine banks and "rock reefs" of the Miami Limestone in the Everglades National Park. Geol. Soc. Am. Abs., 15(1):1.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] In Everglades National Park, long, linear, low (0.3 m) topographic highs occur in the Pleistocene Miami Limestone. Morphologically similar features are accumulating today in Florida Bay as marine mudbanks. The origin of the "rock reefs" has been proposed as being controlled by preexisting topographic features, structurally controlled, sedimentary depositional features, or diagenetically controlled erosional features. To learn more about the "rock reefs," the mud banks in Florida Bay were studied for comparative purposes. Significant differences in texture and grain size indicate the "rock reefs" are not sedimentary depositional features similar to the mudbanks. The reefs show no structural or topographical control. Evidence indicated the reefs are diagenetically controlled erosional features.

1983

Nelsen, J. E., and R. N. Ginsburg (1986) Calcium carbonate production by epibionts on *Thalassia* in Florida Bay. J. Sed. Petrol., 56:622-8.

Annual production of lime mud by two genera of red algae and one genus of serpulid worms was estimated for an area of modern lime mud accumulation in eastern Florida Bay. The red algae *Melobesia membranacea* and *Fosliella farinosa* and the serpulid worm *Spirobis* sp. live as epibionts on the leaves of *Thalassia testudinum*, the extensive marine grass. The lime mud produced by the epibionts was estimated by quantifying: (1) the life span of *Thalassia*, (2) the abundance of *Thalassia*, and (3) the average amount of epibiont calcium carbonate per blade. The estimate also accounts for both aerial variations in standing crop and seasonal variations in growth rate of *Thalassia*. The estimated annual production of epibiont carbonate is 118 ± 44 g m^{-2} yr^{-1}, over six times more than the estimated production by the green alga *Penicillus capitatus* from the same area. This leads to the conclusion that the epibionts on *Thalassia* produce significant amounts of lime mud in Florida Bay. This result is close to the published estimate for epibiont production in Jamaica of 180 g m $^{-2}$ yr^{-1}, but it is significantly less than a published estimate for epibiont production in Barbados Turtle grass has been around since the late Cretaceous, and algae most likely have had a longer history. Therefore, epibionts may have been significant contributors since the late Cretaceous.

1983 ◊

Sorensen, C. E. (1983) Relationship of geochemical, biological, and sedimentological parameters in basins in Florida Bay, Florida. Geol. Soc. Am. Abstr., 15(1):1.

[ABSTRACT ONLY. NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] This abstract presents information on recent studies of geochemical (CO_2, O_2, pH, salinity), biological, and sedimentological (turbidity, grain size, composition) parameters within three basins (Madeira Bay, Captain and Shell Key basins) of Florida Bay. Preliminary results indicate that in all basins, as turbidity and pH increase, O_2, CO_2 and salinity decrease, proximity of sampling sites to tidal channels effects sedimentological and geochemical parameters, and faunal and floral distributions which effect geochemical parameters are dependent on depth. Between basins, grain-size and floral-faunal diversity increases in those basins with "normal" marine geochemical parameters.

1983 - 1984

Ehrhardt, N. M., D. J. Die, and V. R. Restrepo (1990) Abundance and impact of fishing on a stone crab (*Menippe mercenaria*) population in Everglades National Park, Florida. Bull. Mar. Sci., 46(2):311-23.

The stone crab (*Menippe mercenaria*) supports an important commercial fishery in southwest Florida. Heavy commercial exploitation of stone crab stocks in Everglades National Park prompted statements of concern about their status of utilization. During the 1983 and 1984 fishing seasons, tagging studies, diving surveys and monitoring of commercial fishing operations were implemented to assess abundance and rate of exploitation of localized stocks. Results indicate that an important stock is centered in the area off Cape Sable. The fishing season (15 October - 15 May) corresponded to a period between two consecutive recruitment seasons. An adult male stock recruited in the spring and summer of 1984 was almost fully utilized during the first 5 months of the season. The fishery was subsequently sustained by new 1985 spring recruitment. Abundance estimated for different population fractions resulted in similar relative seasonal trends. Fishing mortality associated with the 1984 fishing season was 0.751 while expected natural mortality rate for the same period was 0.939. On an annual basis, exploitation rate for the stock is 0.318, which represents a 63.6% level of stock utilization. It is concluded that the fishing season may have a dual role of protecting berried females during peak summer spawning, as well as acting as a buffer against fishing exploitation. Under new regulations all commercial fishing activities in the Park ceased as of 31 December 1985. The need for assessment work to study population growth under conditions of no exploitation is indicated.

1983 - 1984

Harrigan, P. (1986) The food web of the gray snapper, *Lutjanus griseus*, a stable isotope approach. M. S. Thesis. University. of Viriginia, Charlottesville, VA. 117 pp.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] To determine if gray snapper, *Lutjanus griseus*, are dependent on seagrass as a base of nutritional support, a combined stomach content analysis and stable carbon and isotope analysis was utilized to assess the contribution of various primary organic sources to its food web from, each, a seagrass dominated (Florida Bay) and a mangrove dominated (Whitewater Bay) area. The results from the stomach contents analysis indicated that gray snapper from each food web had similar diets, consisting mostly of shrimp supplemented by fish or fish and crabs. Isotopic results reveal that the food webs are isotopically similar to the dominant vegetation. Estimates of trophic level fractionation were 3.2 and 1.3% for nitrogen and carbon respectively. Both qualitative and quantitative results suggest that nutritional support to food web members is derived from seagrass in the seagrass dominated location and from mangrove, *Rhizophora mangle,* and benthic vegetation, *Ruppia maritima*, in the mangrove dominated area. Despite the isotopic distinction between areas, within each food web carbon and nitrogen are transferred through a detrital food web by similar mechanisms.

1983 - 1984

Lapointe, B. E. (1989) Macroalgal production and nutrient relations in oligotrophic areas of Florida Bay. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):312-23.

Abundant macroalgae of southern Florida Bay were assayed during 1983 and 1984 for nitrogen (N) and phosphorus (P) limitation of productivity by enrichment effects on in situ growth rate, tissue C: N: P molar ratios, and capacity of alkaline phosphatase. Growth of two frondose rhodophytes, *Cracilaria tikvahiae* and *Laurencia poitei* was stimulated primarily by P (although N was also limiting during winter) as was growth of two frondose phaeophytes, *Sargassum polyceratium* and *Sargassum pteropleuron.* Tissue C:P and N:P ratios of the unenriched rhodophytes were elevated, ranging from 1,080 to 1,939 and 75 to 147, respectively; C:P and N: P ratios of the unenriched phaeophytes were lower, ranging from 550 to 1,307 and 23 to 25, respectively. These tissue ratios support the primary P limitation suggested by the growth assays and suggest that phylogenetic differences may exist in storage and utilization of N and P compounds relative to C. Levels of dissolved inorganic nutrients (NH_4^+, NO_3^-, and PO_4^{-3}) in seawater during these studies also suggest that P, relative to N, was most limiting during summer months when NO_3^- and NH_4^+ were seasonally elevated and seawater N:P ratios were >30:1. Assays for alkaline phosphatase activity in phylogenetically diverse forms of Florida Bay macroalgae indicated broadly different capacities of this exoenzyme, with the highest rates observed for *Dictyota divaricata* and *L. poitei* and the lowest rates for G. *tikvahiae.* Considering that *D. divaricata* and *L. poitei* had the greatest observed capacity for this enzyme and that these and related species are particularly abundant in southern Florida Bay, utilization of dissolved organic phosphate pools appears to be ecologically important to sustaining productivity of indigenous frondose macroalgae in P-limited Florida Bay. The study sites were at Big Pine Key in the Florida Keys and at Content Key in the Bay.

1983 - 1984

Larson, D. K., and A. P. Ramus (1984) Distribution of caridean shrimp (Decapoda: Natantia:Caridea) in the shallow waters of western Florida Bay. Fla. Sci., 47(suppl. 1):20.

In conjunction with ongoing research on the settlement behavior of penaeid shrimp in Florida Bay, data has been collected for caridean shrimp. Species richness, distribution and abundance of caridean shrimp in shallow seagrass habitat bordering mangrove islands of Johnson Key Basin were studied from November 1983 to the present. A series of transects, 20 m long, were located perpendicular to the shoreline of the islands. Shrimp were collected from square meter plots located at regular intervals along the transects. Of six caridean shrimp species recorded, dominants included *Thor floridanus, Hippolyte pleuracanthus,* and *Palaemonetes intermedius.* Also, numbers of *Tozeuma carolinense* were observed to increase at offshore sites dominated by *Thalassia testudinum.* Total numbers of caridean shrimp were as high as 322 shrimp m^{-2}. Preliminary results indicate that greatest species richness and peak abundance of caridean shrimp occur at the *Haladule wrightii* and *Thallassia* transition zone.

1983 - 1985

Ehrhardt, N. M. (1985) Cooperative stone crab research program Everglades National Park. Final Rep. University of Miami (RSMAS) to US Fish and Wildlife Service and South Florida Research Center, Everglades National Park, Homestead, FL. 55 pp.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] Several surveys conducted to assess the amount and spatial distribution of stone crabs traps fished in Park waters showed that during the period of this study, fishing for stone crabs was substantially reduced from past trends and that most fishing operations were restricted to an area along the coast of Cape Sable, and to a lesser extent on the southeast boundary of the park, along the Florida Keys. The sampling design used in this study assessed the stone crabs stocks exploited off Cape Sable and abundance estimates were obtained by direct censuses mostly through diving and by tagging. An analysis of the temporal-spatial location of increased stock abundance demonstrated that fishing operations were closely associated with areas of maximum crab abundance. Standing stock abundances in the study area ranged from 200,000 to 1,333,000 individuals based on diver surveys. Population size estimates based on tagging experiments indicated that an average of 35,071 males were in the study area during October 1984 and that this population level declined to 15,211 males through February 1985 as a result of fishing exploitation. Based on catchability coefficients, instantaneous mortality rates, it was concluded that the exploitation rate observed (0.50) during the 1984/85 fishing season in the Cape Sable area was 88.8% of that required to fully exploit the stock. Without a closed season a severe overexploitation of this resource would occur.

1983 - 1985

Scott, G. P., M. R. Dewey, L. J. Hansen, R. E. Owen, and E. S. Rutherford (1989) How many mullet are there in Florida Bay? Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):89-107.

A fishery independent sampling survey design was implemented in Florida Bay to estimate the monthly biomass of mullet (*Mugil* spp.) in the area during 1983 - 1985. The method was an application of aerial visual sampling, photogrammetric sampling, and shipboard sea-truth sampling. Aerial visual sampling was used to estimate the density (D_M) and number of "muds" in the study area. Photogrammetric sampling was used to estimate mud surface area, and shipboard sampling was used to estimate the proportion of muds containing mullet and the biomass of mullet per unit area of mud (b). Total biomass was estimated as the product of these four variables. The method applied proved to be appropriate for silver mullet. Biomass of silver mullet estimates were found to be characterized by a high degree of variation (CV ≈ 35%), owing primarily to variability of estimates of b and D_M. Mud density estimates were found to be a relatively precise (CV ≈ 20%) index of presumed mullet abundance based on comparison with fishery data. Bias was estimated to result in underestimation of mullet biomass on the order of a factor of 9.6 to more than 19.0. The major source of bias was due to estimates of b. Estimated monthly harvest of silver mullet in April-December 1984 ranged from 2.4 to 12.0% of the bias-adjusted estimates of biomass.

1983 - 1985

Loftus, W. F. (1987) Possible establishment of the Mayan cichlid, *Cichlasoma urophthalmus* (Gunther) (Pisces: Cichlidae), Everglades National Park, Florida. Fla. Sci., 50(1):1-6.

The first United States collections of the Mayan cichlid (*Cichlasoma urophthalmus*), a native of Central America, were made in January 1983 in Everglades National Park. The estuarine sampling site was Snook Creek, which empties into Joe Bay, northeastern Florida Bay. Subsequent surveys have shown that its distribution is limited to two areas in the Taylor Slough drainage basin. Several dozen specimens, both juveniles and adults, ranging from 54.0 mm to 191.0 mm SL, were collected and observed from 1983 to 1985. The larger population inhabits an estuarine creek system where spawning was observed in 1984 and 1985 at salinities of 26 °/oo and 10 °/oo, respectively. A smaller population occurs in a strictly freshwater habitat subject to seasonally-fluctuating water levels. Establishment of the Mayan cichlid is indicated by observations of spawning activity, the wide range of specimen lengths, and its persistence for three years in Park waters. The potential for range expansion is enhanced by its exceptional tolerance of changes in salinity and water levels and its ability to colonize varied habitats. These data suggest that the Mayan cichlid may become a permanent member of Florida's ichthyofauna. The source of the introduction remains unknown.

1983 - 1984

Powell, G. V. N., J. W. Fourqurean, W. J. Kenworthy, and J. C. Zieman (1991) Bird colonies cause seagrass enrichment in a subtropical estuary: observational and experimental evidence. Est. Coastal Shelf Sci., 32:567-79.

Colonies/roosts of piscivorous birds in Florida Bay concentrate nutrients by feeding away from their colonies/roosts and returning with food for young and to defecate. Seagrass beds surrounding the colony islands were markedly different from those around similar islands that did not contain colonies. Seagrass standing crop was enhanced up to 200 m from bird colony islands compared with islands without colonies. Perches were placed in shallow water and were monitored during 1983 - 1984. The species of seagrass were also different at colonies, where *Halodule wrightii* and *Ruppia maritima* predominated in zones close to the colony islands. Around islands without colonies, only *Thalassia testudinum* was present. Experimental bird perches placed to stimulate concentrated bird presence produced changes in adjacent seagrass meadows that were similar to differences between islands with colonies and those without. Over 5 yrs, seagrass standing crop increased around the experimental perches, and species dominance shifted from *T. testudinum* to *H. wrightii.* No similar changes occurred at control locations. These experimental results indicate that the bird concentrations are responsible for the observed differences in seagrass communities surrounding islands that contain colonies. These enriched areas are significant to the seagrass ecosystem because many seagrasses in Florida Bay appear to be nutrient-limited. Demersal fish and invertebrate density and species richness have been shown to be a function of the seagrass standing crop and species composition, so the changes in seagrasses stimulated by localized bird concentrations have the capacity to alter the entire community structure.

1983 - 1985

Zieman, J. C., and J. W. Fourqurean (1985) The distribution and abundance of benthic vegetation in Florida Bay, Everglades National Park. Final Rep. Contract CX5280-2-2204, University of Virginia. South Florida Research Center, Everglades National Park, Homestead, FL. 105 pp.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] This study was undertaken to delineate and describe the benthic vegetation communities in the submerged portions of Florida Bay. Distributional, standing crop, productivity and isotope data along with water characteristics and sediment properties were used to identify seven primary benthic vegetational communities in Florida Bay: Northeast, East Central, Interior, Atlantic, Gulf, Mainland, and Conchie Channel. Some of these communities were qualitatively compared to communities described in earlier studies. The importance of environmental factors (salinity, temperature, and light) on controlling the distribution and extent of these communities in Florida Bay was discussed. This report also provides complete data sets for qualitative descriptions of each study site, quantitative standing crop data, leaf mark and ^{14}C uptake proc ctivity data.

1983 - 1987

Powell, W. M., W. J. Kenworthy, and J. W. Fourqurean (1989) Experimental evidence for nutrient limitation of seagrass growth in a tropical estuary with restricted circulation. Bull. Mar. Sci., 44:324-40.

We studied the impacts of additions of nutrients to a seagrass community on a carbonate mudbank in Florida Bay. Shallow mudbanks dampen lunar tide in Florida Bay, and empoundment and channelization of the upland watershed (the Everglades) have reduced freshwater input, resulting in restricted circulation and reduced nutrient availability. Nutrients were supplied by seabirds defecating from experimental roosts. Seabirds used the roosts approximately 7% of the time so the input of nutrients was constant and quantifiable. The birds delivered approximately 2 - 4 g of excrement per day, resulting in an average loading rate of 0.052 g N and 0.009 g P m^{-2} d-1. Only a portion of the excrement is immediately released as inorganic NH_3 and $P0_4$; about 80% reaches the sediment surface in a relatively insoluble form. There was a significant buildup of phosphate and ammonium in the pore water at the enriched. sites. The ammonium profile of low concentrations at the surface and then increasing with a steep slope through 20 cm suggests a rapid uptake and demand for mineralized nitrogen. Phosphorus in contrast had relatively high levels at the surface. Nutrient addition significantly increased areal leaf production and standing crop of *Thalassia testudinum* and *Halodule wrightii.* Above ground biomass at enriched sites averaged twice controls while below ground biomass was not significantly different between fertilized and control plots. Increased standing crop was produced primarily through longer, wider blades by *Thalassia* and longer blades and increased short shoot density by *Halodule. Thalassia* areal leaf production was 60% greater at enriched sites than at controls. *Halodule* areal leaf production increased by three orders of magnitude at enriched sites. Tissue nutrient content and nitrogen fixation assays suggest that phosphorus availability limits seagrass growth in unenriched conditions, but that nitrogen becomes limiting with the addition of bird excrement.

1984

Ducommun, J. J., and C. D. Burke (1987) Interpretation of paleosalinities from two cores from Florida Bay. The Compass, 64(2):82-88.

Florida Bay encompasses a wide variety of paleosalinity environments. The distribution of ostracode and foraminifer taxa in this area can be used to interpret the fluctuations in salinity that occur in the Bay. Populations of microfossils from Florida Bay were analyzed from two cores. Interpretation of these assemblages suggests that salinity ranged from normal marine to brackish water. Analysis of population parameters with statistical tests (e g, Kruskal - Wallis, Log ANOVA) suggests that the two cores originated from different environments. These statistical tests, however, could not pinpoint environmental changes within cores.

1984

Fonseca, M. S., G. W. Thayer, and W. J. Kenworthy (1987) The use of ecological data in the implementation and management of seagrass restorations. Fla. Mar. Res. Publ., 42:175-87.

Effective restoration of seagrass systems can be implemented best through incorporation of basic ecological data into decision-making processes. The data are comprised mainly of seagrass population growth and coverage models. Careful selection of a site to be transplanted and monitored under strict performance standards offers functional restoration of a system. Environmental factors such as light, temperature, salinity, tidal range, and sediment stability may be used to determine a priori whether seagrass growth could be supported at a given site. On-site restoration directly addresses a return of ecosystem productivity. From an ecological perspective, off-impact-site restoration often results in the selection of sites unacceptable as a mitigative tradeoff. These data suggest that unvegetated patches among natural meadows should not be transplanted as a method to compensate for destruction of existing meadows. Most important for effective management is the utilization of seagrass-population-growth models in the planning process. These data allow (1) selection of the appropriate species for the site in question, (2) setting of precise and testable performance standards, (3) accurate planning of the transplanting operation, including spacing between plantings, (4) development of a monitoring program, and (5) an objective determination by regulatory agencies as to when compliance has been achieved. This transplantation study took place during April 1984 in several sites in the Florida Keys including sites on the Bay side.

1984 ◊

Mahadevan, S., J. Sprinkel, D. Heatwole, and D. H. Wooding (1984) A review and annotated bibliography of benthic studies in the coastal and estuarine areas of Florida. Florida Sea Grant Rep. No. 66. 576 pp.

The intention of this report is to provide the reader with a reference document on available information (published and unpublished) on the benthic environment and its flora and fauna of Florida's estuarine and coastal areas. To facilitate ease of use, the annotated bibliography is arranged by counties. The hope is that this report will serve as a starting point for the investigators of benthic studies to be conducted in the next few decades. As is frequently the case with literature reviews, this report is already out of date beyond 1982. The methodological references compiled are intended to aid the investigator's awareness of the variety of methods available and to hopefully guide the investigator in choosing the best available methodology for achieving study objectives. The taxonomic references compiled are intended to help the investigator by making available a majority of keys, descriptions and guides, thereby improving the taxonomic adequacy of the study. We hope that his report will also be helpful to resource managers, regulators, and interveners by providing basic historical information in their respective areas of concern. A compilation of over 1500 papers were compiled for the report.

1984

Merriam, D. F., S. Sengupta, and P. J. Zimmerman (1985) Regional variation of water-chemical properties affecting the water/sediment interface in Florida Bay. The Compass, 62(2):106-15.

Florida Bay is a large triangular-shaped area in southern Florida bounded on the north by the Everglades on the mainland, on the south and southeast by the Keys and is open to the Gulf of Mexico on the southwest and west. The recently flooded Bay (in the last approximately 5,000 yrs), floored by the Pleistocene Miami Limestone, is shallow, usually less than 10 ft, and contains grove-covered islands. The Bay is a prolific carbonate factory and of interest to researchers as a modern analog to ancient conditions. Recent studies have emphasized the water/sediment interface, geographic variation of different parameters of both Recent and Pleistocene units, and the most recent history of the Bay as interpreted from shallow, soft-sediment cores. Water properties of salinity, pH, dissolved CO_2 and O_2 and turbidity are important factors along with physical parameters in determining the origin, distribution, and accumulation of the Recent sediments. In January 1984, 21 stations were occupied in the Bay and samples taken and analyzed on site with a portable chemical kit. These spatial data were subjected to trend-surface analysis to determine the regional pattern of values for each variable. Salinity is normal marine in the center of the Bay decreasing to brackish conditions along margins. Dissolved O_2 decreases toward the center of the Bay as do the pH and turbidity. In general, the salinity and CO_2 of the water decrease as O_2, pH, and turbidity increase. These conditions are the result of a complex interplay of basin configuration, circulation, dilution and pollution, animal activity and vegetation, light, temperature, agitation, sediment availability, and many other variables.

1984 ◊

Quinn, T. M. (1984) Evolution of selected Holocene mangrove-fringed islands of west-central Florida Bay. M. S. Thesis. Wichita State University, Wichita, KS. 114 pp.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Florida Bay is a large, triangular-shaped, shallow water, marine embayment which occupies an area of approximately 1550 sq km between the Florida Keys on the southeast, and the Florida mainland on the north. Calcium carbonate is being produced in situ by a variety of green algae, whereas the remainder of the sediment is composed of molluscan-foraminifera shell fragments. This sediment is being deposited unconformably on the surface of the southwestwardly gently sloping Pleistocene Miami Limestone. The variability in the stratigraphic history of the Holocene mangrove-fringed islands of Florida Bay, as revealed by numerous cores, suggests that there may be fundamental differences in the processes involved in island evolution between islands that developed in northeastern and north Florida Bay than from those islands that developed in west-central Florida Bay. This suggests a revised model for carbonate-sediment deposition in the area of west-central Florida Bay. The sedimentary record and principal sedimentary environments in this area in upward succession are: (1) freshwater carbonate mud that developed from shallow, freshwater ponds; (2) a transgressive peat which reflects the changing of environments from freshwater marsh and swamps, to brackish-water conditions, and finally paralic mangrove swamps; (3) molluscan packstone unit that was deposited in a littoral environment; and (4) supratidal mudstone, that developed from a coastal tidal flat where the rate of deposition was greater than the rate of Holocene sealevel rise. It seems that island evolution as a function of mangrove colonization of mudbanks is a more recent phenomena, and that islands that formed earlier in the history of the marine inundation of the Bay in west-central Florida Bay nucleated from a coastal tidal flat that developed on a transgressive peat deposit.

1984

Sengupta, S. (1985) Recent carbonate sedimentation in Florida Bay: A study to define major subenvironments. M. S. Thesis. Wichita State University, Wichita, KS. 135 pp.

Florida Bay is a large triangular-shaped area in southern Florida bounded on the north by the Everglades, on the southeast and south by the Gulf of Mexico. The environment in Florida Bay is influenced by the freshwater runoff from the Everglades, ground water seeping through the 'basement rocks', rainfall, and marine waters from the Atlantic Ocean and Gulf of Mexico. The relation of water properties such as salinity, pH, dissolved oxygen, dissolved carbon dioxide, turbidity, calcium, and magnesium along with sedimentological, geochemical, and biological properties of the Recent sediments collected in Florida Bay were used to determine the subenvironments. Statistical data analysis of these spatial data reveals that: (a) salinity increases from brackish to marine towards center of Bay; (b) pH is normal marine towards center of Bay, and it increases towards the mainland and Keys; (c) turbidity increases towards the mainland; (d) dissolved oxygen decreases towards the center of the Bay; and (e) dissolved carbon dioxide increases towards the center of the Bay. The statistical analysis allows definition of four subenvironments extant in the Bay: three peripheral ones - Northern, Gulf, and Atlantic, and an interior restricted environment. The subenvironments show a distinct change in their orientation from the winter to the summer. These changes are attributed to various causes chief among them being wind direction, nutrient supply, rainfall, water circulation, and basin configuration. Geochemical analysis indicated that the waters of Florida bay are supersaturated with respect to calcium carbonate. Inorganic precipitation of calcium carbonate can occur in certain regions of the Bay, particularly in the Northern subenvironment. X-ray diffraction studies indicate no evidence for diagenesis in the mineralogy of the sediments from Florida Bay. Forty one stations were sampled during 1984.

1984 ◊

Tebeau, C. W. (1974) South Florida water management. Environments of South Florida: Present and Past. Memoir 2. P. J. Gleason (ed.). Miami Geological Society, Coral Gables, FL. 362-6.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] This citation is a historical review of water management in South Florida.

1984 ◊

VanArman, J. (1984) South Florida's estuaries. Environments of South Florida: Present and Past II. P. J. Gleason (ed.). Miami Geological Society, Coral Gables, FL. 79-96.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The coastal estuaries are among the most threatened natural environments in Florida. They exist where freshwater runoff from the uplands, streams and rivers meets the sea and are under continual threat from land development, pollution and dredge and fill activities, as well as commercial and recreational overuse. Florida's estuaries are similar in structure to estuaries throughout the world. However due to location and climate, they support biological communities that are unique within the continental United States. These estuaries were formed through combined forces of reef building, land subsidence, sedimentation, periodic storms and a gradual rise in sea level during the last 4000 to 6000 yrs. Man's activities during the last century have resulted in five major types of adverse impacts: (1) changes in natural watershed characteristics have severely altered inflow of freshwater, nutrients and sediments; (2) structural changes have occurred to stabilize inlets, create and maintain channels and modify shorelines; (3) the timing and quantity of freshwater inflow have been altered; (4) water quality has been degraded through the introduction of excessive nutrients and pollutants; and (5) benthic and shoreline communities have been destroyed or extensively damaged. Twelve major estuarine areas of South Florida are identified. A physical description, summary of research, discussion of problems, and survey of current management studies are presented for each estuary. A list of references for the region and for each estuary is provided as a guide to the literature. These studies and the level of current interest indicate that major efforts are underway to analyze and resolve the problems of South Florida's estuaries. The result will be a substantial increase in knowledge and our ability to manage these systems.

1984 - 1985

Bryant, H. E., M. R. Dewey, N. A. Funicelli, G. M. Ludwig, D. A. Meineke, and L. J. Mengel (1989) Movement of five selected sports species of fish in Everglades National Park. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):515.

[ABSTRACT ONLY.] Studies to determine movement of spotted seatrout, *Cynoscion nebulosus*, red drum, *Sciaenops ocellatus*, gray snapper, *Lutjanus griseus*, black drum, *Poganias cromis*, sheepshead, *Archosargus probatocephalus*, were conducted in Florida Bay and along the west coast of Everglades National Park. A total of 3,237 fish of the five species were tagged from March 1984 to March 1985; 1,797 individuals from Florida Bay, and 1,440 individuals from the west coast were tagged. Spotted seatrout moved less than 6 km from point of tagging and had return rates of 3 and 1.6% for the west coast and Florida Bay, respectively. Red drum moved less than 8 km. The fish that moved the greatest distances were the larger fish (over 750 mm). Red drum return rates were 9.4% for the west coast and 2% for Florida Bay. Gray snapper returns indicated movement to the southwest as the individuals grew. The mean distance traveled by these fish was 18.3 km. Black drum returns illustrated general northwest movement out of the park from January to April and substantiated the schooling behavior of the species. Sheepshead tag returns indicated that they remained near shore during the fall and early winter and were absent from these waters during the late winter. Maximum traveled distance was 10 m prior to spawning season.

1984 - 1985

Chester, A. J., and G. W. Thayer (1990) Distribution of spotted seatrout (*Cynoscion nebulosus*) and gray snapper (*Lutjanus griseus*) juveniles in seagrass habitats of western Florida Bay. Bull. Mar. Sci., 46(2): 345-57.

The distribution, abundance, and biomass of juvenile spotted seatrout *(Cynoscion nebulosus)* and gray snapper *(Lutjanus griseus)* were evaluated along with information on seagrasses, sediments, water temperature, and salinity in basin and channel habitats of western and central Florida Bay during 1984 - 1985. Spotted seatrout juveniles were most prevalent in basin habitats in the western portion of the Bay, near the Gulf of Mexico, and were collected during every month sampled except May (1984); smallest individuals were collected during May (1985), June (1984, 1985), and July (1984). The habitats in which spotted seatrout occurred had deeper more organic sediments with greater density and biomass of the seagrass, *Syringodium filiforme,* than did non-seatrout areas (ANOVA, $P < 0.05$). Gray snapper juveniles were most prominent in channels of the southeastern part of the Bay but also occurred in basins located to the northwest. The presence or absence of gray snapper was related to the distribution of seagrass biomass, particularly that of *Thalassia testudinum* in the basins and *Syringodium* in the channels. These data suggested that seagrass meadows are critical habitats for spotted seatrout and gray snapper in the Bay.

1984 - 1985

Cooper, D. J. (1986) Variability in biogenic hydrogen sulfide emissions from selected Florida ecosystems. M. S. Thesis, University of Miami., Coral Gables, FL. 164 pp.

Hydrogen sulfide emission fluxes were measured from several different habitats in Florida, characterizing a freshwater swamp, mangrove fringes, various tidal marshes and natural water surfaces. Variability in emission rates from different ecosystems is explained in terms of the availability of oxygen, sulfate and organic matter, whilst variability at the individual sampling locations is explained in terms of diel or tidal effects. Diel effects were found at all sites except where tidal inundation of reducing sediments was occurring. Soil surfaces exhibited an afternoon peak in emission rates with a broad night time minimum, while emissions from water surfaces peaked before dawn and had a broad minimum during the day. The lowest emitting soil surface in sawgrass (*C. jamaicense*) swamp had a range of 1.6 - 41 mg S (H_2S) m^{-2} yr^{-1} and the highest emitting soil surface in a spike grass (*D. spicata*) tidal marsh had a range of 73 - 1336 mg S m^{-2} yr^{-1}. The lowest emitting water surface was a highly organic coastal water with a range of 0.6 - 19.6 mg S m^{-2} yr^{-1} and the highest emitting water surface was in the *D. Spicata* marsh with a range of 6.2 - 13100 mg S m^{-2} yr^{-1}. Tidal effects were more dramatic, and occurred for brief periods as water inundated the sampling site. Individual flux measurements from bare sand in a *S. alterniflora* marsh ranged from 10.7 - 130400 mg S m^{-2} yr^{-1} from a mudflat in a mangrove fringe. Using different averaging techniques to account for the factors controlling emission rates in the various ecosystems, an annual flux of 1.8×10^9 S (H_2S) yr^{-1} can be calculated for the entire state of Florida. This is insignificant compared to the anthropogenic SO_2 flux of over 5×10^{11} g S (SO_2) yr^{-1}, but because the highest H_2S emissions are measured from specific plant communities (mangroves and tidal marshes), the natural input to the atmosphere may be important on a smaller scale. Measurements at Flamingo took place in 1984 and 1985.

1984 - 1985

Dewey, M. R., L. J. Mengel, N. A. Funicelli, H. E. Bryant, G. M. Ludwig, and D. A. Meineke (1989) Trammel net efficiency in the coastal waters of Everglades National Park. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):516-7.

Quantitative trammel net sampling was conducted in the Florida Bay from 1984 to 1985 to obtain estuarine fish standing stock estimates. Efficiency tests were conducted to obtain more accurate estimates of standing stock from the net samples. Trammel net sampling efficiencies were calculated from spotted seatrout *(Cynosion nebulosus),* gray snapper *(Lutjanus griseus),* pinfish *(Lagodon rhomboides),* catfish, which included sea catfish *(Arius felis)* and gafftopsail catfish *(Bagre marinus)* and mullet, which included white mullet (*Mugil curema*) and striped mullet (*Mugil cephasus*). Nine efficiency tests were conducted with mean efficiencies ranging from 29% for pinfish to 70% for catfish. Variability among replicates in set efficiency was high for each taxonomic group. No significant correlations were noted between high number of fish collected in the trammel net and efficiency of the set. With the methodology used in this study, an extensive number of tests would have to have been conducted to obtain minimally acceptable levels of accuracy and precision. Sampling efficiency of any one set appears to be influenced by a variety of often unmeasurable and unrecorded variables including method of deployment, strike efficiency, the differential behavior of species reacting to net deployment and strike, and variable habitat conditions sampled.

1984 - 1985

Ehrhardt, N. M. (1990) Mortality and catchability estimates for the stone crab (*Menippe mercenaria*) in Everglades National Park. Bull. Mar. Sci., 46(2):324-34.

Estimates of natural mortality have not been reported for the stone crab *Menippe mercenaria*, yet this information is essential for describing the population dynamics of the species and to manage the stocks. In this study, mortality of adult males inhabiting an area off Cape Sable was estimated by sequential tagging experiments and by analysis of fishery statistics for the period October 1984 to May 1985. Natural mortality rates range from 0.780 to 6.867 per annum. Differences in the mortality estimates are attributed to dominance of specific size groups included in the tagging experiments, with mortality rates varying linearly with size of tagged individuals. The higher natural mortality rates corresponded to individuals with carapace widths at or above the average size at terminal molt. The mortality estimates were obtained from information gathered under exceptional circumstances and complexities of estimating these rates due to difficulties of aging crustaceans are recognized. This problem is further complicated in the stone crab fishery because only claws are harvested and landed, therefore, the true age composition of the stocks may never be known from standard commercial statistics.

1984 - 1985

Funicelli, N. A., D. A. Meineke, H. E. Bryant, M. R. Dewey, G. M. Ludwig, and L. S. Mengel (1989) Movements of striped mullet, *Mugil cephalus*, tagged in Everglades National Park, Florida. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):171-8.

The movements of striped mullet, *Mugil cephalus,* were studied from fish tagged in Everglades National Park. A total of 16,604 fish were tagged from March 1984 to September 1985. During the period of December 1984 through February 1985, recaptured tagged fish moved significantly further and more northerly out of the Park's waters than they did the rest of the year. Tags were returned from 2.8% of the fish tagged along the west coast and ɔm 0.3% of the fish tagged in Florida Bay and west coast mullet form a series of spatially overlapping stocks.

1984 - 1985

Hettler, W. F. (1989) Food habits of juveniles of spotted seatrout and gray snapper in Western Florida Bay. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):155-62.

Stomach contents were analyzed from 144 juvenile spotted seatrout, *Cynoscion nebulosus,* and 215 juvenile gray snapper, *Lutjanus griseus,* collected by trawl or rotenone from shallow seagrass flats, deep bank channels, or mangrove prop root habitats in western Florida Bay. Collections took place in 1984 and 1985 and are detailed in Thayer and Chester (1989). Both species fed almost exclusively on crustaceans and fishes. Smaller non-decapod crustaceans—copepods, amphipods, and mysids were more abundant as measured by percent occurrence in the smallest size classes (<50 mm SL). Penaeid shrimp, the most numerous prey in both fishes, and caridean shrimp increased in percent occurrence as fish increased in size. Fish were important in the largest size classes, above 150 mm SL. Rainwater killifish, *Lucania parva,* was the most common fish consumed. About 20% of the trout and snapper had empty stomachs when collected in grass flats, whereas about 60% of both species had empty stomachs when taken in channels. Relatively few fish were collected in mangroves and none of these specimens contained penaeids. No prey species were identified in either gamefish that are not common in Florida Bay.

1984 - 1985

Holmquist, J. G., G. V. N. Powell, and S. M. Sogard (1989) Decapod and stomatopod assemblages on a system of seagrass-covered mud banks in Florida Bay. Mar. Biol., 100:473-83.

The latticework of seagrass-covered mudbanks in Florida Bay divides the Bay into distinct subenvironments and supports a robust seagrass community subject to pronounced physical stress. Throw-trap sampling of decapods and stomatopods during 1984 and 1985 (December - April, May - August and September - November of each year) showed that bank sides exposed to turbulence had low abundance but similar species richness to that of bank tops and sheltered sides. The fauna was more Gulf-Carolinean than Antillean. The sampling sites were near or at Lake Key, Pass Key, Eagle Key, Cross Bank, Cowpens Key, Buchanan Key, Oyster Key, and Murray Key. The crustacean communities of the different subenvironments, however, were distinct, with both Antillean and temperate assemblages represented and with one isolated area markedly depauperate. The two subenvironments adjacent to the Atlantic Ocean and Gulf of Mexico held the greatest densities. Multiple-regression techniques suggested that vegetational habitat characteristics played a secondary role compared to various physical factors. Restricted circulation (compounded by winter cold-fronts or other seasonal causes of density maxima, juxtaposed faunal provinces, and the wider salinity range of the isolated regions of the Bay may be primarily responsible for the strikingly different communities of the various subenvironments. [This work was also discussed in: Holmquist, J. G., G. V. N. Powell, and S. M. Sogard (1989) Decapod and stomatopod communities of seagrass-covered mudbanks in Florida Bay: inter- and intra-bank heterogeneity with special reference to isolated subenvironments. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):251-62.]

1984 - 1985

Ludwig, G. M., J. E. Skjeveland, and N. A. Funicelli (1990) Survival of Florida Bay fish tagged with internally anchored spaghetti tags. Fla. Sci., 53:38-42.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] Studies were conducted from January 1984 to September 1985 to determine movement and estimate population sizes of certain commercial and sport fishes in the coastal marine waters of the Everglades National Park (Florida Bay - Ten Thousand Islands) and experiments to determine mortality caused by tagging and the amount of tag shedding were conducted as part of that research. The percent survival of Florida Bay white mullet, striped mullet, spotted seatrout, and gray snapper marked with internally anchored spaghetti tags was 22, 67, 75, and 100, respectively. Unmarked fish of the same species had survival percentages of 27, 77, 75, and 100, respectively. Transporting the fish up to 16 km from the point of capture did not significantly decrease survival in either tagged or untagged fish.

1984 - 1985

Mengel, L. J., M. R. Dewey, H. E. Bryant, N. A. Funicelli, G. M. Ludwig, and D. A. Meineke (1989) Relative abundance and standing stock estimates for finfish in Florida Bay trammel nets. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):518-9.

[ABSTRACT ONLY] This study was part of a cooperative effort by the US Fish and Wildlife Service, the National Park Service and NOAA/NMFS, to address the management needs of Everglades National Park. The relative abundance and standing stocks of the major sport and commercial fish species was estimated from quantitative trammel net samples. Usually, 60 random samples were collected throughout the Park each month: 42 in Florida Bay; 6 in Whitewater Bay; and 12 along the west coast. Standing stocks were estimated by dividing the average number of fish caught per set by the area sampled and multiplying it by the total area. Sample efficiency was determined by another study and reported separately. Efficiencies for standard sets varied from 6.8% for gray snapper to 58% for striped and white mullet. From June 1984 to June 1985, 689 random sets yielded 86 species. Seventy-two species were taken in 477 sets in Florida Bay. Sixty species were taken in 135 sets on the west coast. Whitewater Bay (77 net sets) catches yielded 27 species. The west coast had consistently higher fish density than Florida Bay. The order of decreasing relative abundance for 10 most prevalent species in our Florida Bay catches were: pinfish, sea catfish, gray snapper, spotted seatrout, cravelle jack, grafftopsail catfish, striped mullet, white mullet and red fish. The order of decreasing relative abundance for 10 most prevalent species in our west coast catches were sea catfish, grafftopsail catfish, striped mullet, spotted seatrout, pinfish, crevalle jack, white mullet, gray snapper, sheepshead and red drum. Monthly relative abundance was estimated by habitat type and physical parameters. Oyster reefs had the highest relative abundance of fish (70 fish/set) while sand and rock flats had the greatest species diversity (48 species collected).

1984 - 1985

Perrine, D. (1987) Some possible effects of the declawing of female stone crabs, *Menippe mercenaria*. M. S. Thesis, University of Miami., Coral Gables, FL. 36 pp.

Sixty female stone crabs (*Menippe mercenaria*) were paired and held in individual aquaria or individual cages in large tanks supplied with running seawater. One member of each pair had both claws removed. The other retained both claws. Otherwise both members received identical treatment. During a 4-month period (March-June, 1985) declawed crabs produced more egg masses than crabs with claws. This was significant (chi square goodness of fit; $P < 0.05$) for the first three months. The spawning season for stone crabs is approximately April - September. Molting normally occurs in mature females in fall - winter following the completion of spawning. Molting has been shown to be accelerated by removal of claws early in the intermolt period. The observed increase in spawning by declawed crabs during the early months of the spawning season may be a result of interactions between the molting and spawning cycles, with both processes shifted forward in time as a reaction to declawing.

1984 - 1985

Powell, A. B., D. E. Hoss, W. F. Hettler, D. S. Peters, L. Simoneaux, and S. Wagner (1987) Abundance and distribution of ichthyoplankton in Florida Bay and adjacent waters. Final rep. SSFRC-87/01. South Florida Res. Center, Everglades National Park, Homestead, FL. 44 pp.

An ichthyoplankton survey was carried on in Florida Bay and adjacent waters that focused on the abundance and distribution of larvae of four target species: red drum (*Sciaenops ocellata*), snook (*Centropomus undecimalis*), gray snapper (*Lutjanus griseus*) spotted seatrout (*Cynoscion nebulosus*). Twenty sampling stations were established: eight to document larval entry into Florida Bay and adjacent estuarine waters, and 12 within Florida Bay and adjacent estuarine waters to provide insight into larval fish distribution and movement. Ten larval fish collection trips were made during 1984 and 1985. Spotted seatrout was the only target species whose larvae were regularly collected. No snook, one red drum and 16 potential gray snapper were collected. Based on the distribution of early stage larvae, spotted seatrout spawned in intermediate to high salinity waters within western Florida Bay and adjacent estuarine waters, but did not appear to spawn in brackish waters. We never collected spotted seatrout in the Keys area. Temporally, spotted seatrout have a protracted spawning season with spawning minimal during late fall and winter and most intense from May to September. Based on the absence of early larval stages, gray snapper, snook and red drum apparently spawn outside of the Everglades National Park. All larvae identified as snapper larvae were found in the ocean but young juveniles were found both in Florida Bay and the ocean. It appears that gray snapper spawn near offshore reefs in the Atlantic Ocean and at least some enter the Park as juveniles. The lack of larval snook and red drum in our samples does not indicate they are absent from the area. Adults spawn outside the Park, thus the larval supply may be susceptible to considerable mortality prior to migrating into the Park. They are less vulnerable to the gear because they are relatively well developed, and they may not be available to standard ichthyoplankton gear due to preference for the poorly sampled microhabitats (e.g., crevices, the bottom and channel edges). Step-oblique tows with standard ichthyoplankton gear was appropriate for sampling early stage trout larvae to determine the spatial and temporal distribution of spawning. The development of different gear may be required to study the late larval and early juvenile stage. Although our research focused on the four target species we were able to gain an insight into the distribution and abundance of non-gamefish within Florida Bay and adjacent waters. One of the most striking patterns was the dominance by and ubiquitous distribution of gobiid larvae.

1984 - 1985

Powell, A. B., D. E. Hoss, W. F. Hettler, D. S. Peters, and S. Wagner (1989) Abundance and distribution of ichthyoplankton in Florida Bay and adjacent waters. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):35-48.

This ichthyoplankton survey in Florida Bay and adjacent waters focused on the abundance and distribution of larvae of four species: red drum *(Sciaenops ocellata)*, snook *(Centropomus undecimalis)*, gray snapper *(Lutjanus griseus)* and spotted seatrout *(Cynoscion nebulosus)*. Spotted seatrout was the only target species whose larvae were regularly collected. The data indicated that this species spawned in intermediate to high salinity waters within western Florida Bay and adjacent estuarine waters, but not in brackish waters. No spotted seatrout larvae were collected in the Keys area. Ten sampling trips were made from March 1984 to September 1985. Larvae were collected in all months except November. All snapper larvae were found in the Atlantic Ocean, but juveniles were found both in Florida Bay and the Atlantic Ocean. Gray snapper appeared to spawn near offshore reefs, during the summer, in the Atlantic Ocean and at least some entered the Bay as advanced larvae or juveniles. One of the most striking patterns of this survey was the dominance and ubiquitous distribution of gobiid larvae.

1984 - 1985

Sogard, S. M., G. V. N. Powell, and J. G. Holmquist (1989) Utilization by fishes of shallow, seagrass-covered banks in Florida Bay: 1. Species composition and spatial heterogeneity. Environ. Biol. Fishes, 24(1):53-65.

Species composition and relative capture rates of water column fishes occurring on the shallow (<1 m), seagrass-covered mudbanks of Florida Bay were assessed using small-mesh gill nets. The fauna was largely temperate, with few tropical representatives, and was similar to the fish community of the adjacent basins. There was high variability in the catch across the Bay, reflecting heterogeneity in both the physical environment and various aspects of the seagrass canopy. The Gulf site, in the northwest section of the Bay, had the highest species richness and highest capture rates of individual species, relative to other sites. Higher densities of potential prey, greater available foraging area, and organically rich, fine sediments are probably influencial in the greater fish utilization of the bank. The greater exchange of western Florida Bay with open Atlantic or Gulf waters is proposed as a secondary factor influencing species richness; the probability of non-resident species occasionally appearing on western banks is greater than in isolated interior sections of the Bay.

1984 - 1985

Sogard, S. M., G. V. N. Powell, and J. G. Holmquist (1989) Utilization by fishes of shallow, seagrass-covered banks in Florida Bay: 2. Diel and tidal patterns. Environ. Biol. Fishes, 24(2):81-92.

Diel and tidal patterns in the occurrence of water column fishes were examined on four shallow banks in Florida Bay, using continuous 72 h gillnet sets. Nets were set on the edge of a mudbank and remained in place 72 h. The fish were removed from the net every half hour. Banks were sampled during five series over a two-yr period (March, July and November, 1984; and March and July, 1985). Patterns in capture rates were presumed to indicate movement of fishes on and off the seagrass-covered banks. Species that were nocturnally active on the banks included *Arius felis, Mugil gyrans, Opisthonema oglinum, Harengula jaguana, Elops saurus, Lutjanus griseus,* and *Bairdiella chrysoura.* Diurnal species included *Eucinostomus gula, Lagodon rhomboides,* and *Mugil cephalus. Strongylura notata* and *Mugil curema* showed no consistent patterns. At the two sites with significant tidal fluctuation in water level, different activity patterns on the bank relative to tidal stage were evident for several species. At extreme low tides, water column fishes apparently left the banks to avoid stranding. Cycles of fish utilization of the bank habitat are proposed to be related to both availability of prey (diel patterns) and water level (tidal patterns). These cycles in turn influence activity patterns of predators foraging on these fishes.

1984 - 1985

Sogard, S. M., G. V. N. Powell, and J. G. Holmquist (1987) Epibenthic fish communities on Florida Bay banks: relations with physical parameters and seagrass cover. Mar. Ecol. Prog. Ser., 40:25-39.

Epibenthic fish communities residing in seagrass beds on shallow (< 0.5 m) mudbanks in Florida Bay were quantitatively sampled with a throw trap method. Sampling took place three times a year during 1984 to 1985. The overall average density of 11 fish m^2 was substantially higher than most previously reported densities for seagrass habitats. Four sites, representing 4 different subenvironments of Florida Bay, differed widely in species composition and densities of individual species. Results of discriminant function analysis indicated that fish communities at the 4 sites were relatively distinct. Species composition at different sites may be the result of complex interactions between the deterministic influence of habitat quality and the stochastic influence of larval availability. Restricted water circulation, effected by the network of banks, and different sources of water mass exchange were proposed as constraints on larval availability. Differences in species richness and fish densities across individual banks corresponded to gradients in depth, sediment structure, detrital loads, and various measures of seagrass structural complexity. The greater physical stress on top of a bank appeared to limit species richness, while fish densities across individual banks were regulated by habitat gradients. Multiple regression analysis indicated that the standing crop of seagrasses and the accumulation of vegetation litter were important determinants of fish densities. Physical factors, such as depth and sediment structure, were also influential.

1984 - 1985

Sogard, S. M., G. V. N. Powell, and J. G. Holmquist (1989) Spatial distribution and trends in abundance of fishes residing in seagrass meadows on Florida Bay mudbanks. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):179-99.

Fishes inhabiting seagrass beds on shallow mudbanks in Florida Bay were sampled with throw traps, to capture the relatively sedentary, epibenthic species, and gillnets, to capture the more mobile species occupying the overlying water column. There was a strong heterogeneity in species composition and abundances of both components across different subenvironments of the Bay. The Interior section, characterized by a low tidal range and hypersaline conditions, harbored few epibenthic species relative to sites on the periphery of the Bay. Densities of *Lucania parva*. however, reached outstanding values, with a mean of 39 fish per m^2 at a West Interior site. Species richness of the water column component was also low in the Interior subenvironment, but a few species had high capture rates, despite salinities of up to 50 °/oo. Three years of sampling in the northeast subenvironment indicated a trend from estuarine to marine conditions in salinity regime, seagrass growth, and densities of epibenthic fishes. A conceptual model was developed to aid in understanding the potential role of various biotic and abiotic factors in structuring fish communities on the banks. The distinctiveness of different subenvironments suggests that physical factors of water circulation and salinity patterns play a more influential role in Florida Bay than in more congruous seagrass ecosystems. This paper described the 1984 and 1985 results of the study. The results from the first two years of the study can be found in Sogard *et al.* (1987) and Sogard *et al.* (1989).

1984 - 1985

Thayer, G. W., D. R. Colby and W. F. Hettler (1987) Utilization of the red mangrove prop root habitat by fishes in south Florida. Mar. Ecol. Prog. Ser., 35:25-38.

The inherent difficulty of sampling the red mangrove prop root habitat has impeded our understanding of the utilization of this habitat by fishes. A block net and rotenone method was developed and used to sample 2 sites in each of 4 regions in Everglades National Park. At each site a 3-mm mesh net was used to enclose 3 sides of a mangrove island while an onshore berm formed the fourth side. Samples collected from the mangrove prop root environment were compared with samples collected using a 2-boat otter trawl in the immediately (8 to 10m) adjacent fringing seagrass habitat. The density and biomass of fish collected by the 2 gear were greater in the prop root habitat than in the adjacent fringing seagrass areas. There also were consistent differences in species composition between the 2 habitat types across all 4 geographic regions. Analysis of the stomach contents of gray snapper *Lutjanus griseus* suggested that smaller snapper tend to feed in the prop root habitat while larger snapper may forage out into adjacent areas to feed. The red mangrove prop root habitat is utilized by a wide variety of fish, and greater attention should be given to evaluating its contribution to fish production in south Florida and elsewhere.

1984 - 1985

Thayer, G. W., and A. J. Chester (1989) Distribution and abundance of fishes among basin and channel habitats in Florida Bay. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):200-19.

Surface and bottom trawls were used to sample fishes in basins and channels in the western half of Florida Bay during 1984 and 1985. These data were evaluated in conjunction with information on environmental parameters, including seagrasses, to identify fish-habitat associations. Florida Bay is utilized by a diverse fish assemblage dominated by juveniles and forage species. The western portion of our sampling area within Florida Bay, adjacent to the Gulf of Mexico, and channels within the Bay, consistently supported the highest diversity of fish. Channel areas generally displayed the highest overall standing crop and density of seagrasses. Basins in the eastern portion of the Bay were most diverse in terms of seagrass composition and exhibited the highest overall densities of *Syringodium filiforme.* Cluster analysis revealed two major station groups. One, characterized by fish species that occurred frequently and in large numbers, occurred primarily in channels and in western Florida Bay where mixtures of seagrasses were prevalent; a second, characterized by low fish densities, occurred in generally monotypic stands of *Thalassia testudinum.* Discriminant function analysis demonstrated that comparatively higher sediment organic contents, slightly shallower water, and abundant *Halodule wrightii* and *Syringodium* populations were important factors at stations belonging to the typically high density fish cluster.

1984 - 1985

Thayer, G. W., W. F. Hettler, A. J. Chester, D. R. Colby, and P. T. McElhaney (1987) Distribution and abundance of fish communities among selected estuarine and marine habitats in Everglades National Park. Rep. SFRC-87/02. South Florida Research Center, Everglades National Park, Homestead, FL. 166 pp.

The overall objective of this juvenile study was to evaluate relative species abundance and size composition of fish communities among selected habitats in estuarine and marine waters of Everglades National Park and to provide descriptions of the habitats in which these fishes occurred. Particular emphasis was placed on spotted seatrout (*Cynoscion nebulosus*) and gray snapper (*Lutjanus griseus*). The study was divided into two subobjectives: juvenile fish associated with open water habitats, and fish utilizing red mangrove prop root habitats. The study area was subdivided into five sampling strata that included Whitewater Bay - Coot Bay, channels in Florida Bay, and three open water areas between western and eastern Florida Bay. Random sampling was conducted within these strata as well as regular periodic sampling at several selected sites. Biological, physical and chemical data, fish, shrimp, crabs, vegetation and sediment were collected during 1984 and 1985. Coot Bay and eastern Whitewater Bay are characterized by low salinities and sediments with high organic content and generally low densities of *Ruppia maritima* and/or *Halodule wrightii.* Channel areas in Florida Bay generally display the highest overall standing crop and density of seagrasses composed of *Thalassia testudinum, Syringodium filiforme* and *Halodule wrightii.* The western strata of Florida Bay adjacent to the Gulf of Mexico was the most diverse in terms of seagrass composition, particularly in the northern portion, and exhibits the highest overall densities of *Syringodium*. The central and eastern strata are dominated by monotypic stands of *Thalassia* with the sparsest seagrass densities occurring in the eastern area adjacent to the Florida Keys. Here the sediment veneer is the thinnest observed in our study area. Over 90 species of fish representing 43 families were collected during the study, and all species contributed to over 90% of the fish collected. Western Florida Bay and channels in Florida Bay consistently supported fish communities that were comprised of similar species and the highest densities relative to other study areas. On an areal basis, the average numerical abundance and standing crop values of fish we observed are similar to, but at the low end of, the range of several published reports of fishes in seagrass meadows. Cluster analysis demonstrated two obvious associations. One cluster was characterized by species that occurred frequently and in large numbers, and this grouping occurred primarily in channels and in northwestern Florida Bay where mixtures of *Syringodium* and *Thalassia* were prevalent. A second cluster was of low fish density stations that are generally in areas of sparse monotypic meadows of *Thalassia*. Juvenile gray snapper and spotted seatrout were collected regularly, but in small numbers, during the stratified sampling phase as well as at regular sampling at Joe Kemp Key and Bradley Key. Although gray snapper were collected in western Florida Bay, they were most abundant in channels in eastern Florida Bay. This distribution is coincident with our larval sampling which found larval snapper only in the vicinity of the Florida Keys. Juvenile spotted seatrout were collected primarily in northwestern Florida Bay, and primarily in areas with mixed seagrass meadows containing *Syringodium*. Larval seatrout also were collected in greatest abundance in the same area, possibly suggesting only limited geographic movement of juveniles after settlement out of the plankton. Discriminant function analyses of data from randomly sampled sites were employed in an attempt to identify those environmental characteristics most important in determining juvenile spotted seatrout and gray snapper habitat. High densities of *Syringodium* and high percentages of organic matter in the sediments were particularly diagnostic of spotted seatrout habitat, while *Halodule* and biomass were the most informative variables in describing gray snapper habitat, particularly when these seagrasses were present in channels. These discriminant functions were employed to classify Joe Kemp Key and Bradley Key collections as having occurred at target fish or non-target fish habitat. Target fish were collected on all occasions at Joe Kemp Key and Bradley Key. The discriminant functions developed from our stratified random sampling phase of the study classified the sampling locations at Joe Kemp Key and Bradley Key as target fish habitat on all but one occasion. Data are also presented on the food habits of juvenile gray snapper and spotted seatrout, and on the distribution of spiny lobsters, blue and ornate crabs, and a penaeid shrimp based on otter trawl collections at the randomly sampled sites. Food habit data was similar to published accounts for similar size fish. There appeared to be distinct distribution patterns of lobsters, crabs, and shrimp. The red mangrove prop roots of Whitewater Bay, Coot Bay and Florida Bay provides extensive habitat that heretofore has not been evaluated quantitatively for fishes. A technique was developed and tested to sample these habitats quantitatively. Fishes collected from this habitat type were compared with fishes collected by trawl from the immediately adjacent seagrass habitat. The mangrove prop root habitat supported an overall greater density and standing crop of fish. Several of the species utilizing the prop root habitat are of commercial and recreational importance (e.g., mullet and gray snapper), while many are forage foods for predatory fishes. This phase of the study demonstrated that the red mangrove prop root habitat is utilized by a wide variety of fish, and that greater attention should be given to evaluating it as a refuge and a source of food resources for fishes in Everglades National Park.

1984 - 1986

Holmquist, J. G., G. V. N. Powell, and S. M. Sogard (1989) Decapod and stomatopod communities of seagrass-covered mud banks in Florida Bay: inter- and intra-bank heterogeneity with special reference to isolated subenvironments. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):251-62.

The decapod and stomatopod fauna of the grass covered mudbanks in five major subenvironments of Florida Bay were sampled using throw traps, and the collected specimens tested for zonation in these fauna across individual banks. The sampling sites were the same as those of Holmquist *et al.* (1989). Samples were collected three times a year in accordance with the ecologically distinct periods of the Bay : December - April, May - August, and September - November). The East Central (Cross Bank), Atlantic (Buchanan Bank) and Gulf (Dave Foy Bank) subenvironments were sampled during 1984 - 1985; the East Interior (bank adjacent to Coon Key) and West Interior (between Roscoe and Dump Keys) during 1986; and the Northeast (Eagle Key Bank) during 1984 - 1986. The vegetation in these locations was described by Zieman *et al.* (1989) and the decapod and stomatopod communities by Holmquist *et al.* (1989). Fauna was primarily Gulf-Carolinean, despite the presence of a rich Antillean community just outside the bay. The two subenvironments adjacent to open ocean had high species richness, but banks became increasingly depauperate toward the interior of the bay, with the innermost study site supporting a virtual monoculture of the grass shrimp *Thor floridanus.* Species richness was similar across bank tops and exposed and sheltered sides. For the majority of species and sites, the exposed sides had the lowest abundance of the three transects. Restricted circulation may limit larval recruitment to inner portions of the bay, particularly for those species whose adult populations within the bay frequently fell to virtually nil, and that physical parameters, especially salinity, partially mediate the community structure of organisms that do gain access to the Bay's isolated areas.

1984 - 1986

Holmquist, J. G., G. V. N. Powell, and S. M. Sogard (1989) Sediment, water level and water temperature characteristics in Florida Bay's grass-covered mud banks. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):348-64.

Florida Bay is a shallow lagoonal estuary divided into basins by a latticework of mudbanks, which exert a disproportionate influence on the bay ecosystem. The East Central (Cross Bank), Atlantic (Buchanan Bank) and Gulf (Dave Foy Bank) subenvironments were sampled during 1984 - 1985; the East Interior (bank adjacent to Coon Key) and West Interior (between Roscoe and Dump Keys) during 1986; and the Northeast (Eagle Key Bank) during 1984 - 1986. The vegetation in these locations was described by Zieman *et al.* (1989) and the decapod and stomatopod communities by Holmquist *et al.* (1989). Prevailing northeasterly winds resulted in distinct sheltered and exposed sides on narrow banks, the former with fine sediment and a high organic content and the high energy exposed sides with coarser sediment and low organic content. Bank water levels were highest in fall. Lunar tidal flux appeared to be directly related to the degree of access to open ocean for any given site. Water levels also demonstrated some degree of wind-dependency at all sites. Although water levels on narrow banks were highly correlated with those of basins, one 2-km-wide bank retained a lens of water at low tide despite lower levels in adjacent basins. Bank temperatures ranged from 7.5°C to 37.0°C and demonstrated a mean daily range of 4.5°C, but up to 15°C, in contrast to basin ranges of 1 to 2°C. Temperature range was a function of air temperature range and water level. September through November was the most benign period on the banks. A bank in the northeastern bay was the physically severest of our six study sites. We discuss implications of the physical scenario for bank organisms; in general, banks should represent a more stressful habitat than deeper grass beds.

1984 - 1986

Powell, G. V. N., S. M. Sogard, and J. G. Holmquist (1987) Ecology of shallow water bank habitats in Florida bay. Final rep. contract CX5280-3-2339. South Florida Research Center, Everglades National Park, Homestead, FL. 405 pp.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] This study was designed to describe the physical environment of Florida Bay's bank habitats, including topography, tidal flux, wind direction and velocity, temperature and salinity regimes, sediment characteristics, and seasonal variations of the above. In addition, the distribution and abundance of fishes and decapod crustaceans and variation in seagrass growth on banks was determined. The effects of seagrass parameters and variations in physical parameters on species composition and density was determined. The effects of nutrients on seagrass parameters, fish and invertebrates was presented. Results indicated that bank seagrass communities were affected to a greater degree than submerged systems. Standing crop of seagrasses was the most important biotic factor influencing fish and decapod densities. Water level and wind stress had a major impact on the shallow banks. Seagrass, demersal fish, pelagic fish, and decapod populations on the banks varied in a consistent manner across the bay. Seagrass cover on banks allowed species to survive during periods of extreme physical stress and insured a source of prey for fish and birds.

1985

Bosence, D. (1989) Biogenic carbonate production in Florida Bay. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):419-33.

This paper reviews previous work on biogenic carbonate production within Florida Bay and presents new data from a 1985 survey on production from the Upper Cross Bank and Buchanan Key areas. Production figures for bank and lake environments were calculated from standing crop surveys and growth rates determined from published work and short-term growth measurements. The organisms studied were: *Porites, Thalassia,* epibionts, mollusks, *Penicillus,* soritid foraminifera and *Halimeda* listed in order of decreasing carbonate productivity. Production figures indicate that banks produced twice as much skeletal carbonate per unit area as lakes. However lakes were much larger than banks and, within the study areas, lakes generated about four times the amount of sediment as that formed on banks. This excess sediment was considered to have been transported to the southwest of the Bay to areas with larger constructional banks or out of the Florida Bay system. The migrating Upper Cross Bank generated sediment at rates nearly one order of magnitude less than those of the more stable Buchanan bank and the back-reef mound of Tavernier. Production rates may therefore be effecting bank stability.

1985

Bosence, D. (1989) Carbonate budgets for carbonate mounds Florida, USA. Proc., 6th Coral Reef Symposium, Townsville, Australia. Vol. 2. 529-34.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] Carbonate production rates are compared with sediment volumes for shallow water mounds in Florida Bay along a transect from the back-reef Tavernier mound to Buchanan Bank in outer Florida Bay to Upper Cross Bank, inner Florida Bay. Production rates are established from standing crop and growth rate data. Production rates decrease by orders of magnitude from reef to back-reef and outer-bay mounds and from outer to inner-bay mounds. Intermound production is less than mound production but represents 90% of the inner-bay area and therefore contributes more sediment to the region than the mounds. It was found that the inner-bay has import mounds, the outer-bay has export mounds and that probably there is large-scale sediment transport out of the bay to account for overproduction of biogenic carbonate since it was flooded some 3700 yr ago.

1985 ◊

Dzou, I-P. L. (1985) In-situ and pyrolytic hydrocarbons in carbonate sediments from Florida Bay. M. S. Thesis. University of Texas at Dallas, Richardson, TX. 109 pp.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] In the northern portion of Florida Bay, the sediments contain an average of 1.3% organic carbon and the bitumen content ranges from 230 to 310 µg/g, and averages 268 µg/g. In the more open southern and western portions, the sediments have 1% average organic carbon, and the bitumen content ranges from 270 to 360 µg/g and averages 360 µg/g. Hydrocarbons analyses were obtained on the bitumen extract of the organic matter from 28 core samples from Florida Bay. Column and gas chromatography were used to characterize the C_{15+} fraction of the normal hydrocarbons. The distribution of the C_{15+} normal paraffins in the northern portion of the Bay shows a bimodal distribution, with maxima at C_{27} or C_{29} and C_{18}, and a marked predominance of odd- over even-carbon-number molecules in the C_{23} to C_{31} range. This distribution is characteristic of marine and land-plant sources of hydrocarbons. In contrast, the C_{15+} normal hydrocarbons in the southern and western portions show a different bimodal distribution of n-alkanes, with maxima at C_{17} or C_{18} and C_{23} or C_{24}; n-alkanes greater than C_{25} with an odd-carbon-number predominance are essentially absent, indicating dominantly marine organisms as a major source of hydrocarbons. Anhydrous and hydrous pyrolysis of the modern carbonate sediments at 250°C for three days produced new hydrocarbons. The new hydrocarbon distributions resemble those typical of Upper Cretaceous carbonate rock extracts in South Florida and Silurian Salina-A1 carbonate rock extracts in the Michigan Basin. A special feature observed in these hydrocarbon distributions is the even predominance of n-alkanes. The pattern is attributed to reduction of even carbon-numbered parent molecules (fatty acids and alcohols) in strongly reducing and hydrogenating sediments during laboratory pyrolysis and natural maturation.

1985

Heatwole, D. W., J. H. Hunt, and F. S. Kennedy (1988) Catch efficiencies of live lobster decoys and other attractants in the Florida spiny lobster fishery. Fla. Mar. Res. Publ., 0(44):1-15.

Studies reported in this paper are among several conducted by the Florida Department of Natural Resources to evaluate the efficacy of measures proposed to minimize or eliminate losses due to present fishery practices. Proposed measures include mandatory use of live wells to curtail exposure of lobsters to air and escape gaps to permit undersize lobsters to avoid capture in traps. To mitigate effects of regulatory measures which would decrease or eliminate use of shorts as bait and thereby reduce catch efficiency under present fishery conditions, testing was conducted to evaluate baiting alternatives. The present study was conducted near Marathon, to compare catch efficiency of shorts with three other conventional lobster baits, two artificially produced attractants, and unbaited traps. All baits were tested in both the Atlantic Ocean and Florida Bay to address the contention of fishermen that shorts are more effective attractants in the bay than in the ocean.

1985 ◊

Holliday, V. E. (1985) Mechanisms of deposition of a carbonate mud spit; Ramshorn Spit, eastern Florida Bay. M. S. Thesis. Lehigh University, Bethlehem, PA.

In this report four sediment types based on particle size distribution, organic content, and faunal assemblages are described from core samples taken at Ramshorn Spit, eastern Florida Bay. The basic types were: (1) very thin discontinuous shelly packstones, representing storm deposits; (2) thin continuous basal shelly packstones, the initial marine deposit on bedrock; (3) muddy wackstones, of variable thickness, deposited in the presence of seagrass; and (4) very thick, fairly laminated fine mudstones, with very sparse fauna, representing transported sediments out of suspension. These classifications were confirmed by discriminant analysis which showed that these sediment layers were correlatable between cores, indicating a change in stratigraphy southwestward from the spit and bank junction. The author concludes that Ramshorn Spit, throughout its depositional history, seems to have been accreting outward into the surrounding "lake" by means of a current-transported mud fraction; sediments are subsequently stabilized by turtle grass cover.

1985 ◊

Holliday, V. E., and J. M. Parks (1985) Mechanisms of deposition of a carbonate mud spit; Ramshorn Spit, eastern Florida Bay. Am. Assoc. Petrol. Geol. Bull., 69:266.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The turtle grass (*Thalassia testudinum*) community has a significant influence on sedimentation in Florida Bay, but the roles other processes may play in the buildup of mudbank and spit sediments are poorly understood. Samples from cores taken from Ramshorn Spit and Ramshorn Shoal were classified into 4 basic types on the basis of particle size distribution, organic content, and faunal assemblages. In order of increasing volumetric importance they are: (1) very thin, discontinuous shelly packstones, representing overbank or storm deposits; (2) thin, continuous basal shelly packstones, the initial marine deposit on the Pleistocene bedrock surface; (3) muddy wackestones, of variable thickness, deposited in the presence of a seagrass community; and (4) very thick, faintly laminated fine mudstones, with very sparse fauna, representing weak current-transported sediments settling out of suspension. Discriminate function analysis confirms the classifications and shows that these sediment layers are indeed correlatable between cores. Interpretation of the core logs from Ramshorn Spit indicates a definite change in stratigraphy southwestward from the spit and bank junction to the tip of the spit itself. The different sediment layers show a small but significant inclination to the southwest. Throughout its depositional history, Ramshorn Spit seems to have been actively accreting outward into the surrounding "lake" by means of a current-transported fine mud fraction. After settling out at the growing tip of the spit, the sediments are subsequently stabilized at some later time by a turtle-grass cover.

1985

Kieber, D. J., and K. Mopper (1987) Photochemical formation of glyoxylic and pyruvic acids in seawater. Mar. Chem., 21:135-49.

Glyoxylic and pyruvic acids were formed when filter-sterilized seawater was exposed to solar radiation. Samples were collected in 1985. Production rates varied from samples collected from distinctly different regions of the sea. Humic-rich seawater from Florida Bay exhibited net photochemical production rates (glyoxylate, 27.5 nM W-h^{-1} m^{-2}; pyruvate, 12.9 nM W-h^{-1} m^{-2}) that were significantly greater than net production rates for humic-poor water (glyoxylate, 3.1 nM W-h^{-1} m^{-2}; pyruvate, 1.8 nM W-h^{-1} m^{-2}) collected in the Gulf Stream. When seawater was not filtered, the concentrations of glyoxylate and pyruvate were found to undergo diurnal variations resulting from an imbalance between biological and photochemical processes. A depth profile of the glyoxylate concentration from several oceanic stations showed a pronounced daytime maximum in the upper 10 m; this finding is consistent with laboratory results that demonstrated that glyoxylate is formed photochemically in seawater. Pyruvate, in contrast, showed no clear trend with depth; its distribution in the water column may be primarily controlled by biological processes rather than by photochemical processes. Biological processes are generally thought to control the spatial and temporal distribution of simple organic metabolites in seawater. Our results show that photochemical processes may also be important in the marine cycling of some biochemical compounds.

1985

King, C. A. (1987) Organochlorines in bottlenose dolphins, (*Tursiops truncatus*) and Pygmy sperm whales (*Kogia breviceps*) from southeastern Florida. M. S. Thesis, University of Miami, Coral Gables, Fla. 92 pp.

Organochlorine concentrations in melon tissue from Atlantic bottlenose dolphins (*Tursiops truncatus*) and pygmy sperm whales (*Kogia breviceps*) were determined to test the hypotheses that there are intraspecific differences in concentrations in relation to body length and sex, and that there are interspecific differences related to distribution and diet. Melon samples from 15 bottlenose dolphins and 18 pygmy sperm whales stranded in southeastern Florida were analyzed for chlorinated pesticides and PCBs using a modified version of the standard EPA method. One specimen each of these two species was found in Florida Bay. These two species were chosen for study because of their frequency of stranding, and differences in their distribution and feeding habits. PCB (Aroclor 1254), heptachlor epoxide, 4,4'-DDT, and 4,4'-DDE were detected in all melon samples; heptachlor, dieldrin, 4,4'-DDD, 2,4'-DDT, 2,4'-DDE, and lindane were detected infrequently. In both bottlenose dolphins and pygmy sperm whales, concentrations of PCB and chlorinated pesticides were significantly higher in males than in females. There was no significant correlation between body length (as a measure of age) and organochlorine concentrations Results demonstrated that bottlenose dolphins had significantly higher concentrations of chlorinated pesticides and PCB than pygmy sperm whales, as predicted by distribution and diet. When compared to levels of PCBs and DDT previously reported in odontocetes, concentrations of DDT in pygmy sperm whales and bottlenose dolphins in the present study are within the low range of global contamination. Concentrations of PCB in pygmy sperm whales are also within the low range of global contamination of odontocetes, while bottlenose dolphins, particularly males, had concentrations of PCB within the high range. Information from the present study can be applied as baseline data in the future monitoring of organochlorine concentrations in bottlenose dolphins from southeastern Florida. Continued monitoring is suggested since the future management of these dolphins should take into account the impact of contamination by organochlorines, especially PCB's.

1985 ◊

Quinn, T. M., and D. F. Merriam (1985) Florida Bay revisited: development of a shallow-water carbonate facies mosaic in response to Holocene transgression. Geol. Soc. Amer. Abs., 17:694.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] A complex shallow-water carbonate facies mosaic has developed in Florida Bay in response to the Holocene transgression. This complex facies mosaic is incorporated in the sedimentary record of most Florida Bay islands and consists, in upward succession, of: (1) a freshwater low-Mg calcite mud facies; (2) a transgressive basal peat facies; (3); packstone and wackestone facies; (4) an organic-rich skeletal and pelletoidal wackestone facies; (5) an intercalated upper peat facies; and (6) a supratidal mudstone and wackestone facies. Detailed sediment analyses have revealed that facies 3, 4, and 5 are absent from portions of numerous Florida Bay islands. Islands whose sedimentary records consist of the supratidal mudstone and wackestone facies (6) directly overlying the basal peat facies (2) are interpreted to have initiated from a coastal tidal flat that developed overlying a paralic peat. Furthermore, while there is evidence that mudbank sediments are an important component of some Florida Bay islands, we believe that the majority of islands initiate and nucleate from coastal supratidal flats. Data generated from ^{14}C analyses of sediments from the basal peat facies (2) have been combined with existing ^{14}C data to form an integrated ^{14}C database for South Florlda peats. An updated Holocene sea level curve based on this database indicates a rise in sea level at 1.9 mm yr^{-1} from -5.6 m to -1 m (5400 to 3000 yr BP). The rate of sea level rise slowed considerably so that between -1 m and present mean sealevel (3000 yr BP to the present), South Florida has been inundated at a rate of 0.3 mm yr^{-1}.

1985 ◊

Seaman, W. J. (ed.) (1985) Florida aquatic habitat and fishery resources. Fla. Chap. Amer. Fish. Soc., Kissimmee, FL. 543 pp.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] This book summarizes and reviews over 1000 technical articles on the latest fishery and habitat-related scientific information of lakes, rivers, coastal marshes, mangrove forests, bays, and oceanic systems of Florida. Florida Bay and the Ten Thousand Islands, located within the boundaries of the Everglades National Park, are discussed as major estuarine-lagoon systems. Conclusions are presented concerning Florida's major coastal and offshore fisheries which are dependent upon species related to nursery areas in estuaries and nearshore areas.

1985 ◊

Sengupta, S., and D. F. Merriam (1985) Definition of major sub-environments in Florida Bay. Geol. Soc. Amer. Abstr., 17(7):712.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The environment in Florida Bay is influenced by the freshwater run off from the Everglades, ground water seeping through the Pleistocene "basement rocks", rainfall, and marine waters from the Atlantic Ocean and Gulf of Mexico. The relation of water properties such as salinity, pH, dissolved oxygen, dissolved carbon dioxide, turbidity, calcium, and magnesium along with sedimentological, geochemical, and biological properties of the recent sediments collected in Florida Bay were used to determine the subenvironments. Statistical data analysis of these spatial data reveals that (a) salinity increases from brackish to marine towards center of Bay, (b) pH is normal marine towards center of Bay, and it increases toward the mainland and keys, (c) dissolved oxygen decreases toward the center of the Bay, and (d) dissolved carbon dioxide increases towards the center of the Bay. The statistical analysis allows definition of four subenvironments which show a distinct change in orientation from winter to summer. These changes are attributed to wind direction, nutrient supply, rainfall, water circulation, and basin configuration. Geochemical analyses indicate that the waters of Florida Bay are supersaturated with respect to calcium carbonate. Inorganic precipitation can occur in certain regions of the Bay, particularly in the northern subenvironment. X-ray diffraction studies indicate no evidence for diagenesis in the mineralogy of the sediments.

1985 ◊

Sorensen, C. E., and D. F. Merriam (1985) Geochemical and grain-size distribution in three basins in Florida Bay. Geol. Soc. Amer. Abs., 17(3):19.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Sediment and water samples were collected in three basins (lakes) of Florida Bay to determine whether biological or physical processes control sediment grain size. The three basins were selected because of their similar size and their location in different parts of the

Bay reflecting different environments. In addition to the grain-size analysis, the sediments were analyzed for weight percent of Ca, Mg, Ti, Si, Al, Sr, Fe, and K using x-ray fluorescent spectrometry. Water samples were analyzed *in situ* for pH, temperature, dissolved oxygen, dissolved carbon dioxide, salinity, and turbidity by a portable chemical analysis kit. Populations of benthonic organisms were estimated at all 45 sampling stations spread through the three basins. X-ray diffractometry determined mineralogical content of each sediment sample. Means, standard deviations, and correlation coefficients were calculated to elucidate the relationships between the different components. Interpretation of the results obtained from the measured parameters indicate that physical processes control the grain-size distribution in Shell Key and Crab Key Basins, but biological processes control the grain-size distribution in the northernmost basin, Madeira Bay. The average strontium concentration of the sediments in all three basins inferred molluscan origin, instead of the expected algal origin. Chemical conditions above the sediment-water interface were not favorable for inorganic physiochemical precipitation of calcium carbonate at the time the measurements were taken. The expected significant negative correlation between *Thalassia testudinum* density and the percentage of coarse grains was recognized in only one basin. [This may be based on the same data used in Sorensen (1985).]

1985

Swart, P. K., D. Berler, D. McNeill, M. Guzikowski, S. A. Harrison, and E. Dedick (1989) Interstitial water geochemistry and carbonate diagenesis in the sub-surface of a Holocene mud island in Florida Bay. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):490-514.

Diagenetic reactions occurring in the sub-surface of an exposed Holocene island in Florida Bay were investigated in a core taken on Crane Key. Interstitial waters squeezed from the sediments at 10-cm intervals were filtered and analyzed for Ca, Mg, Cl, Sr, S and stable isotopic (C and O) compositions. Alkalinity, pH, salinity and sulfate concentrations were also determined. Mineralogy of the bulk sediments was also determined. These data were compared with the mineralogy, Sr concentration and carbon and oxygen isotopes of the bulk sample and isolated dolomite. Salinities throughout the core were in excess of 80 g kg^{-1}. To eliminate effects of evaporation pore water data were normalized to the concentration of chloride. These data indicate that while Ca^{2+}/Cl^-, Mg^{2+}/Cl^- and Sr^{2+}/Cl^- ratios all increase downcore, Mg^{2+}/Ca^{2+} and Sr^{2+}/Ca^{2+} ratios exhibit a decrease in certain intervals which we believe is attributable to the dissolution of high magnesium calcite and perhaps the precipitation of dolomite. These findings are supported by the discovery of dolomite with a ^{14}C age some 2,000 yrs younger than the host sediment. The flux of magnesium, calculated from the present day gradient, indicates that more than enough Mg^{2+} has been available from the dissolution of high magnesium calcite to account for the observed dolomite. The dolomites which were analyzed in this investigation did not form contemporaneously with deposition, but rather at some time between 2,600 BP and the present day. These conclusions are supported by stable carbon and oxygen isotopic data and calculation of the saturation state of relevant carbonate minerals.

1985 ◊

Thayer, G. W., W. F. Hettler, and D. W. Peters (1985) Utilization of the red mangrove prop root habitat by fishes in South Florida. Estuaries, 8(2B):104A.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Mangroves dominate the shorelines of South Florida, constituting about 4 x 10^5 acres of estuarine and coastal habitat. Studies have described the composition of fishes utilizing mangrove-fringed bays and lagoons, but, to our knowledge, none have evaluated the use of the fringing red mangrove prop root habitat by juvenile and adult fish. We sampled permanent stations for more than one year in Whitewater Bay, Coot Bay and in Florida Bay adjacent to Flamingo on the north coast and Plantation Key on the south coast to evaluate the variability in composition and abundance of fish among mangrove areas. Block nets and rotenone were used to sample the intertidal fringing habitat, and two-boat otter trawls were employed to sample the adjacent seagrass areas to compare species composition. Stomach contents of some fish species from both habitats also were evaluated. In addition, such structural characteristics as prop root and seagrass density and sediment particle size and organic content were measured. Our data indicate that fringing red mangrove prop root habitats in Everglades National Park are utilized by juvenile and adult fish.

1985 ◊

Thayer, G. W., D. E. Ross and D. W. Peters (1985) Habitat utilization by young-of-the-year fishes in the Everglades National Park. Estuaries, 8(2B):33A.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] In cooperation with the National Park Service, the Southeast Fisheries Center, Beaufort Laboratory initiated a research program to examine habitat utilization during the early life history of four species of fish (red drum, *Sciaenops ocellatus*; spotted seatrout, *Cynoscion nebulosus*; snook, *Centropomus undecimas;* and mangrove snapper, *Lutjanius griseus*) that are important to the sport fishery in the Everglades National Park. The long-term goal of this research is for ENP to understand the causes of variation in abundance and distribution of these fishes. The emphasis is on life history stages, habitats, ecological processes and environmental factors that are believed to be related to abundance. Specific objectives are to: (1) determine the relative abundance timing and location where larval fishes enter the Park and (2) evaluate the relative abundance and composition of juvenile fish communities among habitat in the Park and develop descriptions of habitats in which fish occur. Major habitats being examined are (1) coastal spawning areas, (2) migration routes, (3) seagrass meadows, and (4) intertidal mangroves.

1985, 1987

Fuhr, J. M. (1988) Stratigraphy and depositional history of the Pleistocene bedrock underlying Florida Bay. M. S. Thesis. Stephen F. Austin State University, Nacogdoches, TX. 132 pp.

Ten cores from Florida Bay reveal new information concerning Pleistocene sedimentary units deposited in South Florida. Using R. D. Perkins "Q-unit" classification proposed in 1977, four units (Q1 through Q4) were recognized. A Q5 unit was not observed. Units older than Pleistocene were penetrated in several cores. Contoured maps show several paleotopographic features that influenced Pleistocene sedimentation. The Cape Sable and South Florida Highs were draped with clastics eroded from the mainland. The Pleistocene shelf edge and an open marine-platform are also discernible. Q2 time marked a switch from clastic sedimentation to in situ carbonate production. In Q3 time a barrier reef began growing at the Pleistocene shelf edge, with patch reefs growing in the back-reef area. A peloidal unit, the bryozoan facies of the Miami Limestone, was deposited in the lagoonal back-reef area during Q4 time. This deposit comprises the upmost Pleistocene bedrock immediately underlying Florida Bay. The cores were taken from Ninemile Bank, Twin Key, Russell Key, Park Key, Nest Key, Black Betsy Key, Crane Key, East Key, Cotton Key and Windley Key.

1985, 1988

Textoris, S. D. (1988) Stratigraphy and depositional history of Late Pleistocene Key Largo patch reefs underlying Florida Bay. M. S. Thesis, Wichita State Univ., Wichita, KS. 165 pp.

This study was conducted in Florida Bay utilizing twenty cores of Pleistocene bedrock which were taken up to 70 ft in depth. Based on a classification scheme developed by

Perkins, four marine-deposited units (Q1 through Q4) were recognized in Upper Pleistocene rocks underlying the Bay. Differentiation between units was based upon the recognition of unconformities and subaerial features associated with sealevel lowstands. Antecedent topography affected Pleistocene sedimentation. Contour maps of each unit depict the topography, thickness, lithofacies, and paleoenvironment during the time of deposition. Configuration maps reveal the Cape Sable and South Florida Highs were covered with siliciclastics eroded from the mainland. The Pleistocene shelf-edge and an open-marine platform were among the major factors influencing sedimentation in South Florida and Florida Bay during Q1 time. Sealevel transgression during Q2 time resulted, in part, in a transition from clastic sedimentation to *in situ* carbonate production and deposition. In Q3 time a barrier reef grew on the Pleistocene shelf-edge. A lagoonal back-reef area (Florida Bay) developed leeward of the barrier. Cores reveal that reef mounds, and patch reefs in the back-reef, did not begin to flourish until the beginning of Q3 time. Fluctuation in sealevel greatly affected facies deposition and patch reef growth during Q3 a Q4 time. East Key patch reef initiated growth from a Q3 reef mound subsequent to a minor sealevel drop; subaerial exposure of the reef at the end of Q3 time resulted in the death of the reef. Lignumvitae Key patch reef growth probably was initiated in Q3 time and, similar to the barrier reef, continued growth throughout Q4 time.

1985 - 1987

Schropp, S. J., F. G. Lewis, H. L. Windom, J. D. Ryan, F. D. Calder, and L. C. Burney (1990) Interpretation of metal concentrations in estuarine sediments of Florida using aluminum as a reference element. Estuaries, 13(3):227-35.

Metal contamination of estuarine sediments is an increasing problem in Florida and elsewhere as urbanization extends into previously undeveloped areas. Effective estuarine management practices require scientifically valid tools to assess the extent of estuarine contamination. Interpretation of anthropogenic metal contributions has been hampered by the fact that natural metal concentrations in sediments vary by orders of magnitude in different sediments. Normalization of metal concentrations to a reference element, Al, appears to be a promising method for comparing estuarine sediment metal concentrations on a regional basis. This paper describes an interpretive method based on the relationship between sediment metals and Al derived from statewide data on natural estuarine sediments in Florida. Data from the Miami River and Biscayne Bay were used to demonstrate the interpretative method. Sediment samples were collected from 1985 to 1987 from 28 coastal sites and analyzed for Al, Cr, Ni, Cu, Zn, As, Cd, Hg, and Pb. Analytical methods and quality assurance protocols are described in the paper.

1985 - 1987

Bosence, D. (1989) Surface sublittoral sediments of Florida Bay. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):434-53.

Results of detailed analysis of sediments from the restricted Cross Banks area and the more open marine Buchanan Keys area are discussed as well as previous work. Sediments of the Cross Banks area were composed principally of mollusk and foraminifera grains with a pelleted, silt-sized matrix. Textures on the banks varied from windward mud-pebble-conglomerates, packstones and grainstones to bank-top leeward, and lake, wackestones and mudstones. The latter was deposited in patchy to dense seagrass beds. Sediments of the Buchanan Banks area comprised grains of *Halimeda,* coral and lithoclasts in addition to mollusk and foraminifera grains. Windward facies were packstones, grainstones and some *Porites* framestones. Bank top and leeward margins accumulated peloidal mudstones and wackestones under seagrass cover. Lake floors were bare but have a thin packstone covering. In both areas, facies consistently occurred as bands paralleling the bank margins. Sedimentary structures, textures, seagrass rhizome depths and measurements of changes in bank morphology all indicated windward erosion and leeward deposition of mound sediment. This supported the hypotheses of down-wind bank migration, and suggested that this occurs in normal but sporadic weather conditions. When surface sediment composition and benthic communities were compared regionally within south Florida, they showed a trend of reducing diversity from the reef tract through to central Florida Bay. Sediment textures varied locally with windward and leeward environments. This work was based on studies of aerial photographs and a series of measurements from 1985 through 1987 along two transects in Upper Cross Bank.

1985 - 1988

Bowman, R., and G. T. Bancroft (1989) Least bittern nesting on mangrove keys in Florida Bay. Fla. Field Nat., 17(2):43-6.

The lest bittern (*Ixobrychus exilis*) is found throughout much of the western hemisphere. It is usually associated with a variety of freshwater habitats and to a lesser extent salt marshes. In southern Florida, the lest bittern is a common resident of the Everglades freshwater marshes, nesting primarily in sawgrass and cattail. Most sightings of the least bittern in the Florida Keys have been during the fall or winter months suggesting migrating or wintering birds. This study reports the first observations of least bittern nesting on mangrove keys in Florida Bay. Observations were made from 1985 to 1988 on Middle Butternut Key and Bottle Key.

1986

Butler, M. J., and W. F. Herrnkind (1991) Effect of benthic microhabitat cues on the metamorphosis of pueruli of the spiny lobster *Panulirus argus*. J. Crustacean Biol., 11(1):23-8.

To determine whether settlement microhabitat induces metamorphosis in the puerulus stage of the Caribbean spiny lobster (*Panulirus argus*) and to identify the specific features of the habitat that might elicit the response, we monitored the metamorphic progress of more than 200 pueruli exposed to 6 different settlement substrates: seawater alone (no substrate), red algae, seagrass, artificial algae, algae-treated seawater, and artificial algae plus algae-treated seawater. Initial pigmentation followed settlement by approximately 1 day and began 3 - 6 days (mean = 5 days) after the swimming pueruli were intercepted entering the Florida Bay nursery. Presence of red algae, *Laurencia* spp., a preferred settlement substrate, accelerated the rate of pigmentation, but by less than a day. Metamorphosis to the first benthic juvenile stage occurred 7 - 9 days (mean = 8 days) after pueruli entered the Bay and were unaffected by any of the substrates tested. Rates of both pigmentation and metamorphosis varied by as much as 2 days among replicate experiments conducted during the summers of 1986 - 1988. These results suggest that metamorphosis of pueruli of *P. argus* is essentially determinant; thus, physiological constraints may limit the distance that pueruli can disperse into the nursery and may force many pueruli to settle in inappropriate habitats where survival is improbable.

1986 ◊

Tagett, M. G., and H. R. Wanless (1986) Marine mudbank nucleation and evolution, western Florida Bay. Geol. Soc. Amer. Abs., 18:768.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Detailed lithofacies and faunal analysis of over 100 cores demonstrates that Dildo Key mudbank, one of three large mudbanks separating western Florida Bay from the Gulf of Mexico, is an amalgamation of several smaller "core" mudbanks. These are similar to younger mudbanks now forming in east-central Florida Bay. Portions of the islands have maintained supratidal facies (peats and supratidal muds) throughout their sequence and are remnants of once continuous coastal levees. "Core" mudbanks nucleated upon levees and mangrove peats and prograded over brackish to marine packstones that accumulated in deeper lagoons. Intrabank lagoons filled forming one large mudbank. Radiocarbon dates of peat and shell material indicate that this coastal levee was overridden and marine mudbank accretion began about 2,500 yrs BP. Intense marine bioturbation blended levee and brackish sediments with overlying marine sediments as "core" mudbanks grew up to sea level, destroying large portions of the levee deposits upon which banks nucleated. Increased detrital input related to the erosion and initiation of tidal channels through mudbanks to the west resulted in continued bank accretion and infilling of intrabank lagoons creating one large mudbank.

1986

Smith, T. J., H. T. Chan, C. C. McIvor and M. B. Robblee (1989) Comparisons of seed predation in tropical, tidal forests from three continents. Ecology, 70(1):146-51.

An inverse relationship between the amount of seed predation and the dominance of a tree species in mangrove forest canopies has been hypothesized based on field studies conducted in Australia. Seed predation experiments have recently been performed in mangrove forests of North America and southeast Asia on several species of *Avicennia, Bruguiera,* and *Rhizophora*. The results of these experiments are compared with additional data from Australia to test the generality of the dominance-predation model. Significant differences were found in the amount of predation on four species of *Avicennia*. All *Avicennia* were consumed in greatest quantity where they were rarest in the forest canopy and in least amounts where they dominated the canopy. Consumption of *Rhizophora apiculata* in Australia and Malaysia followed patterns similar to that for *Avicennia*. For *R. mangle,* however, contradictory results were obtained. No *R. mangle* were eaten in Florida. In Panama, more were consumed where this mangrove dominated the canopy compared to a forest where it was rare. Results for *Bruguiera cylindrica* in Malaysia supported the dominance-predation model, whereas results from Australia for *B. gymnorrhiza* did not. Data for Avicennia clearly support the dominance - predation model. Regardless of species, seed predators exert an influence on the distribution of *Avicennia* in mangrove forests. Variation In the amount of predation on *Rhizophora* among regions is partly attributable to differences in the composition of the predator guilds between the forests studied. Predator guilds in the Malaysian and Australian forests are dominated by grapsid crabs. In Florida, crabs are minor consumers of propagules and three genera of snails are most important. Seed predation is variable among forests. The effect of seed predators on mangrove forests is related to the type of mangrove tree and composition of the seed predator guild. Sampling in Florida took place in 1986.

1986

Sternberg, L., and P. K. Swart (1987) Utilization of freshwater and oceanwater by coastal plants of south Florida. Ecology, 68:1898-905.

The coastal vegetation of southern Florida is undergoing dramatic changes due to the instability of the ocean water-freshwater boundary. These vegetation changes will be determined by the response of each particular species to saline ocean water, particularly whether it can use ocean water or not. In this study, isotopic data were used to determine the relative usage of freshwater or ocean water by plants in the Florida keys. The results indicate that, with some exceptions, plants toward the interior of the Keys were using freshwater, while those toward the edge were using ocean water. A plot of the hydrogen and oxygen isotopic composition of the plant water yielded a mixing line between typical freshwater values and those of ocean water. In general, the isotopic ratios of stem water for species found in hardwood hammocks were confined to the freshwater end of the line, followed by values of stem water from mangrove margin species. Species found in mangroves, however, had water with extremely variable isotopic ratios, ranging from values typical of ocean water to values typical of freshwater. This variability is consistent with the hypothesis that mangroves are fully capable of growing in freshwater, but are limited to saline habitats because of competitive exclusion by fast-growing glycophilic plants.

1986 - 1987

Bowman, R., G. V. N. Powell, J. A. Hovis, N. C. Kline, and T. Wilmers (1989) Variations in reproductive success between subpopulations of the osprey (*Pandion haliaetus*) in South Florida. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):245-50.

Reproductive success of ospreys was used to evaluate the habitat quality of Florida Bay. Subpopulations that bred and foraged exclusively in Florida Bay were compared with those nesting adjacent to the Bay on the Keys and foraging in the Atlantic Ocean, a relatively undisturbed habitat. The study took place in 1986 - 1987. Osprey reproduction on Gulf side islands in the lower Keys, which have a structure similar to keys in Florida Bay but are more affected by oceanic influences, was compared with nest success on adjacent mainline Keys. Florida Bay ospreys produced significantly fewer fledglings per occupied, active, and successful nest than those on the upper Keys. In the lower Keys, however, there was no significant difference between gulfside and mainline key nesting success. Ospreys nesting on the upper mainline keys departed on foraging trips towards the Bay and the ocean in nearly equal proportions. However, 47.2% of food deliveries came from the direction of the ocean while only 19.5% came from the Bay. Access to the ocean played a significant role in the greater reproductive success of birds nesting on the Keys and suggested that Florida Bay ospreys are experiencing decreased reproductive success due to an inadequate food supply.

1986 - 1987

Lapointe, B. E., J. D. O'Connell, and G. S. Garrett (1990) Nutrient couplings between on-site sewage disposal systems, groundwaters, and nearshore surface waters of the Florida Keys. Biogeochem., 10:289-307.

This paper reports the results of a one-yr study to determine the effects of on-site sewage disposal systems (OSDS, septic tanks) on the nutrient relations of limestone ground waters and nearshore surface waters of the Florida Bay side of the Florida Keys. Monitor wells were installed on canal residences with OSDS and a control site in the Key Deer National Wildlife Refuge on Big Pine Key. Ground water and surface water samples were collected monthly during 1987 and analyzed for concentrations of dissolved inorganic nitrogen (DIN = $NO_3^- + NO_2^- + NH_4^+$), soluble reactive phosphate (SRP), temperature and salinity. Significant nutrient enrichment (up to 5000-fold) occurred in ground waters contiguous to OSDS; DIN was enriched an average of 400-fold and SRP some 70-fold compared to control ground waters. Ammonium was the dominant nitrogenous species and its concentration ranged from a low of 0.77 μM in control wells to 2.75 mM in OSDS-enriched ground waters. Concentrations of NO_3^- plus NO_2^- were also highly enriched and ranged from 0.05 μM in control wells to 2.89 mM in enriched ground waters. Relative to DIN, concentrations of SRP were low and ranged from 30 nM in control wells to 107 μM in enriched ground waters. N: P ratios of enriched ground waters were consistently > 100 and increased with increasing distance from the OSDS, suggesting significant, but incomplete, adsorption of SRP by subsurface flow through carbonate substrata. Nutrient concentrations of ground waters varied seasonally and were approximately two-fold higher during the winter (DIN = 1035 μM; SRP = 10.3 μM) compared to summer (DIN = 470 μM; SRP = 4.0 μM). In contrast, surface water nutrient concentrations were two-fold higher during the summer (DIN =

5.0 μM; SRP = 0.50 μM) compared to winter (DIN = 2.5 μM; SRP = 0.15 μM). Direct measurement of subsurface ground water flow rate indicated that tides and increased ground water recharge enhanced flow some two-fold and six-fold, respectively. Accordingly, the observed seasonal coupling of OSDS-derived nutrients from ground waters to surface waters is maximum during summer because of seasonally maximum tides and increased hydraulic head during the summer wet season. The yearly average benthic flux of anthropogenic DIN into contiguous canal surface waters is 55 mmol m^{-2} day^{-1}, a value some five-fold greater than the highest rate of benthic N-fixation measured in carbonate-rich tropical marine waters.

1986 - 1987

Montague, C. L., R. D. Bartleson, and J. A. Ley (1989) Assessment of benthic communities along salinity gradients in northeastern Florida Bay. Final Rep. to the National Park Service. Contr. CA 5280-5-8004. University of Florida and South Florida Water Management District from South Florida Research Center, Everglades National Park, Homestead, FL. 155 pp. + App.

Submerged vegetation and bottom-dwelling animals (benthic communities) were quantified together with aquatic system metabolism and a variety of environmental parameters at twelve stations along three salinity gradients in northeast Florida Bay, south of C-111 canal. Scheduled modifications to the canal will likely change the freshwater delivery to this region. Concern has been expressed about the potential impact this may have on a variety of fish and wildlife, especially commercially and recreationally valuable fishes that may use the region as habitat. Benthic communities are known to provide food and cover to a wide variety of juvenile and adult estuarine and marine fishes and shellfishes. The purpose of this assessment was to document the type and development of existing benthic communities and to provide information about how changes in salinity might affect changes in the benthic communities in this area. It was believed that repeatedly sampling at stations located along salinity gradients would meet these objectives. Following a pilot study of five field trips to 21 stations (March through August 1986), 12 stations were selected for final study, four in each of three tributary-to-bay systems in northeast Florida Bay. Within each system, stations were selected to be as similar as possible in all respects except salinity. The salinity change from upstream to outer stations was similar among the three systems. The western system (Taylor River, Little Madeira Bay) is considered to be little influenced by the C-111 canal and therefore serves as a potential control for judging future effects of canal modifications. The central system (Snook Creek, Joe Bay, Trout Cove) and eastern system (Highway Creek, Long Sound, Little Blackwater Sound) are believed to be directly in the pathway of any influence of canal modifications. In the main study, stations were sampled using identical techniques every other month for 12 months beginning in August 1986 (through September 1987). Benthic community development and metabolism were very low in general. Overall gross primary production was only 188 g C m^{-2} yr^{-1}. Gross primary production at outer stations, however, was three times higher than at upstream stations. The planktonic portion of this production was very low at all stations, but was twice as high at upstream stations, where it accounted for 44% of the gross production (as opposed to only 72 at outer stations). Benthic communities at outer stations, although low in production and biomass compared to other Florida Bay seagrass-dominated communities, had roughly 50 times more numbers of animals and biomass of plants than upstream stations. Plants at outer stations were dominated by turtlegrass (*Thalassia testudinum*) and calcareous green macroalgae (primarily *Penicillus* and *Udotea*). The few plants at the upstream stations consisted mostly of shoalgrass (*Halodule wrightii*), widgeongrass (*Ruppia maritima*), and the green macroalgae *Chara*. Roughly 95% of all animals collected at each station were polychaetes, peracaridean crustaceans (amphipods, isopods, and tanaids), and bivalve mollusks. Variation in salinity that includes frequent changes from freshwater to marine conditions is believed to account for the depauperate benthic communities at upstream stations. Upstream stations had both lower mean salinity and much more variable salinity than outer stations. Many other environmental conditions did not systematically vary from upstream to outer stations, owing in part to careful selection of stations. These included average water depth, average water-level fluctuation, sediment thickness, sediment organic content and sediment particle size. Weather and water temperature, light extinction, pH, biochemical oxygen demand (BOD), orthophosphate concentration, morning dissolved oxygen, and plankton metabolism also did not vary significantly from upstream to downstream. Some parameters did vary systematically from outer to upstream stations. These include daily change in dissolved oxygen concentration, dissolved oxygen level in the afternoon, and total open-water oxygen metabolism (all lower upstream), total nitrogen, total phosphorus, and ammonium concentrations (all higher upstream), variation in total nitrogen and ammonium concentrations (higher upstream), total suspended solids (lower upstream), and bottom water temperature (slightly higher upstream). Some of these tendencies, however, could be partially or wholly explained by the lack of vegetation, which if present would increase oxygen and decrease nutrient concentrations. Some environmental differences were noticed among the three systems (western, central, and eastern). The eastern system tributary (Highway Creek) was lower in salinity and higher in upstream discharge of water. Differences in benthic community development and degree of salinity fluctuation between upstream and outer stations were greatest in the western system, perhaps resulting from a lower discharge of freshwater in that system. It seems apparent that the US Highway 1 causeway (together with the routine plugging of the C-111 canal) accounts for the greater flow of water in the eastern system by blocking an apparently historical water flow more to the east (as judged by the northwest-to-southeast orientation of tree "islands" in the marshes on each side of the highway). Phosphorus appears to be in very short supply compared to nitrogen in the water at our stations. In nature an atom-based nitrogen-to-phosphorus ratio of 16:1 is often used for comparison. The waters of our stations have an average ratio of over 300:1, indicating the likelihood of severe phosphorus limitation. No indication of significant supplies of nitrogen or phosphorus from inflowing waters was found, though our study was not designed with this objective in mind and did not include all necessary measurements for a definitive conclusion about nutrient transport in freshwater flow into northeast Florida Bay. Salinity fluctuation is apparently much more influential on benthic community development than are nutrients at our stations. Addition of nutrients would undoubtedly increase primary production at our stations, but the form of this production is difficult to predict. It could be benthic bluegreen algae (e.g. *Lyngbya*), benthic diatoms, planktonic microalgae, or submerged vegetation, such as seagrasses and macroalgae.

1986 - 1987

Montague, C. L., and J. A. Ley (1993) A possible effect of salinity fluctuation on abundance of benthic vegetation and associated fauna in northeastern Florida Bay. Estuaries, 16(4):703-17.

In southern Florida, a vast network of canals and water control structures mediate freshwater discharge into the coastal zone. Management protocol for one such canal network (C-111) is being modified in part to try to improve habitat for estuarine fish and wading birds in northeastern Florida Bay. Changes in canal management could alter the spatial and temporal salinity regime in the estuary. To better predict the effect of such changes on estuarine habitat, abundances of submersed vegetation and benthic animals were sampled repeatedly at 12 stations during 1986 to 1987 that differed in salinity. A variety of other parameters were also measured (nutrients, light, temperature, oxygen, sediment characteristics, and others). Mean salinity among stations ranged from 11.4 to 33.1 °/oo. Densities of benthic plants and animals differed among stations by several orders of magnitude. The standard deviation of salinity was the best environmental correlate with mean plant biomass and benthic animal density: less biota occurred at stations with greater fluctuations in salinity. The two stations with the least plant biomass also had the highest mean water temperatures. In a stepwise multiple regression analysis, standard deviation of salinity accounted for 59% of the variation in the logarithm of mean plant biomass among stations. For every 3 °/oo increase in the standard deviation, total benthic plant biomass decreased by an order of magnitude. Mean water temperature accounted for only 14% of the variation, and mean salinity was not included for lack of significance. At stations with widely fluctuating salinities, not only was biomass low, but species dominance also frequently changed. Severe fluctuation in salinity may have prevented abundant benthos by causing physiological stress that reduced growth and survival. Salinity may not have remained within the range of tolerance of any one plant species for long enough to allow the development of a substantially vegetated benthic community. Hence, gaining control over salinity fluctuation may be the key to estuarine habitat improvement through canal management in southern Florida.

1986 - 1987

Swart, P. K., L. D. S. L. Sternberg, R. Steinen, and S. A. Harrison (1989) Controls on the oxygen and hydrogen isotopic composition of the waters of Florida Bay, USA. Chem. Geol. (Isot. Geosci. Section), 79(2):113-23.

The oxygen and hydrogen isotopic composition has been measured in waters from Florida Bay and from fluids squeezed from sediments which make up Holocene islands in the Bay. Although, these waters ranged in salinity from 27 to 120 g kg^{-1}, most were found to have very similar hydrogen and oxygen isotopic compositions ($\delta^{18}O$ = +2 to +4 °/oo, δD = +5 to +25 °/oo). In order to explain these observations, the Craig-Gordon and Gonfiantini evaporation models, which account for oxygen and hydrogen isotopic fractionation during the desiccation of saline water bodies, were applied. These models provide excellent agreement for the evaporation of water into an environment with a relative humidity of 77%, a temperature of 25°C and atmospheric water vapor possessing $\delta^{18}O$- and δD-values of -11 and -75 °/oo, respectively. The salinity of fluids from one core on Cluett Key (26.9 g kg^{-1}) was well below that of the surrounding Bay (>40 g kg^{-1}) and the water from this locality was depleted in both D and ^{18}O. These $\delta^{18}O$- and δD-values, plotted together with other data from this study, fall on a line possessing a slope of 4.90 (± 0.41), similar to what would be expected from the evaporation models. This line intersects the meteoric water line at $\delta^{18}O$- and δD-values which are within error, similar to average $\delta^{18}O$- and δD-values measured for rainfall in the Miami area. Water samples were collected on several occasions from Cluett Key and Crane Key during 1986 and 1987.

1986 - 1988

Montague, C., [R. D. Bartleson, J. F. Gottgens, J. A. Ley, and R. M. Ruble] (1989) The distribution and dynamics of submerged vegetation along gradients of salinity in northeast Florida Bay. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):521.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Submerged vegetation, important habitat for juvenile stages of many fish and shellfish, was sampled along salinity gradients in three tributary to bay transects (west, central and east) each with four stations (Bay to upstream). The three transects are 10 to 12 km apart on the eastern 20 km of the mainland coast that borders northeast Florida Bay. The objective was to collect information relevant to the effects of changes in freshwater delivery to this area. Samples have been collected eight times during 1988 to document changes in vegetation. The stations differ in both mean salinity and salinity variation. Mean surface salinities at the outermost stations ranged from 31 °/oo (western transect) to 23 °/oo (eastern). At the uppermost stations, mean surface salinities were: 15 °/oo (western), 10 (central) and 11 (eastern). Temporal variation in salinity was highest at the upstream stations and lowest at the outer stations, except in the central transect, where all stations were variable. Upper stations ranged from near fresh to over 30 °/oo during the past year. The western outermost station was the least variable, ranging from 28 to 34 °/oo. Vegetation in the entire area was sparse (0 to 600 g dry mass m^{-2}), perhaps owing in part to fluctuation in salinity. Least variable stations had the greatest biomass. The outermost stations were dominated by turtlegrass (*Thalassia testudinum*) or the calcareous alga *Penicillus.* Dominants change to widgeongrass (*Ruppia maritima*) and the algae *Chara* and *Batophora* at the upstream stations. Shoalgrass *(Halodule wrightii)* was common at intermediate stations. Vegetation at upstream stations was dynamic. In March 1986, the upstream stations of the central transect were covered with dense stands of *Ruppia, Chara* and *Batophora.* Salinity was 13 °/oo, suitable for the growth of these plants. By May, however salinity rose to 26 °/oo and the vegetation had disappeared. Despite the return of lower salinities, vegetation at these stations remained sparse. Vegetation at the other upstream stations was sparse throughout the study period. The potential for dense stands of submerged vegetation is perhaps present at some or all of these upstream stations, but the frequency and magnitude of fluctuations in salinity may prevent stand development.

1987 ◊

Dawes, C. J. (1987) The dynamic seagrasses of the Gulf of Mexico and Florida coasts. Fla. Mar. Res. Publ., 42:25-38.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Of the seven species of seagrasses that occur in Florida and the Gulf of Mexico, three species form the dominant biomass in open shallow water (0.5 - 5 m): *Thalassia testudinum* (turtle grass), *Syringodium filiforme* (manatee grass), and *Halodule wrightii* (shoal grass). Although a much smaller plant by comparison, *Halophila decipiens* forms large meadows in deep waters (5 - 100 m). *Halophila johnsonii* and *H. englemannii* occur mixed in shallow-water seagrass communities. *Ruppia maritima* forms dense stands at the mouths of rivers where salinities rarely exceed 10 °/oo, on tidal flats where it is exposed to desiccation, and in subtidal areas of higher salinity. One hundred and thirteen algal epiphytes have been identified in seagrass blades around Florida. Up to 120 macroalgal species have been identified in seagrass communities. Proximate constituent and kilocalorie levels have been used to demonstrate that the rhizome of the larger seagrass species is a storage organ with soluble carbohydrate changing seasonally. Cellulose fiber levels in the blades of the three larger seagrasses are similar to those of true terrestrial grasses, being highest in the blades of *H. wrightii,* and correlating with water movement. The biomass of six seagrass communities on Florida's west coast averaged 385 g dry wt m^{-2}, and energy levels averaged 981 kcal m^{-2}. Caloric values are highest in seagrass communities during the summer, and range from a 15-month winter low of 344 to a summer-fall high of 1837 kcal m^{-2}, of which drift and attached seaweeds account for 75%. The lack of information regarding epiphyte biomass, energetics, and productivity, as well as the need to model a *T. testudinum* seagrass community, and the need for more growth and energetics information on the below-ground component of seagrass communities are pointed out.

1987 ◊

Fry, B., S. A. Macko, and J. C. Zieman (1987) Review of stable isotopic investigations of food webs in seagrass meadows. Fla. Mar. Res. Publ., 42:189-209.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Seagrasses are important sources of organic matter for food webs in many coastal ecosystems. However, stable isotopic investigations conducted over the past decade have shown that phytoplankton and epiphytic algae can have an equal or greater nutritional importance than seagrasses for consumers in many seagrass meadows. Nutrient availability may govern the relative importance of algal and seagrass foods, with the result that eutrophic waters favor food webs based on algae, but detrital seagrasses are more important in oligotrophic waters. This review summarizes many previously unpublished stable isotopic studies of seagrass ecosystems. Assumptions commonly made in interpretation of isotopic values are evaluated, and four main conclusions are drawn: (1) Within one species, seagrass $\delta^{13}C$ varies significantly between individuals, populations, and seasons; (2) Carbon isotopic changes during seagrass decomposition are small, approximately 1 ‰; (3) Little fractionation of carbon isotopes occurs during food web processing of live or detrital seagrasses; and (4) Benthic algae can have carbon isotopic values close to those of seagrasses, consequently $\delta^{13}C$ measurements are not always unambiguous tracers of seagrass carbon. Latter sections show that stable hydrogen, nitrogen, and sulfur isotopic measurements can be used in conjunction with carbon isotopic measurements to show consumer dependence on seagrass organic matter, and that isotopic measurements can be useful for mapping highly localized food webs.

1987 ◊

Gilmore, R. G. (1987) Subtropical-tropical seagrass communities of the southeastern United States: fishes and fish communities. Fla. Mar. Res. Publ., 42:117-137.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Paper reviews the community relationships of fishes associated with seagrasses and is based on studies done in the southeastern US including Florida Bay. Prior to 1960, most ichthyofaunal research was necessarily taxonomic and zoogeographic, with little attention given to habitat or substrate associations. With the advent of long-term faunal studies within specific habitats and analyses of physical and biological parameters affecting fish distribution, seagrasses were recognized as a distinct fish habitat. Regional ichthyological research in seagrass ecosystems has been conducted primarily in the northeastern Gulf of Mexico and principally in the Apalachee Bay region. Consequently, regional tropical and subtropical seagrass ichthyofaunas have received little study. The available literature on tropical and subtropical fish-seagrass associations is not adequate for quantitative assessment, but it reveals zoogeographic distribution patterns and enables some prediction of species occurrence in seagrass ecosystems. Fishery species have received the most intense study, particularly certain sciaenids and sparids, such as the spotted seatrout, *Cynoscion nebulosus*, and the pinfish, *Lagodon rhomboides*. However, many species need further treatment as their microhabitat associations, general biology, behavior, and mortality rates during juvenile developmental periods have not received adequate attention. Typically diminutive and numerically abundant nonfishery species, such as gobiids and syngnathids, make up the majority of resident species within the seagrass ecosystem. Their biology and impact on this ecosystem await further study. The inter- and intraspecific interactions of various seagrass residents and systematically occurring transients need to be researched, particularly with regard to predatory relationships, territorial behavior, invertebrate population dynamics and distribution, seagrass morphology, and meadow homogeneity. The hierarchical predatory relationships between various fish species guilds throughout the total ecosystem, particularly with regard to tertiary and upper level predators, have been virtually ignored.

1987

Kieber, D. J. (1988) Marine biogeochemistry of alpha-keto acids. Ph. D. Dissertation University of Miami, Coral Gables, FL. 243 pp.

There is an increasing awareness of the importance of dissolved organic matter (DOM) in a variety of physical, chemical, and biological processes in seawater. Measurements of specific components of DOM (e.g., amino acids) have provided valuable insights into these processes. α-Keto acids represent a potentially important component of DOM; however, their marine biogeochemistry is poorly understood. Therefore, a detailed investigation of processes affecting cycling of α-keto acids in seawater was undertaken. Initial studies demonstrated that α-keto acids were formed when filtered seawater was irradiated with sunlight. Average photochemical production rates for Biscayne Bay seawater were 8.2 and 5.7 nM W^{-1} hr^{-1} m^{-2} for glyoxylic and pyruvic acids respectively. Photochemical production rates varied significantly for seawater collected from distinctly different regions of the sea. Higher production rates were observed for seawater from coastal locations (e.g., Biscayne Bay, Florida Bay) relative to oligotrophic seawater from the Sargasso Sea or the Gulf Stream. Photochemical decarboxylation rates of α-keto acids were determined using radiolabeled tracers. Decarboxylation rates were less than 5% of photoproduction rates. Slow rates of decarboxylation indicated that the major removal pathway of α-keto acids in seawater was biological and not chemical. Midday photochemical production rates of α-keto acids were highly correlated with their rate of biological uptake (pyruvate, r = 0.967; glyoxylate, r = 0.736) suggesting that these processes may be closely related in the photic zone. These results suggest that photochemical processes may play an important role in the transformation and remineralization of DOM in the photic zone. An intensive field study was undertaken to assess the spatial and temporal distribution of α-keto acids in the northwest Atlantic Ocean and Cariaco Trench. Physical, chemical, and biological factors were important determinants controlling the cycling of these compounds in the sea. Oxic-anoxic interfaces or the onset of a sharp pycnocline were particularly active zones of α-keto acid production and consumption. Strong diurnal fluctuations in α-keto concentrations were often observed in surface seawater. A potentially important degradation pathway of biologically refractory dissolved organic carbon (DOC) is its photochemical oxidation in the photic zone. α-Keto acids were not quantitatively important oxidation products of this process; their production represented less than 0.1% of DOC oxidized.

1987 ◊

Livingston, R. J. (1987) Historic trends of human impacts on seagrass meadows in Florida. Fla. Mar. Res. Publ., 42:139-151.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Since 1940, Florida has undergone unprecedented population growth, which is expected to accelerate into the next century. Municipalization, industrialization, and agricultural activities in coastal drainage systems have been accompanied by various impacts in almost every bay system in Florida. Seagrass meadows have been virtually eliminated in most portions of the Pensacola Bay and Tampa Bay systems. Significant losses have been noted over the past 20 - 40 yrs in Choctawhatchee Bay, Apalachee Bay, Charlotte Harbor, Biscayne Bay, and the Indian River. A lack of reliable data precludes appropriate evaluations in other areas. However, the two primary concentrations of seagrasses in the northern hemisphere, Florida Bay and the northwest Gulf coast (including Apalachee Bay), are currently threatened by wide-ranging forms of human activity, which include freshwater diversion, agricultural activities, dredging, and offshore oil drilling The general lack of long-term, multidisciplinary ecological studies has inhibited a thorough understanding of the problem. Recent studies in Apalachee Bay indicate that relatively minor water-quality changes can destroy or severely alter seagrass distribution and productivity. Recovery after impact appears to be slow. Land planning and resource management efforts to protect seagrass habitats have been either lacking or largely ineffectual in the state as a whole. In some areas, such as the Apalachicola estuary, a comprehensive research and management effort has been developed and could provide a model for future planning in Florida, although the long-term effectiveness of such programs remains untested. Nevertheless, in a few decades, human activities have eliminated significant proportions of existing seagrass meadows in Florida. Based on past encroachment and projected population increases, the outlook for remaining seagrass beds is bleak.

1987 ◊

Mitchell-Tapping, H. J. (1987) Application of tidal mudflat model to Sunniland Formation (Lower Cretaceous) of south Florida. Am. Assoc. Petrol. Geol. Bull., 70:1120.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] For many years, the Lower Cretaceous Sunniland oil-producing fields have been interpreted as reef deposits. Petrologic evidence from cores from field and wildcat wells strongly indicates, on the basis of faunal composition and character, that the fields are produced from moundlike shoals. These shoals are considered to have been deposited in a mudflat environment similar to that of present-day Florida Bay. This present-day Florida Bay analog is used to determine the various environmental subzones and controls on the deposition of the Sunniland Formation. This concept of using a model together with a modern analog can be a powerful tool in the exploration of stratigraphic traps. A petrologic and petrophysical study of the Sunniland Formation in the wells that have been drilled in the Florida Bay and Keys areas was made to extend the model and its application throughout the South Florida basin. The evaluation of these wells has produced new insights into the tectonics of this basin and its relationship to the Bahamas and Caribbean areas.

1987 ◊

Mitterer, R. N., I. P. Dzou, R. M. Miranda, and M. E. Caughey (1987) Extractable and pyrolyzed hydrocarbons in shallow-water carbonate sediments, Florida Bay, Florida. Advances in organic geochemistry. Part I, Organic geochemistry in petroleum exploration. Proc., 13th international meeting on organic geochemistry. L. Mattavelli, and L. Novelli (eds.). Organic Geochemistry, 13(1-3):283-94.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] A three-dimensional organic geochemical survey conducted in Florida Bay, a subtropical carbonate environment with multiple sources of organic matter, illustrates the hydrocarbon source potential of shallow water carbonate sediments and the effect of multiple biochemical sources on the organic sedimentary imprint. Organic carbon (TOC) in the sediments averages about one per cent. Concentrations of extractable organic matter (EOM) and hydrocarbons are slightly higher, and of organic carbon slightly lower, in sediments of the marine-dominated part of the Bay. Hydrocarbon distribution, which is a function of the type of organic matter, also varies across the Bay. The C_{15+} n-alkanes in sediments of the terrestrially-influenced portion exhibit a bimodal pattern, with maxima at C_{27}, or C_{29} and C_{18} and a marked odd/even carbon-number predominance in the C_{21}-C_{31} range. In contrast, C_{15} *n*-alkanes in sediments of the marine-dominated portion have maxima at C_{17} or C_{18} and C_{23} or C_{24}. TOC decreases, but EOM and hydrocarbon content increase, with depth in the sediment. Hydrous and anhydrous pyrolysis of bulk sediments and individual carbonates generates a new suite of n-alkanes with n even carbon-number predominance and a maximum at C_{22}. Yields of EOM and hydrocarbons are comparable for both types of pyrolyzates and are 6 to 8 times greater than in situ EOM and hydrocarbons. Carbonate sediments deposited in low energy, shallow-water, environments have the potential to be good oil source rocks.

1987 ◊

Pike, S. F. (1987) Computer simulation of configuration and sealevel changes in Florida Bay. M. S. Thesis. Wichita State University, Wichita, KS. 160 pp.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Florida Bay is a large triangular, shallow-marine, shovel-shaped basin at the southern tip of mainland Florida. The Bay is bounded to the south and east by the Florida Keys, to the west by the Gulf of Mexico, and to the north by the Florida Everglades. Florida Bay covers approximately 900 sq mi. The Bay has been the site of numerous sedimentological studies since it was discovered that in situ calcium carbonate is being deposited there. A quantitative simulation of the Bay was developed using basic data from previous studies. This study was done to be able to predict possible future configurations of the Bay with different topographic. structural, and sealevel changes. There has been some discussion recently about whether Florida Bay is filling in with sediment or eroding, and whether sealevel is rising faster than the rate of accumulation. The three main features of this simulation. which uses the present configuration compiled from available navigation charts are: (1) use of a modified Holocene sealevel curve; (2) different waves of generation and accumulation of carbonate mud; and (3) tilting of the Bay to the southwest at variable rates. By differing the three variables, it is possible to project forward in time to predict future conditions. The study determined that sealevel was the major factor of the factors simulated, in controlling the configuration of the Bay. It also was determined that the Bay is filling in with sediment from the north and west.

1987 ◊

Powell, G. V. N. (1987) Habitat use by wading birds in a subtropical estuary: implications of hydrography. The Auk, 104:740-9.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The dynamics of foraging habitat use by long-legged wading birds was analyzed with respect to water-level fluctuation patterns in Florida Bay. Wading bird presence at four sites situated to sample the heterogeneity of the Bay was quantified by repeated surveys collected throughout the day and year. Models for habitat availability were generated using water-level data collected from continuous recorders, staff gauges, and habitat profile maps. These models were tested against the survey data. Roseate spoonbills (*Ajaja ajaja*) foraged on the study areas primarily at night. Great blue herons (*Ardea herodias*) fed both day and night, but primarily at night where the tidal range was small. Great egrets (*Casmerodius albus*), snowy (*Egretta thula*) and reddish (*E. rufescens*) egrets, little blue (*E. caerulea*) and tricolored (*E. tricolor*) and white Ibis (*Eudocimus albus*) fed during daylight. Where tidal range was small (<5 cm) diurnal species fed throughout the day. Florida Bay has a pronounced annual water-level cycle that causes monthly mean water levels to vary by as much as 30 cm between October (high) and May (low). Models derived from hydrology data predicted that this seasonal variation in water level would have a major impact on habitat availability, particularly where tidal flux was small. The predictions were supported by survey data. At sites with minor tides, most wading-bird species had a cycle in seasonal abundance that correlated with seasonal changes in water level. Only the tallest species, *Ardea herodias*, was uniformly present throughout the year. The large daily range in tide (approximately 80 cm) afforded year round access to foraging habitat and these abundance patterns did not exist. The seasonal variability in habitat availability has major management implications because the maintenance of stable wading bird populations depends on the availability of alternative foraging sites when water levels are high. Historically these sites have tended to be targeted for human development.

1987 ◊

Virnstein, R. W. (1987) Seagrass-associated invertebrate communities of the southeastern USA: a review. Fla. Mar. Res. Publ., 42:89-116.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Community structure of invertebrates associated with seagrasses in the southeastern United States is intensively studied and well described at a few sites, but generally is not well understood. A high regional diversity exists, due to the overlap of subtropical, tropical (Caribbean), and warm-temperate (Carolinian) faunas. Decapod crustaceans, especially the caridean shrimps, numerically dominate the larger (trawl susceptible) fauna. Dominant species of decapods are similar throughout most of the region. Community structure of smaller macrofauna (emphasized in this review) is dynamic. Species composition (dominant species) and density vary widely over small and large distances and over short (hours to days) and long (years) time scales. Dominant higher taxa are peracarid crustaceans (especially amphipods), gastropod mollusks, and polychaete worms. Important controlling physical factors are sediments (for the infauna) and habitat complexity (for the epifauna). The latter is determined largely by seagrass density, which is best measured in terms of plant surface area. Seagrasses exert their influence primarily by providing physical structure to the habitat. Additional physical structure is provided by drift algae and epiphytes; the latter is especially important for smaller macrofauna and meiofauna. Predation, especially by pinfish and pink shrimp, is thought to be the major biological interaction affecting community structure. Evidence for the importance of predation comes from feeding studies, correlations of invertebrate abundance with predator abundance in the field, and predator exclusion and inclusion caging studies. Competition affects micro-distribution of two shrimp species, but the effects of competition, habitat selectivity, food supply, migrations, behavior, reproduction, and recruitment have received little attention. Two major functions of seagrass meadows are the provision of food and of refuge; together, these constitute the "nursery" function. Epiphytes, not detritus or living seagrass tissue, provide the major source of food for the invertebrates. Small invertebrates are important prey for most abundant species of fish and decapod crustaceans. Some species of decapods are herbivores, however, and decapods cannot be lumped into a single trophic category. The degree of refuge provided by seagrasses depends on the relationships between, and characteristics of, habitat, predator, and prey.

1987 ◊

Zieman, J. C. (1987) A review of certain aspects of the life, death, and distribution of the seagrasses of the southeastern United States 1960 - 1985. Fla. Mar. Res. Publ., 42:53-71.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Seagrass meadows are among the richest and ecologically most important coastal habitats. In the United States, the greatest seagrass resources are along the south and west coasts of Florida, with over 5,500 km^2 of seagrass in south Florida, and a second extensive bed covering over 3,000 km^2 between Tampa and Apalachee Bay. Well developed seagrass meadows occur at depths over 10 m in clear waters, but are often limited to less than 2 m in turbid, polluted estuaries. In these latter areas, suspended particulate matter, as well as overgrowths of epiphytic algae, brought about by excess nutrients in the water column, can stress the seagrasses. In more pristine waters, seagrasses maintain high productivity by obtaining nutrients from the sediments via extensive root and rhizome systems, which, coupled with the current-baffling effect of the leaf canopy, protect and stabilize the sediments. In turbid, shallow seagrass systems, much of the food web is based on epiphytic algal grazing, but the dominant trophic pathway in most seagrass systems seems to be via the detrital food web. Seagrass leaves are a relatively rich food source, compared to saltmarsh plants and mangroves, but are grazed directly by few organisms, especially outside of tropical Caribbean waters. In addition to contributing to local food webs, detached seagrass blades are often exported great distances and serve as food sources hundreds of kilometers from their source beds.

1987 - 1988

Zieman, J. C., J. Fourqurean, M. B. Robblee, M. Durako, P. Carlson, and G. Powell (1988) A catastrophic die-off of seagrasses in Florida Bay and Everglades National Park. EOS Trans., 69:1111.

[ABSTRACT ONLY.] Over the past year, Florida Bay has experienced a major die-off of seagrasses and benthic macrophytes totaling several thousands of hectares. Dead areas range from patches 0.5 m across to contiguous, thousand hectare dead zones and include all benthic vegetation. There are four major distressed areas, three in the west-central bay and one in the east. None are directly adjacent to the Florida Keys. The areas affected are primarily basins and the sides of basins, all with very dense seagrass (primarily *Thalassia*) cover and reduced circulation. Abnormal amounts of dead leaves were first noted in August 1987. By July-August 1988, the phenomenon appears to be slowly enlarging, although there is definite evidence of regrowth in some affected areas. Surviving and recolonizing shoots possess unique morphologies, including short internodal distances and abnormally high leaves/shoot (up to 17). Pore water sulfide concentrations were about two times higher in dead areas as opposed to nearby, apparently dead areas (2.14 vs 1.32 mmol). Several hypothetical mechanisms responsible for the die-off are being explored including (l) abnormally high temperatures in summer l987, (2) extreme salinities, and (3) disease, among other possibilities. At the present time the area is experiencing abnormal epiphyte and algal growth, apparently due to the release of nutrients from the nutrient rich barren sediments and the thousands of metric tons of decaying seagrass.

1987 - 1989

Fourqurean, J. W., J. C. Zieman, G. V. N. Powell (1992) Relationships between porewater nutrients and seagrasses in a subtropical carbonate environment. Mar. Biol., 114:57-65.

The primary source of nutrients for seagrass growth is considered to be sediment porewater. Porewater nutrient concentrations were measured in 18 seagrass beds across Florida Bay during the summers of 1987 and 1988. Concentrations of nutrients in porewater varied widely, with median values of 0.34 µM for soluble reactive P (SRP) and 78.6 µM for NH_4^+. SRP and NH_4^+ concentrations were positively correlated. Due to spatial heterogeneity, there were no apparent trends with sediment depth (down to 40 cm) in the porewater nutrient concentrations. The SRP concentration of the porewater was highest in areas supporting *Halodule wrightii,* intermediate in areas of *Thalassia testudinum,* and lowest in sediments without seagrasses. There was no similar relationship with NH_4^+. Porewater SRP, but not NH_4^+, was significantly correlated with total seagrass standing crop. Elemental content (both N and P) of green leaves of *T. testudinum* was a function of the concentration of the nutrients in the porewater. Standing crop of *T. testudinum* was correlated with phosphorus content, but not with N content, of the seagrass leaves. The results support the hypothesis that sediment porewaters are the most important source of nutrients for seagrass growth. In the Bay's subtropical carbonate environment, the availability of P in the porewater limits the development, and controls the species composition of seagrass.

1987 - 1989

Fourqurean, J. W., J. C. Zieman, G. V. N. Powell (1992) Phosphorus limitation of primary production in Florida Bay: evidence from C:N:P ratios of the dominant seagrass *Thalassia testudinum.* Limnol. Oceanogr., 37(1):162-71.

Variation of C, N, and P content of leaves of *Thalassia testudinum* was measured on two spatial scales: locally (10-100 m) in relation to a point source of nutrients associated with a bird colony in eastern Florida Bay, and regionally (10-100 km) across all of the Florida Bay. Locally, the P content of leaves decreased from a high of 0.16% P (wt/wt) 30 m from the nutrient source to a low of 0.08% 120 m from the source; the C and N content (34.9 and 2.19%) was independent of distance from the nutrient source. Due to variations in P content, C:P and N:P, but not C:N, varied locally. Regionally, P content varied greatly, from 0.05 to 0.209%. Carbon (29.4 - 39.5%) and N (1.7 - 2.7%) showed considerably less variation. Variation in C:P and N:P across the Bay encompassed a range nearly as great as reported for all seagrasses around the world combined. The C:N ratio showed little variation. Local variation around the nutrient point source indicated that C:P and N:P were indicators of P availability, and trend analysis of the regional spatial variation in C:P and N:P showed that P availability was greatest in northwest, and least in eastern Florida Bay. This pattern mirrored abundance of seagrasses and productivity in the Bay. *T. testudinum* from the Bay appears to be P limited and N saturated, even in the sparsest seagrass communities. This study was carried out from 1987 to 1989.

1987 - 1989

Strong, A. M., R. J. Sawicki, and G. T. Bancroft (1991) Effects of predator presence on the nesting distribution of white crowned pigeons in Florida Bay. Wilson Bull., 103(3):415-25.

From 1987-1989, surveys were conducted throughout Florida Bay, Card and Barnes Sounds, the southern portion of mainland Florida, and the mainline Keys south to Long Key to determine the breeding distribution of white-crowned pigeons (*Columba leucocephala*). We found pigeons nesting on 88 of 169 keys over a wide range in Florida Bay, Card and Barnes Sounds, and in one location in the mainline Keys. Their nesting distribution appeared to be limited by the presence of raccoons (*Procyon lotor*). Of the 33 keys on which we found evidence of raccoons, only six had nesting white-crowned pigeons. Other potential nest predators did not seem to influence nesting distribution. In Florida, white-crowned pigeon breeding populations apparently are limited by the availability of nesting sites without raccoons.

1987 - 1990

Robblee, M. B., T. R. Barber, P. R. Carlson, M. J. Durako, J. W. Fourqurean, L. K. Muehlstein, D. Porter, L. A. Yarbro, R. T. Zieman, and J. C. Zieman (1991) Mass mortality of the tropical seagrass *Thalassia testudinum* in Florida bay (USA). Mar. Ecol. Prog. Ser., 71:297-9.

This report documents the rapid and widespread mortality of the seagrass *Thalassia testudinum* Banks ex König (turtlegrass) in Florida Bay. More than 4,000 ha of seagrass beds have been completely lost in recurring episodes of mortality since the summer 1987. An additional 23,000 ha have been affected to a lesser degree. Loss of *T. testudinum*, the dominant macrophyte species in this highly productive system, may affect the ecosystem function within the Bay as well as estuarine-dependent sport and commercial fisheries. A pathogenic protist related to the causal agent of the eelgrass wasting disease may be involved in the mortality and may place *T. testudinum* populations outside Florida Bay at risk. Environmental factors and chronic hypoxia of below-ground *T. testudinum* tissue may also contribute to the die-off. Blade density data of test beds in Johnson Key Basin collected from June 1988 to March 1990 are presented in the paper.

1988 ◊

Knight, C. D. (1988) Mechanical compaction of Recent carbonate sediments in Florida Bay. The Compass, 65(2):111-15.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Mechanical compaction of a cross bank core from Florida Bay produced sedimentary features recognized in ancient fine-grained limestone. These features included: (1) reduction of sediment thickness by 40-50%, (2) creation of organic, wispy layers that mimic stylolites, (3) obliteration of identifiable marine grasses, (4) creation of packstone layers because of compaction of wackestone sediments, and (5) reorientation of fossils toward the horizontal. The end product was an artificial rock that resembled a biomicritic limestone.

1988 ◊

Knight, C. D. (1988) Pore-fluid chemistry and selected carbonate mudbanks and mangrove-fringed islands, Florida Bay. M. S. Thesis. Wichita State University, Wichita, KS. 236 pp.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] By comparing Florida Bay water and carbonate interstitial pore-fluid Ca/Cl, Mg/Cl, and Sr/Cl ratios, was possible to infer if diagenesis was occurring in selected carbonate mudbanks (Cross Bank and Crab Key Bank) and mangrove-fringed islands (Bald Eagle and Crane Key) within the Bay. The Cross Bank pore-fluid ratios indicate that the bulk of the mudbank aragonite and high-magnesium calcite sediments have undergone little diagenetic change. The Bald Eagle pore-fluid ratios indicated the following: (1) high-magnesium calcite sediments and some of the lower island aragonite sediments have started to convert of low-magnesium calcite, (2) incipient phreatic cementation within the upper 1 - 3 ft, and (3) formation of protodolomite in the northern lake regions. Saturation calculations indicate that both the mudbank and island interstitial pore-fluids are supersaturated with respect to calcite and aragonite. The saturation profiles within the mudbanks and islands sediments can be attributed in part to the reduction of sulfate by heterophic bacteria in the process of oxidation of organic matter. Mechanical compaction of a Cross Bank core produced sedimentary features that included: (1) reduction of sediment thickness by 40 - 50%, (2) creation of organic wispy layers, (3) obliteration of identifiable marine grasses, (4) creation of packstone layers, and (5) reorientation of fossils toward the horizontal.

1988 ◊

Lyons, W. G. (1988) A review of Caribbean Acanthochitonidae (Mollusca: Polyplacophora) with descriptions of six new species of *Acanthochitona* Gray, 1821. Amer. Malacol. Bull., 6(1):79-114.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Nine previously described species of Acanthochitonidae are recognized in the region between Bermuda and the Caribbean coast of South America: *Acanthochitona andersoni* Watter, 1981; *A. astrigera* (Reeve, 1847); *A. balease* Abbott, 1954 (+ *A. elongata* and *A. interfissa*, both Kaas, 1972); *A. bonairensis* Kaas, 1972; *A. hemphilli* (Pilsbry,1893); *A. pygmaea* (Pilsbry, 1893); *Choneplax lata* (Guilding, 1829); *Cryptoconchus floridanus* (Dall, 1889). Four new species (*Acanthochitona lineata*, *A. roseojugum*, *A. worsfoldi*, and *A. zebra*) are described from Florida, the Bahama Islands and the northern Caribbean; *Acanthochitona ferreirai* sp. nov. is described from Pacific coasts of Panama and Costa Rica. No subsequently collected specimens were seen of *Acanthochitona spiculosa* (Reeve, 1847), originally described from the West Indies; *A. spiculosa* is considered a species *inquirenda*. Some specimens were collected in Florida Bay and the Florida Keys.

1988 ◊

Mackin, J. E., and R. C. Aller (1988) Dissolved boron production in biogenic sediments; patterns and causes. EOS, Transactions, 69(44):1263-4.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Profiles of dissolved B vs depth were determined in short (~20 cm) and long (>100 cm) cores, taken at several sites in the carbonate sediments of Florida Bay. Boron concentrations reached double the seawater value at depths >50 cm, in some cases. Highest B concentrations corresponded to high dissolved silica concentrations of >1 mM. Also, dissolved B and silica production rates, observed during anoxic sediment incubation experiments were directly related, showing a decrease with depth into the sediment. When the sediment was spiked with solid silicic acid, and pore waters rapidly achieved saturation with respect to amorphous silica (1.5 mM), dissolved B production was completely inhibited. These data imply that B production in these sediments is caused by dissolution of biogenic opal, the dominant silica-bearing phase. Laboratory experiments show that, when normalized to BET surface area, B consumption by solid silicic acid at pH 8 was comparable to that observed for clay minerals like kaolinite and smectite. The tendency for solid silicic acid to remove B from solution was lowered by nearly an order of magnitude when the pH was lowered to pH < 7. These data suggest that B production in biogenic sediments primarily reflects the large pH difference between overlying waters (pH = 8), where plankton grow and incorporate boron, and the sedimentary environment (pH < 7), where net dissolution of opaline plankton tests occurs and boron uptake is least favorable.

1988 ◊

Merriam, D. F. (1988) Some recent developments in the study of Florida Bay geology. The Compass, 65(30):157-74.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Recent work in Florida Bay has kindled a resurgence of interest in this classic example of a dynamic lime-mud factory. History of work in the area can be subdivided into three periods: (1) early exploration and description (1850 - 1953), (2) general stratigraphy and sedimentology (1953 - 1977), and detailed in-depth studies (1977 - present). Since 1977, much effort has gone into the study of generation, distribution, accumulation, and preservation of the lime mud on the drowned Miami Limestone (Pleistocene) surface during the past 5,000 yrs. Sea-level change has been refined with additional data. Physical features in the Bay - islands, mudbanks, basins (lakes); chemical features - sediment and water; and biological features - fauna and flora, including sediment generation, have received considerable attention. Some work has been done on outline environmental sub divisions in the Bay by hydrographic, faunal, and sediment budget factors. Much new data have become available on the 'bedrock' geology with drilling of core holes in the Bay. Compaction and geochemical studies of the sediment have provided information on diagenetic changes during the lithification process. With the vast amount of data now available, it is possible to stimulate processes operational in the Bay and predict changes. Stimulation utilizing basin configuration, sea-level change, and sediment-generation rates show that the Bay is infilling from the west and north, and that sea-level change is the dominant factor in shaping the end result. Future research should be directed toward a better description and understanding of features in the Bay, their development, and subsequent change through time, and the Pleistocene and Recent geologic history with projections into the future of short-and long -range changes both natural and man-made.

1988 ◊

Ogden, J. C., and A. Sprunt (1988) Population trends and reproductive strategies by south Florida wading birds. Wildlife in the Everglades and Latin America Wetlands, 1985. G. W. Dalrymple, W. F. Loftus, and F. S. Bernardino (eds.). Florida International University, Miami, FL. 6.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] This citation is a discussion of population trends and reproductive strategies by wading birds. Historical data is discussed.

1988

Powell, G. V. N., and F. C. Schaffner (1991) Water trapping by seagrasses occupying bank habitats in Florida Bay. Est. Coastal Shelf Sci., 32(1):43-60.

Seagrasses, largely *Thalassia testudinum,* occupy habitats atop shallow carbonate mudbanks adjoining basins up to 3 m deep in Florida Bay. In this study, the phenomenon of water trapping whereby, during low tides, the seagrass meadow matrix retains a thin (< 20 cm) layer of water high on the bank top despite water levels in the adjoining basins being some 25-70 cm lower. The matrix slows water flow off the banks such that changes in the rate at which water recedes through time approximates a sigmoid function of water level. A meadow with a large seagrass standing crop (59 g dry mass m^{-2}) held a 17.4-cm layer of water atop the bank, while a meadow of lesser standing crop (less biomass per area, 130 g dry mass m^{-2}) that may have been facilitated by a topographical berm held just 3.3 cm of water. Similarly, on the bank slope the higher standing crop meadow held 10.4 cm of water while the bank slope meadow at the site with lesser standing crop held only 1.6 cm of water. Water trapping by seagrass can keep water on the banks for up to 8 hr during low tides, preventing desiccation of the bank, and thereby providing permanent habitat for a diverse community of epibenthic fishes and invertebrates. The water trapping phenomenon presumably enhances overall prey abundance and diversity, and regulates the temporal patterns of prey exposure to different types of predation risk, e.g. to wading birds vs. predatory fishes. This study took place in Murray Key and Sandy Key during 1988.

1988 ◊

Quinn, T. M., and D. F. Merriam (1988) Evolution of Florida Bay islands from a supratidal precursor: evidence from westernmost Bob Allen Key and Sid Key. J. Geol., 96(3):375-82.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Cores from the interior portions of westernmost Bob Allen Key and Sid Key document island nucleation from a supratidal precursor developed on a paralic peat deposit; whereas cores from exterior portions of these islands document development of marine mudbanks, progradation or colonization by mangroves, and supratidal sedimentation. The supratidal precursor beneath these islands consists of eroded remnants of coastal tidal flats or local topographic highs that remained supratidal throughout the Holocene sea-level rise. Sedimentologic and biostratigraphic evidence suggest erosion of mangroves by storms or inundation of mangroves by storm deposits is a common precursor to subsequent sediment aggradation on both islands. If other Florida Bay islands developed from mangrove colonization of marine mudbanks, then data from westernmost Bob Allen Key and Sid Key indicate that nucleation from a supratidal precursor and mangrove colonization of marine mudbanks are both viable mechanisms for island initiation. The absence of evidence of a supratidal nucleus beneath an island can result from (a) island migration and subsequent erosion or (b) insufficient sampling density. Stratigraphic data from Florida Bay are insufficient to discriminate between the relative importance of these two models of island evolution; we contend that any model of the evolution of Florida Bay islands must incorporate island nucleation from a supratidal precursor as a viable mechanism for island evolution.

1988

Smith, K. N., and W. F. Herrnkind (1992) Predation on early juvenile spiny lobsters *Panulirus argus* (Latreille): influence of size and shelter. J. Exp. Mar. Biol. Ecol., 157:3-18.

Juvenile spiny lobsters *Panulirus argus* (Latreille) from three behaviorally and ecologically distinct ontogenetic groups (algal, 5-15 mm carapace length; transitional, 16-25 mm CL; and post-algal, 26-35 mm CL) were tethered in their characteristic shelters and on open substratum to evaluate size related differences in predation risk.

Field experiments performed during 1988 at two sites near Long Key, Florida Bay nursery habitat indicated that juveniles attained a partial size refuge from a suite of abundant algal lobster predators at about the time they emerged from settling habitat. Algal lobsters experience significantly decreased mortality by sheltering at night, thereby attaining a survival rate comparable to that of larger, older juveniles that forage nocturnally in the open. Diver surveys and limited net sampling revealed an array of lobster predators including octopus, portunid crabs, bonnethead sharks, nurse sharks, sting rays, gray snapper and toad fish, as well as general crustacean predators including bonefish and permit. High relative mortality of the smallest juveniles suggests that predation on the algal and early transitional phases was a potential bottleneck to population recruitment.

1988, 1990

Rude, P. D., and R. C. Aller (1991) Fluorine mobility during early diagenesis of carbonate sediment; an indicator of mineral transformations. Geochim. Cosmochim. A., 55(9)2491-509.

The abundant occurrence of calcium carbonate minerals in marine sediment, their well-documented dissolution or precipitation during diagenesis, and their high F content suggest that carbonate mineral diagenesis may be an important influence on F behavior in marine sediment. To test this hypothesis, the geochemistry of F in shallow carbonate mudbank sediment of Florida Bay was examined. The F content of biogenic calcium carbonate in Florida Bay varies with mineralogy, positively correlates with the Mg content of calcite, and occurs in similar abundance to Sr (high-Mg calcite: F/Sr = 2.4 mol/mol; aragonite: 0.53-0.79 mol mol^{-1}; low-Mg calcite: 0.22 mol mol^{-1}. Models of porewater distributions, direct solute flux measurements, and reaction rate estimates over the upper 0 - 16 cm of sediment from Bob Allen Key Bank predict net fluxes out of the sediment of 170 μmol F $m^{-2}\ d^{-1}$, 230 μmol Sr $m^{-2}\ d^{-1}$, and 5.6 mmol Ca $m^{-2}\ d^{-1}$. The net solute flux ratio of F/Sr (0.71 mol mol^{-1}) is consistent with dissolution of aragonite or high-Mg calcite, but F/Ca and Sr/Ca ratios (28 mmol mol^{-1} and 40 mmol mol^{-1}, respectively) are 3 - 10 times that of biogenic carbonate sources. Selective dissolution of a high F and Sr content phase or, more likely (based on dissolution experiments), concurrent dissolution and reprecipitation of phases with different F and Sr contents account for this discrepancy. The loss of F, Sr, and Ca to fluorapatite precipitation, as predicted from a stoichiometric model of phosphate release, can be added to the transport reaction model predicted net fluxes. A resulting, more complete mass balance model incorporating both carbonate mineral reactions and fluorapatite formation yields total release estimates of F, Sr, and Ca of 770 μmol, 332 μmol, and 53 mmol $m^{-2}\ d^{-1}$, respectively. Calcium carbonate minerals apparently undergo transformation whereby 34 mmol high-Mg calcite $m^{-2}\ d^{-1}$ and 19 mmol aragonite $m^{-2}\ d^{-1}$ dissolve, and 46 mmol low-Mg calcite $m^{-2}\ d^{-1}$ precipitates (ignoring other cations besides Ca). If no fluorapatite formation occurs, the required fluxes are that 23 mmol aragonite $m^{-2}\ d^{-1}$ dissolves and 3.4 mmol high-Mg calcite $m^{-2}\ d^{-1}$ and 14 mmol low-Mg calcite $m^{-2}\ d^{-1}$ precipitate. Net loss of $CaCO_3$ from the deposit by dissolution is 6-7 mmol $m^{-2}\ d^{-1}$ (3% of the accumulation flux). The magnitude of these fluxes could cause significant mineralogical and chemical changes on rapid time scales in nearshore carbonate sediment. Fluorine is probably mobile in other carbonate deposits undergoing diagenetic alteration on short and longer time scales and is a powerful additional constraint on the rates and nature of carbonate mineral diagenesis. Sample collection for this study took place during 1988 and 1990.

1988 - 1989

Forcucci, D., M. J. Butler, and J. H. Hunt (1994) Population dynamics of juvenile Caribbean spiny lobster, *Panulirus argus*, in Florida Bay, Florida. Bull. Mar. Sci., 54(3):805-18.

Despite a wealth of information on the growth and population dynamics of sub-adult and adult Caribbean spiny lobsters (*Panulirus argus*), there is far less information about younger juveniles under natural conditions. Growth and population dynamics of juvenile spiny lobsters (12 - 68 mm carapace length, CL) that were studied for 14 months (October 1988 - December 1989) are described using mark-recapture techniques in a hardbottom community in Florida Bay. The supply of postlarvae into the region in 1988 and 1989 was monitored using Witham-type surface collectors in an effort to link peak periods of settlement of postlarvae with subsequent cohorts of juveniles. Field estimates of growth were the highest ever reported for this species, averaging 0.95 mm CL wk^{-1} (range: 0.35 - 1.25 mm CL wk^{-1} for individuals 2 - 25 mm CL and 40 - 45 mm CL, respectively). These results indicate that lobsters in some areas in Florida Bay can reach Florida's legal harvestable size (76 mm CL) 1.5 yrs after settlement. Season and lobster size had significant effects on growth rates; less growth occurred during the winter and among small individuals. Differences in growth among size classes resulted from changes in molt increment, whereas seasonal differences were a result of changes in intermolt interval. Using mark-recapture techniques, we estimate that the density of juvenile spiny lobsters <45 mm CL in this prime nursery habitat was 454 ha^{-1}, that the mean monthly probability of survival (reflecting actual mortality plus emigration) was 0.51, and that an average of 131 lobsters entered the population through re-recruitment and immigration each. month. Recruitment of juveniles was significantly correlated ($r = 0.83$) with the supply of postlarvae to the region 8 months earlier. This relationship is stronger than was previously believed, and may only be manifested in areas with superior nursery habitat. Sampling took place in Fiesta Key from 1988 to 1989.

1988 - 1989

Ley, J. A., and C. Montague (1989) Influence on changes in freshwater flow to northeast Florida Bay on use of mangrove prop root habitat by fish. Pilot study submitted to the South Florida Water Management District. University of Florida, Gainesville, FL. 42 pp + appendices.

The objective of this study was to measure quantitatively the fish communities in the fringing red mangrove habitat of Florida Bay over a broad range of mean salinity and salinity variation conditions and determine if corresponding fish community differences exist. To accomplish this objective, upstream, mid-bay and downstream stations across a salinity gradient were located in two tributary creek systems, Snook Creek in Joe Bay and Highway Creek in Long Sound, that carry freshwater to northeast Florida Bay. Comparisons were made between upstream and downstream over a period of transition from along dry season (winter and spring) to wet (summer and fall). Also sampled were sites in Little Blackwater Sound, Duck Key and Pelican Key. Eight methods were used to sample fish, three visual and five collecting methods. Overall, more than 43,000 fish and invertebrates were observed at 71 station/dates. All data is included in the citation.

1988 - 1990

Manire, C. A., and S. H. Gruber (1991) Effect of M-type tags on field growth of juvenile lemon sharks. Trans. Amer. Fish. Soc., 120:776-80.

Previous experience with M-type dart tags suggested that their implantation causes trauma and retards growth of small sharks. To test this hypothesis, a group of 76 Juvenile lemon sharks *Negaprion brevirostris* of a precaudal length of less than 80 cm, were marked with tiny (2 mm x 11 mm), passive integrated transponder (PIT) microtags, implanted intramuscularly. A second group of 563 lemon sharks of the same size range was marked with M-type dart tags, and both groups were released around Big Pine Key in Florida Bay. Growth of 10 recaptured fish with the M-type tag averaged

8.6 ± 2.34 (SD) cm yr^{-1}, compared with an average of 17.1 ± 4.25 cm yr^{-1} for 10 recaptured fish with PIT tags. Growth of the PIT-tagged group was significantly greater ($P < 0.001$) than that of the dart-tagged group (one-way ANOVA). It is recommend that biologists refrain from marking young or small sharks with M-type dart tags, especially for age and growth studies. This study took place from 1988 to 1990.

1988 - 1991

Strong, A. M., and G. T. Bancroft (1994) Postfledging dispersal of white-crowned pigeons: implications for conservation of deciduous seasonal forests in the Florida Keys. Conservation Biol., 8(3):770-9.

From 1988 to 1991, we studied the postfledging dispersal of 31 radio-tagged white-crowned pigeons (*Columba leucocephala*) from three natal keys in Florida Bay. Immature birds dispersed from the natal keys at 26-45 days after hatching, and most young dispersed more than 20 km during the first 10 days postdispersal. Dispersing birds flew either north to the Florida mainland or east to northeast to the mainline Florida Keys. On the mainland, immature birds fed nearly exclusively within Everglades National Park or an adjacent state wildlife management area. On the mainline keys, white-crowned pigeons selectively used 5.01 20 ha forest fragments ($p < 0.10$) during the first 72 hr post dispersal. After this period, dispersing birds showed no preference among fragment size classes but used deciduous seasonal forests more frequently than suburban habitat ($p < 0.10$). The spatial pattern of dispersal on the mainline keys suggests that, during the first 72 hr postdispersal, whitecrowned pigeons are not able to reach northern Key Largo, where 69% of the deciduous seasonal forests are protected in state or federal ownership. Protection of large forest fragments, especially on southern Key Largo, should be a priority for maintaining populations of white-crowned pigeons These forests provide a series of "stepping stones" that enable dispersing immature white-crowned pigeons to fly to more distant areas where habitat availability is less restricted.

1989

Baratta, A. M., and R. J. Fennema (1994) The affects of wind, rain, and water releases on the water depth and salinity of northeast Florida Bay. Bull. Mar. Sci., 54(3):1072.

[ABSTRACT ONLY] This study is an exploratory examination of factors affecting salinity levels and water depths in the northeast estuaries of Everglades National Park. Wind speed and direction, water releases through the C-111 canal system, and upland stage data were correlated with local rainfall, salinity, conductivity, depth, and water temperature measurements recorded at five stations located in the northeast Florida Bay estuaries. The statistical analysis of this data for the study year 1989, as well as individual events during that year, were used to formulate models of the C-111 system. These models indicated that water depth varies directly and conductivity varies inversely with major C-111 water releases through gate structure 18-C. During other periods, regression results indicated that ground water stage, not C-111 releases, was the major independent variable influencing estuary depth and salinity. Wind was found to increase estuary water depth when coming from the southern quadrants, and decrease water depth when coming from the north. With the exception of isolated events, local rainfall events during the year were not of the magnitude to have a significant influence on Bay depth or conductivity.

1989 ◊

Bert, T. M., and J. M. Stevely (1989) Population characteristics of the stone crab, *Menippe mercenaria*, in Florida Bay and the Florida Keys. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):515.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Stone crabs are high level carnivores that exhibit sexual dimorphism and support an important commercial fishery in southwest Florida. Previous population surveys of stone crabs used remote sampling methods (trapping), whereas the information discussed in this paper on distribution and abundance, habitat use and reproductive patterns in western Florida Bay and the Florida Keys was obtained from quantitative diving surveys. Density of stone crabs was highest on the Gulf of Mexico side of the middle Keys and lowest on the Atlantic Ocean side of the upper Keys. Mean size of males was largest in western Florida Bay and smallest on the Gulf side of the Keys; mean size of females was smallest on the nearshore Atlantic side and largest in western Florida Bay and offshore on the Atlantic side. Density in the Keys shifted seasonally, being highest on the Atlantic side in spring and on the Gulf side in fall. Stone crabs excavate burrows under emergent hard substrate (rocks, large sponges, coral heads) or in seagrass *(Thalassia testudinum)* beds. Density was highest in mixed rock/seagrass habitat, where stone crabs occur in greater densities in holes under hard substrate than in seagrass burrows. Females apparently inhabit rock/seagrass preferentially (average male: female ratio 1:2), whereas males apparently prefer mixed rock/sand habitat (average ratio 3:1). Seasonal habitat occupancy changed between sexes and differed in proportion of habitat types available. On the Gulf side of the Keys, where proportions of seagrass and hard substrate were roughly equal, sex ratio shifted between habitats during the fall mating season. Males occurred principally in holes under hard substrate and females in burrows in adjacent seagrass beds. In western Florida Bay, where hard substrate constituted approximately 5% of available habitat, no difference in den habitat between sexes was noted, and individuals were distributed randomly. Gravid females occurred in disproportionately high numbers under hard substrate in mixed rock/seagrass habitat. Mating pairs occurred during spring and fall (principally April and October) throughout the study area. Mean size of mating males was significantly larger than that of all males, and mean size of mating females was significantly smaller than that of all females. Size of mating pairs was not correlated. Percent of spawning females was highest in August, when nearly all females were gravid. The population structure of stone crabs suggested territoriality and/or habitat dominance related to reproductive patterns. Seasonal use of den habitat type changed during mating and spawning seasons. Males may have competed for females, and mating habitat use varied on a sliding scale, dependent upon relative proportions of habitat types available (e.g., emergent hard substrate vs. seagrass). Dens excavated under hard substrate presumably require less energy to dig and were quite stable. Preference for that habitat by males during mating season and females during spawning season may be related to ease of den excavation and/or defense.

1989 ◊

Burke, C. D., and W. D. Bischoff (1989) Chemical differences among the shells of two euryhaline species of fossil ostracoda (Crustacea): a preliminary study. Trans. Kansas Acad. Sci., 92(1-2):94-106.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Microfossils were extracted from a Florida Bay sediment core, and brackish and marine environments were interpreted on the basis of fossil ostracode and foraminiferid assemblages. A total of 48 hand-picked specimens of two species of euryhaline ostracodes (*Cyprideis salebrosa* and *Peratocytheridea setipunctata*) were chemically analyzed for Ca, Mg, Sr, and Fe concentrations to determine the effect of salinity on bulk skeletal chemistry. Results indicate that adult specimens of the two species have similar Mg and Sr concentrations, but Fe is more concentrated in the shells of *C. salebrosa.* There are no differences in trace element concentrations in adult specimens from brackish or marine sections of the core. Nodose and non-nodose instars of *P.*

setipunctata contain similar concentrations of Sr, but greater concentrations of Mg and Fe than conspecific adults or adults of *C. salebrosa.* The enrichment of Mg and Fe in instars may be the result of rapid shell growth rate. Rapid carapace calcification may represent an adaptive strategy for survival that is maintained throughout the ontogeny of an individual. The samples were obtained from one core collected in Crab Key.

1989 ◊

Childers, D. L., J. Fourqurean, and G. V. N. Powell (1989) Intertidal seagrass banks as critical estuarine habitat: Evidence from a nutrient exchange study in Florida Bay, FL. Abs., 10th Biennial Estuarine Research Conf., Baltimore, MD. 15.

[ABSTRACT ONLY.NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] The transformation and intertidal exchange of nutrients and materials by intertidal seagrass banks represents an indirect habitat interaction with the associated estuarine water column. These processes were measured on a regularly-exposed *Halodule/Thalassia* bank in western Florida Bay over 5 tidal cycles using a 60 m through-low flume. Averages of significant fluxes are provided and compared with exchanges from flumes in Louisiana marsh systems. Fluxes from the Florida Bay seagrass bank were orders of magnitude greater than 1 for inorganic nitrogen, 1 - 2 for POC and PON, and 3 for TSS.

1989 ◊

Cohen, A. D., and T. D. Davis (1989) Petrographic/botanical composition and significance of the peat deposits of Florida Bay. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):515-6.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The purpose of this study was to develop an understanding of the early vegetation and geologic history of Florida Bay by analysis of the petrographic/botanical compositions of its surface and subsurface peat deposits. Over 600 sites were investigated, of which 134 were found to contain some peat. Most of these peat deposits were basal layers overlain by marine carbonate-rich marls. A representative selection of these peat deposits was sampled and analyzed using piston coring and microtome-sectioning procedures. Peat types representing 13 different autochthonous depositional environments were identified. Three of these represented marine, mangrove-dominated settings (*Rhizophora* Peat, *Rhizophora-Avicennia* Peat, and *Avicennia* Peat); two were transitional settings (*Rhizophora* Transitional Peat and *Conocarpus* Transitional Peat); and eight represented freshwater settings (*Mariscus* [*Cladium*]) Peat, *Acrostichum-Mariscus* Peat, *Mariscus-Sagittaria* Peat, *Mariscus-Nymphaea* Peat, *Mariscus-Cephalanthus* Peat, *Cephalanthus* Peat and *Myrica-Persea-Salix* Peat). The primary micropetrographic parameters used in defining each of the peat types and in reconstructing its environment of deposition were the abundances and types of: (1) botanically identifiable plant fragments; (2) plant decomposition products; (3) animal remains (such as sponge spicules, radiolaria, foraminifera, shell fragments and insect parts); and (4) mineral components (such as carbonates and pyrite). The identification of the freshwater peat types in all sites analyzed were especially significant because these types represent depositional settings that do not occur in Florida Bay today but are, however, presently forming on the mainland Everglades. The petrograph botanical evidence thus supports an hypothesis that the peat deposits of Florida Bay represent erosional remnants of a more extensive area of freshwater Everglades-type peat that occupied portions of the region before it was converted to Florida Bay by a transgressing sea.

1989 ◊

Cottrell, D. J. (1989) Holocene evolution of the coast and nearshore islands, northeast Florida Bay, Florida. Ph. D. Dissertation. University of Miami, Coral Gables, FL. 194 pp.

[DATE OF SAMPLING UNKNOWN OR NOT AP[illegible]ICABLE.] The comparative stratigraphy of the mainland coast and islands of northeastern Florida Bay shows that both islands and the present coastline initiated from paralic shoreline deposits during an earlier stage of the Holocene sea level rise. The present mainland coast is composed of 1.5 to 2 m of Holocene sediment over a shallowly submerged Pleistocene limestone surface. This build-up initiated from paralic peats and muds from which evolved two basic coastal landforms: an east-west trending coastal levee, and several narrow north-south trending peninsulas extending into Florida Bay. The coastal levee is characterized by basal paralic swamp and marsh sediments overlain by supratidal levee muds. These levee mud deposits represent stable, continuous shoreline development during the past 2,500 yrs. Peninsulas, however, have resulted from supratidal sediments accreting over subtidal mud build-ups. Peninsulas have a westward-thinning wedge of paralic peat or marsh sediment at the base of their windward (eastern) margins. This wedge is interpreted as a remnant of the basal paralic deposit from which the peninsulas initiated. Windward shore erosion and leeward progradation have caused peninsulas to migrate westward across leeside subtidal deposits. Most of the offshore islands in northeastern Florida Bay have a wedge of paralic or marsh sediment at the base of their windward margins. Supratidal muds directly overlie this basal wedge along portions of the windward side of some islands. This sequence is identical to that of the coastal levees, and these portions of islands are interpreted as eroded sections of former coastal levees. On the windward margin of other islands, the basal paralic sediment wedge is overlain by subtidal sediments, which become thicker to the west, and are capped by supratidal muds which thin to the west. This indicates that the windward margins of islands, like the peninsulas, have eroded and the islands are migrating (prograding) westward. It is concluded that the position of early shorelines was defined by pre-existing drainage patterns produced by mangrove-bordered rills, along which swamp and marsh sediments accumulated. As the area flooded, these deposits persisted and evolved into thin, northwest-southeast trending mangrove peninsulas. Subtidal sediments accumulated adjacent to leeward shores, while windward shores eroded. With sea level rise and transgression, sections of the shoreline were breached, forming islands. These early islands continued to accrete leeward muds and erode their windward margins, resulting in the westward migration of islands from their point of inception.

1989 ◊

Cottrell, D. J. (1989) Holocene evolution of the northeastern coast and islands of Florida Bay. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):516.

[ABSTRACT ONLY, DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The comparative stratigraphy of the mainland coast and islands of northeastern Florida Bay showed that both the islands and the present coastline initiated from paralic shoreline deposits during an earlier stage of Holocene sea level rise. The present mainland coast is composed of 1.5 to 2 m of Holocene sediment over a shallowly submerged, Pleistocene limestone surface. This build-up initiated from paralic peats and muds from which evolved two basic coastal features: an east-west trending coastal levee and several narrow, north-south trending peninsulas extending into Florida Bay. The coastal levee is characterized by basal paralic swamp and marsh sediments overlain by supratidal levee muds. These levee mud deposits represent stable, continuous shoreline development during the past few thousand years. Peninsulas, however, have resulted from supratidal sediments accreting over subtidal mud build-ups. Peninsulas have, at the base of their windward (eastern) margins, a westward thinning wedge of paralic peat or marsh sediment. This wedge was interpreted as a remnant of the basal paralic deposit from which the peninsulas initiated. Windward shore erosion and leeward progradation have caused peninsulas to migrate westward across leeside subtidal deposits. Most of the offshore islands in northeastern Florida Bay have a wedge of paralic or marsh sediment at the base of their windward margin. Supratidal muds directly overlie this basal wedge along portions of the windward side of some islands. This sequence is identical to that of the coastal levees, and these portions of islands are interpreted as parts of former coastal levees. On the windward margins of other islands, the basal paralic swamp and marsh sediment wedge is overlain by subtidal sediments, which become thicker to the west, and are capped by supratidal muds which thin to the west. This indicates that the windward margins of islands, like the peninsulas, have eroded and the islands are migrating (prograding) westward. It was concluded that the position of early shorelines was defined by pre-existing drainage patterns produced by mangrove-bordered rills, along which swamp and marsh sediments accumulated. As the area flooded, these deposits persisted and evolved into thin, northwest-southeast trending mangrove peninsulas. Subtidal sediments accumulated adjacent to leeward shores, while windward shores eroded. With sea level rise and transgression, sections of the shoreline levees and peninsulas were breached, forming islands. These early islands continued to accrete leeward muds and erode their windward margins, resulting in the westward migration of islands from their point of inception.

1989 ◊

Davies, T. D., and A. D. Cohen (1989) Composition and significance of the peat deposits of Florida Bay. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):387-98.

[DATE OF SAMPLING PRIOR TO 1980 BUT UNKNOWN.] Late Holocene vegetation and geologic history of Florida Bay is elucidated by analysis of the petrographic/botanical compositions of its surface and subsurface peat deposits. Over 600 sites were investigated, of which 134 were found to contain some peat. Cores were obtained in Ninemile Bank, Spy Key - Panhandle Key Bank, Joe Kemp Key, Cluett Key, Jim Foot Key, Samphire Key, Man-of-War Key, Shell Key, Panhandle Key, Spy Key, Russell Key, Eagle Key, Crane Key and Pigeon Key. Most of these peat deposits were overlain by marine carbonate-rich marls. A representative selection of these peat deposits was sampled and analyzed using piston coring and microtome-sectioning procedures. Peat types representing 12 different depositional environments were identified. Three of these represent marine, mangrove-dominated settings (*Rhizophora* Peat, *Rhizophora-Avicennia* Peat, and *Avicennia* Peat); two are transitional settings (*Rhizophora* Transitional Peat and *Conocarpus* Transitional Peat); and seven represent freshwater settings (*Uariscus* [*Cladium*] Peat, *Acrostichum* Peat, *Acrostichum-Mariscus* Peat, *Mariscus-Nymphaea* Peat, *Mariscus-Cephalanthus* Peat, *Cephalanthus* Peat, and *Myrica-Persea-Salix* Peat). The properties used in defining each peat type and in reconstructing its environment of deposition were the abundances and types of: (1) identifiable plant fragments, (2) plant decomposition products, (3) animal remains (such as sponge spicules, radiolaria, foraminifera, shell fragments, and insect parts), and (4) mineral components (such as carbonates and pyrite). The identification of the freshwater peat types at all sites analyzed is especially significant because these types represent depositional settings that do not occur in Florida Bay today but are presently forming on the mainland in the Everglades. The evidence thus supports the hypothesis that the peat deposits of Florida Bay represent erosional remnants of a more extensive area of freshwater Everglades-type peat that occupied portions of this region before it was converted to Florida Bay by a transgressing sea. [This study was also presented in: Cohen, A. D., and T. D. Davis (1989) Petrographic/botanical composition and significance of the peat deposits of Florida Bay. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):515-6. Abstract only.]

1989 ◊

Durako, M. J. (1989) Morphoanatomical characteristics and recovery potential of *Thalassia testudinum* in sites affected by die-back in Florida Bay. Abstracts 10th Biennial Estuarine Research Conf., Baltimore, MD. 22.

[ABSTRACT ONLY. NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] Morphoanatomical analyses of *Thalassia* ramets collected from 3 basins affected by die-back in Florida Bay revealed significant temporal and spatial variability. Short-shoot and rhizome apex densities, maximum leaf lengths and widths, shoot-specific and bottom-specific leaf areas significantly decreased along a gradient from healthy beds to die-back patches. Mean numbers of leaf scars and leaves per short-shoot significantly increased along this same gradient during summer; surviving short-shoots within die-back patches were characteristically solitary. However, in November, the mean leaf scar pattern was reversed. Ten percent of the short-shoots collected had new rhizome apices, and up to 40% of the short-shoots in die-back and dying fringe samples exhibited a novel branching pattern.

1989 ◊

Galli, G. (1989) Is Holocene storm-generated stratification in Florida Bay a reflection of solar storm cycles? Palaeogeogr., Palaeoclimatol., Palaeoecol., 76:169-85.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] A descriptive analysis of surficial sediments of Crane Key showed that the sediments consist of storm layers (winter storm and hurricane deposits) and algal laminated sediments. Storm layers are riddled with the following types of cavities: gas escape vugs, dissolution vugs, burrows, rootholes, and cryptalgal vugs. Structures and sediment types are arranged into a 15-cm thick thickening-upward, storm-generated sequence which formed in approximately 100 yrs under a deepening trend. Periodograms of sea level variations match the frequency distribution of strong intensity storms which occurred in south Florida since the beginning of this century. The calculated recurrence time of strong storms (10 ± 3 yr) and the time interval of formation of the sequence (100 ± 25 yr) are probably a response of climatic parameters to short period (11-yr) and longer-period (90 - 100-yr) cycles of solar activity. Comparison with the ancient record shows analogous dm-thick storm generated sequences probably linked to solar cycles and 100-yr sea level rises.

1989 ◊

Livingston, R. J. (1989) Ecosystem research and resource management: application to Florida Bay. Bull. Mar. Sci., 44:517.

[ABSTRACT ONLY.] There are three basic components concerning research that is ultimately to be used for management purposes: (1) the design of an interdisciplinary research product, (2) adequate computational facilities for continuous analysis of data, and (3) the application of the results to management problems. There is considerable disagreement and controversy concerning how to carry out comprehensive, interdisciplinary programs that are designed to generate information that can ultimately form the basis of predictive models. Spatially, most coastal areas are subject to important changes associated with land runoff, consequently, a system such as Florida Bay is closely dependent on freshwater runoff that has its origin hundreds of miles away. Such systems also have close ecological ties with offshore areas as centers of spawning for many dominant estuarine populations. Temporal variation has many scales, from hourly changes to interannaul periodicity. Different physical and chemical processes and the various levels of biological organization all operate within the various families of spatial and temporal scales so the complexity of cause and effect mechanisms is considerable. Various processes, including productivity, energy distribution via food-web relationships, and diverse multispecies interactions at the population and community levels, form the basis of ecosystem-level changes that remain imcomprehensible when subjected to limited sampling efforts. Comparative studies indicate that individual estuarine and coastal systems are unique in terms of how these common factors interact and respond to natural and anthropogenous disturbance; hence, another level of complexity is added via problems of interpretation and extrapolation of research results. Without adequate, long-term, interdisciplinary studies, properly scaled to answer questions not yet asked, resource management becomes a haphazard, crisis-oriented process that ultimately has one final outcome; the reduction or loss of the natural resource base as a result of the cumulative impacts of various anthropogenic activities. Even if the scientific data base is adequate for an understanding of basic system functions, and even if the data are held in a form that facilitates appropriate analysis on a continuing basis, there is no guarantee that the data will be applied to questions involving long-term planning and resource management. It is at this stage (i.e., the application of basic scientific findings to complex resource management questions) that most important unresolved problems remain in terms of management initiatives. A major ecosystem, such as Florida Bay, is composed of multitudinous factors that resemble the individual strands of a fine tapestry; in this case, the tapestry changes continuously in an episodic, kaleidoscopic fashion. Most ecosystem research is carried out in patchwork-quilt fashion, with 6 months of data here, 12 months of data there, in the hope that someone can stick it all together and make sense out of the results. The problems that result from this approach reflect the basic differences between a patchwork quilt and a fine tapestry. In terms of money and time spent for research, the patchwork quilt approach is both inefficient and scientifically unsatisfactory. This method also encourages the mindless generation of monitoring data, the so-called "sorcerer's apprentice" approach to ecological studies. There is ample evidence that the patchwork-quilt proponents, who dominate in today's scientific world, are in part responsible for the wholesale deterioration of natural ecosystems, both in Florida, a rapidly developing state, and the nation as a whole. The reason is that, although a scientific database by itself cannot solve the important environmental problems of the world, without such data and an enlightened use of the results, habitat deterioration becomes a certainty.

1989 ◊

Ludwig, G. M., J. E. Skjeveland, N. A. Funicelli, H. E. Bryant, D. A. Meineke, L. J. Mengel, and M. R. Dewey (1989) Survival of Florida Bay fish tagged with internally anchored spaghetti tags. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):518.

[ABSTRACT ONLY, DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Experimental studies to determine the short term survivability of tagged white *(Mugil curema)* and striped mullet (*M. cephalus),* spotted seatrout *(Cynoscion nebulosus),* and gray snapper *(Lutjanus griseus),* captured in the marine waters or Everglades National Park were performed. Survival was found to be related to the method of fish capture. Striped mullet mortality rates were: 16% for fish caught by commercial purse seines; 33.3% for those caught by gill nets; and 0% for those caught by trammel nets. White mullet, which were all caught with gill nets, had mortality rates of 77.4% while gray snapper was 0%. Mortality of spotted seatrout was 45.% for fish caught in nets and 5% for fish caught by angling.

1989 ◊

Merriam, D. F. (1989) Overview of the geology of Florida Bay, review of recent developments. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):519.

[ABSTRACT ONLY, DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Florida Bay is a shallow-water, triangular-shaped area of about 1,000 square miles wedged in between the south Florida mainland and the string of elongated Florida Keys. Protected by the Keys mainland, it is open to the southwest into the Gulf of Mexico, but the open-water effects on the Bay are dampened by the anastomosing mudbanks, which cordon the Bay into a series of internal basins (or "lakes" as known locally). Major changes in the Bay usually occur during severe storms (hurricanes). Because of its geographic position, climate and geological factors, carbonate sediments are generated in the Bay which is a modern carbonate factory). Its accessibility and conditions make it a popular modern analog for understanding ancient sediments in the rock record deposited under similar conditions. The study of the Bay can be divided into three segments: (1) early exploration and description (1850 - 1953); (2) general stratigraphy and sedimentology (1953 - 1977); and (3) detailed, in-depth studies (1977-). The first studies of southern Florida, commencing in the mid-19th century, were mainly exploratory and descriptive. The modern reef tract attracted attention and interest but mostly in regard to the flora and fauna because they were different from those in other parts of the United States. Such workers as Louis Agassiz and T. Wayland Vaughan drew attention to the importance of the area. Others, including C. W. Cooke and S. Mossom, J. H. Davis, S. Sandford, E. M. Thorp and G. Matson and F. G. Clapp, were concerned with the general geology of the area. These broad-brush studies were instrumental in understanding the setting and preparing the way for additional work. The second period is one of careful and thoughtful studies of stratigraphic and sedimentologic processes and descriptions of the features in the Bay and its development during the past 5,000 yrs. R. Ginsburg did his pioneering work in the early to mid-1950's, followed shortly by D. Scholl's work. Such workers as M. Ball, P. Enos, D. Gorsline, R. Halley, J. E. Hoffmeister, M. Lloyd, G. Lynts, G. Multer, R. Perkins, G. Shinn, D. Steinker, K. Stockman, J. Turney and H. Wanless were active beginning in the mid to late 1960's. This period culminated with publication of the now classic paper in 1977 by P. Enos and R. Perkins on "Quaternary Depo-positional Framework of South Florida" (Geological Society of America Memoir 147). Since 1977 much effort has gone into refining the concepts on generation and accumulation of the calcareous mud in the Bay and its preservation in relation to sea level changes. Geochemistry of the sediments has received much attention. Island stratigraphy has been the focus of other studies along with the mechanisms for distribution of the geologic, biologic and chemical parameters of the Bay. Pleistocene bedrock cores have been taken to determine the distribution of the Miami Limestone facies. In addition simulation studies of the Bay are underway utilizing available data. Groups currently working on the problems are located at Alberta Geological Society, University of Connecticut, Lehigh University, University of Miami, University of South Florida, Wichita State University and the US Geological Survey at Fisher Island in Miami and at Denver, CO. Many individuals in the United States and in Europe are working on various problems at different locations in the area. This "Symposium on Florida Bay," sponsored by the US National Park Service, Everglades National Park and the University of Miami, Rosenstiel School of Marine and Atmospheric Science, is an excellent opportunity for an update and exchange of information in regard to the latest developments on research of Florida Bay and vicinity.

1989 ◊

Merriam, D. F., J. M. Fuhr, R. V. Jenkins, and P. J. Zimmerman (1989) Pleistocene bedrock geology of Florida Bay, the Keys, and the Everglades. Bull. Mar. Sci., 44:519-20.

[ABSTRACT ONLY.] The Late Pleistocene Miami Limestone of southern Florida comprises three facies: bryozoan, coral, and oolite. The coral facies of Miami is termed the Key Largo Limestone and the oolitic facies the Miami Oolite (= Key West

Oolite). The three facies interfinger locally and are approximately 130,000 years old BP. The Florida Keys are an archipelago of elongate coral limestone islands, near parallel to the present offshore reef, and extend from near Miami southwest to Bahia Honda Key, and continue under water as far west as the Dry Tortugas. The southern Keys from Big Pine Key to Key West consist of oolite facies with a northwestern trend, which is approximately at right angles to the trend of the reef and which reflects the old Pleistocene tidal influence of their development. To the north on the mainland, the oolitic facies occupies mot of the Atlantic Coastal Ridge from Boca Raton to a point southwest of Homestead and extends as a thin sheet several miles into the Everglades. The reminder of the exposed Miami Limestone is termed the bryozoan facies and covers an area of approximately 3,000 sq. mi from the southern coast of Florida into the Everglades. Diamond-drill cores taken of the bedrock in Florida Bay reveal that the bryozoan facies underlies most of the Bay, but in a more complicated manner than previously suspected. Patch reef(s) occur locally in the Bay; one has been identified just east of East Key about 45+ ft thick. In other parts of the Bay, freshwater limestone has been observed. The bryozoan facies is composed of peletal packstones and grainstones and is so named because locally up to 70% of the rock may be composed of colonies of the bryozoan *Schizoporella floridana*. After bryozoans, pellets are the most abundant constituent; other important constituents are miliolids, peneroplids and ooids, and locally the unit contains burrows and calcareous worm tubes. The facies of the Miami Limestone was deposited on a broad, shallow-water marine platform where water depths probably did not exceed 30 ft. Long, linear, low topographic highs occur on the Miami Limestone in Everglades National Park. Known locally as "rock reefs," their length ranges from 8 to 15 mi, width from 30 to 60 ft, and height up tp 3 ft. Morphologically they are similar to the carbonate mudbanks accumulating today in Florida Bay.

1989 ◊

Merriam, D. F., and T. M. Quinn (1989) Recent sediments of Bald Eagle Key and implications for Florida Bay island stratigraphy. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):520.

[ABSTRACT ONLY, DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Bald Eagle Key is low-lying, saucer-shaped, mangrove-fringed island in Florida Bay. Located in Everglades National Park between easternmost Bob Allen and Captain Key and south or Russell Key, it is one of approximately 170 such islands in the Bay. Most of the islands are connected by a series of narrow anastomosing mudbanks. In general the islands are larger in the northeastern part of the Bay adjacent to the mainland and the mudbanks are thicker and wider in the western part fronting on the Gulf of Mexico. The islands are composed of carbonate mud that has accumulated over the Miami Limestone (Pleistocene) "bedrock" during sealevel rise throughout the past 5,000 yrs. The "normal" stratigraphic succession (A) of sediments forming the islands consists of: (a) freshwater marl, (b) mangrove peat, (c) shelly marine carbonate mud, (d) sort, marine carbonate mud usually with live mangrove roots, and (e) a cream-colored flaky supratidal carbonate mud (locally laminated). On other islands, another sequence (B) of events consists of only: (a), (b) and (e). Events (a) through (c) have been interpreted as transgressive, and events (d) to (e) regressive. Interpretation of sequence (A) is that of islands formed by mangrove colonization of marine mudbanks; whereas for (B) islands nucleated from a supratidal precursor. Both mechanisms are equally viable for island initiation. If marine mudbanks form subsequent to island nucleation from a supratidal precursor, then the absence of evidence of a supratidal nucleus beneath an island can result from: (1) island migration and subsequent erosion, or (2) an insufficient sampling density. Twenty-nine soft sediment cores were taken on the 0.2 by 0.4 m wide island. Sediment thickness ranged from about 7 to 8 ft with a 1- to 18-in thick peat present under the eastern side. The island developed over a slight topographic low on the microkarstic bedrock surface. The sediment sequence is of type (A) with all units from (a) through (e) present. The eastern side of the island is firm and appears erosional, whereas the western side is soft mud and appears depositional. From this evidence and distribution of sediments, it is interpreted that the island is migrating westward.

1989 ◊

Merriam, D. F., S. Sengupta and C. E. Sorensen (1989) Definition and implications of the subenvironments of Florida Bay. Bull. Mar. Sci., 44:520.

[ABSTRACT ONLY.] The subenvironments of Florida Bay have been defined in several different ways. Salinity levels have been used to subdivide the Bay into hydrographic zones; molluscan assemblages have been used to recognize subenvironments, and the net sediment budget used to arrive at sediment accumulation zones. Water properties such as salinity, pH, dissolved oxygen, dissolved carbon dioxide, turbidity, Ca, and Mg along with sedimentological, geochemical, and biological properties of the sediments were analyzed statistically to outline four sub-environments, the three peripheral ones - Northern, Gulf, Atlantic - and an Interior restricted zone. Because the water and sediment parameters are changing constantly, the boundaries of the different subenvironments fluctuate reflecting the dynamic conditions in the Bay. The water properties, particularly susceptible to change, show a distinct reorientation from winter to summer reflecting the change from the dry to wet season. These changes are attributed to various causes chief among them being wind direction, nutrient supply, rainfall, water circulation, and basin configuration. Water properties of salinity, pH, dissolved CO_2 and O_2, and turbidity were subjected to trend-surface analysis to determine the regional pattern of values for each variable. Salinity is normal marine in the center of the Bay, decreasing to brackish conditions along margins where the circulation is more restricted. Dissolved CO_2 is higher in the central part of the Bay, but dissolved CO_2 decreases towards the center of the Bay as does the pH and turbidity. In general, the salinity of CO_2 of the water decreases as O_2, pH and turbidity increase. These conditions are the result of a complex interplay of basin configuration, circulation, dilution and pollution, animal activity and vegetation, light, temperature, agitation, sediment supply and many other variables. The Northern subenvironment, which is in proximity to the mainland, and is characterized by a freshwater influx from the Everglades. Depth ranges from 2 - 4 ft, sediment grain size is from fine to coarse sand. Shallow regions are covered with vegetation, whereas the deeper areas are barren. *Laurencia* and *Thalassia* are abundant and the water usually is turbid and brackish. Gastropods and pelecypods comprise the fauna. Salinity is high in the Interior Subenvironments because of restricted circulation. Water depth ranges from 3 - 8 ft, and sediment grain size from medium to coarse sand. Although much of the substracte is bare, *Thalassia* and *Penicillus*, and other forms of algae are abundant locally. Because of the restricted circulation and limited nutrient supply, the flora and faunal diversity are low. The Gulf and Atlantic Subenvironments are regions of deeper waters (average 7 ft) and the sediment grain size is dominantly coarse sand. A high floral and faunal diversity is observed because of an open tidal exchange with the Gulf and Atlantic Ocean. *Thalassia* is abundant along with *Laurencia, Penicillus, Udotea, Halimedia* and other forms of algae, and *Porites*, sponges and shrimp mounds.

1989 ◊

Mukherki, K. K. (1989) Holocene development of Sandy Bank in the western Florida Bay. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):521-2.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Sandy Bank is located at the extreme western edge of the Florida Bay facing the open shelf of the Gulf of Mexico. The study focuses on the key features of mudbank development based on the nature of sediments, internal framework of sedimentary units, distribution of floral and faunal communities and ^{14}C dates. The sediments were primarily carbonates (90-98%) with siliciclastic components constituting 2 - 10% of the sediment. The sediment accumulated on a subaerially weathered, fairly irregular Pleistocene bedrock surface with a raised seaward margin. Holocene sediments formed a shallow submerged bank rising 1 - 2.5 m above the rocky submarine floor. The bank profile was gently asymmetric with a flat interior becoming steeper seaward. The entire bank surface was carpeted with marine grass. The central part, which is nearly exposed at low tide, was colonized by *Thalassia* only. A mixed grass community of *Thalassia* and *Syringodium* formed the bank edges with progressive decline in *Thalassia* at depth. The sediments were a mixture of mud (<0.062 mm) and shells (>0.062) with the proportion of mud in the sediments ranging from 10-98%. Mollusks were the chief skeletal grains, and green algae, sponge spicules, foraminifera, radiolari, etc., made up a maximum of 5% of the total shell fraction. Mudstones, wackestone and packstone were the principal sediment types, representing approximately 45%, 40% and 15% of the bank thickness. On the bank surface, mudstone was restricted to the central *Thalassia* Zone and Wackestone was associated with the mixed grass bottom community. Often mudstones exhibited weakly defined, very fine lamination. Animal burrows, plant roots rhizomes were common organic structures in the muddy bank sediment. Mollusks defined three distinct surface zones of brackish (Northern), marine (Gulf), and mixed (Transitional) subenvironments. The mosaic of surface environments could be recognized throughout the upper half to two thirds of the bank's internal stratigraphy. Sediment cores revealed an ascending sequence of dark brown to black peat; pale-orange *Pseudocyrena-Batillaria* mudstone with interlaminated peat; *Pseudocyrena-Anomalocardia* packstone; mangrove and/or *Thalassia* (rare) mudstone; *Anomalocardia-Transennella* packstone; and a highly bioturbated wackestone and/or mudstone with frequent interbedded, thick (2 - 4 cm) *Transennella* packstones. The internal stratigraphy indicated a progressive vertical change in the depositional environment from a semi-restricted coastal swamp through open brackish Bay to the recent nearly marine condition. ^{14}C dates on basal peat; *Pseudocyrena-Anomalocardia* packstone; *Anomalocardia-Transennella* packstone; and a *Transennella* packstone in the top most unit yielded average ages of 5,213, 4,290, 2,690 and 1,190 yrs respectively. Layer cake stacking of ^{14}C dated units and their lateral persistence strongly suggested accumulation of carbonate sediment over the entire mudbank area throughout the Holocene. Ubiquitous *Thalassia* free packstone underlying root and rhizome bearing mudstone signifies a temporary killing of grass by the sudden spread of coarse shell debris on the bank due to a temporary rise in the sea level during an exceptionally intense physical regime. The nature, thickness and site of the mudstones appear to have been influenced by the post-agitation rate of settling of suspended fines from the water column, the vigor of recolonization and the density of *Thalassia* on the newly established substrate. The overall sediment accumulation rate on the bank varied between 27 - 75 cm per 1,000 yrs. However, the central and thickest bank sequence reflects a systematic increase in sedimentation rate from the base to the top. The basal peat marked the slowest accretion rate of 13 cm per 1,000 yrs and the brackish water mangrove-*Thalassia* mudstone showed a growth rate of 31 cm per 1,000 yrs. This increase was attributed to trapping of fine sediment by mangrove roots and sparse *Thalassia* community. The uppermost mudstone, wackestone intercalated units had the maximum growth (65-88 cm per 1,000 yrs) due to an intense growth of grass on the bank under nearly marine conditions. It is suggested that the Pleistocene bedrock played a major role in the initial trapping of fine sediments in protected areas behind the weakly raised seaward edge. Later, the spread of marine grass influenced the bank development and a complex, very active phase of bank growth look place following the most vigorous colonization by marine grass at 2,690 BP. ^{14}C ages of the basal peat provided indication of southward progradation of the bank.

1989 ◊

Porter, D., and L. K. Muehlstein (1989) The role of fungi and slime molds in the die-back of *Thalassia testudinum* in Florida Bay. Abs., 10th Biennial Estuarine Research Conf., Baltimore, MD. 65.

[ABSTRACT ONLY. NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] The wide spread die-back of turtle grass, *Thalassia testudinum*, in Florida Bay is characterized by once continuous meadows of turtle grass which have either been completely lost or are interspersed at frequent intervals by irregular patches of bare sediment. The live plants near the die-back areas have many blackened streaks and spots on their leaves. These necrotic regions are symptoms of a disease which may be a direct cause of the disease. It was found that an undescribed species of the marine slime mold, genus *Labyrinthula*, is the only eukaryotic microorganism associated with the necrotic leaf pieces at a much higher frequency than from green leaf pieces. The relationship between seagrass disease and *Labyrinthula* is not unexpected. A different species of *Labyrinthula* has been demonstrated to be the cause of the wasting disease of eelgrass, *Zostera marina*.

1989 ◊

Powell, G. V. N., J. G. Holmquist, and S. M. Sogard (1989) Physical and environmental characteristics of Florida Bay with emphasis on mud banks. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):522.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The mudbanks of Florida Bay exert a disproportionate influence on the ecosystem as they represent most of the Bay's sediment, support half the Bay's seagrass standing crop, provide almost all of the Bay's wading birds' foraging habitat, and function as barriers to circulation, dividing the area into subenvironments. The banks were found to be basically flat-topped with gently sloping sides that graded into basins. The prevailing northeasterly winds resulted in distinct sheltered and exposed bank sides, the former with fine sediment and a high proportion of organics, and the high energy, exposed sides with coarser sediment and low organic content. Bay water levels were highest in fall. Lunar tidal flux was directly related to access to ope ocean for any given site. Water levels also demonstrated some degree of wind-depenuency at all sites, but particularly at those without pronounced lunar influence. Although water levels on narrow banks tracked those of basins, one 2 km-wide bank retained a lens of water at low tide. Bank temperatures ranged from 7.5°C to 37.0°C and demonstrated daily ranges of 4.5°C and up to 15°C, in contrast to basin ranges of 1.2°C. These physical characteristics shape Florida Bay's character by affecting plant and animal community structure and defining 3 distinct ecological periods. The banks are the stage for complex interaction of physical forces. Much of this interplay would be attenuated in the deeper grassbeds that have been the subject of most previous studies.

1989 ◊

Robblee, M. B. (1989) Changes in benthic fauna associated with an extensive seagrass die-off in western Florida Bay. Abs., 10th Biennial Estuarine Research Conf., Baltimore, MD. 69.

[ABSTRACT ONLY. NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] Seagrasses, principally *Thalassia testudinum*, have experienced extensive die-off in western Florida Bay since the summer of 1987. Die-off has resulted in areas of complete canopy loss ranging from several square meters to hundreds of hectares. In a few instances, *Halodule wrightii* has replaced turtle grass as the dominant seagrass after die-off. Currently, stations sampled quantitatively for pink shrimp, careidean shrimp, and benthic fish prior to seagrass die-off are being resampled to evaluate impacts on shrimp and fish abundance and species composition as well as differences in shrimp and fish relationships to grass canopy structure. Western Florida Bay, a major nursery ground, is possibly the principal nursery ground for the Tortugas pink shrimp fishery. It is likely that seagrass die-off on the scale being seen in Florida Bay will seriously impact its nursery function.

1989 ◊

Ryan, J. D., F. G. Lewis, and S. J. Schropp (1989) Metal and nutrient concentrations in Florida Bay sediments. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):523.

[ABSTRACT ONLY, DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Geochemical conditions of bays and estuaries can be determined by analyzing bottom sediments, which comprise a reservoir reflecting present, as well as historic inputs to these coastal environments. For naturally occurring substances (e.g., metals and nutrients), however, an interpretive problem arises in distinguishing an anthropogenic contribution to the natural fraction. Using two interpretive tools developed for coastal Florida, metal (Cd, Cr, Cu, Hg, Ni, Mn and Zn) and nutrient (total organic carbon, total Kjeldahl nitrogen and total phosphorus) concentrations were assessed for sediments from a variety of habitats in Florida Bay (i.e., seagrass beds, mangroves and soft-bottom unvegetated areas). Nutrient data were collected seasonally, while metals data were obtained only once. Results were compared with data from several other pristine coastal environments of South Florida to attempt to establish background ranges of these constituents for the lower peninsula of the State. Metal and nutrient levels in Florida Bay were very low and typical of those reported for clean carbonate sediments.

1989 ◊

Shaw, A. B. (1989) Distribution of mollusks in sediments of Florida Bay and reef tract. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):523.

[ABSTRACT ONLY, DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Collections of mollusks from bottom sediment samples of Florida Bay and the adjoining reef tract were classified into 9 major biofacies or assemblages, 5 minor and 4 subfacies. Most were recognizable by the dominant taxon (i.e., the most abundant taxon in the sample). The biofacies were diagnosed so they could be used in the field. Salinity patterns seemed to influence the distribution of the major biofacies in the interior of the bay, but the correspondence was not rigid, presumably because of fluctuations in salinity both seasonally and from year to year. Bathymetry was more closely correlated with the distribution of some of the biofacies, although the total range of depths within the bay was not large.

1989 ◊

Snedaker, S. C. (1989) Overview of ecology of mangroves and information needs for Florida Bay. Symp. on Florida Bay: A Subtropical Lagoon. Miami, FL. June, 1987. Bull. Mar. Sci., 44(1):341-7.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The mangrove forest areas bordering Florida Bay have provided research data and information which have formed the bases both for conservation laws and for the advances in mangrove research at other laboratories throughout the world. In this regard, the structural diversity of Florida Bay mangroves has been reasonably documented, but little research has been done on functional diversity, particularly as it relates to the nearshore estuarine flora and fauna. It was postulated that the quantity, quality and timing of fluxes of dissolved organic matter from different mangrove forest types may have a significant regulatory or control role in the structure and functioning of estuarine populations. This postulation focuses on a new area in chemical ecology which could lead to important new research findings on the interrelationships between mangrove forest habitats and the biological organization of estuarine communities.

1989 ◊

Tagett, M. G. (1989) Stratigraphy and dynamic growth of a Holocene carbonate mudbank complex: Dildo Key Bank. M. S. Thesis. Rosenstiel School of Marine and Atmospheric Science, University of Miami, Miami, FL. 266 pp.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Detailed lithofacies and faunal analysis of 121 cores demonstrated that Dildo Key mudbank, one of three large mudbanks separating western Florida Bay from the Gulf of Mexico, is an amalgamation of four smaller core mudbanks. These core banks are similar to younger mudbanks now forming in east-central Florida Bay. Core banks nucleated along the trend of early islands and prograded over basal peat and brackish to marine sediments. Interbank lagoons filled creating one large mudbank complex. Islands and basal peat beneath core banks are remnants of a once continuous coastal levee positioned by a broad horse-shoe shaped bedrock depression 30 cm deeper than the surrounding bedrock. Radiocarbon dates of peat and articulated pelecypod shells indicate that this coastal levee was overridden and marine mudbank accretion began about 2,500 yrs BP. Intense marine bioturbation blended levee and brackish sediments with overlying marine sediments as core banks developed. Core banks rapidly caught up to sea level at a rate of 9.1 to 61.7 cm 100 yr^{-1}. This rapid rate of core bank sedimentation was made possible by the landward recycling of large volumes of carbonate sediment during the Holocene transgression. When core banks caught up to sealevel the focus of sedimentation shifted to core bank flanks and areas between core banks filled forming one large mudbank. Present mudbank dynamics in western Florida Bay is controlled by the distribution and mortality of seagrass, sediment supply, winter storms and hurricanes. The Great Labor Day Hurricane of 1935 caused significant erosion and bank accretion. Vertical aerial photographs from 1935 to 1989 were used to document the morphology of the bank.

1989 ◊

Vincent, A. C. J., and R. S. Clifton-Hadley (1989) Parasitic infection of the seahorse (*Hippocampus erectus*) - a case report. J. Wildlife Diseases, 25(3):404-6.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] This paper details the development of a microsporidan infection in a colony of seahorses (*Hippocampus erectus*) caused by *Glugea heraldi*. Of 76 animals imported from Florida Bay, two survived. A myxosporidan (*Sphaeromyxa* sp.) and an unindentified nematode infection were also diagnosed in the same colony, but these infections were not considered important, causative factors in the mortalities.

1989 ◊

Yarbro, L. A., P. R. Carlson, S. Benford, and T. A. Tedesco (1989) Sediment sulfide and physiological characteristics of *Thalassia testudinum* in die-back areas of Florida Bay. Abs., 10th Biennial Estuarine Research Conf., Baltimore, MD. 92.

[ABSTRACT ONLY. NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] Sediment sulfide concentrations, as well as alcohol dehydrogenase activities and amino acid concentrations in *Thalassia testudinum* rhizomes, were measured in die-back patches located in three basins in Florida Bay. Sediment sulfide concentrations of 1.3 to 7.8 mM were congruent with variations in the intensity of die-back among sites. Rhizome ADH activities were significantly correlated with sediment sulfide concentrations. Significant differences were found among basins for concentrations of total free amino acids, glutamic acid, proline, and arginine. Glutamine and proline also exhibited significant differences among die-off zones. Current data suggest (1) hypoxic stress may play an important role in the die-off process, and (2) physiological assays may be dramatically affected by tissue heterogeneity.

1989 ◊

Windom, H. L., S. J. Schroop, F. D. Calder, J. D. Ryan, R. G. Smith, L. C. Burney, F. G., Lewis, and C. W. Rawlinson (1989) Natural trace metal concentrations in estuarine and coastal marine sediments of the southeastern United States. Environ. Sci. Technol., 23:314-20.

Over 450 sediment samples from estuarine and coastal marine areas of the southeastern United States remote from contaminant sources were analyzed for trace metals. Although these sediments are compositionally diverse, As, Co, Cr, Cu, Fe, Pb, Mn, Ni, and Zn concentrations covary significantly with Al, suggesting that natural aluminuosilicate minerals are the dominant natural metal bearing phases. Cadmium and Hg do not covary with Al apparently due to the importance of the contribution of natural organic phases to their concentration in sediments. It is suggested that the covariance of metals with Al provides a useful basis for identification and comparison of anthropogenic inputs to southeastern U.S. coastal/estuarine sediments. By the use of this approach sediments from the Savannah River, Biscayne Bay, and Pensacola Bay are compared. Samples were collected in the Ten Thousand Islands, Whitewater Bay, and Florida Bay.

1989 - 1990

Carlson, P. R., M. J. Durako, T. R. Barber, L. A. Yarbro, Y. deLama, and B. Hedin (1990) Catastrophic mortality of the seagrass *Thalassia testudinum*. Annual completion rep. Florida Dept. of Enviromental Regulation, Florida Marine Research Institute, St. Petersburg, FL. 51 pp.

Rapid and widespread mortality of the seagrass *Thalassia testudinum* is occurring in Florida Bay at the southern tip of the Florida Peninsula. This study was performed to: (1) quantify the current extent and dynamics of this die-back, (2) assess the recovery potential of the die-back sites, and (3) determine the cause(s) of the die-back. Sampling was performed in Johnson Key and Rabbit Key Basins and Ranking Lake in the Bay during 1989 - 1990. Quantitative bimonthly sampling monitored temporal and spatial variability in *Thalassia's* morphometric characteristics. Short-shoot densities, leaf lengths, and leaf area indices decreased significantly along gradients from visually healthy beds to die-back patches. Leaf numbers per short-shoot were usually highest in die-back patches reflecting very low plastochrone intervals (as short as 4-6 days). Leaf numbers were lowest in October and December as a result of normal summer leaf die-back. Bimonthly sampling of sediment sulfide and *Thalassia* rhizome metabolites revealed that porewater sulfide levels were highest in October, a period of peak intensity of die-back. Sulfide concentrations at this time exceeded 2 mM; a level which may cause cytotoxic effects. This suggests that sulfide may play a synergistic role in the die-back phenomenon. Rhizome ethanol concentrations were significantly affected by tissue type, sample interval, and basin, but were not significantly different between zones and times of day. Rhizome alcohol dehydrogenase activity (ADH) was significantly related to sample date and basin, but effects of zone and tissue type on ADH were not significant. ADH activities are not specific indicators of die-back induced stress, but they are useful as an index of cumulative, chronic hypoxic stress from all sources. No amino acids exhibited significant zone effects which might indicate disruption of normal metabolism by the die-back process. An assessment of the roles of vegetative and sexual reproduction in the recovery potential of die-back sites revealed that isolated survivor *Thalassia* short-shoots have the ability to initiate new lateral growth. However, the rate of shoot initiation (average 2.5 new short-shoots) was quite low during the study period. The occurrence of flowering short-shoots and seedlings was very patchy and no flowering short-shoots or seedlings were observed at the two basins most affected by the die-back. *Halodule wrightii* (shoal grass) was present in 52-78% of the quadrats in die-back patches in the two most severely affected basins, and in 28% of the quadrats in the least affected basin. These observations indicate that the rapid vegetative spread of *Halodule* may outstrip *Thalassia* in the initial recovery process. Seedling bioassays of toxicity and pathogenicity of chemical and biological system elements were conducted in March 1990. Seedlings growing in peat pellets received one of nine experimental treatments - raw or autoclaved: seawater from a die-back site, dieback sediments, *Thalassia* leaves with lesions, and dying *Thalassia* rhizomes. The last treatment was inoculation with the slime mold *Labyrinthula*, which had been isolated from lesions on *Thalassia* leaves from die-back sites in Florida Bay. No acute toxicity was noted for water, sediment, or plant material from the die-back site. All of the seedlings inoculated with *Labyrinthula* developed necrotic lesions within one week, however the spread of the lesions was quite slow and none of the seedlings died during the coarse of the experiment. Field experiments were conducted to test the role of environmental stressors in the die-back process. Short-term anoxia caused dramatic reductions in rhizome oxygen concentrations and increased carbon dioxide concentrations. Dead short-shoot densities were highest and live densities lowest, in the glucose addition treatment. Iron addition lowered porewater sulfide levels, but did not significantly affect short-shoot survival. Etiological studies of a die-back episode suggest that elevated porewater sulfide and rhizome ethanol concentrations precede the appearance of necrotic *Labyrinthula* lesions on *Thalassia* leaf blades by two months. A conceptual model of interacting causes of seagrass mortality suggests that (1) environmental stresses weaken *Thalassia* and make it vulnerable to infection, and (2) the proximal cause of death is probably by the pathogenic slime mold *Labyrinthula*.

1989 - 1990

Fourqurean, J. W., R. D. Jones, and J. C. Zieman (1993) Processes influencing water column nutrient characteristics and phosphorus limitation of phytoplankton biomass in Florida Bay, FL, USA: interferences from spatial distributions. Est. Coastal Shelf Sci., 36(3):295-314.

The concentrations of nutrients, dissolved and particulate organic matter, salinity and chlorophyll-*a* in the water column were measured over the period of June 1989 to August 1990 at a network of 26 sampling locations across Florida Bay. Florida Bay was hypersaline during this time period, with an average salinity of 41.4 °/oo. Dissolved organic phosphorus was the dominant form of P in the water column, while soluble reactive P was generally less than 5% of the total P. Organic nitrogen forms dominated the N pool, and NH_4^+ was the dominant form of dissolved inorganic nitrogen. Many of the measured parameters were correlated. Principal Components Analysis extracted three composite variables that described 90.3% of the variation in the original data set. PC_I was highly correlated with total organic N, total N, total organic C and salinity. PC_{II} was correlated with all measures of P and chlorophyll-*a*. PC_{III} was correlated with measures of inorganic N. The spatial distribution of factor scores for these principal components indicates three processes acting independently to control the composition of the water column of Florida Bay: the evaporation-driven concentration of dissolved material in Florida Bay, the delivery of P to the Bay through water exchange with the Gulf of Mexico; and the delivery of freshwater with an excess of N with respect to P to the Bay. The phytoplankton biomass in the water column of Florida Bay was shown to be P-limited.

1989 - 1990

Ley, J. A., C. L. Montague, and C. C. McIvor (1994) Food habits of mangrove fishes: a comparison along estuarine gradients in northeastern Florida Bay. Bull. Mar. Sci., 54(3):881-99.

Gut analyses were performed on 1,081 fishes from four species resident in mangrove habitats in northeastern Florida Bay to determine: (1) if the diets varied systematically along complex salinity gradient; and (2) if diets in the upstream areas were of lower overall quality than those from portions of the gradient with less salinity variability. Fishes commonly consumed amphipods, isopods, shrimp, nematodes, eggs of unknown origin, fish, insects, and algae. Diets of two of the four species differed significantly along the estuarine gradient. This systematic variation in diet along the longitudinal gradient may distinguish locations in terms habitat quality. The tidewater mojarra (*Eucinostomus harengulus*) and goldspotted killifish (*Floridichthys carpio*) ingested more algae, a relatively low quality food, upstream in areas of high salinity variability. These same species ingested more benthic invertebrates, relatively high quality foods, downstream in areas of lesser salinity variability. If the premise that gut contents of fishes are a good indicator of habitat quality is accepted, then these upstream locations afford fishes a relatively poor quality habitat. It is proposed that highly variable amounts of submerged aquatic vegetation in upstream locations provide reduced and variable abundances of benthic invertebrates for fishes at these sites. Our results, combined with those of others cited herein, provide support for the hypothesis that water management practices in the catchment of northeastern Florida Bay may be, at least in part, responsible for lowered productivity there. We suggest that gut contents of resident fishes can be used as one measure of habitat quality as part of a comprehensive monitoring and restoration program for the region. Sampling took place in two upstream locations, Joe Bay and Highway Creek; two midstream locations, Trout Cove and Little Blackwater Sound; and two downstream locations, Buttonwood Sound and Blackwater Sound, from 1989 to 1990. In addition to the two species mentioned above, gulf killifish (*Fundulus grandis*) and redfin needlefish (*Strongylura notata*) were also collected.

1989 - 1990, 1992

Carlson, P. R., L. A. Yarbro, and T. R. Barber (1994) Relationship of sediment sulfide to mortality of *Thalassia testudinum* in Florida Bay. Bull. Mar. Sci., 54(3):733-46.

Sediment porewater sulfide concentrations in Florida Bay seagrass beds affected by the catastrophic mortality of *Thalassia testudinum* (turtlegrass) were considerably higher than those of seagrass beds in the Indian River, Charlotte Harbor, or Tampa Bay. Sulfide concentrations in apparently healthy seagrass beds were highest in fall and might have contributed to chronic hypoxic stress of *Thalassia* roots and rhizomes. High porewater sulfide concentrations measured in dying areas of seagrass beds suggest that sulfide produced by microbial degradation of dying *Thalassia* might exacerbate stress on adjacent, surviving seagrass. Sulfide concentrations in recent die-off areas initially were higher than in adjacent, surviving grass beds. By the end of the study, however, the pattern was reversed apparently due to depletion of *Thalassia*-derived organic matter in the sediments of die-off areas. In June 1990 high sulfide concentrations preceded a die-off episode at one site, suggesting (1) elevated sulfide concentrations might be involved in a suite of factors that trigger die-off episodes or (2) elevated porewater sulfide results from death and decomposition of below ground *Thalassia* tissue before necrosis of shoots becomes visible. In either case, elevated porewater sulfide concentrations might be of value in predicting die-off. We conclude that porewater sulfide probably is not the primary cause, but a synergistic stressor, which has acted in concert with factors (such as hyperthermia, hypersalinity, and microbial pathogens) suggested by other researchers, to cause *Thalassia* die-off in

Florida Bay. Sites in Johnson Key Basin, Rabbit Key Basin, Rankin Lake and Sunset Cove were sampled in 1989, 1990 and 1992.

1989 - 1991

Wang, J. D., J. van de Kreeke, N. Krishnan, and D. Smith (1994) Wind and tide response in Florida Bay. Bull. Mar. Sci., 54(3):579-601.

Florida Bay is a shallow estuarine environment located between the Everglades freshwater wetlands and a chain of islands called the Florida Keys. The assimilation, transformation and transport of biogeochemical elements in the Bay are important in influencing the health of the regional ecosystem. This system includes extensive live coral reefs seaward of the Keys, the only such reefs in the continental US. Distinct compartmentalisation by partially submerged banks and multiple islands cause extraordinary damping of diurnal and semidiurnal tides within the Bay. The reduced circulation has resulted in partial isolation of water masses in subregions and strong gradients in salinity. We have collected and analyzed wind data from Miami Airport, Key West, Flamingo, and a CMAN station at Molasses Reef for 1989-1991. Although, seasonal variations and sea-breeze effects are more pronounced in the mainland stations, spatial coherence is high throughout. Correlation of water surface fluctuations with wind observations are used to determine the wind-forced dynamic response and water exchange. The main responses are distributed within three period bands: diurnal and semidiurnal tides, 3 - 5 d-period wind forcing, and long period (about 14.7 d) astronomical tides. Numerical model simulation shows that tides are strongly influenced by a combination of bottom friction and obstruction to flow from chained islands and submerged banks. The damping of the progressive tidal wave is the source of a mean sealevel rise of approximately 0.01-0.02 m within the Bay. A large part of the wind response is due to remote forcing and results in long wave surges in the Bay. Model results also indicate a net southward exchange between the bay and the Atlantic Ocean driven by the elevated mean sealevel inside the bay. This net southward exchange is supported by results of previous field measurements.

1990 ◊

Bosence, D. W. J. (1990) Biodetrital mud mounds of Florida Bay. Proc., 13th International Sedimentological Congress. University London, London, UK. August 28-31, 1990. 13:55-6.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] During the last five years a new sedimentary model for the mud-mounds of Florida Bay has been proposed. Early work suggested that the banks were biogenic mound-like structures formed from the trapping and binding of locally produced (mainly algal) aragonitic mud. Recent work shows that the mixed carbonate mineralogy mound sediments are generated from the range of shelly biotas within the bay and that production rates exceed sediment accumulation rates. Sediment generated within the Bay is transported, as both suspended and bed-load, largely by northeast wind-driven currents, towards the Gulf of Mexico to the southwest. Mounds in the center of the bay are characterized by southwest progradation geometries and physical erosional and depositional structures. Large mounds at the mouth of the bay have progradational and agradational sequences and result from amalgamation of former southwest prograding mounds. These mounds therefore serve as excellent models of mud mounds formed of biodetrital mud which is physically deposited, in contrast to recently interpreted Paleozoic microbial mud-mounds. A detailed study based on 90 cores illustrates the geometrics, facies and muds of central Florida Bay mounds. Leeward dipping wedges of the following facies were found: basal mollusk, intraclast wacke - packstone, mollusk, foram mudstone, mollusk, foram wacke-packstone, foram, mollusk pack - grainstone, Peloid, mollusk wacke-packstone. Muds form 10% of windward facies and 40% of leeward facies and are predominantly silt-sized (4 - 7 ϕ) aragonitic and high magnesian calcite grains. SEM examination of muds of this modal size indicated skeletal fragments of mollusks and forams. Grains >10 ϕ have plate, bun and prismatic shapes consistent with a mixed skeletal origin. Strontium vs. aragonite values do not vary with different mud sizes, and, together with SEM evidence, indicate mud generation through local breakdown of available shelly faunas. Three end member sources for the muds are suggested: high aragonite- low strontium mollusks, low aragonite- low strontium; forams, *Thalassia* epibionts and lithoclasts, and high aragonite-high strontium green algae. Surface sediments and thin sections indicate that deposition is often in the form of mm sized fecal pellets. These biodetrital mud-mounds are therefore characterized by progradational geometries, physical erosional and depositional sedimentary structures, associated facies with coarser biogenic textures, silt-sized skeletal mud of mixed mineralogy and geochemistry and an absence of microbial textures and structures.

1990 ◊

Bosence, D., and D. Waltham (1990) Computer modeling of the internal architecture of carbonate platforms. Geology, 18:26-30.

[NO COPY OF PAPER AVAILABLE. ABSTRACT FROM SCHMIDT (1991).] A numerical computer model is described that calculates the internal architecture of carbonate platforms in response to varying values of carbonate production, subaerial and submarine erosion, sediment redeposition, and sea-level changes. The computer-generated sections closely resemble large-scale outcrops and interpreted seismic profiles through carbonate platforms. Stillstand and transgressive sequences have prograding and downlapping platform geometries with lagoons developing in transgressive systems. Regressive sequences have downlapping clinoforms and erosional upper surfaces. Carbonate erosion rates are varied and have an important effect on the morphology of floodback surfaces. Data for lagoonal and back-reef production rates are taken from Bosence (1989). The computer program gives a visual picture of the quantitative effects of the many parameters controlling carbonate geometrices, and it aids quantitative analysis of the architectures and time scales of ancient outcrop or seismic sequences.

1990 ◊

Rude, P. D., and R. C. Aller (1990) Fluorine and strontium mobility during carbonate mineral diagenesis. EOS, Transactions, 71(43):1421.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The F content of biogenic marine carbonates varies with mineralogy (calcite: 20 - 1200 ppm; aragonite: 650 - 1600 ppm), positively correlates with the Mg content of calcite, and occurs in similar abundance to Sr (high-Mg calcite F/Sr = 2.4 mol mol^{-1}; aragonite: 0.53 - 0.79; low-Mg calcite: 0.22). Models of pore water over the upper 0 - 15 cm of sediment in the shallow water carbonate muds of Florida Bay give fluxes of Ca^{2+}, Sr^{2+} and F^- out of the sediment due to carbonate dissolution which should produce measurable compositional changes to the deposit. The flux ratio of F/Sr (0.71 mol mol^{-1}) is consistent with a biogenic carbonate source but the F/Ca and Sr/Ca are 3-10% that of the bulk sources. Selective dissolution of a high F and Sr content phase or concurrent dissolution and precipitation of phases with different F and Sr contents are possible explanations for this discrepancy. The sediment deposit is ~50% aragonite, ~40% high-Mg calcite and ~10% low-Mg calcite. The sediment F/Ca and Sr/Ca are lower than that of the source material, and this difference could be produced in a few tens of years by the preferential loss of F and Sr predicted by pore water distribution-derived fluxes. These measurements demonstrate that significant mineralogical diagenesis occurs on rapid time scales in nearshore carbonate sediment and that F is probably extremely mobile in other carbonate environments undergoing diagenetic alteration on short and longer time scales. Although phosphatic phases and fluorite may play a role in controlling F behavior in various cases, carbonate mineral diagenesis is likely to have a major influence.

1990

Schmidt, T. W., and M. B. Robblee (1994) Causes of fish kills in the Flamingo area of Everglades National Park. Bull. Mar. Sci., 54(3):1083.

[ABSTRACT ONLY.] During the summer/fall period of 1990, three large fish kills occurred in the Snake Bight area, east of Flamingo in north central Florida Bay. These events caused public concern which prompted the Park to initiate a study to determine if fish kills occurred as a result of stressful environmental conditions or in response to anthropogenic contaminants. In December funding was obtained to begin a study. The objectives of the study were to: (1) gather and summarize historical data on fish kills in park coastal waters; (2) establish a continuous water quality monitoring platform in Snake Bight; and (3) survey fish associated with a fish kill for potential anthropogenic contaminants. Based on summaries of historical park fish kill events, it was found that 38 kills have occurred since 1944; seven took place during the passage of south Florida cold fronts while the remaining 31 occurred between March and November and appear to have resulted from hypoxic conditions due to local environmental extremes. Nearly half of the kills took place in the waters of either Florida or Whitewater Bays; 24% occurred east of Flamingo in Snake Bight. Over half of the Snake Bight kills were considered severe (1,000 to 100,000 fish reported as dead); most took place over the past 15 yrs. Snake Bight is an area characterized by extreme environmental conditions (i.e., severe seagrass die-off, poor water quality, elevated salinities, and hypoxia due to restricted tidal circulation and very shallow water), and relatively frequent fish kills. Presumably, fish kills result from significant drops in water temperature or by stress related hypoxia associated with these extreme environmental conditions. To date no substantive information is available to suggest that fish kills are caused by the disposal of pollutants in the Everglades National Park. It is possible that the effects of severe seagrass die-off east of Flamingo contributed to the three fish kills reported in Snake Bight during the summer-fall period of 1990. However, the causal factors involved in seasonal fish kills are unknown. To answer these questions, we need to continue collecting fish kill information, improve this documentation, monitor water quality data in relation to environmental conditions associated with a fish kill and, when necessary, analyze fish for potential contaminants.

1990, 1993

Schmidt, T. W. (1993) Report on fish kill investigations in the Flamingo area of the Everglades National Park. South Florida Research Center, Everglades National Park, Homestead, FL. December 1993.

During the late summer-early fall period of 1993, three fish kill events were documented in the Snake Bight area, east of Flamingo The most extensive kill in terms of size occurred in Garfield Bight in late august where the total numbers of dead fish were estimated between 5,450 to 7,150 and were observed over 1-mile of shoreline. The largest in terms of area (over 3 miles of shoreline affected), *but not in* mortality occurred in northwest Snake Bight during late September where the range of total numbers of fish killed was 3,300 to 5,400. The smallest in area and in fish mortality occurred in the Buttonwood Canal/Coot Bay boat ramp area of Flamingo during late October where a total kill was estimated between 950 and 1,100 fish. These fish kill events affected a variety of temperate and subtemperate species. These shallow coastal zone inhabitants were mostly bottom and near bottom feeders such as adult and sub-adult sized black and read drum, catfish, mullet, and spotted seatrout. They were the predominant native species affected while juvenile Mayan cichlids were the predominant non-native species involved. A combination. of physical conditions produced the extensive fish mortality observed in the study areas: (1) air and water temperatures maximas in late August were very high; (2) dissolved oxygen concentrations on August 23 experienced a rapid decline with a dissolved oxygen minima approaching short-lived hypoxia/anoxia, whereas persistent, long-lived hypoxic/anoxic conditions were observed in the Buttonwood Canal areas; and (3) large charges in the spring-neap lunar tidal cycle, the seasonal oceanic water level cycle and poor water circulation. Higher than average tides associated with higher than normal water levels, particularly in Snake Bight, may have permitted greater access to the shallowest inlets along the mainland. Subsequently, when the warmest waters were unable to provide sufficient oxygen (e.g., Garfield Bight), a shallow water "refuge-death trap" phenomenon occurred. It is believed that this is the first time that hypoxic conditions have been documented during a Park marine fish kill event. In 1990, three fish kills occurred at the same time in both the Snake Bight and Garfield Bight areas east of Flamingo. They were described as having the same general pattern as noted in 1993 kills except that a larger number of fish may have died. No water quality measurements were made during the 1990 die-off. However, because the similarities involved, it is quite possible that the kills in earlier years were also caused by oxygen depletion. Peak periods of annual fish kills in the southeastern United States usually occur during mid-summer to early fall. These fish kills may result from stress related hypoxia (dissolved oxygen values <5.0 ppm) associated with high air/water temperatures, large rainfall events, extreme low water and or a combination of these factors. It is this time of the year dissolved oxygen concentrations in estuarine and coastal marine waters are experiencing their lowest levels of the year. Although findings have been significant with respect to the cause of the fish kills in the Flamingo area, they have also highlighted the complex and difficult nature of the Florida Bay ecosystem. It is not yet known what, precisely, from a myriad of sources contribute to hypoxia/anoxia in the Snake Bight area. It may represent a natural phenomenon with which the fishes are in a delicate balance. It should be noted that stresses associated with eutrophication could affect the oxygen budget as well as decomposition of organic material (e. g. seagrass die-off), and nutrient over-enrichment could result in hypoxic conditions.

1990 ◊

Textoris, S. D. (1990) Patch reefs in the Pleistocene of South Florida and their implications. The Compass, 67(2):115.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The Pleistocene underlies much of the southern tip of the Florida mainland and extends southward through the Keys and beneath Florida Bay. Five units, designated Q1 through Q5 (oldest to youngest), are separated unconformably by freshwater limestones and supposed subaerial(?) crusts. The upper part of the sequence (Q4 and Q5) consists of the Miami Limestone for which three facies are recognized, coral, 'bryozoan', and oolite, each the result of a different environment — shelf-edge, quiet protected back—reef, and shallow agitated marine. The lower part of the section, tentatively correlated with the Fort Thompson Formation, consists of quartzose sandstone (Q1 and Q2) followed by carbonate deposition (Q2 and Q3) as the source of clastics diminished and the water became shallower. The reef of the Key Largo Limestone (in part the coral facies of the Miami Limestone) began growing along the shelf edge in its present position in Q3 time contemporaneously with the development of patch reefs in the Bay area. At least three patch reefs are known and have been outlined by diamond-drill 11 coring and another is suspected in the backreef area. The presence of a configuration similar to present-day conditions supports the supposition that the Keys formed in part as a barrier reef during the late Pleistocene. Termination of the reef growth occurred when they either were smothered by the colite or exposed subaerially with the withdrawal of the sea from the area.

1990 ◊

Walter, L. M., W. P. Patterson, and K. Muehlenbachs (1990) Variation in carbon isotopic composition of surface seawater on tropical carbonate platforms; Florida Bay and Atlantic reef tract, Florida. EOS, Transactions, 71(43):1390.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Although fluctuations in the C isotopic compositions of ancient shallow marine carbonates are used in constructing geochemical cycling models, relatively little is known of C isotopic variation in waters associated with modern carbonate platforms. Investigation of C isotopic composition along with other chemical parameters (Cl, alkalinity, TIC, Ca) of surface seawaters overlying shallow platforms of the Florida Keys revealed significant spatial variability. Carbon isotopic compositions of the least chemically evolved waters sampled seaward of the reef tract were about +1.8 ‰ PDB, slightly lighter than values for Atlantic surface waters. C isotopic compositions decreased by up to 1.5 ‰ in more restricted waters (salinity of about 38 ‰) of the inner shelf. In even more restricted waters of Florida Bay, where salinities increased up to 60 ‰, depletions in alkalinity and Ca were more severe, and C isotopic values decreased to values as low as -4 ‰. Although associated with changes in water chemistry driven by $CaCO_3$ precipitation, the magnitude of isotopic variations (nearly 6 ‰) is inconsistent with fractionation during precipitation. Instead, we attribute the isotopic variations to recycling of isotopically light organic C from sediment pore waters which would have greatest impact on surface waters with longer residence times. Less detailed C isotopic data on sediment samples show that those from Florida Bay are about 1.5 ‰ lighter than those of the inner reef tract. Thus, isotopic differences in the waters are long-lived and reflected in the sediment record over the last several 1000 yrs.

1990 - 1991

Peters, D. S., L. Settle, J. Burke, and E. Laban (1994) Comparative utilization of Florida Bay as a nursery area by juvenile grunts. Bull. Mar. Sci., 54(3):1082.

Seven trawl surveys of Florida Bay, Everglades National Park, were conducted between June 1990 and October 1991, in order to describe spawning times, size at recruitment to the bay, relative abundance, and distribution and growth rate of juvenile grunts. Species present in decreasing order of abundance, were white grunt, blue striped grunt, pigfish, sailors choice and French grunt. The northern and western regions of the Bay, with high turbidity and dense grassbeds, were the only regions used by pigfish and contained the highest density of white grunt. Sailors choice and blue striped grunt were present in all areas though more common in the east. Pigfish (as small as 15 mm and 50 days old) recruited to the nursery area in March, grew more rapidly than other species (0.76 mm day^{-1}) and by winter were either gone or no longer available to our gear. Blue striped grunt were spawned throughout the year with a peak from February through April, recruited to the Bay at approximately 30 mm SL and 70 days old, grew 0.46 mm SL day^{-1} and remained in the bay up to a year. White grunt, the product of spring (May - June) and fall (September November) spawnings, recruited to the western bay at about 20 mm SL and 50 days old and central bay at about 50 mm SL and 130 days old. They remained in the bay up to a year, growing on average 0.23 mm day^{-1}, however, those in the turbid west grew much faster than those in the clearer central region.

1990 - 1991

Schirripa, M. J., and C. P. Goodyear (1994) Simulation modeling of conservation standards for spotted seatrout (*Cynoscion nebulosus*) in Everglades National Park. Bull. Mar. Sci., 54(3):1019-35.

A stock assessment was conducted on the spotted seatrout (*Cynoscion nebulosus*) stock of Florida Bay including simulated outcomes of six possible regulatory options. Female ovarian weight (g) was regressed on total length (in) (ovarian weight = 9.62E x 10^{-4} total length$^{3.542661}$; r = 0.78). Annual estimates of fishing mortality (F) for fully recruited fish (age 4-8) ranged from F = 0.28 in 1981 to F = 0.91 in 1974 with an overall average of F = 0.54. Annual estimates of spawning potential ratio ranged from a low of 28% in 1974 to a high of 35% in 1981. Yield-per-recruit analysis suggests that with 10% release mortality the fishery is now operating very near the level of mortality that would produce the maximum yield-per-recruit. However, a 25% release mortality would place the fishery beyond this level. Simulations indicate that if fishing mortality continues at the estimated levels for 1990 then increasing the minimum size to 16 in. would increase yield per-recruit by 15% and increase the spawning potential ratio to 40% within 5 yrs. Spotted seatrout gonad samples were collected from Flamingo and West Lake in 1990 and 1991.

1990 - 1991

Thayer, G. W., P. L. Murphy, and M. W. LaCroix (1994) Responses of plant communities in western Florida Bay to the die-off of seagrasses. Bull. Mar. Sci., 54(3):718-26.

Seagrass habitats in western Florida Bay have been undergoing changes from monotypic *Thalassia testudinum* meadows to large landscapes of barren bottoms or to increasingly heterogeneous *Thalassia* meadows as a result of seagrass die-off patch formation. The cause of die-off is unknown but current hypotheses point to environmental stress making this seagrass susceptible to disease. The potential exists for colonization and recovery of these die-off patches but the sequence of events and the persistence of the recovery have not been evaluated. Based on an existing model that represents theoretical successional steps toward the *Thalassia* climax, four habitat types were sampled in each of two basins of western Florida Bay. Data demonstrated a high potential for recovery of the denuded die-off patches. The alga *Batophora oerstedii* is the first colonizer with replacement by other algal species and subsequently *Halodule wrightii* and eventually *Thalassia*. Under the existing conditions of high resuspended carbonate sediment and biological turbidity, which are thought to be secondary responses of the system to the die-off of seagrasses, persistence of the colonizing habitats and the climax community itself is tenuous. Decreases in both *Halodule* and *Thalassia* in non-dieoff areas of Johnson Key Basin between spring and fall 1991 occurred as did decreases in densities of these species in recovering patches. Subsequent visits in 1993 revealed that the sample sites were devoid of seagrasses. Plant densities were determined in Johnson Key Basin and Rabbit Key Basin during 1990 and 1991.

1990 - 1992

Sheridan, P. F. (1994) Community response to seagrass die-off in Florida Bay I. Shallow banks. Bull. Mar. Sci., 54(3):1083.

Drop sampling in 1990 - 1992 compared fishes and decapods in healthy *Thalassia*, open water caused by die-off, and algal and *Halodule* regrowth. In waters <1 m depth, fishes were dominated by *Lucania* in *Thalassia* and by *Floridichthys* elsewhere. Decapods were dominated by *Thor* in *Thalassia* and by a mixture of *Thor, Penaeus* and *Pagurus* elsewhere. Fish and decapod densities were usually highest in *Thalassia*, lowest in open water, and intermediate in *Halodule* and algae. Fish and decapod species diversities were usually higher in disturbed habitats. These distributions may be affected by behavior, feeding or predation. Laboratory experiments with *Lucania* and *Cyprinodon* (a congener of *Floridichthys*) indicated that single species distributions may be altered when schools of different species interact. Infaunal communities were altered as well. Predatory *Opsanus* consumed more *Lucania* in disturbed habitats than in healthy *Thalassia.*

1991 ◊

Andrews, J. E. (1991) Geochemical indicators of depositional and early diagenetic facies in Holocene carbonate muds, and their preservation potential during stabilization. Chem. Geol., 93(3-4):267-89.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Holocene carbonate muds (<63-μm fraction) and macro-organic matter were collected from marine subtidal mudbanks and supralittoral mud islands of Florida Bay, and freshwater marshes of the Everglades. Geochemistry, sedimentology and mineralogy were used to determine whether carbonate mud formation in specific marine and freshwater environments was geochemically distinct and to assess the importance of early diagenetic reactions on mud chemistry and mineralogy. Significant variations were found in the relative amounts of carbonate minerals, not just between the marine and freshwater environments, but also within Florida Bay. In particular, Mg-calcite is enriched in Crane Key muds by ~10% relative to nearby Cross Bank. The Mg-calcite appears to precipitate in the surface-living cyanobacterial mats of the key and seems to be linked to Mg chelation by the cyanobacterial organic matter. This Mg-calcite has a distinct $\delta^{13}C$ around -4 ‰, 6 ‰ lighter than Mg-calcite derived from *Thalassia* epibionts in the Cross Bank muds. Dolomite was found just below the cyanobacterial mats forming in the only part of the core where reactive organic carbon has been completely removed by sulfate-reducing bacteria. The $\delta^{13}C$ values of this dolomite (at least -4 ‰) are consistent with previously published $\delta^{13}C$ values of dissolved inorganic carbon in pore waters at this horizon which support dolomite formation in situ. Mg supply for dolomite formation may be from dissolution of the overlying cyanobacterial mat Mg-calcite. The various types of organic matter have distinctive $\delta^{13}C$-values ranging from ~ -25 ‰ (mangrove and sawgrass) to ~ -10 ‰ (cyanobacterial mats) and -8 ‰ (*Thalassia* seagrass). Values intermediate between these end-members record mixing of the organic matter types which shows particularly the time when the bank muds became dominated by *Thalassia* organic matter, i.e. were relatively removed from mangrove vegetation. Five Holocene mud suites (bank, key, cyanobacterial mats, mangrove swamp, and freshwater Everglades swamp) show distinct chemical signatures in their mean $\delta^{13}C$, $\delta^{18}O$, $MgCO_3$ and Sr values. Sodium distinguishes between seawater and non-seawater influenced environments but Fe, Mn and P are mainly controlled by non-carbonate materials. Comparison with published stable isotope and elemental data for Pleistocene limestones in the South Florida area suggests that only the facies diagnostic signatures of $\delta^{13}C$ and Mg will be resolvable once the muds have been stabilized to micrite. Alteration of the $\delta^{18}O$ and Sr values during stabilization will probably be more severe to the extent that original facies variations are destroyed.

1991 ◊

Fourqurean, J. W., and J. C. Zieman (1991) Photosynthesis, respiration and whole plant carbon budget of the seagrass *Thalassia testudinum*. Mar. Ecol. Prog. Ser., 69:161-70.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The photosynthesis versus irradiance (P/I) response of the seagrass *Thalassia testudinum* from Florida Bay was measured using the oxygen evolution of intact short shoots enclosed in sealed chambers, and found to have a light-saturated P/I behavior. All plants for this study were collected near Crane and Panhandle Keys and shipped to Charleston, VA. All four of the commonly used mathematical formulations of the P/I curve were of equal utility in describing the data. When fit to the data using a least-squares fitting procedure, they produced nearly identical lines explaining 90% of the variance in the data. The estimates of the P/I model parameters α and P_{max} produced by the four different formulations varied widely, however, so parameter values generated using one model cannot be used in other models. Green photosynthetic leaves accounted for only 15.0% of the total biomass of Florida Bay *T. testudinum.* The remaining 85% was apportioned into below ground short shoots, rhizomes and roots. Leaves had higher respiration rates (7.4 μg O^2 g^{-1} min^{-1}) than the below ground structures (0.9 to 4.6 μg O^2 g^{-1} min^{-1}), and accounted for 42.6% of total plant respiration. The P/I curve and respiration data were used to build a daily carbon budget for Florida Bay *T. testudinum.* Estimated carbon fixation rates agreed closely with previously collected field ^{14}C uptake measurements. Under average summer light conditions, the budget was positive as deep as 4 m, suggesting that plants can survive at this depth. H_{sat} was 0 h at depths greater than 3 m, however.

1991 ◊

Lidz, B. H., and E. A. Shinn (1991) Paleoshorelines, reefs, and a rising sea: South Florida, USA. J. Coastal Res., 7(1):203-29.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The porous limestone bedrock, thin sediment cover, and tectonic stability of the Florida Platform during the post 15 ka BP provide an exceptionally suitable setting for reconstruction of paleoshorelines and onshore projection of future shorelines in a rising-sea scenario. Paleoshorelines for 8, 6, 4 and 2 ka BP show that: (1) a series of limestone islands formed, then drowned, along the outer platform; (2) a distinct trough, called Hawk Channel, separated the outer islands from shore; (3) the lower Keys flooded earlier and more rapidly than the rest of the Keys; and (4) Florida Bay and tidal passes through the middle Keys into the Bay developed within the past 4 ka BP. During the Quaternary, topographic highs were preferential sites for coral growth. Bathed by clear oceanic waters, reefs near the platform flourished. As sea level rose, reefs developed on the platform margin and were gradually displaced to more shoreward bedrock highs. Upon platform flooding, water quality deteriorated and reef luxuriance diminished. Projection of future shorelines onto land shows that most land forming the Florida Keys would flood in a rise of 1 to 2 m and that a rise of little more than 5 m would submerge all land. Offshore reefs would die, while nearshore reefs would shift landward as the mainland shoreline migrated northward. Onshore topographic highs would become numerous small islands as the Keys flooded, until all drowned. The submerged highs would then become preferred sites for coral growth, until water quality and depth exceeded the optimum for survival.

1991 ◊

Reynolds, J. E., and D. K. Odell (1991) Manatees and Dugongs. Facts on File, NY. 192 pp.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] This book contains chapters on the evolution of manatees and dugongs, and the species found in Florida, the Antilles, West Africa and the Amazon. The chapter on the Florida manatee contains descriptions of the anatomy, senses, and behavior of this species in Florida waters.

1991 ◊

Rude, P. D. (1991) On the marine geochemistry of fluorine. Ph. D. Dissertation. State University of New York, Stony Brook, NY. 206 pp.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Dissolved fluoride concentrations in marine sediment pore water often differ from those found in overlying seawater. The common explanation for these differences has been reactions of F-bearing phosphatic phases. Fluoride concentrations during diagenesis could vary due to reactions involving other F-bearing phases. The purpose of this dissertation was to examine the behavior of F during other mineral reactions in the sea. The involvement of F in carbonate and alumino-silicate mineral reactions during sediment early diagenesis are examined as is the effect of MgF^+ ion pair formation on F^- adsorption. The approach was to combine field sampling, manipulative laboratory experiments, and diagenetic modeling. Models of pore water solute distributions, direct solute flux measurements, and reaction rate estimates from carbonate sediment of Florida Bay predict net F^-, Sr^{2+}, and Ca^{2+} fluxes out of the sediment. The net flux ratio of F/Sr is consistent with dissolution of aragonite or high-Mg calcite, but F/Ca and Sr/Ca are 3 - 10 times that of biogenic carbonate sources. Concurrent dissolution and reprecipitation of phases with different F and Sr contents accounts for this discrepancy. These fluxes could cause significant mineralogical and chemical changes on rapid time scales in carbonate sediment. The speciation of F^- in seawater is dominated by the free ion (51%) and the MgF^+ ion pair (47%). Experiments with hydrous oxides demonstrate that F^- adsorption in seawater is predominantly reversible and directly linked to the formation of MgF^+ in solution and co-adsorption of Mg^{2+} and F^- at particle surfaces. MgF^+ formation in seawater and its influence on F^- adsorption has important implications for the mobility and distribution of F^- in the sea. Tremendous dissolved F^- uptake by Amazon continental shelf sediment during early diagenesis occurs. The majority of this uptake (~7% of the previously defined global ocean sinks) is due to alteration of detrital alumino-silicates or authigenic alumino-silicate formation. If Amazon sediment is representative of all tropical river sediment, then F uptake by such reactions would equal ~40% of the previously defined global F sinks and be the most important mechanism of fluoride removal in the sea.

1991 - 1992

Butler, M. J., W. F. Herrnkind, and J. H. Hunt (1994) Sponge mass mortality and Hurricane Andrew: catastrophe for juvenile spiny lobsters in south Florida?. Bull. Mar. Sci., 54(3):1073.

[ABSTRACT ONLY.] The hardbottom communities of Florida Bay and Biscayne Bay are dominated by sponges, macroalgae, and octocorals, and are prime settlement and juvenile nursery habitat for south Florida's spiny lobster (*Panulirus argus*) population. We have been studying spiny lobster recruitment in south Florida for nearly a decade and, in 1991—1992, our ongoing field investigations provided us the opportunity to quantitatively assess the impact of two large-scale disturbances on hardbottom community structure and, consequently, juvenile spiny lobster population dynamics. From November 1991 - January 1992, a massive sponge die-off occurred in south-central Florida Bay following an episodic phytoplankton bloom thought to have resulted from the nutrient flux emanating from a seagrass die-off event. Nearly every species of sponge was impacted and over 90% of the sponges were dead or damaged in many areas. Sponges are the primary shelter for juvenile spiny lobsters and their loss precipitated dramatic shifts in lobster shelter use and abundance. Hurricane Andrew slammed into south Florida the following September and passed directly over Biscayne Bay, where we had completed surveys of juvenile spiny lobster abundance and hardbottom habitat structure only a month before. We are resurveying those sites to determine the effect of the storm on hardbottom community structure and the juvenile spiny lobster abundance and distribution. These two massive, but dissimilar disturbances have potentially important consequences for south Florida's hardbottom habitat and the juvenile spiny lobsters that reside there.

1991 - 1992

Childress, M. J., and W. F. Herrnkind (1994) The behavior of juvenile Caribbean spiny lobster in Florida Bay: seasonality, ontogeny and sociality. Bull. Mar. Sci., 54(3):819-27.

Laboratory experiments and field manipulations were conducted to evaluate the extent to which ontogenetic and certain environmental conditions interact to alter the behavior of juvenile Caribbean spiny lobsters following settlement. In addition we evaluated whether articular behavioral changes could increase a juvenile's chance of survival. We tested the effects of time of day, season, developmental stage and the presence of conspecifics on the activity state and sheltering behavior of lobsters. We also estimated relative predation rates by tethering lobsters under five types of shelter during summer and late fall. Algal phase lobsters (8 - 12 mm CL) were more active at night, and foraged more and walked less in summer than in the late fall. Post-algal phase lobsters (24 - 28 mm CL) were more active when in the presence of conspecifics. Predation rates in all seasons were highest for lobsters without cover and lowest while in algal cover. The proportion of algal juveniles found walking during their active period changed with the seasons and significantly fewer individuals foraged in late fall than in summer. Variation in the behavior of post-algal lobsters may reflect the niche shift from full-time algal dwelling to diurnal crevice sheltering yet the difference in predation risk between algal sheltering and crevice sheltering is not sufficient to explain the size at which this transition should occur. Shifting from algae to crevices could potentially produce a population bottleneck for lobsters in areas devoid of appropriate structure. This may be especially important for evaluating the impact of recent widespread shelter loss by sponge die-off in the Florida Bay lobster nursery. The lobsters used for this study were collected in Fiesta Key, Conch Key, and Long Key.

1991 - 1992

Frankovich, T. A., and J. C. Zieman (1994) Total epiphyte carbonate production on *Thalassia testudinum* across Florida Bay. Bull. Mar. Sci., 54(3):679-95.

Previous investigations of epiphytic carbonate production have suggested that seagrass epiphytes are significant producers of calcium carbonate and may be a primary source of lime muds in Florida Bay. This study determined total epiphyte and epiphytic carbonate standing stocks and calculated minimum estimates of yearly production at seven sites within Florida Bay and one site oceanside of the northern Florida Keys. These sites span a larger geographical area of increased environmental variability than those of previous Florida Bay epiphyte studies which were conducted in areas where conditions are considered favorable for epiphyte production. Total epiphyte and epiphytic carbonate loads along with seagrass shoot density and productivity were measured during four periods between August 1991 and August 1992. Epiphyte composition, standing stock, and production all exhibited marked variation across Florida Bay. Calcifying epiphytes were dominant in Florida Bay, and their distribution and the distribution of epiphyte production appear to reflect differences in the physical characteristics of salinity and the variability thereof. Minimum estimates of annual epiphytic carbonate production range from 1.9 g $CaC0_3$ m^{-2} yr^{-1} to 282.7 g $CaC0_3$ m^{-2} yr^{-1}, a range lower than previous estimates. The differences between these estimates and previous ones are attributed to differences in environments and, to a lesser extent, differences in methodology.

1992 ◊

Barber, T. R. (1992) Biogeochemistry of light hydrocarbons in South Florida wetlands. Ph. D. Dissertation. University of South Florida, St. Petersburg, FL. 166 pp.

[NO COPY OF PAPER AVAILABLE.]

1992 ◊

Cubit, J. D. (1992) Global climate change and the importance of tidal flat ecosystems in the Caribbean and Gulf of Mexico. Abs. 1992 Symp. on Florida Keys Regional Ecosystem, November 16 - 20, Miami, FL.

[ABSTRACT ONLY, DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Algae, corals, seagrasses and other living organisms actively construct and maintain extensive tidal flat structures in the Gulf of Mexico and Caribbean. The various types of tidal flats, including reef flats, algal flats, and seagrass flats, are important economically and ecologically. They rank among the world's most productive ecosystems and export much of their organic material to adjacent ecosystems. These biogenic structures of carbonate rock and consolidated sediment, covered by meadows of plants and sessile animals, function as foraging grounds, nursery areas, natural breakwaters and shoreline reinforcements. Models of global climate change predict considerable changes for coastal environments of the Gulf and Caribbean, including rises in sea level, increases of water temperature, and more frequent hurricanes. Physical and geographic features of the Florida Bay and the Keys, such as the narrow tidal range and location in the "hurricane belt," would make this region particularly sensitive to the effects of global climate change. Long term, integrated monitoring of natural variations of the physical environment and populations of algae, seagrasses, corals, and other reef flat biota on the Caribbean coast of Panama demonstrate that changes in sea level and sea temperature can affect the distribution and abundance of these organisms, but the tidal flat communities as a whole should be able to maintain vertical rates of habitat accretion in pace with predicted rises in sea level until the middle of the next century. However, studies of the effects of a major oil spill at this site illustrate that such pollution can cause longer-term damage of the groups of biota essential for building tidal flat structures. Proper management to maintain the tidal flat ecosystems in the Gulf and Caribbean, including the diverse tidal flats of Florida Bay and the Keys, could mitigate much of the potential damage expected from global climate change, including erosion of shorelines, loss of endangered species habitats, destruction of developed property and reduction of fisheries.

1992 ◊

Egglestons, D. B., and R. N. Lipcius (1992) Experimental enhancement of the Caribbean spiny lobster: a geographical comparison of the importance of settlement, habitat features, migration and predator guilds. Bull. Ecol. Soc. Amer., 73(Suppl. 2):166.

[ABSTRACT ONLY, DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Field observations quantified the abundance of juvenile and adult spiny lobsters in shelter-enhanced habitats of varying settlement strength and refuge availability. Spiny lobster abundance increased significantly over 12 months in shelter-enhanced systems in the Bahamas, but not in control sites. However, the relative abundance of lobsters between the Bahamas and a replicate experiment in Florida Bay was substantially lower due to the joint effects of refuge availability and settlement strength. Shelters located near a migration route out of a nursery habitat in the Bahamas attracted high numbers of large juvenile and adult lobsters, as well as large piscine predators (i.e., Nassau grouper). Small juvenile lobsters suffered significantly higher mortality on shelters located near the migration route versus away from it. The success of artificial shelters in enhancing lobster abundance depends not only upon settlement strength and refuge availability, but on local recruitment and movement patterns of predators.

1992

Field, J. M., and M. J. Butler (1994) The influence of temperature, salinity, and larval transport on the distribution of juvenile spiny lobster, *Panulirus argus*, in Florida Bay. Bull. Mar. Sci., 54(3):1074.

Florida Bay is the major nursery area for Florida's spiny lobster, *Panulirus argus.* It is characterized by a series of shallow hardbottom or seagrass covered basins separated by seagrass covered mud banks less than one meter in depth. Because these mud banks serve as barriers to circulation, the basins formed between the banks may experience extreme fluctuations in temperature and salinity due to reduced tidal influx and high rates of evaporation. Larval transport to areas of Florida Bay that experience these temperature/salinity fluctuations were monitored monthly (March 1992 - July 1992) using artificial benthic collectors. Diver surveys to monitor new recruits and characterize lobster habitat were also conducted at eight sites along two transects (four sites per transect) leading from the cuts between the Florida Keys and extending north and northwest to Twin Key Bank and the subsequent basin. Concurrently, postlarval *P. argus* were reared in the laboratory, in a completely crossed design, at four temperatures (18°C, 22°C, 29°C, and 33°C) and four salinities (25, 35, 45, and 50 ‰). Survival, time to metamorphosis, and growth to first stage juvenile were measured. Results from monthly benthic collector censuses suggest that postlarvae are not regularly transported beyond Twin Key Bank, however, diver surveys indicate that some recruitment does occur in the western and central position of Twin Key basin, but not in the eastern portion of the same basin. During this study, temperature and salinity readings in this basin ranged from 21°C to 32°C and 35 ‰ to 45 ‰ , respectively. Laboratory results indicate that this range of temperatures and salinities could be tolerated, however, mortality is greatest at high temperatures in conjunction with high salinities.

1992 ◊

Fourqurean, J. W. (1992) The roles of resource availability and resource competition in structuring seagrass communities of Florida Bay. Ph. D. Dissertation. University of Virginia, Charlottesville, VA. 280 pp.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] This dissertation examines the effects of the availability of light and nutrients on the structure of seagrass beds of Florida Bay. The tradeoffs made in resource acquisition strategy by the three most common seagrass species from the Bay, *Thalassia testudinum*, *Halodule wrightii*, and *Syringodium filiforme*, determined the distributions of these three species. The relative importance of the nutrients, nitrogen and phosphorus, in limiting the productivity of the seagrass-dominated Florida Bay ecosystem was also evaluated. Laboratory measures of photosynthetic and respiratory rates were made for leaves, non-photosynthetic portions of the short shoots, rhizomes and roots of all three species. A carbon budget model of the light requirements of seagrasses was developed. Observed differences in the light requirements of seagrasses were explained using this budget model. Differences in light requirements were shown to be caused by interspecies differences in apportionment of biomass into photosynthetic and non-photosynthetic structures, as well as differences in metabolic rates. Light requirements of all three species was a function of the relative apportionment of biomass to different plant tissues: the more plant biomass allocated to nutrient gathering organs, the greater the light requirement. Phosphorus availability limited the phytoplankton and seagrass productivity of Florida Bay. The main sources of P for Florida Bay was shown to be the Gulf of Mexico, while freshwater runoff from the Everglades was a source of N. The density of seagrass in Florida Bay was directly related to the concentration of P, but not N, in the sediment porewater. P availability also determined the species composition of seagrass beds. The P content of *Thalassia testudinum* leaves from Florida Bay was highly variable, and the elemental content of seagrass tissue proved to be an indicator of the availability of nutrients to seagrasses, both on local and regional scales. Changing the nutrient supply rates to seagrass beds in Florida Bay caused the species composition of the seagrass beds to shift. Both this shift, and the normal successional sequence and distributional patterns of the seagrasses of Florida Bay can be explained by different resource acquisition strategies of the seagrass species.

1992

Kramer, P. A., P. K. Swart, H. L. Vacher, and T. Juster (1994) Controls on salinity in Florida Bay islands. Bull. Mar. Sci., 54(3):1078.

[ABSTRACT ONLY.] Holocene mud islands found within Florida Bay often contain ephemeral ponds in their interior which are periodically flooded by either bay water during high tides and storms, or by meteoric water during seasonal rainfall. The salinity within these ponds, and the island sediments underlying the ponds, is thought to be controlled by the frequency and intensity of flooding, type of flooding, and intensity of evaporation. To better understand these controls, salinity was measured in ponds and in pore fluids taken from 15 islands across much of Florida Bay in February, 1992. In addition, one island, Cluett Key, was instrumented with pressure transducers to determine the frequency of tidal flooding. Although large variations in salinity exist between different islands (38 - 130 g kg^{-1}), the shape of the salinity profiles within each island was similar, often reaching a maximum between 60 and 80 cm depth from the surface. There appears to be no trend in the magnitude of an island's salinity with it's geographic location within Florida Bay, suggesting that rainfall gradients and salinity gradients within Bay waters are having little effect on an island's salinity. Based on this survey, we hypothesize that it is the flooding frequency of Bay waters over an island and thus the elevation of an island relative to Bay waters that controls the magnitude of it's salinity. Transducer data from Cluett Key support this scenario, and in fact show that the island is flooded daily by Bay waters during the highest tides of a month.

1992

Kuta, K. G., and L. L. Richardson (1994) Distribution and frequency patterns of black band disease in the northern Florida Keys. Bull. Mar. Sci., 54(3):1078.

[ABSTRACT ONLY.] Black band disease is present throughout the coral reefs of the Florida Keys. The disease consists of a population of the cyanobacterium *Phormidiurn corallyticum* and associated microbial community, and is characterized by an active season which occurs during the warmer months when water temperature is at or above 25°C. A field investigation was carried out during the 1992 active season to determine the distribution and frequency patterns of infected scleractinian coral colonies, and to support a statistical analysis of coral species which became infected. Three reefs were chosen for an in depth study - Algae Reef, Grecian Rocks, and Key Largo Dry Rocks. The reefs are patch and fringing reefs, and all are offshore from Key Largo in the Florida Keys National Marine Sanctuary. The study was carried out using both photo transects and 10 m radius quadrats (10 per site). Dispersion indices were used to determine the distribution pattern of the disease on each of the reefs. Distribution of black band occurrence was clumped. In areas of high incidence of the disease, colonies which had been infected in 1991 were observed to become reinfected in 1992. There were distinct differences in the coral species infected between the three study reefs. Most notably, on Algae Reef black band disease was absent from all *Montastrea annularis,* the coral reported to be most susceptible to black band. Infected *M. annularis* was found at both Grecian Rocks and Key Largo Dry Rocks. Also infected were colonies of M. *cavernosa, Diploria strigosa, Colpophyllia natans* and *Colpophyllia breviserialis.*

1992 ◊

Lapointe, B. E., and M. W. Clark (1992) Nutrient inputs from the watershed and coastal eutrophication in the Florida Keys. Estuares, 15(4):465-76.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Widespread use of septic tanks in the Florida Keys increase the nutrient concentrations of limestone groundwaters that discharge into shallow nearshore waters, resulting in coastal eutrophication. This study characterizes watershed nutrient inputs, transformations, and effects along a land-sea gradient stratified into four ecosystems that occur with increasing distance from land: manmade canal systems (receiving waters of nutrient inputs), seagrass meadows, patch reefs, and offshore bank reefs. Soluble reactive phosphorus (SRP), the primary limiting nutrient, was significantly elevated in canal systems compared to the other ecosystems, while dissolved inorganic nitrogen (DIN; NH_4^+ and NO_3^-), a secondary limiting nutrient, was elevated both in canal systems and seagrass meadows. SRP and NH_4^+ concentrations decreased to low concentrations within approximately I km and 3 km from land, respectively. DIN and SRP accounted for their greatest contribution (up to 30%) of total N and P pools in canals, compared to dissolved organic nitrogen (DON) and dissolved organic phosphorus (DOP) that dominated (up to 68%) the total N and P pools at the offshore bank reefs. Particulate N and P fractions were also elevated (up to 48%) in canals and nearshore seagrass meadows, indicating rapid biological uptake of DIN and SRP into organic particles. Chlorophyll a and turbidity were also elevated in canal systems and seagrass meadows; chlorophyll a was maximal during summer when maximum watershed nutrient input occurs, whereas turbidity was maximal during winter due to seasonally maximum wind conditions and sediment resuspension. DO was negatively correlated with NH_4^+ and SRP; hypoxia (DO < 2.5 mg L^{-1}) frequently occurred in nutrient-enriched canal systems and seagrass meadows, especially during the warm summer months. These findings correlate with recent (<5 yr) observations of increasing algal blooms, seagrass epiphytization and die-off, and loss of coral cover on patch and bank reef ecosystems, suggesting that nearshore waters of the Florida Keys have entered a stage of critical eutrophication.

1992 ◊

Ley, J. A. (1992) Influence of changes in freshwater flow on the use of mangrove prop root habitat by fishes. Ph. D. Dissertation. University Florida, Gainesville, FL. 171 pp.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The hypothesis that seasonal changes in freshwater inflow (indicated by salinity) influence habitat use by fishes was tested in northeastern Florida Bay. Fishes were sampled monthly for 13 months using visual censuses and enclosure nets. Of the 305,589 individuals observed, 91% were estuarine residents, numerically dominated by engraulids, atherinids and cyprinodontids. Occasional marine and freshwater visitors comprised 2% of the individuals, and estuarine transients, 8%. No young-of-the-year estuarine transients were observed. Salinity ranged between 0.0 to 58 ‰ upstream, 19.5 to 54 ‰ midstream, and 30 to 50 ‰ downstream. The 77 species were grouped for analysis: small benthic, small water column, and larger fishes. Abundances of larger fishes were consistently lower upstream (0.15 fish m^{-2}), than mid- (0.65 fish m^{-2}), or downstream (0.55 fish m^{-2}). Species of larger fishes numbered fewer upstream (11), than midstream (15), and downstream (22). Benthic and water column fish abundances did not vary along the gradient. Temporally, fish distribution was uncorrelated with salinity. Development of mangrove habitat and submerged aquatic vegetation (SAV) were reduced upstream. Fish diets shifted to other foods upstream. Thus, where seasonal changes in freshwater inflow were greater (i.e. upstream), species and numbers of larger fishes were lower, possibly due to salinity conditions, food availability and habitat development. To determine if lower salinity conditions alone led to reduced predation, prey fishes were tethered along the gradient. Predator encounter rates were not different over the salinity range tested, but were 50% lower at the most remote sites. This was perhaps a function of accessibility of the sites to roving predators. Water management strategies to increase mangrove development and SAV are recommended research priorities. However, severe ecotonal differences between Bay and ocean waters, coupled with limited circulation and significant predation may inhibit recruitment and survival of postlarval fishes from offshore. An unbroken continuum of good habitat from outer to upper reaches may be necessary if northeastern Florida Bay is to function as a prime nursery area for estuarine transient fishes.

1992

Machusak, D. D., and L. R. Kump (1994) Geochemistry of near-shore groundwaters, Fiesta Key, FL. Bull. Mar. Sci., 54(3):1079.

In June 1992 five piezometers were installed along a 75 m shallow water transect offshore of a mangrove patch on Fiesta Key. At each well site a 5 cm dia. core was extracted using a rotary hydraulic drill, and a 2.5 cm dia. A PVC piezometer was installed. Four wells were cased to bedrock depths ranging from 75 cm to 140 cm with 50 cm of screened interval. One shallow well was cased to 20 cm with 2.5 cm of screen. Wells were developed and sampled 24 hr after installation; well recovery was instantaneous. It is important to emphasize that the following results are preliminary and associated with initial well development. The majority of sampling will take place in mid-August 1992. Temperatures of sampled ground waters were consistently 27.0 ± 0.2°C (1 - 3°C cooler than Florida Bay waters) with salinity values of 35 - 36 ‰ (38 ‰ for Bay water). All ground water samples contained a strong sulfidic odor. Ground water samples were also analyzed for alkalinity, pH, and Soluble Reactive Phosphate (SRP). Ground water alkalinity increased from 4.0 ± 0.1 meq L^{-1} at 13 m away from the mangroves to 5.1 ± 0.1 meq L^{-1} at 72 m out. pH also increased from 7.3 ± 0.1 to 7.5 ± 0.1 at 13 and 72 m respectively. SRP followed a decreasing trend outward from the mangrove patch. At 13 m SRP measured 0.75 µM and decreased to 0.45 ± 0.12 µM at 72 m out. The highest value for SRP, 0.88 µM, was measured in the shallow well located at 20 m out. Ground water samples collected in August will also be analyzed for sulfide, N-species, F^-, Cl^-, SO_4^{-2}, Ca^{+2}, Mg^{+2}, and Na^+. Cored materials represent Pleistocene patch reef deposits of coral and cemented shell hash and carbonate mud. In each of the four longer cores there are 1 - 5 cm thick highly porous zones (presumably of secondary origin) that contain light-colored coatings of carbonate precipitates. Other high porosity zones appear 'grungy' with coatings of darker material that may be associated with organic/inorganic processes. Cores will be examined using SEM, XRF and Microprobe techniques for comparison with aqueous determinations. At present there are insufficient data to suggest any definite conclusions, but it does appear that ground waters closest to the mangroves differ in measured alkalinity, pH, and SRP from those ground waters located at greater distances offshore. Continued study will elucidate these preliminary findings and it is hoped that inferences can be made about potential anthropogenic and/or natural ground water effects.

1992 ◊

McClanahan, T. R. (1992) Epibenthic gastropods of the Middle Florida Keys: the role of habitat and environmental stress on assemblage composition. J. Esp. Mar. Biol. Ecol., 160:169-90.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] A survey of epibenthic prosobranch gastropods was undertaken in both seagrass and hard substratum (coral or old reef rock) habitats on opposite sides of the Florida Keys (Florida Bay and Hawk Channel) to compare faunal differences attributable to differences in the above two habitats and environments. Additionally, two data sets (26 continuous months) of daytime dissolved oxygen, surface salinity and water temperature from Florida Bay (Long Key) and Hawk Channel (Key Largo) environments were compared to determine differences that might constitute environmental stresses likely to affect the fauna. The above data were collected to determine if several hypotheses concerning effects of stress on organisms, assemblage, community and faunal composition were consistent with data on assemblage structure. These hypotheses were that: (1) stress should reduce the average size of organisms; (2) shorten food chains; (3) reduce predation intensity; (4) reduce species richness and diversity; and (5) increase the relative abundance of predator-susceptible ancestral species (i.e., Archaeogastropoda). Water quality data suggest that the two most likely forms of stress in deeper (> l m) areas of Florida Bay adjacent to the Keys are cold water temperatures associated with winter cold fronts and low predawn oxygen associated with warm summer temperatures, high salinity, and periodic algal and seagrass drift buildups. Seagrass sites had high population densities and low diversity due to the dominance of *Astraea americana* Gmelin (American star shell) in Florida Bay and *Modulus modulus* L. in Hawk Channel seagrass habitats. Florida Bay sites had high species richness on a small spatial scale, but Hawk Channel sites had more species and greater encounter rates of new species on a larger scale. Predawn oxygen measurements taken during July in four habitats were positively correlated with prosobranch species richness and diversity. Faunal data, analyzed on a population density basis, fit the above hypotheses of body size, trophic level, and evolutionary age of the species. Attempts to measure predation on an experimental prosobranch (A. americana) were unsuccessful but a tethering experiment with a sea urchin (*Echinometra lucunter* L.) indicated higher predation in the less stressful Hawk Channel than Florida Bay hard substratum sites. Stress appears to reduce the abundance of higher trophic levels (both prosobranch and finfish predators) resulting in the dominance of ancestral forms not adapted to predation but tolerant of environmental stress. Eutrophication or increased oxygen demands in Florida Bay could result in further species richness and diversity declines.

1992 ◊

McClanahan, T. R., and N. A. Muthiga (1992) Comparative sampling methods for subtidal epibenthic gastropods. J. Esp. Mar. Biol. Ecol., 164:87-101.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] A comparative survey of patchily distributed prosobranchs inhabiting seagrass and hard substratum (live, dead or Pleistocene coral) in both the Florida Bay and Hawk Channel environments of the Florida Keys was undertaken to compare a l-hr search versus a quadrat method (5 m^{-2}) of sampling. We tested the hypotheses that (1) there are differences in observer search ability and calculated community structure parameters, (2) large-bodied species will be over-sampled compared to small-bodied species, (3) abundant species will be under-sampled due to observer habituation towards abundant species, (4) individuals with cryptic or nocturnal habits will be under-sampled during daytime sampling, and (5) there are differences in search efficiency among habitats. Two independent observers using the search method had less than 20% variation in all community structure parameters and 10% variation in community composition similarity (Bray-Curtis Index) suggesting that observer-bias is small for experienced observers. In three habitats, Hawk Channel seagrass, Florida Bay seagrass and hard substratum, there was no evidence of over-sampling large-bodied species or of habituation to abundant species. In Hawk Channel hard substratum sites, *Strombus gigas* L. (Queen Conch) appeared to be the single species over-sampled due to its large body size, and some evidence suggests that *Cerithium literatum* Born, which buries itself in the sand, was under-sampled by the search method. Nocturnal sampling indicated that two species *C. atratum* Born and *Marginella apicina* Menke may have been under-sampled in the Hawk Channel seagrass habitat during the daytime while no species appeared to be under-sampled in the Florida Bay site. These nocturnally active species were patchily distributed, produce population estimates with high variation, and, therefore, day-night population density comparisons were not statistically different. The search method missed cryptic juveniles found by quadrat sampling. Search data displayed a greater pattern of central tendency, low coefficients of variation and more species encountered per unit effort in habitats with by population densities. Quadrat sampling data were right-skewed for low population density sites and had high coefficients of variation suggesting that estimates of population means by sample means may not be accurate when sampling only 5 m^{-2} per replicate. Search sampling is cost effective in terms of data collected per unit of labor and appears to produce fairly reliable population estimates but data are in units of time spent searching versus preferred units of two-dimensional space.

1992

Meeder, J. F., R. Jones, J. J. O'Brien, M. S. Ross, R. J. Sawicki, and A. M. Strong (1994) Effects of Hurricane Andrew on *Thalassia* ecosystem dynamics and the stratigraphic record. Bull. Mar. Sci., 54(3):1080.

Abnormally high bottom currents associated with Hurricane Andrew had significant, varied and localized impacts on *Thalassia*-dominated marine meadows. Extensive areas of *Thalassia* beds along the west side of Totten Key lost up to 80% of their cover. Most grass bed loss was by the removal of D-shaped divots of grass. These divots are up to 8 m wide and considerably longer, often coalescing. The *Thalassia* root system may be: (1) attached at the flat side of the "D" (and overturned or frequently rolled up like a carpet); (2) detached and transported out of the system; or (3) redeposited in either its upright growth position or upside down. Preservation of such erosional remnants should make future chronostratigraphic interpretations of similar settings very difficult. Several ecosystem processes are documented: (1) *Thalassia* detritus and fine-grained sediments were winnowed from grass beds; (2) previously continuous *Thalassia* beds are broken up and eroded, increasing water depth up to 45%; (3) previously buried sediments and nutrients are made available at the watersediment interface; (4) bottom habitat diversity is increased; (5) *Thalassia* edge is increased; and (6) mass export or turnover of stored organic carbon and nutrients occurred. Greatest *Thalassia* loss was closest to shore. Since bottom deepening is associated with cover loss, perhaps island leeward channel origin and maintenance is also associated with scouring storm bottom currents.

1992

Smith, T. J., M. B. Robblee, H. R. Wanless, and T. W. Doyle (1994) Mangroves, hurricanes, and lightning strikes. BioScience, 44(4):256-62.

This paper describes the effect of Hurricane Andrew on mangroves of South Florida. The hurricane passed north of Florida Bay and the mangrove forests and interior marshes of Cape Sable and northern Florida Bay suffered minor defoliation and occasional fine-branch breakage. In comparison, mangroves were 80 to 95% destroyed by trunk snapping and uprooting along the west coast mangrove forests of the Everglades National Park.

1992 ◊

Szmant, A. M., and A. Forrester (1992) Sediment and water column nitrogen and phosphorus distribution patterns in the Florida Keys: SEAKEYS. Abs., 1992 Symp. on Florida Keys Regional Ecosystem, November 16 - 20, Miami, FL.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Nutrient studies were initiated under SEAKEYS because of the concern that anthropogenic nutrients may be impacting Florida coral reefs. Both water column and sediment nutrients are being studied, with the latter emphasized because they integrate the longer-term nutrient dynamics of each area. Samples were collected along eight transects from passes or canals to offshore of the reef-line. The four transects off Key

Largo are in an area with the best present-day reef development; the two off Long Key are in an area with minimal patch reefs and where major passes allow Florida Bay water to flow onto the Florida reef platform. Two patterns of nutrient distribution emerged. Off Key Largo, and from Ohio to Looe Key, concentrations of N and chlorophyll-*a* were elevated near marinas and canals, but returned to oligotrophic levels within ca. 0.5 km of shore (e.g. chlorophyll-*a* $\leq$ 0.25 µg L^{-1}; $NO_3^- \leq$ 0.25 µm; $NH_4^+ \leq$ 0.10 µm). P concentrations, however, were often higher offshore. Sediment N and P were low and comparable to those of pristine reef areas. Sediment N was higher nearshore and decreased offshore; P concentrations varied little or exhibited the reverse pattern. Sediment N:P ratios were consistently lower offshore (1 - 10 vs. 20 - 40 nearshore) indicating that N may be limiting to offshore algae. Low sediment nutrient content suggests that either supply of detrital material to reef tract sediments is low, or that remineralization rates are high. Higher offshore PO_4^{-3} concentrations are attributed to periodic up welling along the shelf edge. The second distribution pattern was found in the "middle keys": Water column nutrients and chlorophyll-*a were* two times those in areas north and west of there. Sediment nutrients were higher also but nearshore and offshore areas did not differ. The middle keys are largely devoid of patch reefs and the offshore reefs are drowned ca. 5 m or more in depth. The higher sediment and nutrient efflux through the wide passes in this area (i.e. Shinn's inimical waters) are likely responsible for the lack of Holocene reef growth in this part of the Florida Keys.

1992 .

Tilmant, J. T., R. W. Curry, R. Jones, A. Szmant, J. C. Zieman, M. Flora, M. B. Robblee, D. Smith, R. W. Snow, and H. Wanless (1994) Hurricane Andrew's effect on marine resources. BioScience, 44(4):230-7.

Florida Bay has undergone dramatic changes in its seagrass beds since 1987 due to an unexplained seagrass dieoff. Before Hurricane Andrew, the decay of the stabilizing rhizome mat had left much of the bay vulnerable to erosion. For several months before the storm, bottom sediments had been disturbed and suspended and an area of milky green to brown water had persisted over much of the Bay. After Hurricane Andrew, the area appeared unchanged. From air and underwater observations, Florida Bay does not appear to have been affected directly by the storm. However, we expected eventual longer-term alterations to Florida Bay form nutrient increases associated with post-storm runoff. During the first few weeks after the storm, several reports of massive fish kills within the mangrove zone of the Everglades National Park and of an extermely strong smell of hydrogen sulfide over the west coast region were made. This suggests significant mortality during the storm or in relation to depleted oxygen levels associated with organic loading immediately afterward. Four weeks after the storm, no evidence of fish kills was found by the authors. Impact of the storm on loggerhead sea turtles, crocodile nests and the manatee population was minimal.

1992 ◊

Zieman, J. C., R. Davis, J. W. Fourqurean, and M. B. Robblee (1992) The role of climate in the Florida Bay seagrass dieoff. Abs., 1992 Symp. on Florida Keys Regional Ecosystem, November 16 - 20, Miami, FL. Bull. Ecol. Soc. America., 73(2):398.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Since the fall of 1987, Florida Bay has experienced a major die-off of seagrasses and benthic macrophytes totaling tens of thousands of hectares. After several years, dieoff of *Thalassia* continued at a reduced rate, while colonization and growth of the colonizer *Halodule* became widespread. Anomalies in the recent climate record may have played a significant part in the dieoff initiation. Retrospective analysis of earlier data coupled with current studies show a large increase in seagrass biomass prior to the dieoff and a decline in turnover rate or specific plant productivity during the dieoff. External stress in the form of hypersaline conditions (maximum salinities > 70, max. yearly station averages > 50 ‰), which are partly anthropogenically derived, were prevalent during much of the dieoff. Climatic stresses are (1) excessively warm waters in the late summer and fall of 1986 - 1988, and 90, and (2) a reduction of historic tropical storm frequency and intensity. Increased temperatures and decreased day length in the fall negatively impact seagrass P/R. Historical and anecdotal evidence suggests a continuing shift over the past decades from a mixed habitat to an increasingly monospecific *Thalassia* community. While recolonization processes are establishing a more diverse mixture of habitats with the potential of enhanced secondary productivity in some areas, in 1992, major dieoff expansion has occurred in western Florida Bay.

1993 ◊

Barber, T. R., and P. R. Carlson (1993) Effects of seagrass die-off on benthic fluxes and porewater concentrations of ΣCO_2, ΣH_2S, and CH_4 in Florida Bay sediments. Proc., 10th Annual Meeting, Internatl. Society of Environmental Biogeochemistry. R. S. Oremland (ed.). 530-50.

[NO COPY OF PAPER AVAILABLE.]

1993

Barkay, T., P. Vaithiyanatahn, R. Kavanaugh, E. Saouter, and C. J. Richardson (1994) Is there a role for eutrophication in methylmercury accumulation in the Florida Everglades? Abs., ASLO/PSA Joint Mtg., Miami, FL. a-4.

[ABSTRACT ONLY.] One possible mechanism for the recently reported accumulation of Hg in fish in the Florida Everglades is the increased production of methylmercury in eutrophied wetlands. To test this hypothesis we collected peat samples along a phosphorus/hydrology gradient, created by the input of agricultural run-off, in Water Conservation Area 2A during the summer of 1993. Samples were analyzed for total Hg, P, N, C and H and for the potential rates of biological Hg(II) methylation and $CH_3Hg(I)$ degradation. Preliminary results showed an inverse correlation between total P and Hg in the soils ($r^2 = 0.95$; $P = 0.052$; $N = 4$) and a positive relationship between soil total P and the ratio of potential methylation to demethylation rates ($r^2 = 0.92$; $P < 0.05$; $N = 5$). These results may suggest that (1) Hg accumulation is reduced in eutrophied soils, possibly as a result of enhanced rates of Hg mobilization and/or increased rates of peat accretion and hydrologic conditions, and (2) eutrophication increases net methylmercury production. These trends are currently being investigated by a more rigorous sampling regime.

1993 ◊

Hallock, P., and M. W. Peebles (1993) Foraminifera with chlorophyte endosymbionts: habitats of six species in the Florida Keys. Mar. Micropaleontology, 20:277-92.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Three species, *Androsina lucasi, Archaias angulatus,* and *Cyclorbiculina compressa,* all members of the subfamily Araiasinae, are among the largest and most abundant benthic foraminifera in the Florida Keys. Each species harbors a different chlorophyte endosymbiont, and each species thrives in a different habitat. *Androsina lucasi* is the most euryhaline species. It is found in exceptional abundance in open, dwarfed-mangrove flats in water commonly less than 0.2 m in depth, growing on mangrove roots and propagules, and algae such as *Batophora oerstedii. Archaias angulatus* is moderately eurohaline, thriving at sites in Florida Bay and Largo Sound at depths less than 2 m, where temperatures range from 14°C in winter to 33°C in summer and salinities range from 29 to 39 ‰,. Substratum includes rubble, seagrass (*Thalassia testudinum*), *Halimeda* and a variety of other macroalgae, especially when overgrown by epiphytes. *Archaias* is also common open shelf and shelf-margin settings. *Cyclorbiculina compressa* is the most stenohaline, occurring in open shelf settings typically at depths of 5 - 30 m. Optimum habitat appears to be short (~ 1 cm) filamentous algal turf on limestone pavement reef rubble. Three other chlorophyte-bearing species, *Broeckina/Parasorites orbitolitoides, Laevipeneroplis proteus* and *L. bradyi,* are also common in this habitat. Chlorophyte-bearing taxa are the most abundant and diverse group of larger foraminifera in the Holocene western Atlantic. Despite widespread occurrence throughout the Tethyan region during the Miocene, this group is represented in the Holocene Indo-Pacific by only two species. The decline of this lineage in the Indo-Pacific and its success in the tropical western Atlantic is opposite of biogeographical trends typically reported for shallow-water tropical taxa through the Neogene.

1993 ◊

Paul, J. P., J. B. Rose, S. C. Jiang, C. A. Kellogg, and L. Dickson (1993) Distribution of viral abundance in the reef environment of Key Largo, Florida. Appl. Environ. Microbiol., 59(3):718-24.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The distribution of viral and microbial abundance in the Key Largo reef environment was measured. Viral abundance was measured by transmission electron microscope direct counts and plaque titer on specific bacterial hosts in water and sediment samples from Florida Bay (Blackwater and Tarpon Sounds) and along a transect from Key Largo to the outer edge of the reef tract in Key Largo Sanctuary. Water column viral direct counts were highest in Blackwater Sound of Florida Bay (1.2 x 107 viruses mL^{-1}), decreased to the shelf break (1.7 x 106 viruses mL^{-1}), and were inversely correlated with salinity (r = -0.97). Viral direct counts in sediment samples ranged from 1.35 x 108 to 5.3 x 108 cm^{-3} of sediment and averaged nearly 2 orders of magnitude greater than counts in the water column. Viral direct counts (both sediment and water column measurements) exceeded plaque titers on marine bacterial hosts (*Vibrio natriegens* and others) by 7 to 8 orders of magnitude. Water column viral abundance did not correlate with bacterial direct counts or chlorophyll-*a* measurements, and sediment viral parameters did not correlate with water column microbial, viral, or salinity data. Coliphage, which are indicators of fecal pollution, were detected in two water column samples and most sediment samples, yet their concentrations were relatively low (<2 to 15 L^{-1} for water column samples, and < 2 to 108 cm^{-3} of sediment). Our findings indicate that viruses are abundant in the Key Largo environment, particularly on the Florida Bay side of Key Largo, and that processes governing their distribution in the water column (i.e., salinity and freshwater input) are independent of those governing their distribution in the sediment environment.

1993 ◊

Porter, D. (1993) Seagrass die-off in Florida Bay: the role of the marine slime mold, *Labyrinthula*. Bull. Ecol. Soc. Amer., 74(Suppl. 2):397.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The seagrass, *Thalassia testudinum* (turtle grass) is the dominant member of the seagrass Community in Florida Bay, a large, carbonate sediment lagoonal system between the southern tip of peninsular Florida and the Florida Keys. The western portion of Florida Bay has been little influenced by the direct actions of human activities. However since 1988, large areas of dense seagrass meadows in this region have become defoliated resulting in massive die-off of *T. testudinum.* These die-off events are positively correlated with the presence of black, necrotic lesions in the leaves of the seagrass prior to die-off. The leaf necrosis is caused by a species of the marine slime mold *Labyrinthula.* As of January 1993, there have been no observed seagrass die-off episodes on the Atlantic Ocean side of the Florida Keys. However, similar leaf necrosis symptoms have been observed recently in the seagrass meadows in Hawk Channel between the Keys and the coral reefs to the southeast.

1993 ◊

Snedaker, S. C. (1993) Impact on mangroves. Climatic Change in the Intra-Americas Sea. G. Maul (ed.). Edward Arnold, New York. 282-305

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Within the region, there are approximately 3,230,000 hectares of coastal shoreline dominated by mangrove vegetation which represents some 15% of the world inventory of mangroves. Unlike some parts of Asia, the mangroves of the region are not utilized in a sustainable manner although there are a variety of local uses, such as for timber, fuel and charcoal. In less populated areas, mangrove vegetation persists in a relatively undisturbed state. In populated areas, however, the habitat is used for the disposal of wastes, cleared for development projects, or exploited for other purposes, such as shrimp mariculture, all of which are incompatible with the sustainability of nearshore fisheries and environmental quality. In the context of global change, mangroves are more likely to be affected by changes in regional precipitation rather than by rising temperature and sea level. Specifically, mangrove areas that receive substantial precipitation and freshwater runoff are likely to persist, whereas mangrove areas exposed to full-strength seawater may be overstepped and lost. Because of the importance of intertidal mangroves in shoreline protection, fisheries support and water quality, efforts should be taken by the appropriate authorities and organizations to curb abuses and protect the resource for both ecological and economic purposes. Florida Bay is listed in the paper as one of the mangrove forests in the US.

1993 ◊

Van Lent, T. (1993) Towards the restoration of Taylor Slough. South Florida Natural Resources Center, Everglades National Park, Homestead, FL. 20 pp.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] In this report, we have tried to describe in a clear and unambiguous manner why water levels, not surface water inflows, are the key to restoring Taylor Slough and its headwaters. The most tangible measure of hydrologic restoration is the extent to which natural water levels and inundation patterns are reproduced. If water levels are corrected, then the timing and distribution of flows in Taylor Slough and into Florida Bay will directly follow. We have outlined a proposed water management approach that specified target water levels at two locations as guidelines for the restoration of the Taylor Slough basin. These target water levels are based upon the hydrologic conditions observed at approximately the time when the Park was established. By making these stations respond to rainfall and reproduce the pattern of historical water levels, we contend that this is the most reliable way of reestablishing more natural water levels and flows throughout the basin. This proposal addresses two fundamental points: (1) it defines water level targets that are more like the estimated pre-project conditions, and (2) it reestablishes the traditional linkage between marsh water levels and rainfall. Our proposal does not specify exactly how these targets are to be met by operation of the regional water management system. Therefore, water managers will enjoy some flexibility in balancing the conflicting goals of flood control and water supply with the environmental requirements of Everglades National Park. This approach provides a tangible blueprint to meet the legislative mandate for minimum levels in the Everglades, and is a step toward restoring a more natural Everglades ecosystem. The most important points we wish to make in this brief report are the following. Water levels, not flow volumes, are the most tangible measure of hydrologic restoration. Restoring water levels will result in the restoration of both the timing and distribution of surface water flows in Taylor Slough and Florida Bay. The environmental requirements of

Everglades National Park should be given the same priority as flood control and water supply when operating the C&SF project, as required by Federal and State statutes. The most significant hydrologic changes to Taylor Slough are that: peak water levels have dropped in the eastern periphery of the Park because of flood control operations of the C&SF Project; dry season water levels have increased due to the South Dade Conveyance System operation; and water management near the Park boundary has resulted in a disconnection of water levels with rainfall; we have proposed a water management scheme for Taylor Slougll based upon water levels. The plan sets an average target level for two sites in the upper portion of Taylor Slough, and depends upon rainfall over the basin during the previous 52 weeks; this plan meets the letter and spirit of F. S. 373-042 requinng the South Florida Water Management District to set minimum levels for natural areas, and it moves toward restoration of natural wetland functioning. Increased pumping at S-332 is not a viable scheme for mimicking natural wetland functioning if water levels are not increased. When canal levels are low, the source of the water pumped at S-332 is Taylor Slough and the Roclcy Glades. When canal levels are low, much of the water pumped at S-332 flows directly back into the canal, and is simply recirculated. Thus the net benefit to Taylor Slough is low. Pumping whenever water is available is not likely to reproduce natural wetland response to rainfall. Unless marsh water level criteria are applied in conjunction with pumping, the increased pumping capacity will likely be used to harm Taylor Slough. This did occur during October and November of 1993, in violation of the three party agreement.

1993 ◊

Van Lent, T., R. Johnson, and R. Fennema (1993) Water management in Taylor Slough and effects on Florida Bay. Rep. SFRC 93-03. South Florida Research Center, Everglades National Park, Homestead, FL. 79 pp plus appendices.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Taylor Slough has historically been a major contributor of freshwater to Florida Bay. Since 1982, progressive lowering of canal stages in and near the headwaters of Taylor Slough has lowered water levels throughout southern Dade County, and probably reduced freshwater flow to Florida Bay. The primary purpose of this report is to inform Everglades National Park management about the effects of changing water management in the L-31N, L-31W and C-111 canal systems on the Park's water resources. The report also provides some recommendations on how to protect and improve the Park's water resources. The analysis is split into six parts. First, we document the operational rules of the water control structures along the eastern boundary of the Park along with their evolution, and their effect on water levels and flows in and near the Park. Second, we develop water budgets for the canals near the Park's eastern boundary, and demonstrate how current operational policies have resulted in significant drainage of the marshes west of L-31N and L-31W. Thirdly, we examine the Flood Control Project during several wet periods documenting operations to divert water from Taylor Slough into C-111. Fourth, we look at salinity in Florida Bay and how freshwater inflows affect the pattern of salinity. Fifth, we apply the Natural System Model and the South Florida Water Management Model to estimate freshwater flows to Florida Bay and how increasing canal stages will modify the inflow regime. Lastly, the report concludes with recommendations for water resources management to be pursued by Everglades National Park.

1994 ◊

Atkeson, T. D. (1994) Mercury in Florida's environment. Abs., ASLO/PSA Joint Mtg., Miami, FL. a-3.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] In 1989 a monitoring project by state agencies found Hg in large mouth bass from the Everglades to average in excess of 2 $\mu g\ g^{-1}$. Because of its potential neurotoxicity to humans, these findings led to issuance of Health Advisories to fishermen urging cessation of consumption of bass from the Everglades and limited consumption of several other species. Subsequent surveys have shown average Hg levels to exceed 0.5 $\mu g\ g^{-1}$ in the majority of freshwater lakes and streams in the Atlantic and Gulf Coastal Plain Provinces and down through the peninsular region and the issuance of advisories to limit consumption of bass from the effected waters. It also has been shown that Hg poses chronic dietary risks to the endangered Florida panther and high body burdens of Hg are common in wading birds formerly abundant in south Florida. Similar observations of increasing Hg levels in freshwater lakes and streams are apparent worldwide, particularly in the Northern Hemisphere. The causes of this general increase, much less the specific causes of the Florida problem, are not well understood. To elucidate the contributions of local, regional and global sources of Hg to Florida's environment, a multi-agency task force has initiated a research program to complement similar work elsewhere. Studies are underway or being planned to measure temporal trends in mercury in Florida's environment, fine-scale monitoring of atmospheric Hg and deposition, and aquatic and wetland studies to define the pathways and processes of Hg accumulation in the Everglades food chain.

1994 ◊

Cubit, J. D. (1994) Global climate change and the importance of tidal flat ecosystems in the Caribbean and Gulf of Mexico. Bull. Mar. Sci., 54(3):1073.

[ABSTRACT ONLY, DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Algae, corals, seagrasses and other living organisms actively construct and maintain extensive tidal flat structures in the Gulf of Mexico and Caribbean. The various types of tidal flats, including reef flats, algal flats, and seagrass flats, are important economically and ecologically. They rank among the world's most productive ecosystems and export much of their organic material to adjacent ecosystems. These biogenic structures of carbonate rock and consolidated sediment, covered by meadows of plants and sessile animals, function as foraging grounds, nursery areas, natural breakwaters and shoreline reinforcements. Models of global climate change predict considerable changes for the coastal environments of the Gulf and Caribbean, including rises in sea level, increases of water temperature, and more frequent hurricanes. Physical and geographic features of the Florida Bay and the Keys, such as the narrow tidal range and location in the "hurricane belt," would make this region particularly sensitive to the effects of global climate change. Long-term, integrated monitoring of natural variations of the physical environment and populations of algae, seagrasses, corals and other reef flat biota on the Caribbean coast of Panama demonstrate that changes in sea level and sea temperature can affect the distribution and abundance of these organisms, but the tidal flat communities as a whole should be able to maintain vertical rates of habitat accretion in pace with predicted rises in sea level until the middle of the next century. However, studies of the effects of a major oil spill at this site illustrate that such pollution can cause longer-term damage of the groups of biota essential for building tidal flat structures. Proper management to maintain the tidal flat ecosystems in the Gulf and Caribbean, including the diverse tidal flats of Florida Bay and the Keys, could mitigate much of the potential damage expected from global climate change, including erosion of shorelines, loss of endangered species habitats, destruction of developed property and reduction of fisheries.

1994 ◊

Durako, M. J., and K. M. Kuss (1994) Effects of *Lybyrinthula* infection on the photosynthetic capacity of *Thalassia testudinum*. Bull. Mar. Sci., 54(3):727-32.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Blackened, necrotic lesions on *Thalassia testudinum* leaves are frequently associated with seagrass die-off in Florida Bay. A previously undescribed species of the marine slime mold, genus *Labyrinthula,* is the primary causal agent of these lesions. When *Labyrinthula* infection was present, variations in lesion coverage resulted in significant differences in dry-weight based photosynthesis versus irradiance (P/I) responses of *Thalassia* leaf tissue, reducing photosynthetic capacity and oxygen output. Maximum photosynthetic rate, P_{max}, decreased to below zero when lesions covered 25% or more of the leaf tissue. In addition, respiration rates in infected leaves were up to three times greater than in adjacent, uninfected tissue. Alpha (α), the initial slope of the P/I relationship, exhibited little change with low lesion coverage but was usually reduced with higher lesion coverage. These results show that the presence of *Labyrinthula* lesions impair photosynthesis of *Thalassia* leaf tissues and might reduce oxygen available for transport to below ground tissues, possibly making *Thalassia* more susceptible to hypoxia and sulfide toxicity. *Thalassia* shoots were collected in Johnson Key Basin, Rabbit Key Basin, Rankin Lake and Sunset Cove.

1994 ◊

Fong, P., and M. A. Harwell (1994) Modeling seagrass communities in tropical and subtropical bays and estuaries: a mathematical model synthesis of current hypotheses. Bull. Mar. Sci., 54(3):757-81.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] A preliminary simulation model was generated to predict changes in the biomass of five components of the autotrophic seagrass community that dominates tropical and subtropical bays and estuaries. Changes in productivity and biomass are based on relationships among three species of seagrass (*Thalassia testudinum, Halodule wrightii,* and *Syringodium filiforme*), epiphytes attached to seagrass, macroalgae, and several environmental factors, including light, temperature, salinity, sediment nutrients, and water-column nutrient concentrations. These relationships were derived from the published literature and include both experimental data and current alternative hypotheses. The model predicts that *Thalassia* is the community dominant under "normal" bay or estuarine conditions in tropical and subtropical regions, including high solar insolation, intermediate levels of seasonal variability in temperature and salinity, and low water-column and intermediate-to-high sediment nutrient concentrations. Increasing the supply of nutrients to the water column stimulates the productivity of epiphytes on seagrass, resulting in decreased light to seagrass blades and less *Thalassia* productivity. *Thalassia* and epiphyte biomass undergo seasonal changes in abundance; however, epiphyte biomass lags *Thalassia* by about 40 days. *Halodule* dominates when sediment nutrients are high and when there are environmental extremes of temperature and salinity. *Syringodium* is the community dominant in areas with more oceanic influence, characterized by less variability in salinity and temperature and lower water-column and sediment nutrients. This model is still in an early developmental stage. Preliminary sensitivity analyses identified important factors for community productivity and composition. The most important model parameters or seagrass include the productivity/biomass relationships, differential tolerances to extreme salinities, and the P/I curves (especially for *Thalassia*). All of the relationships between environmental factors and epiphytes are important, and these are the least certain derivations. We need to conduct a thorough sensitivity analysis, validate the model with field data, and generate more information on the algal components of the community. This simple community model will eventually be expanded to simulate seagrass dynamics across a spatial domain. Data from Florida Bay seagrass studies is discussed in this paper.

1994

Frankovich, T. A., J. W. Fourqurean, and R. D. Jones (1994) Epiphyte loads and seagrass C:N:P ratios as indicators of nutrient availability. Abs., ASLO/PSA Joint Mtg., Miami, FL. a-27.

[ABSTRACT ONLY.] Epiphyte levels on seagrasses have been shown to be good indicators of nutrient availability in the environment. The elemental composition of seagrasses has also been used to assess relative nutrient supply. The validity of these factors in the assessment of relative nutrient availability across a regional scale was determined. During the winter of 1994, total epiphyte loads, epiphyte chlorophyll and the C:N:P ratios of the leaves of *Thalassia testudinum* was measured at each of 24 sites within Florida Bay, a shallow marine embayment located at the southern tip of Florida. Multivariate and univariate statistical analyses were performed on these data and nutrient concentration data collected from each site during the study period to test for correlations among measured water column nutrients and one two potential biological proxies of nutrient avalability.

1994 ◊

Frewin, N. L. (1994) The distribution of organic matter in a dynamic carbonate sedimentary system, Florida Bay. Bull. Mar. Sci., 54(3):1075.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Sedimentary organic matter (OM) has been recovered from a Recent carbonate mudmound environment. Input sources have been identified via chemical characterization of the soluble OM fractions. Use of these chemical markers as tracers has provided confirmation of a sedimentary process model previously based on facies distribution. Twenty-two cores were taken from the windward leeward aspects of mudmounds in Florida Bay. Solvent soluble OM fractions have been analyzed using gas chromatography/mass spectroscopy (GC/MS) and solvent resistant OM fractions using pyrolysis GC/MS. This study has resulted in the recognition of distinctive chemotypes (chemical markers thought to have been derived from a particular OM source), revealing clear variations on a centimeter to kilometer scale. Changes are primarily caused by proximity to source, sedimentary facies variation and sediment reworking through bioturbation or storm processes. In particular, the preservation potential of higher plant (i.e. seagrass and mangrove) cuticular material within the sediments is clarified through the chemical characterization of the external membrane. The Holocene submergence curve was formulated from Florida Bay stratigraphy by Scholl *et al.* (1969). This study highlighted the importance of backstepping vegetation types during a transgression where there is a shift from freshwater to transitional to marine organo-facies. The relatively simple vegetational succession of Florida Bay makes it particularly sensitive to sea level interpretation. The selective use of organic chemical markers enables us to "fingerprint" organo-facies change, even when the recognizable particulate fraction has been removed through taphonomic processes.

1994 ◊

Ginsburg, R. N., and E. A. Shinn (1994) South Florida's environments are geological inheritances: the past is the key to the present. Bull. Mar. Sci., 54(3):1975.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The geography and bathymetry of South Florida's marine and terrestrial environments are inherited from geologic events extending back millions of years. The interactions of these physiographic subdivisions with marine communities and hydrography during the past several hundred thousand years has produced today's characteristic biotas, sediments, and local topography of reefs and shoals. The template for all of South Florida began to form as a platform of shallow-water calcareous deposits nearly 600 m thick dating back some 200 million years to the Jurassic Period. Some tens of millions of years ago, a dramatic change in deposition began that transformed the regime of the calcareous platform into one of siliceous sands and clays. This geologic revolution was the result of the southward spread of siliceous deposits derived from the Appalachian Mountains and distributed by rivers and movement along shorelines. The template, fully formed when the Gulf Stream-Florida Current system developed some 10 to 15 Ma, had shaped the southeast margin of the siliceous deposits into the gentle curve that is now surmounted by the Florida Keys and offshore reefs. The return of the calcareous deposit regime that would form the Florida Keys, the mainland, and surrounding shallow sea floors came with the onset of glaciation in the Northern Hemisphere. During a highstand of sea level about 125 ka, coral reefs and their associated calcareous deposits that are now the Upper and Middle Florida Keys accumulated preferentially along the southeast edge of the previously deposited siliceous sediments. At about the same time, an arc of calcareous sand banks and tidal channels grew from Ft. Lauderdale to Homestead and Flamingo and formed the present southernmost Atlantic Coastal Ridge. Farther south, similar sand banks accumulated and now form the low-relief limestone islands from Big Pine Key to Key West and the Marquesas. The topography of reefs and sand shoals was fossilized by cementation that occurred when they were above sea level for some 110,000 yrs. Then, a rising sea progressively began to flood the limestone landscape at about 8 ka. A new rim of reefs and shoals formed seaward of the Keys, and on the western, protected side of the Upper Keys, shallow Florida Bay and Barnes and Card Sounds were born. The major physiographic and hydrographic environments - the Florida reef tract, Biscayne Bay, and Florida Bay—are the large-scale template inheritances, but there are smaller scale ones as well. For example, two of the major subdivisions of the modern reef tract, the areas seaward of the Upper and Middle Keys, are determined by the degree of continuity of the islands formed 125 ka. Where an island is linear such as Key Largo, the offshore reef tract is shielded from the inhospitable waters of Florida Bay, and reef communities flourish. Where islands are discontinuous as in the Middle Keys, tidal exchange between the Gulf of Mexico and Atlantic Ocean produces a mobile sand substrate unfavorable for the establishment of corals and associated reef builders. In addition, the inter-island channels allow discharges of inhospitable waters from shallow, restricted Florida Bay to reach the reef tract, which further deter development of reefs offshore. These factors, the mobile sand substrate from cross-shelf tidal currents and the inimical waters from Biscayne Bay, may explain the absence of significant reef development seaward of the Safety Valve south of Key Biscayne.

1994 ◊

Gorte, R. W. (1994) The Florida Bay economy and changing environmental conditions. CRS Report for Congress. 94-435 ENR. Congressional Reserch Service, The Library of Congress. 19 pp.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Florida Bay is a large, triangular coastal lagoon located at the southern tip of Florida, between Everglades National Park and the Florida Keys. Substantial changes in the vegetation of this shallow saltwater bay have occurred within the past decade. The mangroves that ring the mudflat islands are dying. The seagrass that carpets much of the Bay began dying in 1987, and the dieoff now affects nearly a quarter of the Bay. This seagrass dieoff is linked to blooms of blue-green algae that are, in turn, linked to a sponge dieoff. Finally, diatom blooms have become increasingly common in the western portions of the Bay since 1979. Many are concerned that these changes in the vegetation of Florida Bay are affecting the resident fauna. Florida Bay contains resident and transient populations of bottlenose dolphins and provides habitat for the endangered manatee, several endangered sea turtle species, and along the north shore, the endangered American crocodile. The Bay provides feeding and nesting habitat for many bird species, but the number of ospreys and of wading bird colonies has declined. The Bay also provides nursery grounds for many species of finfish and shellfish, as well as habitat for other life stages for some species. The Bay's finfish and shellfish are important foundations for the two major industries in adjacent Monroe County: commercial fishing and tourism. To date, the only measurable economic losses that coincide with the vegetation change are in commercial fishing, principally from the substantial decline in pink shrimp harvests. The losses since 1986, including indirect and induced effects, total about 500 jobs and $32 million in annual personal income. However, commercial harvests of spiny lobster, snappers, and groupers with about 12,800 primary and secondary jobs and $20 million in personal income are threatened by the vegetative changes. Tourism is also threatened by the vegetative changes in Florida Bay. It appears that tourism accounts for about a quarter of the Monroe County economy 12,000 jobs and $200 million in personal income. The threat is less direct than with commercial fishing, but is nonetheless real. The algae and diatom blooms have reduced water clarity in an area previously favored by recreational divers because of its pristine waters. The Bay provides habitat for several important sport finfish, such as spotted seatrout and red drum. The changes in the Bay may also threaten the ocean-side coral reefs that attract sport divers. The imprecision in estimating the tourism economy and in linking it with he vegetative changes makes it difficult to estimate the potential economic effects. Nonetheless, the changes are apparent to tourists and are attracting national attention as an example of ecosystem degradation. Losing a quarter of tourists and seasonal residents is certainly possible. Such a decline would threaten thousands of jobs and tens of millions of dollars in personal income probably exceeding the potential losses associated with a decline in comercial fishing. Furthermore, because changes in tourism are likely to lag behind changes in environmental quality, losses in the tourist economy are likely to persist, even if vegetation in the Bay were to recover quickly. Finally, economic declines would reduce local property values and tax collections.

1994 ◊

McIvor, C. C., J. A. Ley, and R. D. Bjork (1994) Changes in freshwater inflow from the Everglades to Florida Bay including effects on biota and biotic processes: a review. In: Everglades: The Ecosystem and Its Restoration. S. M. Davis and J. C. Ogden (eds.) St. Lucie Press, Delray Beach, FL.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The freshwater Everglades and estuarine Florida Bay ecosystem are closely linked by marine and freshwater hydrologic cycles and by organisms that depend on both systems during different times of the year or periods of their life cycles. Impounding of water in the Water Conservation Areas and diversion of water away from Shark River Slough and Taylor Slough for purposes of urban use and flood control have significantly reduced the volume of fresh water to Florida Bay. As a result, bay waters are now more saline in more locations and for longer periods of time than under premanaged conditions. The filling of passes and shallow banks between several of the Keys for construction of the Flagler Railroad in the early 1900's reduced circulation in Florida Bay, thereby exacerbating anthropogenically generated salinity anomalies. Delivery of fresh water to Florida Bay differs from premanaged conditions in both volume and timing. Numerous effects on biota and biotic processes in the Bay and southern Everglades ecotone have been documented or implicated, including reduced recruitment of pink shrimp, snook, and redfish; lowered reproductive success of ospreys and great white herons; and shifts in distribution of West Indian manatees, American crocodiles, and many of the wading birds that historically nested in the estuarine ecotonal area. One species, however, the gray snapper *(lwutbanus gnseus),* exhibits enhanced recruitment in years of higher salinity in Florida Bay. Reduced freshwater inflow is also implicated as one of a complex series of factors in the mass mortality of seagrasses in the Bay that has occurred since 1987. Similarly, hypersalinity is likely a factor in dieback of mangroves in some Florida Bay localities. Excessive amounts and unnatural timing of freshwater delivery can also adversely affect biota. A sudden release of greatly elevated volumes of fresh water from the C-111 canal resulted in the mortality of many estuarine organisms in Manatee Bay when salinities dropped from near marine to zero in a few hours and remained low for an 8-day period. These observations provide powerful evidence that productivity of Florida Bay is declining under current management practices.

1994 ◊

Philips, E. J., and S. Badylak (1994) Spatial and temporal variability in phytoplankton standing crop and composition in Florida Bay, Florida, USA. Abs., ASLO/PSA Joint Mtg., Miami, FL. a-57.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Spatial and temporal patterns of phytoplankton standing crop and composition in Florida Bay were studied at thirteen sampling stations. Significant spatial differences were observed supporting the hypothesis that the Bay is composed of a number of ecologically distinct regions. The highest standing crops of planktonic algae and cyanobacteria were found in the central-interior region of the bay, where the cyanobacteria *Synechococcus* dominated the planktonic assemblage. Chlorophyll-*a* concentrations up to 40 mg m^{-3} were observed in this region, and *Synechococcus* comprised over 90% of total phytoplankton biovolume. In other regions of the Bay, total chlorophyll a concentrations were significantly lower and diatoms and dinoflagellates were the dominant taxa in terms of biovolume. However, nutrient enrichment bioassays indicated the possibility of P, N and/or N-P co-limitation during certain periods of time.

1994 ◊

Reese, C. J., and L. L. Richardson (1994) Pigment and spectral analysis of seagrass and algal blooms in Florida Bay. Bull. Mar. Sci., 54(3):1082.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The relationship between pigments and reflectance spectra of seagrasses and phytoplankton from numerous basins in Florida Bay is being studied. Both filtered and concentrated samples have been collected for organism identification, enumeration, and chlorophyll fluorescence. Measurement of total absorbance, chlorophylls, carotenoids and phaeopigments from whole cell extractions are made on a Shimadzu spectrophotometer. Separation and identification of specific pigments are performed with a Hewlett Packard 1090 HPLC run in reverse phase. Surface reflectance (368 to 1160 nm in 2 nm increments) is measured with a Spectron Model SE590 spectroradiometer. Second and fourth derivative spectra of the total absorbancy from the extracted pigment samples have been compared with derivatives of surface reflectance spectra of the sampled basin. Although total absorbancy and reflectance spectra derivatives are similar for the predominant seagrass *Thalassia testudinum,* and a vast (11 km dia.) algal bloom composed principally of planktonic diatoms, the data suggest regions of the visible spectrum which may be useful in satellite interpretation of Florida Bay algal and seagrass dynamics.

1994 ◊

Rudnick, D. T. (1994) Interactions of salinity and nutrient cycling in Florida Bay. Abs., ASLO/PSA Joint Mtg., Miami, FL. a-64.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Recent environmental problems in Florida Bay, including seagrass dieback, persistent phytoplankton blooms, and declining fisheries yields, have been attributed to both increased salinity and nutrient enrichment. Increased salinity is the result of water management practices that have decreased freshwater flow into the Bay. Nutrient enrichment is generally attributed to external loading from the Gulf of Mexico and the Florida Keys and to interloading from detrital decomposition following seagrass mortality. However, nutrient loading and salinity are not independent; both chemical and biological aspects of nutrient biogeochemistry can be affected by salinity. Nutrient sorption to sediments can be directly affected by ionic strength. This may be particularly important in the Bay if P binding by carbonate particles is affected. In the Bay's adjacent wetlands, salinity can alter biological processes such as nutrient assimilation by mangroves and decomposition. Nutrient export from these wetlands may thus have changed because of salinity intrusion.

1994 ◊

Shinn, E. A., B. H. Lidz, and M. W. Harris (1994) Factors controlling distribution of Florida Keys reefs. Bull. Mar. Sci., 54(3):1084.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Regional and area-specific high-resolution seismic profiling, combined with core drilling and analysis of aerial photography, indicates that the distribution of Florida's reefs is regulated by two factors. The primary control is Pleistocene topography, created before Holocene sea-level rise (conversion of landscape to seascape). The secondary influence is water quality, which has progressively changed with rising sea level and changing seascape. A regional sequence of flooding, patterns resulting from sea-level rise, is shown by converting contoured structural maps of the underlying Pleistocene limestone into paleoshoreline maps. The maps show that: (1) the area of the reef tract off the Lower Florida Keys flooded sooner than that off the Upper Keys, suggesting that Holocene reef growth began first off the Lower Keys; (2) the major offshore reefs formed around offshore islands, probably as fringing reefs, and became bank reefs as sea level arose; and (3) rising sea level created wide passes through the Lower and Middle Keys, allowing influx of inimical Florida Bay and Gulf of Mexico waters onto the reef tract 3 to 4 ka and causing senility in major Holocene reefs opposite the passes. Detailed seismic mapping of the reef tract in a portion of the Key Largo National Marine Sanctuary off north Key Largo shows that at about 6 to 7 ka a linear chain of barrier islands (Pleistocene outlier reefs) extended along the edge of the platform margin from The Elbow to French Reef. Rising sea level caused flooding of the platform through prominent bedrock depressions south of The Elbow and between French and Molasses Reefs, creating a linear, protected embayment. Corals recruited to a bedrock terrace within the embayment and flourished, forming 14-m-thick linear Holocene reefs, such as Grecian Rocks and Key Largo Dry Rocks. With further rise in sea level, coral patches became established at Mosquito Bank in a bedrock depression within Hawk Channel. At about the same time, marine sediments began to fill a 600-m-diameter sinkhole near Key Largo Dry Rocks. Surprisingly, coral growth along the outlier-reef islands did not lead to major Holocene accumulations at the edge of the platform margin, and reefs such as The Elbow, French, and Molasses are thin (~1 m thick) and are considered geologically senile. These observations are consistent with new data from the Great Barrier Reef of Australia, which also show that older and thicker reef accumulations occur on lagoonal topographic highs rather than on the offshore barrier.

1994 ◊

Smith, T. J., and M. B. Robblee (1994) Relationships of sport fisheries catches in Florida Bay to freshwater inflow from the Everglades. Bull. Mar. Sci., 54(3):1084.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Principal components analysis was used to characterize inflow to Florida Bay from Shark River Slough and Taylor Slough. Four components described >71% of the variation in inflow. The components clearly separated summer-fall inflow from winter-spring inflow. Additionally the pattern of variation in inflow was more complex in Taylor Slough than in Shark River Slough. Regression analysis was used to relate individual species catch rates for gray snapper, spotted seatrout, red drum and common snook to the principal components of inflow. Highly significant ($P < 0.05$) regression models were developed and verified for all species. Increased runoff in the winter led to decreased catches of snapper, seatrout and snook. Above average summer and fall runoff led to increased catches of red drum, seatrout, and snook but decreased catch of snapper. Management practices need to consider not only the volume of water but the timing of delivery to the estuary to ensure fishery yields in the future.

1994 ◊

Strong, A. M., R. J. Sawicki, and G. T. Bancroft (1994) Estimating white-crowned pigeon population size from flight-line counts. J. Wildl. Manage., 58(1):156-62.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The white crowned pigeon (*Columba leucocephala*) is a threatened species in Florida, yet there are no population estimates nor are there methodologies available for estimating population size. During the 1991 nesting season we developed a nondisruptive technique for estimating the nesting population of white crowned pigeons in the upper Florida keys. Using radio telemetry and automatic cameras we determined that breeding males returned to nesting keys later in the morning than do nonbreeding birds ($P = 0.001$). We studied the relationship between number of incoming birds and number of nests on 14 keys by conducting total nest counts and flight-line counts during 0810 - 1300 (mean arrival time for breeding males ±2 SD). We examined 78 regression equations using all possible 10-min increments of time intervals ≥90 min and found that the number of birds arriving during 0820 - 1010 was the best predictor of number of nests on a key ($P < 0.001$). We counted incoming birds from 0820 - 1010 on 43 keys in Florida Bay, Card Sound, and Florida Straits. For each of the 43 keys we entered the number of incoming birds into a regression equation and estimated the breeding population to be 4,880 nests (95% CI = 2,115 < 4,880 ≤ 7,905 nests). We estimated an additional 175 nests at the remaining nesting areas for a total breeding population estimate of 5,055 nests. This technique should be applicable in other areas where white-crowned pigeons occur.

1994 ◊

Tedesco, L. P. (1994) Vertical fluxes resulting from bioirrigation: the significant effect of deep burrowing arthropods. Bull. Mar. Sci., 54(3):1086.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Deep burrowing arthropods (*Callianassa, Alpheus,* and *Upogebia*) are prevalent vertical advectors of sediment throughout the shallow marine bays, lagoons and the reef-tract of South Florida. Their thumb-sized open burrow complexes commonly extend more than a meter into the subsurface. During burrow excavation and feeding, these crustaceans expel suspension-sized sediment to the depositional interface. Expelled sediment is overwhelmingly less than 175 µm in settling diameter and represents grains swept up and out of the burrow by currents generated by the shrimp. Expelled sediment may be the finer-grained sediment from the original substrate in the case of deposit feeders or waste from suspension trapping during filter feeding. Large storms and hurricanes erode, resuspend and transport surficial sediments that infill open burrow complexes. Storm infilling from the surface is with a mixture of traction-bedload-sized grains and mud. Burrow excavation and feeding effectively transports deeply buried (> 1 m) sediments, including particulate and surface adsorbed pollutants, to the depositional interface while storm infilling transports surficial sediment deep into the subsurface. Initial calibration of rates of burrow excavation and infilling using ^{210}Pb geochronologies in Biscayne Bay, demonstrate vertical particle advection rates sufficiently fast to recycle 15 - 25% of the upper l to 1.5 m of deposit over 100 yr time scales. Deep burrowing arthropods are present throughout Biscayne Bay, the reef tract and the more normal marine portions of Florida Bay. Vertical advection of particles by their burrowing and feeding behavior coupled with storm infilling of their burrows represents a major pathway for large-scale particle and pollutant transport.

1994 ◊

Tomasco, D. A., B. E. Lapointe (1994) An alternative hypothesis for the Florida Bay seagrass die-off. Bull. Mar. Sci., 54(3):1086.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] A large die-off of the subtropical seagrass *Thalassia testudinum* has recently occurred in Florida Bay. Currently, it is the belief of many researchers that human activities other than freshwater divergence had little role in the initiation of this die-off. Elevated salinities (>50 °/oo) and water temperatures are thought to be involved with die-off. Previous work indicates that *T. testudinum* has an optimum salinity of about 30 °/oo, with reductions in productivity above and below this level. However, when the die-off areas are overlain on salinity isopleths it is apparent that die-off areas are not centered around areas of highest salinities. In Laguna Madre, a negative estuary similar to Florida Bay, *Thalassia testudinum* is found in areas with salinities above 40 - 45 °/oo, well above values found in most (not all) areas of die-off in Florida Bay. It is the belief of the authors that there is little evidence that suggests high salinities were important in bringing about the die-off of *T. testudinum* in Florida Bay, as has been previously suggested. Therefore, not only would reestablishment of historical freshwater flows into northeast Florida Bay increase nutrient loads into that area (due to anthropogenic nutrient enrichment of discharged water), there is not much promise that this activity would lessen the chance of later seagrass die-offs. However, high temperatures (perhaps related to high water column chlorophyll levels) might be an important component to die-off. What seems more clear is that areas of Florida Bay that experienced later die-off are characterized by higher biomass than areas where die-off did not occur. In addition, these areas of already high biomass had experienced recent large increases in above ground biomass prior to die-off. This leaves the question of how did such an increase in biomass occur? A review of the literature suggests two ways to bring about an increase in seagrass biomass: increase the available light, and increase the sediment nutrient supply. This paper will address the potential role of both increased light levels and increased sediment nutrient levels in triggering the die-off of *Thalassia testudinum* in Florida Bay.

1994 ◊

Wang, J. D. (1994) Circulation in Florida Bay. Florida Coastal Ocean Sciences Symp. April 1994. University of Miami, Miami, FL. 42.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Surface elevation and salinity data obtained from the Marine Monitoring Network of the Everglades National Park were used to explore the causal relationships between forcings and hydrodynamic response in Florida Bay. Astronomical tides entering the Bay from the Gulf of Mexico are primarily diurnal. The tides are strongly damped as they move eastward into the Bay. Model analysis indicates that the damping is primarily due to the horizontal constrictions imposed by mudbanks and islands, although bottom friction in the shallow depths of the Bay is also important. Associated with the damping of the tidal waves is a mean sealevel setup which has been estimated to be about 1 to 2 cm. It is plausible that this mean sealevel setup gives rise to a net flow out of the Bay to the south, through the passes between the Florida Keys. The Bay's hydrodynamic response appears to be dominated by three time scales. The astronomical tides, 1/2 to 1 day; seabreeze, 1 day; winter winds, 3 to 4 days; and 14 day lunar tidal components. Much of the wind response appears to be due to propagation of coastal sea level changes on the West Florida Shelf into Florida Bay. The energetics of the long period tidal response appears to be similar to that of the wind response. To begin addressing issues relating to how much freshwater is reaching the Bay, and to investigate the usefulness of freshness as a tracer, some simple analysis of salinity is presented. Rainfall within the catchment is not sufficient to produce the observed salinity variations. Freshwater releases from canal structures at the catchment boundaries are therefore important and appear to have been similar in magnitude to the direct runoff volume over the last 10 yrs. For an idealized l-day approximation of Northeast Florida Bay, a net evaporation rate (evaporation minus groundwater seepage) of approximately 0.5 cm/day is found from observed salinity variations in the Bay. The makeup water for this evaporation causes transports that vary linearly from the south to the north and attain a value of approximately 100 m^2/day at a distance of 20 km from the edge of the Everglades. With an average depth of 1.5 m, this corresponds to a net speed of 67 m/day or 2000 m/month. The rate of salinity increase HdS/dt under evaporative conditions, i.e. when rainfall and runoff are zero, is approximately 0.16 pptm/day.

1994 ◊

Wanless, H. R., L. P. Tedesco, D. Cottrell, and M. G. Tagett (1994) Holocene environmental history of carbonate banks in Florida Bay and Biscayne Bay, south Florida. Bull. Mar. Sci., 54(3):1087.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Florida Bay is underlain by a gently westward sloping limestone surface which rising sea level transgressed between 4,500 and 3,000 yrs ago. Subtle irregularities in the limestone topography defined landward-penetrating peat-filled sloughs and temporary shore buildups (coastal levees). These peat and levee deposits, though now transgressed and dissected, served as a defining control on the patterns of subsequent growth of carbonate sand and mud banks. Portions of many islands are remnants. Skeletal sand and mud banks in Biscayne Bay either extend from gaps in the seaward limestone ridge (Featherbed Banks and Caesar's Creek Bank) or are positioned bayward of the protection of a shallowly submerged limestone ridge (Safety Valve). The carbonate mud banks in central Florida Bay and Biscayne Bay are either transgressed coastal deposits or marine carbonate banks built by the physical bank growth, extension and migration. The internal stratigraphy of the marine carbonate banks record pulses of physical growth followed by seagrass recolonization. Each physical growth pulse contains a basal erosion or smothering surface, covered by 1 - 10 cm of coarse skeletal sand and gravel (if available) and mud clasts. This is overlain by 1 - 10 cm of layered skeletal to peloidal sand which normally fines upwards. A 10 - 120 cm unit of layered mud (to fine sand in more exposed settings) forms the bulk of each physical growth pulse. Banks are extending/migrating southward and westward by repetitive pulses of physical banks growth. Banks tend not to form in the lee of emergent islands. We interpret these physical pulses of sedimentation to record a hurricane-level storm initiation (scour, smothering, gravel and layered sand) followed by years of layered mud sedimentation by winter storms. Gradual seagrass recolonization helps to stabilize the banks but appears to play little role in bank growth. The broad carbonate banks in western Florida Bay have resulted from the coalescence of smaller banks as interbank bays filled with sediment. Bay infillings are commonly associated with persistent seagrass cover and community. Both the narrow and broad banks tend to build towards and into the intertidal zone. This is accompanied by a coarsening of the substrate and elimination of the stabilizing seagrass and algal communities. Carbonate banks are dynamic features that are highly responsive to sea level changes, storm processes and sediment supply.

1994 ◊

Zieman, J. C. (1994) A conceptual model of seagrass dieoff in Florida Bay. Abs., ASLO/PSA Joint Mtg., Miami, FL. a-85.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Since the summer of 1987, Florida Bay has experienced a major dieoff of seagrasses totaling tens of thousands of hectares, nearly all *Thalassia testudinum.* Dieoff has been accompanied by eutrophic epiphyte and algal growth, apparently due to the release of nutrients from the nutrient rich barren sediments and the thousands of metric tons of decreasing seagrass. Distal causes of dieoff include long-term curtailment of water flow into the Everglades and resulting change in communities, coupled with an abnormal (>3 times normal) time between perturbations by tropical storms. Potential proximal triggers include: (1) abnormally high temperatures in summer and fall of 1987, (2) extreme salinities, and (3) possibly disease. Seagrass photosynthetic capacity is compromised by eutrophic algal growth mud suspended sediments from the unstabilized sediments. Plant death would then result from an inability of the plants to meet respiratory requirements, or hypoxic stress. As the dieoff process continues, the additional dead seagrass leaves and barren sediments maintain a positive growth loop which has not yet reached equilibrium, but the conditions sustaining the dieoff are not the conditions that initiated it. A model of this process is presented.

1994 ◊

Zieman, J. C., R. Davis, J. W. Fourqurean, and M. B. Robblee (1994) The role of climate in the Florida Bay seagrass dieoff. Bull. Mar. Sci., 54(3):1088.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Since the fall of 1987, Florida Bay has experienced a major die-off of seagrasses and benthic macrophytes totaling tens of thousands of hectares. After several years, dieoff of *Thalassia* continued at a reduced rate, while colonization and growth of the colonizer *Halodule* became widespread. Anomalies in the recent climate record may have played a significant part in the dieoff initiation. Retrospective analysis of earlier data coupled with current studies show a large increase in seagrass biomass prior to the dieoff and a decline in turnover rate or specific plant productivity during the dieoff. External stress in the form of hypersaline conditions (maximum salinities >70, max. yearly station averages >50 °/oo), which are partly anthropogenically derived, were prevalent during much of the dieoff. Climatic stresses are: (1) excessively warm waters in the late summer and fall of 1986 - 1988, and 1990; and (2) a reduction of historic tropical storm frequency and intensity. Increased temperatures and decreased day length in the fall negatively impact seagrass P/R. Historical and anecdotal evidence suggests a continuing shift over the past to decades from a mixed habitat to an increasingly monospecific *Thalassia* community. While recolonization processes are establishing a more diverse mixture of habitats with the potential of enhanced secondary productivity, in some areas, in 1992, major dieoff expansion has occurred in western Florida Bay.

Related papers/reports

1905 - 1985

Myers, R. L. (1986) Florida's freezes: an analog of short-duration nuclear winter events in the Tropics. Fla. Sci., 49(2): 105-15.

Recently developed scenarios of nuclear winter effects originating from a nuclear exchange in the north temperate zone point to localized periodic freezes reaching as far south as the Tropic of Capricorn. The effects of freezes on Florida's agriculture and natural ecosystems are assessed as analogs of what might occur at lower latitudes should freezing temperatures from a nuclear winter reach into the tropics. Vegetation damage, population fluctuations, restricted distributions, fishkills, and crop losses are recurrent features associated with freezes in Florida. However, Florida's freezes can only serve as a partial model because of bioclimatic dissimilarities between tropical regions and the Florida peninsula. Florida, itself, would suffer severe environmental consequences during a nuclear winter, yet certain features of it's environment may permit a relatively rapid recovery. Severe freezes occurred in 1905, 1906, 1909, 1917, 1928, 1934, 1940, 1947, 1957-58, 1962, 1970, 1971, 1977, 1981, 1982, 1983, and 1985.

1913 - 1986

Hanson, K., and G. A. Maul (1993) Analysis of temperature, precipitation, and sea-level variability with concentration on Key West, Florida, for evidence of trace-gas-induced climate change. Climatic Change in the Intra-Americas Sea. G. A. Maul (ed.). Edward Arnold, New York. 193-213.

Meteorological and sea-level data for Key West, Florida, have been examined for evidence of changes during recent decades that may be attributed to increasing trace gases in the atmosphere. The 136-yr air-temperature record (1851 - 1986) gives the evidence that a slight warming has occurred, but there has been no appreciable change since 1950. However, there are questions of the reality of the warming because of the varied temperature-observing conditions over the period of record. The 101-yr precipitation record (1886 - 1986) gives evidence that no significant change in precipitation has occurred during the period of record. In addition to Key West weather, sea-level records from all 62 stations on file with the Permanent Service for Mean Sea Level that cover the Caribbean Sea, Gulf of Mexico, the Bahamas, and Bermuda have been examined for linear trends. Average (±1 standard deviation), sea-level rise is 0.4 cm yr^{-1} (± 0.6 cm yr^{-1}) for all stations (mean record length 20 yrs), and 0.3 cm yr^{--1} (± 0.4 cm yr^{-1}) for those stations with records of >10 yrs in length. A regional maximum of $\geq$+1.0 cm yr^{-1} is centered in the northwestern Gulf of Mexico, an area of subsidence. Regional minimums (~ -0.3 cm yr^{-1}) occur in the southwestern Gulf and in the Lesser Antilles, where there is diastrophism. Average sea-level rise at Key West, a site of tectonic stability, is 0.22 cm yr^{-1} (± 0.01 cm yr^{-1}) for the period 1913 - 1986. Key West sea level seems unrelated to local air temperature, barometric pressure, precipitation and records of coral growth, but is significantly lower than normal during the year preceding a strong El Niño - Southern Oscillation event, and higher than normal during the event itself. There is no evidence for accelerated sea-level rise at this site.

1931 - 1946, 1974 - 1989

Ogden, J. C. (1994) A comparison of wading bird nesting colony dynamics (1931 - 1946 and 1974 - 1989) as an indication of ecosystem conditions in the southern Everglades. In: Everglades: The Ecosystem and Its Restoration. S. M. Davis and J. C. Ogden (eds.) St. Lucie Press, Delray Beach, FL.

Patterns of nesting for five species of colonial wading birds (Ciconiiformes) in the central and southern Everglades in Florida were compared between two separate periods: an early drainage period (1931 - 46) and a late drainage period (1974 - 89). Parameters examined during the two periods were: (1) numbers of birds nesting in each colony, (2) locations of colonies, (3) timing and nesting, and (4) colony success. The five species analyzed were: great egret (*Casmerodius albus*), tricolored heron (*Egretta tricolor*), snowy egret (*Egretta thula*), white ibis (*Eudocimus albus*), and wood stork (*Mycteria americana*). These analyses were conducted to show changes in patterns of nesting between periods and to examine how theses changes may have been caused by broader scale changes in hydrological patterns. A more complete, recent colony database (1953 - 89) for wood storks was also examined to supplement these analyses. The total number of nesting wading birds declined from a peak of 180,000 - 245,000 birds (1933 - 34) in the early period to a peak of 50,000 birds (1976) in the recent period. For all species, except the wood stork, the locations of the largest colonies changed between periods from a headwaters subregion located at the lower end of the Shark River Slough to a central Everglades subregion located north of Everglades National Park. Timing of nesting remained largely unchanged between periods, except for the wood stork, which shifted the average time of colony initiation from early December to late January. The best colony success data were for storks, which showed a change from 7 successful nesting years out of 9 years from 1953 to 1961 to 6 successful years out of 28 from 1962 to 1989. Reductions in the number of nesting birds and changes in the location of major colonies appear to correlate with the reduction in the total area of wetland foraging habitat, an increased frequency of extensive dry outs in the lower Shark River Slough marshes, and the relocation of the longer hydroperiod marshes into the Water Conservation Area impoundments. Changes in timing of nesting by wood storks and the reduction in stork reproductive effort and colony success rate appear to correlate with a loss in food resources in the early dry season foraging habitats, located in the higher elevation freshwater marshes that flank the major sloughs and in the extensive mainland estuaries. Restoration of more natural patterns of colonial wading bird nesting will require substantial increases in volumes of water flowing into the southern Everglades, re-establishment of longer hydroperiods in the higher elevation marshes, increased flows into the mainland estuaries, and re-establishment of nearly permanent flooding in the deeper central sloughs.

1913 - 1986

Maul, G. A., and D. M. Martin (1993) Sea level rise at Key West, Florida, 1846-1992: America's longest instrument record? Geophys. Res. Lett., 20(18):1955-8.

The continuous series of sea level at Key West, Florida commenced in 1913, but we have discovered sporadic measurements that date back to 1846. From records at the US Army Corps of Engineers and the U. S. Coast and Geodetic Survey, the sea level series has been connected to a Summary (common) Datum. Thus, a gappy record of monthly and annual mean heights (H[t]), perhaps the United States longest series over San Francisco (ca. 1854) or New York (ca. 1856), can be tested to ascertain if the rise in relative sea level at this site is stationary. Applying first and second order least squares and two-phase regression analyses, we find that dH/dt is 0.19 ± 0.01 cm yr^{-1}, and that $d^2H/dt^2 = [9.6 \pm 8.6]\ 10^{-3}$ cm yr^{-2}; the two-phase regression shows H[t] rising 0.15 ± 0.03 cm yr^{-1} before ca. 1925 and 0.23 ± 0.01 cm yr^{-1} afterwards. Neither the second-order regression coefficient nor d^2H/dt^2 nor the two-phase calculation are significant above the 75% confidence level, but all three are weakly consistent with accelerated rise. For the epoch 1951-1987, Key West sea level, corrected for post-glacial rebound, is best explained by concurrent measurements of 0 - 1,000 db dynamic height anomaly change.

1973 - 1976

Burpee, R. W. (1979) Peninsula-scale convergence in the south Florida sea breeze. Mon. Wea. Rev., 107:852-60.

Computations of peninsula-scale convergence in southern Florida reveal that daily-averaged surface convergence on sea-breeze days with relatively little rainfall is larger than on days with widespread rain. This negative correlation between surface convergence and area-averaged rainfall occurs as a result of significantly less surface convergence in the late afternoon and early evening on those days with considerable rainfall. The decrease in sea-breeze convergence during the late afternoon of the days with extensive rainfall is apparently a consequence of the downdrafts and thunderstorm-generated cirrus cloud cover produced by the deep convection that forms in the sea-breeze convergence zones. Before the typical mid afternoon maximum of deep convection on sea-breeze days, there is no significant difference between the surface convergence averaged for days with widespread rain and for days with little rain. Important differences are observed, however, in the middle troposphere, where the sea-breeze days with widespread rain are more moist and have cooler temperatures than the days with little or no rain. The observations suggest that both the magnitude and timing of the convective response to the sea-breeze forcing during the afternoon are very sensitive to the moisture amount and stability in the mid troposphere. This report is based on data from the Key West, Miami and Tampa weather stations recorded from 1973 - 1976.

1973 - 1976

Burpee, R. W., and L. Lahiff (1984) Area-average rainfall variations on sea-breeze days in south Florida. Mon. Wea. Rev., 112:520-34.

Summer convective regimes over south Florida can be broadly classified as either sea breeze or disturbed. Sea-breeze circulations develop on one or both coasts on most days with relatively little high cloudiness during the morning hours. The sea breeze strongly modulates the development of deep convection and produces sharp mid afternoon peak in rainfall. Disturbed days, which are characterized by extensive high cloudiness near sunrise, also have a rainfall maximum during the afternoon. Relationships between rainfall and thermodynamic and kinematic variables on disturbed and sea-breeze days have some significant differences. Comparison rainfall records from the south Florida peninsula with observations from the Florida Keys, where sea-breeze circulations are relatively weak, indicates that the sea breeze accounts for about 35-40% of south Florida peninsula rainfall during the summer months. Area-averaged rainfall and the time variations of peninsula-scale surface divergence and hourly rainfall sea-breeze days are affected by the value of mid tropospheric humidity, and lower tropospheric lapse rate, wind speed, and wind direction measured at 0700 EST. Days with relatively high humidity and steep lapse rates typically have deep convective activity that tends to develop sooner and reach its peak earlier than normal. Also, on such days surface convergence is significantly less than average in the late afternoon and early evening. Physical and dynamical processes that might account for the smaller values of surface convergence in the late afternoon are discussed. The magnitude of the low-level wind speed (1000 - 800 mb) observed at 0700 EST does not greatly affect the timing of peninsula-scale rainfall. Sea-breeze days with weaker than average low-level wind speeds have relatively large values of surface convergence and more rainfall during the afternoon. There are two sea-breeze regimes for low-level wind speeds > 5 m s^{-1}. When the low-level wind blows parallel to the peninsula, sea-breeze circulation is strong and area rainfall is greater than average. When the wind blows across the peninsula, the sea breeze is absent or weak and rainfall is below average. This report is based on data from the Key West, Miami, Tampa and Cape Kennedy weather stations recorded from 1973 - 1976 and satellite data for the same time period.

1974 ◊

Heald, E. J., W. E. Odum, and D. C. Tabb (1974) Mangroves in the estuarine food chain. Environments of South Florida: Present and Past. Memoir 2. P. J. Gleason (ed.). Miami Geological Society, Coral Gables, FL. 182-91.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Discussion centers around the seemingly different roles of red and black mangroves in estuarine food chains. Red mangroves, the majority of which are intertidal or riverine, produce large quantities of detrital material upon which is based a good chain from microorganisms to top carnivores of sport and commercial value. Many black mangrove communities, by virtue of their location, are probably not significant exporters of detritus to adjacent estuaries. Their importance lies apparently in the mosquito killifish food chain culminating in the same top level carnivores as the red mangrove-based system.

1987 ◊

Moffler, M. D., and M. J. Durako (1987) Reproductive biology of the tropical-subtropical seagrasses of the southeastern United States. Fla. Mar. Res. Publ., 42:77-88

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Studies of reproductive biology in seagrasses of the southeastern United States have addressed descriptive morphology and anatomy, reproductive physiology, seed occurrence, and germination. *Halodule wrightii* Aschers., *Halophila engelmannii* Aschers., *Syringodium filiforme* Kutz., and *Thalassia testudinum* Banks ex Konig are dioecious; *Halophila decipiens* Ostenfeld and *Ruppia maritima* L. are monoecious. In *Halop johnsonii* Eiseman, only female flowers are known. With the exception of *R. maritima,* which has hydroanemophilous pollination, these species have hydrophilous pollination. Recent reproductive-ecology studies suggest that reproductive patterns are due to phenoplastic responses and/or genetic adaptation physico-chemical environmental conditions. Laboratory and field investigations indicate that reproductive periodicity is temperature controlled, but proposed mechanisms are disputed. Water temperature appears to influence floral development and may be important in determining subsequent flower densities and fruit/seed production. Flowering under continuous light in vitro, suggests that photoperiod plays a limited role in floral induction. Flower expression and anthesis, however, may be influenced by photoperiod. Floral morphoontogenetic studies of *T. testudinum* field populations demonstrated the presence of early-stage inflorescence during short- and long-day photoperiods, further suggesting day neutrality in this species. High initial reproductive efforts, annual variation in male sex expression, secondary sex characters, and possible interaction of ramet age with sex expression have also been detected.

1993 ◊

Rood, B. E., J. Delfino, J. Gottgens, C. Earle, T. Crisman, L. Garcia, and N. Ushakoff (1993) Increased mercury accumulation rates in Florida Everglades sediment. American Chemical Soc., Natl. Mtg., Denver, CO. Abs., ACS, 205(1-2):ENVR32.

[ABSTRACT ONLY, DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] This study of Hg in Everglades sediment was initiated after elevated fish Hg levels were identified from this region. The goal of this study was to determine: (1) baseline historic Hg concentrations, (2) chronological changes in Hg accumulation rates, and (3) spatial distribution of Hg. Rates of accumulation have increased as much as ten-fold from pre-1990 conditions. Presently, no spatial distribution pattern is apparent. The Everglades are distinctly different in structure, function, geographical, and climatologic conditions from other described systems, yet the sediment profiles suggest that Hg accumulation in the Everglades is similar to such patterns reported elsewhere.

1994 ◊

Bancroft, G. T., A. M. Strong, R. J. Sawicki, W. Hoffman, and S. D. Jewell (1994) Relationships among wading bird foraging patterns, colony locations, and hydrology in the Everglades. In: Everglades: The Ecosystem and Its Restoration. S. M. Davis and J. C. Ogden (eds.) St. Lucie Press, Delray Beach, FL.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Restoration of wading bird breeding populations in the Everglades requires a better understanding of the relationships among wading bird foraging patterns, colony locations, and hydrology. To address this need, general foraging distribution data from systematic aerial surveys, specific foraging distribution data obtained from following flights, habitat data from the USGS orthophotomaps, hydrological data from gauges and aerial surveys, and coloney location, size, and sucess data from three recent studies were analyzed. Nesting great egrets (*Casmerodius albus*) and white ibises (*Eudocimus albus*) typically foraged within 9 and 10 km, respectively, of their colonies. Historically, these species bred in large, mixed-species colonies in the mangrove zone of Everglades National Park, whereas currently they breed in much smaller colonies in the water Conservation Areas. The persisting historic colonies in the mangrove zone are surrounded by a diverse mosaic of habitats and generally have a smaller percentage of freshwater habitats. In the Water Conservation Areas, great egret and white ibis foraging distributions varied within and among years and were generally correlated with differences in water depth and distribution. Comparison of colony location and size with overall foraging distributions during the months overlapping breeding indicated that colony location for these two species was only a marginal predictor of the location of food resources at the time when they were feeding young. Examination of the formation, growth and decline of the L-67 colony in the Water Conservation Areas during the drought year 1989 showed that, initially, the nesting birds were feeding close to the colony. As the area dried out, the overall foraging distribution shifted well south of the colony. Nesting birds gradually had to fly farther to find foraging sites, and the colony experienced high levels of nest abandonment. It can be concluded that wading birds initiate nesting near foraging aggregations, feeding on large and concentrated prey bases near suitable nesting sites, at physiologically appropriate times of year. These simple cues, however, may no longer be adequate indicators of foraging sites that will provide food for the 3 - 4 months needed to complete nesting. In addition to influencing the patterns and timing of water flows, it is likely that water management has aggravated the effects of dry season rainfall by increasing the severity and duration of reversals, creating pulsed regulatory releases and reducing water levels so that a given rainfall event has a greater diluting effect. The compartmentalization of the Everglades may have decreased the ability of forage fish to migrate through the system, especially into the deeper sloughs during the dry season, thus decreasing the productivity of these areas for nesting wading birds. The extent of wetlands should be maximized by restoring degraded marshes wherever possible. The natural connectivity in the system should be increased by reducing compartmentalization and the critical features of natural hydrology should be replicated, especially in the northern ends of the Water Conservation Areas and Shark River Slough. Additionally, the hydrology and productivity of the lower Shark River Slough wetlands and the associated estuaries should be analyzed more thoroughly, and peak flows out of Water Conservation Area 3A and Shark River Slough should be increased to improve habitats in the areas from Nine

Mile and Paurotis ponds to Watson, North, and Roberts rivers and into the headwaters of Gum, Dixons, Lostmans, and East Slough.

1994 ◊

Frederick, P. C., and G. V. N. Powell (1994) Nutrient transport by wading birds in the Everglades. In: <u>Everglades: The Ecosystem and Its Restoration</u>. S. M. Davis and J. C. Ogden (eds.) St. Lucie Press, Delray Beach, FL.

[DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] The effect of nutrient accumulation resulting from deposition of feces in colonies of colonially breeding and roosting wading birds is estimated in this chapter for breeding and non breeding ciconiiform birds in the Everglades ecosystem, by modeling energy consumption and feces deposition rates and by using existing measurements of size, energy, and nutrient content of prey items from the Everglades. Current populations of breeding and non breeding birds are estimated to consume 4.9 fewer tons of prey (dry mass) per year than the much larger populations of the 1930s and 1940s, equivalent to an estimated 14.6 million fewer prey items per year. This difference translates into 455 fewer tons of feces deposited in roosts and colonies per year, roughly equivalent to 59 fewer tons nitrogen and 5.6 fewer tons phosphorus. Non-breeding birds are estimated to account for only 1.5% of the difference in nutrient flux attributable to birds between the two periods, indicating that the differences are due to reductions in energyintensive breeding attempts. Although even the largest historical populations are estimated to have redistributed only a very small fraction of the total annual deposition of phosphorus and other nutrients in the marsh, loading rates at colonies can be extremely high. Loading rates at historical colony sites could have been as high as 120 g P m^{-2} yr^{-1} (approximately 3000 times the estimated historic atmospheric deposition rate), while current colonies are estimated to have rates of only 0.9 g P m^{-2} yr^{-1} (more than 20 times the historic atmospheric deposition rate). Evidence from the Everglades and other ecosystems suggests that high nutrient concentrations in the vicinity of colonies has a strong effect on the productivity and species composition of aquatic fauna and flora. This may have strong feedback effects for survival of young wading birds, which characteristically develop foraging skills at or near colony sites. Recent relocation of large colonies from the estuarine zone to the freshwater Everglades implies that nutrient input to the estuary has decreased significantly. Nutrient-rich colonies probably serve as islands of refugia for nutrient-tolerant species in the oligotrophic Everglades and may serve to significantly affect the variability in biodiversity of the marsh. Sources of error tend to be in the direction of overestimation of nutrients transported, and in this regard, the amount of food required by nestlings is a central and poorly understood variable.

1994 ◊

Guentzel, J. L., W. M. Landing, and C. D. Pollman (1994) Atmospheric deposition of mercury in Florida: the FAMS Project (1992-1993). Abs., ASLO/PSA Joint Mtg., Miami, FL. a-31.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] A five year study focusing on the atmospheric deposition of Hg and other trace elements in central and south Florida has been initiated. One of the primary objectives of the study is to determine the total pluvial flux of Hg and its partitioning into wet and dry components. Total metal deposition is collected at monthly intervals using continuous bulk deposition samplers. Wet deposition is collected by hand during individual storm events and monthly using a modified version of the automated Aerochem Metrics wet\dry deposition sampler. Preliminary calculations suggest that the atmospheric flux of Hg is seasonal, with the highest fluxes occurring during the summer months. There does appear to be a slight geographic trend, with the depositional fluxes being lowest in central Florida and increasing towards the south. Annual volume weighted fluxes for the five stations are, central Florida; Lake Barco 13 μg Hg m^{-2} yr^{-1}, South Florida; Ft. Myers 19 μg Hg m^{-2} yr^{-1}, Fakahatchee Strand 20 μg Hg m^{-2} yr^{-1}, Tamiami Trail 21 μg Hg m^{-2} yr^{-1}, and Everglades Research Station 25 μg Hg m^{-2} yr^{-1}.

1994. ◊

Hanisak, M. D., and S. L. Miller (1994) Spatial and temporal variability in the elemental composition of benthic macroalgae in the Florida Keys. Abs., ASLO/PSA Joint Mtg., Miami, FL. a-33.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Macroalgae are sensitive integrators of nutrients in coastal ecosystems. The nutrient status of representative field-collected macroalgae is being assessed at a series of stations in the Florida Keys. Preliminary analyses indicate considerable differences among the nitrogen contents of the dominant algal taxa. Nitrogen levels are higher for algae growing in sediment [e.g., *Penicillus* (mean = 2.8% N) and *Avrainvillea* (mean = 3.5% N)] than algae that do not [e.g., *Laurencia* (mean = 1.2% N) and *Dictyota* (mean = I .4% N)]. We hypothesize that, just as seagrasses do, these macroalgae are deriving nutrients from sediments rather than from, or in addition to, the water column. Temporal (i.e., seasonal) and spatial variability (nearshore vs. offshore, upper vs. middle Keys) in the N and P tissue contents also occur. This study will document ecosystem-level inputs of nutrients throughout the Keys, will determine if anthropogenic sources of nutrients cause pollution "hot spots", and will help support or refute recent claims that nutrient eutrophication significantly impacts the Florida Reef Tract.

1994 ◊

Kotra, R. K., L. P. Gough, W. H. Orem, and E. C. Spiker (1994) Geochemical studies of South Florida wetlands. Abs., ASLO/PSA Joint Mtg., Miami, FL. a-41.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] South Florida is an environmentally sensitive region of rapid population growth. Agricultural activities, residential development, and historical water management practices all affect drainage patterns and are potential sources and agents of stress on wetland ecosystems. Our geochemical studies are in support of south Florida earth science projects, including: geologic mapping, water quality assessments, and environmental investigations. In cooperation with the National Park Service, samples of water, sediment, soil, peat, and biota are being characterized to understand the biogeochemical cycling and flux of several important elements (e.g. C, N, S, P, Hg, and As) which may be impacting south Florida wetland ecosystems. We are focusing our efforts on organic rich materials, particularly peat. Preliminary results show related levels of Hg (up to 240 ng g^{-1}) in peat cores from a variety of wetland ecosystems and from recent sediment samples from several locations in south Florida. Sawgrass from wetlands and bromeliads from cypress swamps did not contain unusually high levels of mercury. Biogeochemical factors (such as peat biodegradation and oxidation) which may be influencing the distribution and cycling of Hg and other elements are being investigated.

1994 ◊

Rood, B. E., J. F. Gottgens, and J. J. Delfino (1994) Spatial and temporal distribution of mercury and other trace metals in Florida Everglades flooded soils. Abs., ASLO/PSA Joint Mtg., Miami, FL. a-63.

[ABSTRACT ONLY. DATE OF SAMPLING UNKNOWN OR NOT APPLICABLE.] Elevated Hg concentrations were identified previously in freshwater fish in the Florida Everglades. The goals of this research were to determine the spatial distribution of mercury in Everglades soils and to identify temporal changes of Hg accumulation since the turn of the century. Soil cores or grab samples were retrieved from sixty locations in the Everglades. Seventeen cores were dated after radionuclide assay for ^{210}Pb and ^{137}Cs.

The average Hg concentration in surface sediment (0 - 4 cm) of 121 ng g^{-1} was 2.5 times higher than corresponding deep sediment (11 - 17 cm) concentrations. Post-1985 Hg accumulation rates averaged 53 µg m^{-2} y^{-1} corresponding to a 6.4 (1.6 - 19.1, n = 18) times rate increase since the year 1900. Mercury accumulation rates increase starting about 1940, due perhaps to mid-century alteration of the hydrologic structure of the Everglades, and to increased agricultural and urban development to the north and east. Further, the findings are similar to trends reported for lakes in Sweden, Minnesota, and Wisconsin, perhaps, indicating a global process that leads to similar accumulation rates over widely varying geographic regions.

APPENDIX II

Historical events and studies

[Chronological sequence from 1910 is by date of sampling (if known) or in the case of calculated or inferred parameters by the earliest date determined. Geological studies describing formation of geological features in the area are listed by publication date. Publication date of a paper or report are noted with a diamond next to the year of publication. The study dates are shown in a common time line in Appendix III.]

II.1. Global atmospheric, geological and astronomical phenomena

10-93	Hurricanes
10-93	Solar sunspot cycle
10-93	El Niño events
10-93	Volcanoes

II.2. General papers

54 ◊	Gulf of Mexico (Galtstoff, 1954)
73 ◊	Eastern Gulf of Mexico (Jones *et al.*, 1973)
72 ◊	Gulf of Mexico estuarine inventory (McNulty *et al.*, 1972)
82 ◊	Gulf coast ecological inventory (Beccasio *et al.*, 1982)
84 ◊	Florida estuaries (VanArman, 1984)
20 ◊	Florida ecology (Simpson, 1920)
26 ◊	South Florida ecology (Dimock, 1926)
70-74	Environment of South Florida (McPherson *et al.*, 1976)
43 ◊	Natural features and vegetation of southern Florida (Davis, 1943)
78-80	Vegetation of the southern coastal region of Everglades (Olmstead *et al.*, 1981)
89 ◊	Ecosystem research and resource management (Livingston, 1989)
81 ◊	Role of underwater parks and sanctuaries in the management of coastal resources (Davis, 1981)
83 ◊	Everglades National Park (Hendrix and Morehead, 1983)
59 ◊	Research in marine areas of Everglades National Park (Wallis, 1959)
73 ◊	Effects of natural forces on the Everglades (Craighead, 1973)
77-81	Calorific relationship of Everglades animals (Kushlan *et al.*, 1986)
78 ◊	Energy analysis of Everglades National Park (DeBellevue *et al.*, 1978)
57-62	Ecology of Florida Bay (Tabb *et al.*, 1962)
82 ◊	Ecology of Florida Bay (Schomer and Drew, 1982)
94 ◊	Florida Bay economy and changing environmental conditions (Gorte, 1994)

II.3. Climatology

10-68	Summary of climatological records (Thomas, 1970)
74 ◊	Summary of climatological records (Thomas, 1974)
92 ◊	Climate change and tidal flat ecosystems (Cubit, 1992)
94 ◊	Climate change and tidal flat ecosystems (Cubit, 1994)
52-79	Rainfall estimates in Shark Slough (Lew *et al.*, 1982)
10-89	Florida precipitation and El Niño (Hanson and Maul, 1991)
69, 71	Beaches and ground water of Cape Sable during extreme drought (Russel, 1971)
77	Cold water stress (Roberts *et al.*, 1982)

77	Cold water stress (Roberts *et al.*, 1983)
76-77, 79-81	Cold air outbreaks effects on coral reefs (Walker, 1982)
81	Cold-air outbreak event (Walker *et al.*, 1982)
81 ◊	Cold water kill (Walker, 1981)
74 ◊	Hurricanes in South Florida (Gentry, 1974)
19-89	Hurricanes in Florida Bay (Meeder and Meeder, 1989)
60	Hurricane Donna (Craighead and Gilbert, 1962)
60	Hurricane Donna (Tabb and Jones, 1962)
60	Effects of Hurricane Donna (Ball *et al.*, 1967)
60, 65	Hurricanes Betsy and Donna (Perkins and Enos, 1968)
92	Hurricane Andrew's effect on marine resources (Tilmant *et al.*, 1994)

[Published works on Hurricane Andrew listed under seagrasses, mangroves, crustaceans.]

II.4. Geology

II.4.1. Field guides

57-74	Okefenokee Swamp and Everglades mangrove swamp (Spackman *et al.*, 1974)
62-66	Field guidebook of Everglades (Kolipinski *et al.*, 1967)
64 ◊	Field guide to coal formation environments (Spackman *et al.*, 1964)
72 ◊	Field guide to carbonate sediments (Ginsburg, 1972)
75 ◊	Field guide (Multer, 1975)

II.4.2. General/descriptive

29 ◊	Geology of Florida (Cooke and Mossom, 1929)
44 ◊	Late Cenozoic geology (Parker and Cooke, 1944)
67 ◊	Geological history (Scholl and Craighead, 1967)
73 ◊	Geological inventory of Cumberland Island (University of Georgia, 1973)
74 ◊	Geology (Hoffmeister, 1974)
88 ◊	Geological history (Merriam, 1988)
89 ◊	Geology overview (Merriam, 1989)
94 ◊	South Florida geological environment (Ginsburg and Shinn, 1994)
77 ◊	Depositional framework of Pleistocene rocks (Perkins, 1977)
67 ◊	Miami limestone (Hoffmeister *et al.*, 1967)
80 ◊	Deposition history of Miami limestone formation (Mitchell-Tapping, 1980)
28-94	Evolution of the southwest Florida coastline (Frederick *et al.*, 1994)
91 ◊	Bedrock topography (Lidz and Shinn, 1991)
84	Recent carbonate sedimentation and major subenvironments (Sengupta, 1985)
85 ◊	Definition of major sub-environments (Sengupta and Merriam, 1985)
89 ◊	Definition and implications of the subenvironments (Merriam *et al.*, 1989)

II.4.3. Evolution/development/stratigraphy

84 ◊	Holocene evolution of mangrove islands (Quinn, 1984)
89 ◊	Holocene bank development (Mukherki, 1989)
89 ◊	Holocene evolution of coast and islands (Cottrell, 1989)
89 ◊	Holocene evolution of keys (Cottrell, 1989)
94 ◊	Holocene environmental history of carbonate banks (Wanless *et al.*, 1994)
85, 87	Stratigraphy of Pleistocene bedrock (Fuhr, 1988)
89 ◊	Pleistocene bedrock geology (Merriam *et al.*, 1989)

74 ◊	Neogene stratigraphy (DuBar, 1974)
90 ◊	Patch reefs of the Pleistocene (Textoris, 1990)
88 ◊	Evolution of Florida Bay islands (Quinn and Merriam, 1988)
94 ◊	Florida Keys reefs (Shinn *et al.*, 1994)
68 ◊	Subaerial laminated crusts (Multer and Hoffmeister, 1968)
74 ◊	Mangrove sedimentation (Wanless, 1974)
76	Stratigraphy of Cluett Key (Videlock, 1983)
79 ◊	Evolution of Bay from island stratigraphy (Enos and Perkins, 1979)
80 ◊	Lagoon stratigraphy (Enos, 1980)
81 ◊	Mangrove swamp stratigraphy (Woodroffe, 1981)
85, 88	Stratigraphy and depositional history of the Pleistocene bedrock (Textoris, 1988)
89 ◊	Recent sediments and key stratigraphy (Merriam and Quinn, 1989)
89 ◊	Storm generated stratification during the Holocene (Galli, 1989)
76	Ground water on small carbonate islands (Halley and Steinen, 1979)
76 ◊	Coastal change at Cape Sable (Smith and Roberts, 1976)
90 ◊	Computer modeling of the internal architecture of carbonate platforms (Bosence and Waltham, 1990)

II.4.4. Sea level rise

12-88	Sea level and stability of wetlands (Wanless *et al.*, 1994)
67 ◊	Submergence curve (Scholl and Stuiver, 1967)
67 ◊	Submergence curve, discussion (Smith and Coleman, 1967)
67 ◊	Submergence curve, a reply (Scholl and Stuiver, 1967)
69 ◊	Submergence curve (Scholl *et al.*, 1969)
87 ◊	Computer simulation of sea level changes (Pike, 1987)

II.4.5. Sediments/Sedimentation

10 ◊	Sediments (Vaughn, 1910)
53-54	Laminated algal sediments (Ginsburg *et al.*, 1954)
57 ◊	Early diagenesis of carbonate sediments (Ginsburg, 1957)
64 ◊	Recent sedimentary records in mangrove swamps (Part 1) (Scholl, 1964)
64 ◊	Recent sedimentary records in mangrove swamps (Part 2) (Scholl, 1964)
71-73	Sediments (Grady, 1978)
72 ◊	Coastal sedimentation (Kerr, 1972)
73 ◊	Holocene dolomitization of supratidal sediments, Sugarloaf Key (Carballo, 1973)
74 ◊	Holocene sediments (Gleason *et al.*, 1974)
77 ◊	Holocene sedimentation at Cape Sable (Roberts *et al.*, 1977)
79 ◊	Physical sedimentation (Wanless, 1979)
66 ◊	Recent limestone formation (Scholl, 1966)
81 ◊	Sediments in Florida Bay basin (Tyson, 1981)
82 ◊	Paleoecological significance of *ovoidites* (Rich *et al.*, 1982)
52-54	Grain size and constituents in sediments (Ginsburg, 1956)
62-63	Sediment size distribution and chemistry (Lynts, 1966)
82	Processes affecting grain-size and chemical distribution (Sorensen, 1985)
85 ◊	Geochemical and grain-size distribution (Sorensen and Merriam, 1985)
62 ◊	Carbonate geochemistry and sedimentology (Gleece, 1962)
84	Water chemical properties and the water/sediment interface (Merriam *et al.*, 1985)
69 ◊	Silicate minerals (Manker and Griffin, 1969)
85	Carbonate production (Bosence, 1989)

85-87	Surface sublittoral sediment characteristics (Bosence, 1989)
71 ◊	Insoluble clay minerals (Manker and Griffin, 1971)
59	Unconsolidated carbonate sediments (Taft, 1962)
76	Acid insoluble sediment residues (Layman, 1977)
67-68	Silicate minerals in a carbonate environments (Manker, 1969)
63 ◊	Cation influence on recrystallization of carbonates (Taft, 1963)
63 ◊	Carbonate deposition environments (Gorsline, 1963)
91 ◊	Diagenesis of carbonate muds (Andrews, 1991)
67 ◊	Carbonate sediments (Taft, 1967)
74 ◊	Carbonate sediments (O'Brien *et al.*, 1974)
59, 62	Modern carbonate sediments (Taft and Harbaugh, 1964)
82	Carbonate sediments of Shell Key (Sorensen, 1985)
80-83	Sediments of Shell Key Basin (Merriam *et al.*, 1987)
67 ◊	Sediments of Cross Bank (Muller and Muller, 1967)
81 ◊	Carbonate sediments from Peterson Key Bank (Kick, 1981)
82 ◊	Carbonate mud banks desposition in Ramshorn Spit (Parks *et al.,* 1982)
85 ◊	Deposition of a carbonate mud spit Ramshorn Spit (Holliday, 1985)
85 ◊	Carbonate mud deposition (Holliday and Parks, 1985)
61 ◊	Mineralogy and early diagensis of carbonate sediments (Stehli and Hower, 1961)
85 ◊	Shallow water carbonate facies (Quinn and Merriam, 1985)
79 ◊	Endolithic infestation of carbonate substrates (May and Perkins, 1979)
88 ◊	Compaction of carbonate sediments (Knight, 1988)
70 ◊	Consolidation of carbonate muds (Morelock, 1970)
69-71	Carbonate tidal deltas (Charlton, 1981)
62 ◊	Mineralogy of carbonate sediments (Taft, 1962)
60	Carbonate sediment geochemistry (Fleece, 1962)
63 ◊	Carbonate geochemistry and sedimentology (Fleece and Goodell, 1963)
79 ◊	Carbonate sediments and anomalous sulfur content (Davies, 1979)
85	Carbonate budgets for carbonate mounds (Bosence, 1989)
63 ◊	Aragonite crystals (Studer, 1963)
67 ◊	Dissolution characteristics of carbonate minerals (Berner, 1967)
61 ◊	Dolomite in carbonate sediments (Taft, 1961)
62 ◊	Dolomite in carbonate sediments (Taft, 1962)
77 ◊	Holocene dolomite (Steinen *et al.*, 1977)
82 ◊	Diffusion coefficients in sediments (Ullman and Aller, 1982)
72 ◊	Sedimentology and ecology of a Recent carbonate facies mosaic, Cape Sable (Gebelein, 1972)

II.4.7. Sediment and interstitial water chemistry/composition

71 ◊	Analytical study of Caribbean carbonate sediments (Slack and Sites, 1971)
88 ◊	Dissolved B in sediment (Mackin and Aller, 1988)
62 ◊	^{14}C activity in dolimite (Deffeyes and Martin, 1962)
92 ◊	Sediment and water column nitrogen and phosphorus (Szmant and Forrester, 1992)
73 ◊	Organic carbon in modern carbonate sediments (Roberts *et al.*, 1973)
88, 90	Fluorine in carbonate sediment diagenesis (Rude and Aller, 1991)
77 ◊	Nitrogen diagenesis in nearshore anoxic sediments (Rosenfeld, 1977)
66 ◊	Magnesium interaction with sediments (Berner, 1966)
90 ◊	Fluorine and Sr stability during carbonate sediment diagenesis (Rude and Aller, 1990)
79 ◊	Ammonium in anoxic sediments (Rosenfeld, 1979)

81 ◊	Mangrove root intrusion and sulfur enrichment in peats (Raymond and Davies, 1981)
89-90, 92	Sediment sulfide and seagrass dieoff (Carlson *et al.*, 1994)
80	Geochemistry of I in sediments (Ullman and Aller, 1985)
89 ◊	Metals and nutrients in sediment (Ryan *et al.*, 1989)
85-87	Trace metals in sediment (Schropp *et al.*, 1990)
82 ◊	Trace metals in sediment (Manker *et al.*, 1982)
89 ◊	Trace metals in sediment (Windom *et al.*, 1989)
73-74	Metals in sediments and suspended particulates (Manker, 1975)
87 ◊	Hydrocarbons in carbonate sediments (Mitterer *et al.*, 1987)
82 ◊	Dissolved organic matter in sediment (Caughey, 1982)
77 ◊	Organic carbon interactions in sediment (Mitterer and Carter, 1977)
94 ◊	Organic matter in a dynamic carbonate sedimentary system (Frewin, 1994)
79 ◊	Amino acid diagenesis in anoxic sediments (Rosenfeld, 1979)
66	Decomposition of organic matter in sediments (Lee, 1969)
78 ◊	Amino acid composition of organic matter in sediments (Carter and Mitterer, 1978)
85 ◊	*In situ* and pyrolytic hydrocarbons in sediments (Dzou, 1985)
85	Interstitial water chemistry (Swart *et al.*, 1989)
79 ◊	Interstitial water chemistry (Rosenfeld, 1979)
88 ◊	Pore fluid chemistry (Knight, 1988)
94 ◊	Vertical fluxes resulting from bioirrigation (Tedesco, 1994)
87-89	Nutrients in interstitial water (Fourqurean *et al.*, 1992)

II.4.8. Mudbanks and basins

89 ◊	Physical characteristics of mudbanks (Powell *et al.*, 1989)
76 ◊	Depositional history of carbonate mudbank (Hovorka *et al.*, 1976)
86 ◊	Marine mudbank nucleation (Tagett and Wanless, 1986)
35-89	Evolution of mudbanks (Wanless and Tagett, 1989)
83 ◊	Marine banks and "rock reefs" (Jenkins, 1983)
89 ◊	Growth of carbonate mudbank (Tagett, 1989)
67 ◊	Development of the basin - basin honeycomb (Price, 1967)
78 ◊	Storm generated stratigraphy of carbonate mud banks (Wanless, 1978)
64 ◊	Cyclic cuspate sand spits and sediment transport (Price, 1964)
83 ◊	Relationship of geochemical, biological, and sedimentological parameters in basins (Sorensen, 1983)
71 ◊	Landward movement of carbonate mud (Ginsburg, 1971)
88	Water trapping by seagrasses (Powell and Schaffner, 1991)
84-86	Sediment, water level and temperature of grass-covered mudbanks (Holmquist *et al.*, 1989)
90 ◊	Biodetrital mud mounds (Bosence, 1990)
80 ◊	Arsenic Bank development (Aisner, 1980)
80 ◊	Development of Arsenic Bank (Aisner and Upchurch, 1980)
81 ◊	Genesis of Arsenic Bank (Aisner and Upchurch, 1981)
87 ◊	Tidal mudflat model (Mitchell-Tapping, 1987)
84-86	Ecology of shallow water bank habitats (Powell *et al.*, 1987)
58 ◊	Influence of marine bottom communities on depositional environments of sediments (Ginsburg and Lowenstam, 1958)

II.4.9. Peats

64-68	Petrology of peats (Cohen and Spackman, 1974)
78 ◊	Peats (Davies and Spackman, 1978)

79 ◊	Peat petrography and reconstruction of shoreline migrations (Davies, 1979)
72	Peat formation (Davies, 1980)
89 ◊	Composition and significance of peats (Davies and Cohen, 1989)
89 ◊	Petrographic/botanical composition of peats (Cohen and Davis, 1989)
64, 66-67	Sedimentary environments and environmental change in the peat-forming areas (Smith, 1968)
80 ◊	Palynology of the peats (Davies and Spackman, 1980)
71 ◊	Sulfur in peat (Given, 1971)
79 ◊	Sulfur in peat (Raymond and Davies, 1979)

II.5. Hydrography and suspended particulates

61-62	Marine geology and oceanography (Gorsline, 1965)
60-61	Hydrography (Goodell and Gorsline, 1961)
84	Paleosalinities (Ducommun and Burke, 1987)
56-58	Salinity (McCallum and Stockman, 1961)
57-62	Prediction of estuarine salinities (Tabb, 1967)
75-88	Decade trend in seawater salinity (Halley *et al.,* 1994)
92	Controls on salinity in Florida Bay islands (Kramer *et al.*, 1994)
57-59	Hydrographic data of inshore bays (Tabb *et al.*, 1959)
79-80	Hydrological study of Cross Key (Evink, 1981)
57-89	Quantitative observations of salinity (Robblee *et al.*, 1989)
89-91	Wind and tides (Wang *et al.*, 1994)
72 ◊	Water circulation (McCallum and Stockman, 1972)
94 ◊	Circulation (Wang, 1994)
89	Affects of wind, rain, and water releases on the water depth and salinity (Baratta and Fennema, 1994)
82 ◊	Surface transport of particulate matter (Zieman *et al.*, 1982)
67-68	Organic detritus production (Heald, 1969)

II.6. Water chemistry

10-77	Summary of water quality data (Schmidt and Davis, 1978)
92	Geochemistry of near-shore ground waters (Machusak and Kump, 1994)
86-87	O and H isotopic water composition (Swart *et al.*, 1989)
90 ◊	Carbon isotope variations in surface seawater (Walter *et al.*, 1990)
91 ◊	Marine geochemistry of F (Rude, 1991)
10-83	Lead in water based on corals (Shen and Boyle, 1987)
86-87	Nutrients in water from sewage (Lapointe *et al.*, 1990)
92 ◊	Nutrient inputs from the watershed and coastal eutrophication in the Florida Keys (Lapointe and Clark, 1992)
89-90	Nutrients and phytoplankton (Fourqurean *et al.*, 1993)
94 ◊	Salinity and nutrient cycling (Rudnick, 1994)
87	α-Keto acids (Kieber, 1988)
85	Glyoxylic and pyruvic acid in seawater (Kieber and Mopper, 1987)
79-81	Humic and fulvic acids in seawater (Brown, 1987)
84-85	Sulfide emissions (Cooper, 1986)

II.7. Freshwater management and soil subsidence

10-76	History of water management in South Florida (DeGrove, 1983)
10-82	Historical reconstruction of fresh water flow based on coral banding (Smith *et al.*, 1989)

67	Physical, biological, and geological character of the area south of C-111 Canal (Tabb *et al.*, 1967)
93 ◊	Water management in Taylor Slough (Van Lent *et al.*, 1993)
93 ◊	Restoration of Taylor Slough (Van Lent, 1993)
74 ◊	Predrainage hydrology (Parker, 1984)
84 ◊	Water management (Tebeau, 1984)
94 ◊	Changes in freshwater inflow from the Everglades to Florida Bay (McIvor *et al.*, 1994)
73-74	Effects of watershed management on the Shark Slough Whitewater Bay estuary (Davis and Hilsenbeck, 1974)
13-84	Soil subsidence in Everglades (Stephens, 1984)
74 ◊	Soil subsidence in Everglades (Stephens, 1974)

II.7. Biology

18-82	Benthic studies in the coastal and estuarine areas of Florida (Mahadevan *et al.*, 1984)
47-57	Existing information on marine ecology of Everglades (Tabb, 1963)
85 ◊	Florida aquatic habitat and fishery resources (Seaman, 1985)
57-60	Flora and fauna species list (Tabb and Manning, 1961)
64-68	Flora and fauna of Porpoise Lake (Hudson *et al.*, 1970)
64-68	Key habitat types (Enos, 1989)
86-87	Benthic communities along salinity gradients (Montague *et al.*, 1989)
86-87	Benthic vegetation and salinity fluctuations (Montague and Ley, 1993)

II.7.1. Microorganisms

93 ◊	Viral abundance (Paul *et al.*, 1993)
53	Foraminifera (Moore, 1957)
58-63	Foraminifera handbook (Bock, 1971)
58, 60	Distribution of Recent foraminifera (Lynts, 1962)
61 ◊	Foraminifera (Bock, 1961)
61 ◊	Foraminifera (Lynts, 1961)
62-63	Foraminifera in Buttonwood Sound (Lynts, 1971)
62	Foraminifera standing crop in Buttonwood Sound (Lynts, 1966)
63	Foraminifera in lower Florida Bay (Smith, 1971)
64 ◊	Recent foraminifera (Smith, 1964)
65 ◊	Foraminifera (Lynts, 1965)
77 ◊	Foraminifera (Lidz and Rose, 1989)
77 ◊	Foraminifera (Steinker, 1977)
77 ◊	Foraminifera in Buttonwood Sound (Schold, 1977)
78 ◊	Foraminifera (Crapon de Caprona, 1978)
79 ◊	Foraminifera (Tisserand Delclos, 1979)
82, 85-87	Larger foraminifera and stable isotopes (Brasier and Green, 1993)
93 ◊	Foraminifera (Hallock and Peebles, 1993)
77 ◊	Paleoenvironmental history based on foraminiferida (Vander Kooi, 1977)
74	Benthic diatom assemblages (DeFelice and Lynts, 1978)
79 ◊	Benthic diatom assemblages (DeFelice and Lynts, 1979)
82 ◊	Diatom communities (DeFelice, 1982)
80 ◊	Epiphytic diatoms (DeFelice and Lynts, 1980)
74	Model studies of epiphytic diatoms (DeFelice, 1975)
75 ◊	Model studies of epiphytic and epipelic diatoms (DeFelice, 1975)
47	Plankton (Davis, 1950)
47-48	Brackish water plankton (Davis and Williams, 1950)

47	Plankton (Davis, 1949)
49	Plankton (King, 1949)
94 ◊	Phytoplankton standing crop and composition (Philips and Badylak, 1994)
54-57	Red tide (Finucane and Dragovich, 1959)
55-57	Red tide distribution and occurrence (Finucane, 1964)
89 ◊	Chemical differences among two fossil ostracoda (Burke and Bischoff, 1989)

II.7.2. Flora

30 ◊	Vegetation and erosion (Small, 1930)
83-85	Distribution and abundance of benthic vegetation (Zieman and Fourqurean, 1985)
86	Fresh and ocean water utilization by coastal plants (Sternberg and Swart, 1987)
86-88	Submerged vegetation and salinity gradients (Montague *et al.*, 1989)

II.7.2.1. Algae

76 ◊	Benthic marine algae (Woelkerling, 1976)
81 ◊	Macroalgal seasonality in *Batophora*-dominated communities (Morrison, 1981)
79, 83-84	Seagrasses and macroalgae (Zieman *et al.*, 1989)
64-67	Ecology of microalgae (Wood and Maynard, 1974)
78-80	Seasonality of macroalga (Morrison, 1984)
83-84	Macroalgae production and nutrients (Lapointe, 1989)
72 ◊	Calcium oxalate crystals in green algae (Friedman *et al.*, 1972)
72 ◊	Aragonite in algae (Perkins *et al.*, 1972)
59-61	Production of lime mud by algae (Stockman *et al.*, 1967)
94 ◊	Pigment and spectral analysis of seagrass and algal blooms (Reese and Richardson, 1994)

II.7.2.2. Seagrass

82 ◊	Ecology of the seagrass community (Zieman, 1982)
87 ◊	Isotopic investigations of food webs in seagrass meadows (Fry *et al.*, 1987)
94 ◊	Seagrass communities model (Fong and Harwell, 1994)
87 ◊	Seagrass biology and distribution (Zieman, 1987)
74-80	Seagrass distribution (Iverson and Bittaker, 1986)
87 ◊	Seagrass dynamics (Dawes, 1987)
89 ◊	Nutrient exchange study in seagrass banks (Childers, *et al*, 1989)
87-89	Phosphorus limitation of primary production (Fourqurean *et al.*, 1992)
83-87	Experimental evidence for nutrient limitation of seagrass growth (Powell *et al.*, 1989)
94	Seagrass C:N:P ratios as indicators of nutrient availability (Frankovich *et al.*, 1994)
83-84	Seagrass enrichment by bird colonies (Powell *et al.*, 1991)
92 ◊	Resource availability in seagrass communities (Fourqurean, 1992)
91 ◊	Carbon budget for *Thalassia* (Fourqurean and Zieman, 1991)
83	Calcium carbonate production by *Thalassia* (Nelsen and Ginsburg, 1986)
91-92	Carbonate production by *Thalassia* (Frankovich and Zieman, 1994)
89 ◊	Fungi and slime molds in the die-back of seagrasses (Porter and Muehlstein, 1989)

93 ◊	Seagrasses and slime mold (Porter, 1993)
94 ◊	Seagrasses and slime mold (Durako and Kuss, 1994)
76 ◊	Seagrass damage from motor boats (Zieman, 1976)
87 ◊	Human impact on seagrasses (Livingston, 1987)
40-87	Restoration of seagrass meadows (Lewis, 1987)
89 ◊	Morphoanatomical characteristics and recovery potential of *Thalassia* (Durako, 1989)
90-91	Seagrass dieoffs and plant communities (Thayer *et al.*, 1994)
87-90	Mass mortality of *Thalassia* (Robblee *et al.*, 1991)
87-88	Seagrass die-off (Zieman *et al.*, 1988)
72, 87, 89	Remote monitoring of seagrass die off (Thompson and Robblee, 1989)
90-92	Community response to seagrass die-off (Sheridan, 1994)
89 ◊	Sediment sulfide and seagrass dieoff (Yarbro *et al.*, 1989)
89-90	*Thalassia* mortality and sediment sulfide (Carlson *et al.*, 1990)
93 ◊	Seagrass die-off and interstitial water chemistry (Barber and Carlson, 1993)
92 ◊	*Thalassia* dieoff and climate (Zieman *et al.*, 1992)
92 ◊	Role of climate in the Florida Bay seagrass dieoff (Zieman *et al.*, 1992)
94 ◊	Role of climate in the Florida Bay seagrass dieoff (Zieman *et al.*, 1994)
92	Effects of Hurricane Andrew on *Thalassia* and the stratigraphic record (Meeder *et al.*, 1994)
94 ◊	Hypothesis for seagrass die-off (Tomasco and Lapointe, 1994)
84	Seagrass transplantation, (Fonseca *et al.*, 1987)
94 ◊	Model of seagrass dieoff (Zieman, 1994)

II.7.2.3. Mangroves

82 ◊	Ecology of mangroves (Odum *et al.*, 1982)
89 ◊	Ecology of mangroves (Snedaker, 1989)
45-59, 91	Patterns of deforestation and fragmentation of mangrove and decidous seasonal forests (Strong and Bancroft, 1994)
93 ◊	Climate change impact on mangroves (Snedaker, 1993)
36-38	Ecology and geologic role of mangroves (Davis, 1940)
86	Mangrove seed predation (Smith *et al.*, 1989)
85 ◊	Red mangrove prop root habitat (Thayer *et al.*, 1985)
84-85	Red mangrove root habitat (Thayer *et al.*, 1987)
88-89	Changes in freshwater flow and use of mangrove prop root habitat by fish and invertebrates (Ley and Montague, 1989)
74 ◊	Mangroves in the estuarine food chain (Heald et al., 1974)
64 ◊	Mangroves and hurricanes (Craighead, 1964)
72	Mercury in mangrove detritus (Lindberg and Harris, 1974)
92	Hurricane Andrew, mangroves, and lightning (Smith *et al.*, 1994)

II.7.3. Fauna

92 ◊	Freshwater flow and use of mangrove root habitat (Ley, 1992)
84-85	Faunal communities and vegetation in selected marine habitats (Thayer *et al.*, 1987)
67-69	Endolithic organisms (Green, 1975)
73	Macrofauna in *Thalassia* community (Brook, 1978)
89 ◊	Changes in benthic fauna associated with seagrass die-off (Robblee, 1989)
71-73	DDT, dieldrin and heavy metals in upper food chain (Ogden *et al.*, 1974)
66-67	Suction sampler for benthic organisms (Allen and Hudson, 1970)

II.7.3.1. Corals, sponges, mollusks

87 ◊	Invertebrates in seagrasses (Virnstein, 1987)
10-94	Natural and anthropogenic variations based on O and C isotopes in coral (Swart *et al.*, 1994)
44-74	Coral growth and C and O isotopes (Emiliani *et al.*, 1978)
10-86	Coral growth perturbations (Hudson *et al.*, 1989)
73 ◊	Growth habits and ecology of the stony corals from Don Quixote Bank (Chase, 1973)
92	Coral black band disease (Kuta and Richardson, 1994)
82 ◊	Thermal stress of coral reefs (Walker *et al.*, 1982)
40-77	Sponge harvest (Stevely *et al.*, 1978)
91-92	Sponge mass mortality, juvenile lobsters and Hurricane Andrew (Butler *et al.*, 1994)
53-58	Molluscan distribution (Turney and Perkins, 1972)
89 ◊	Mollusks in sediment (Shaw, 1989)
92 ◊	Epibenthic gastropods (McClanahan, 1992)
92 ◊	Population estimates of gastropods (McClanahan and Muthiga, 1992)
88 ◊	Chiton species (Lyons, 1988)
58-59	Oxygen and carbons isotopes in mollusks (Lloyd, 1964)
60 ◊	Oxygen and carbons isotopes in mollusks (Lloyd, 1960)

II.7.3.2. Echinoderms

58	Distribution and salinity tolerance of the amphiurid brittlestar (Thomas, 1961)
59 ◊	Brittle stars (Thomas, 1959)
65-66	Growth rate of seastar (Halpern, 1970)

II.7.3.3. Amphipods, shrimp, crabs, lobster

70 ◊	Littoral crustacea (Rouse, 1970)
84-85	Decapods and stomatopods (Holmquist *et al.*, 1989)
84-86	Decapods and stomatopods (Holmquist *et al.*, 1989)
66 ◊	Ostracoda of the Vaca Key (Kontrovitz, 1966)
60-64	Lancelots (Pierce, 1965)
58-59	Palaemonid shrimp (Manning, 1961)
57-62	Pink shrimp biology (Tabb *et al.*, 1962)
58-59	Migration, mortality and growth of pink shrimp (Costello and Allen, 1959)
58-59	Pink shrimp migration and growth (Costello and Allen, 1961)
58-63	Geographic distribution of pink shrimp (Costello and Allen, 1966)
58-64	Releases and recoveries of marked pink shrimp (Allen and Costello, 1966)
59-62	Early stages of the pink shrimp (Jones *et al.*, 1970)
60 ◊	Early life history of pink shrimp (Dobkin, 1960)
63-65	Prediction of success of commercial shrimp fishing (Yokel *et al.*, 1969)
63	Food of juvenile migrating pink shrimp (Sastrakusumah, 1971)
63	Pink shrimp abundance (Idyll *et al.*, 1965)
64-65	Migrating juvenile pink shrimp in Buttonwood Canal (Beardsley, 1967)
64-65	Migrating juvenile pink shrimp in Buttonwood Canal (Beardsley, 1970)
64	Pink shrimp life history (Costello and Allen, 1965)
65-67	Catches of post larval pink shrimp in Everglades and commercial catches at Tortugas (Roessler and Rehrer, 1971)
65-67	Catches of post larval pink shrimp in Everglades and commercial catches at Tortugas (Roessler *et al.*, 1969)

65-67	Pink shrimp study (Costello and Allen, 1968)
65-68	Pink shrimp (Costello *et al.*, 1986)
65-68	Pink shrimp study (Costello and Allen, 1969)
65	Pink shrimp study (Costello and Allen, 1966)
65 ◊	Shrimp fisheries and freshwater (Idyll, 1965)
66-67	Abundance of pink shrimp on nursery grounds (Idyll *et al.*, 1968)
66-68	Post larval shrimp (Allen *et al.*, 1980)
66-81	Pink shrimp fisheries (Browder, 1985)
67-68	Morphometric and meristic study of postlarval brown, white and pink shrimp (Chuensri, 1968)
67	Pink shrimp migration and catch (Idyll and Roeslerr, 1968)
67	Pink shrimp study (Costello and Allen, 1968)
67	Seasonal changes in abundance of postlarvae of pink shrimp (Idyll and Roeslerr, 1968)
67 ◊	Activity of juvenile pink shrimp (Wickham, 1967)
67 ◊	Fishes and juvenile stages of pink shrimp from Buttonwood Canal (Yokel *et al.*, 1967)
68 ◊	Substrate emergence of pink shrimp (Hughes, 1968)
69 ◊	Endogenous control of swimming in pink shrimp (Hughes, 1969)
69 ◊	Tidal transport mechanism of pink shrimp (Hughes, 1969)
69 ◊	Tide-associated movements of pink shrimp (Hughes, 1969)
70 ◊	Migration of pink shrimp from Everglades to Tortugas (Yokel, 1970)
70 ◊	Synopsis of biological data on pink shrimp (Costello and Allen, 1970)
72 ◊	Tide-associated displacements of pink shrimp (Hughes, 1972)
81-86	Pink shrimp abundance (Robblee and Tilmant, 1989)
83-84	Caridean shrimp (Larson and Ramus, 1984)
83 ◊	Pink shrimp life history (Bielsa *et al.*, 1983)
82	Geographical variation, biology and hydridization of crabs (Bert, 1985)
82-84	Ecology of mangrove crabs (Wilson, 1989)
82-84	Habitat use by mangrove crabs (Wilson, 1985)
89 ◊	Stone crabs (Bert and Stevely, 1989)
79-80	Stone crabs (Bert *et al.*, 1986)
83 ◊	Stone crab population (Bert *et al.*, 1983)
60 ◊	Growth changes in stone crabs (Manning, 1960)
84-85	Declawing of stone crabs (Perrine, 1987)
77-78	Mortality associated with declawing stone crabs (Davis *et al*, 1978)
84-85	Mortality and catchability of stone crabs (Ehrhardt, 1990)
83-85	Cooperative stone crab research (Ehrhardt, 1985)
83-84	Abundance and impact of fishing on stone crabs (Ehrhardt et al., 1990)
78-79	Spiny lobster (Lyons *et al.*, 1981)
92 ◊	Spiny lobster habitat (Eggleston and Lipcus, 1992)
86	Spiny lobster puereli (Butler and Herrnkind, 1991)
91-92	Seasonality, ontogeny and sociality of juvenile lobsters (Childress and Herrnkind, 1994)
92	Temperature, salinity, and larval transport on the distribution of juvenile spiny lobster (Field and Butler, 1994)
88	Predation on juvenile spiny lobster (Smith and Herrnkind, 1992)
88-89	Population dynamics of juvenile lobsters (Forcucci *et al.*, 1994)
80 ◊	Juvenile spiny lobster management (Davis, 1980)
78-80	Recreational lobster fishery and population dynamics (Davis and Dodrill, 1989)
75-79	Marine parks and lobster fishery (Davis and Dodrill, 1980)
85	Live lobster decoys (Heatwole *et al.*, 1988)
80	Spiny lobster trap fishery (Hunt *et al.*, 1986)

II.7.3.4. Fish

78 ◊	Rare and endangered biota: fishes (Gilbert, 1978)
87 ◊	Subtropical-tropical seagrass fish communities (Gilmore, 1987)
73-76	Ecological study of fishes and water quality (Schmidt, 1979)
54-55	Fish from the southern tip of Florida (Kilby and Caldwell, 1955)
79-80	Dominant forage fishes and decapods in Whitewater Bay (Schmidt, 1993)
73-74	Seasonal biomass of fishes (Schmidt, 1979)
84-85	Distribution and assemblages of fish in basins and channels (Thayer and Chester, 1989)
84-85	Epibenthic fish communities in mudbanks (Sogard *et al.*, 1987)
84-85	Spatial distribution and trends in fishes of seagrass covered mudbank (Sogard *et al.*, 1989)
84-85	Utilization of seagrasses by fish (Part 1) (Sogard *et al.*, 1989)
84-85	Utilization of seagrasses by fish (Part 2) (Sogard *et al.*, 1989)
71-72	Fishes and invertebrates between Cape Romano and Cape Sable (Lindall *et al.*, 1974)
85 ◊	Habitat utilization by young-of-year (Thayer *et al.*, 1985)
84-85	Movement of sports fish (Bryant *et al.*, 1989)
84-85	Finfish standing stock estimates (Mengel *et al.*, 1989)
79	Predator-prey interactions in Shark River (Schmidt, 1979)
71-72	Ichthyoplankton survey (Collins and Finucane, 1984)
84-85	Ichthyoplankton (Powell *et al.*, 1987)
84-85	Ichthyoplankton (Powell *et al.*, 1989)
57-70	Review of juvenile fish studies (Tabb and Roessler, 1989)
89-90	Food habits of mangrove fishes (Ley *et al.*, 1994)
89 ◊	Parasitic infection of seahorses (Vincent and Clifton-Hadley, 1989)
58-86	Snook (Tilmant *et al.*, 1989)
76-79	Snook biology (Thue *et al.*, 1983)
58-86	Red drum (Tilmant *et al.*, 1989)
60-61	Red drum biology (Yokel, 1966)
58-86	Spotted seatrout (Rutherford *et al.*, 1989)
66 ◊	Spotted seatrout (Tabb, 1966)
90-91	Conservation standards for spotted seatrout (Schirripa and Goodyear, 1994)
59-60	Subpopulations of spotted seatrout (Iversen and Tabb, 1962)
58-64	Blue croaker (Robins and Tabb, 1965)
58-86	Gray snapper (Rutherford *et al.*, 1989)
78-80	Gray snapper (Rutherford *et al.*, 1983)
64 ◊	Gray snapper (Starck, 1964)
83-84	Food web of gray snapper (Harrigan, 1986)
73-76, 82-85	Early life history of spotted seatrout, red drum, gray snapper, and snook (Rutherford *et al.*, 1986)
59-60	Growth and food of the gray snapper (Croker, 1960)
59-60	Growth and food of the gray snapper (Croker, 1962)
64 ◊	Trematodes in gray snapper (Schroeder, 64)
61-62	Red drum parasites (Iversen and Yokel, 1963)
63-64	Lizardfish parasites (Overstreet, 1966)
63-64	Lizardfish parasites (Overstreet, 1968)
84-85	Distribution of spotted seatrout and gray snapper juveniles (Chester and Thayer, 1990)
59-60	Spotted seatrout biology (Stewart, 1961)
78-80	Spotted seatrout age, growth and mortality (Rutherford, 1982)

83-85	Mayan cichlid distribution (Loftus, 1987)
63	Needlefish biology (Eidman, 1967)
73-80	Mosquitofish (Getter, 1982)
63-64	Mojarra catch (Waldinger, 1968)
64-65	Systematics of southern Florida anchovies (Daley, 1970)
90-91	Utilization of Bay as nursery by juvenile grunts (Peters *et al.*, 1994)
83-85	Mullet population (Scott *et al.*, 1989)
84-85	Stripped mullet movement (Funicelli *et al.*, 1989)
73-76, 82-85	Early life of seatrout and snapper (Rutherford *et al.*, 1989)
73-76	Feeding habits of young barracuda (Schmidt, 1989)
84-85	Food habits of juvenile spotted seatrout and gray snapper (Hettler, 1989)
83	Gray snapper nutrition (Harrigan *et al.*, 1989)
73-80	Ecology of key silverside (Getter, 1981)
73-76	Systematics and biology of mangrove gambusia (Getter, 1976)
20-60	Tarpon and ox-eye biology (Wade, 1962)
20-60	Tarpon and ox-eye (Wade, 1962)
79-80	Lemon sharks (Gruber, 1982)
73-74	Predation by lemon shark nutrition (Schmidt, 1986)
82-86	Reproduction of bonnethead shark (Parsons, 1993)
82-86	Age determination of bonnethead shark (Parsons, 1993)
88-90	Tagging of juvenile lemon sharks (Manire and Gruber, 1991)
84-85	Trammel net efficiency (Dewey *et al.*, 1989)
84-85	Survival of tagged fish (Ludwig *et al.*, 1989)
89 ◊	Survival of tagged fish (Ludwig *et al.*, 1989)
40	Mortality of fishes due to cold (Miller, 1940)
90, 93	Fish kills in Flamingo (Schmidt, 1993)
90	Causes of fish kills in Flamingo (Schmidt and Robblee, 1994)
58-78	Recreational and commercial fisheries (Davis, 1980)
58-78	Changes in red drum and spotted seatrout fisheries (Davis, 1980)
59-85	Gamefish harvest (Tilmant et al., 1990)
59-65	Catch rates and environmental conditions (Higman, 1967)
40-78	Recent trends in fisheries (Tilmant, 1989)
94 ◊	Relationships of sport fisheries catches to freshwater inflow (Smith and Robblee, 1994)
77-92	Fisheries trends from Monroe County (Bohnsack *et al.*, 1994)
79 ◊	Fisheries management in Everglades (Centaur Associates, 1979)
79 ◊	Fisheries management options in Everglades (Davis, 1979)

II.7.3.5. Birds

74-75	Nesting wading birds (Kushland and White, 1977)
88 ◊	Population and reproduction of wading birds (Ogden and Sprunt, 1988)
85-86	Least bittern nesting (Bowman and Bancroft, 1989)
61-62	White crowned pigeons (Sprunt, 1977)
87-89	White crowned pigeon nesting (Strong *et al.*, 1991)
88-91	Postfledging dispersal of white-crowned pigeons (Strong and Bancroft, 1994)
94 ◊	White-crowned pigeon population size from flight-line counts (Strong *et al.*, 1994)
68-84	Nesting ospreys (Fleming *et al.*, 1989)
86-87	Osprey reproduction (Bowman *et al.*, 1989)
78-79	Brood reduction in ospreys (Poole, 1982)
68-74	Bald eagle territoriality (Ogden, 1975)
28 ◊	Great white heron and Wurdermann's heron (Holt, 1928)

23, 81-84	Great white herons (Powell and Powell, 1986)
34-39, 58-63, 65, 67-68, 84	Great white herons (Powell *et al.*, 1989)
81	Food availability and reproduction of great white heron (Powell, 1983)
35-40, 48, 50-. 62, 66, 68-69, 75, 77-78, 84-87	Roseate spoonbill (Powell *et al.*, 1989)
38, 40, 44, 57, 59, 78	Reddish egret (Powell *et al.*, 1989)
76-82	Brown pelican (Kushlan and Frohring, 1985)
76-82	Laughing gulls (Frohring and Kushlan, 1986)
87 ◊	Habitat use by wading birds (Powell, 1987)
78	Sibling aggression in ospreys (Poole, 1979)

II.7.3.6. Reptiles

40 ◊	Herpetology of Florida (Carr, 1940)
76-81	Salinity and distribution of reptiles (Dunson and Mazzotti, 1989)
80 ◊	Snake survival in seawater (Dunson, 1980)
64-73	Loggerhead sea turtle nesting (Davis and Whiting, 1977)
64	Sea turtle nesting survey on Cape Sable (Holden, 1964)
65	Sea turtle nesting (Holden, 1965)
66	Factors affecting nesting of turtles (Klukas, 1967)
81-83	Salinity tolerance of emydid turtles (Dunson and Seidel, 1986)
49-51	Crocodiles (Moore, 1953)
68-75	Status of American crocodile (Ogden, 1978)
77-81	Ecology of the American Crocodile (Mazzotti, 1983)
78 ◊	American crocodile (Ogden, 1978)
77-80	Distribution of crocodiles (Kushlan and Mazzotti, 1989)
77-82	Population biology of crocodiles (Kushlan and Mazzotti, 1989)
77-82	Population biology and status of crocodiles (Kushlan and Mazzotti, 1982)
78-79	Osmoregulation in crocodiles (Dunson, 1980)
78-79	Salinity and crocodiles (Dunson, 1982)
79	Osmoregulation in crocodiles (Dunson, 1982)
79-80	Crocodile nests (Lutz and Dunbar-Cooper, 1982)
79-80	Crocodile nests (Lutz and Dunbar-Cooper, 1984)
70-82	Crocodile nesting success (Mazzotti, 1989)
80-81	Crocodile nest desiccation and flooding (Mazzotti *et al.*, 1988)
80	Heavy metals in crocodile eggs (Stoneburger and Kushlan, 1984)
77-78	Organochlorine residues in crocodile eggs (Hall *et al.*, 1979)
77-82	Management of crocodiles (Mazzotti, 1988)

II.7.3.7. Mammals

53 ◊	Marine mammals in Florida (Moore, 1953)
73 ◊	Mammals in the Gulf of Mexico (Caldwell and Caldwell, 1973)
49-50	Status of manatees (Moore, 1951)
73-75	Distribution and abundance of marine mammals (Odell, 1976)
73-76	Distribution and abundance of marine mammals (Odell, 1976)
73-74	Aerial censuses of bottlenose dolphins (Odell, 1975)
79	Aerial survey of manatees and dolphins (Irvine *et al.*, 1979)
49-55	Manatee aggregations (Moore, 1956)
91 ◊	Mammals in Florida waters (Reynolds and Odell, 1991)
77-81	Food habits of the manatee (Ledder, 1987)

72	Recurrent *Pseudorca* stranding (Odell *et al.*, 1980)
76	Summary of information on *Pseudorca* stranding (Odell and Asper, 1977)
79 ◊	Summary of information on *Pseudorca* stranding (Odell *et al.*, 1979)
85	Organochlorines in bottlenose dolphins and Pygmy sperm whales (King, 1987)

II.8. Pollutant studies

80-85	Methane flux (Harriss *et al.*, 1988)
79	Pesticide use observations, Monroe County (Anonymous, 1980)
71	Input, cycling, and fate of heavy metal and pesticides pollutants in estuaries of the western Everglades (Harriss *et al.*, 1971)
73 ◊	Mercury geochemistry (Andren, 1973)
94 ◊	Mercury (Atkeson, 1994)
92 ◊	Biogeochemistry of light hydrocarbons in wetlands (Barber, 1992)

II.9. Related studies

13-86	Sea level change at Key West (Hanson and Maul, 1993)
13-86	Sea level change at Key West (Maul and Martin, 1993)
10-85	Florida freezes (Myers, 1986)
73-76	Florida sea breeze and rainfall (Burpee and Lahiff, 1984)
73-76	Florida sea breeze convergence (Burpee, 1979)
94 ◊	Geochemical studies of wetlands (Kotra *et al.*, 1994)
87 ◊	Reproductive biology of tropical seagrasses (Moffler and Durako, 1987)
94 ◊	Elemental composition of benthic macroalgae in the Keys (Hanisak and Miller, 1994)
94 ◊	Atmospheric deposition of mercury (Guentzel *et al.*, 1994)
94 ◊	Mercury and trace metals in Everglades flooded soils (Rood *et al.*, 1994)
93 ◊	Increased mercury accumulation rates in Everglades sediment (Rood *et al.*, 1993)
93	Eutrophication in methylmercury accumulation (Barkay *et al.*, 1994)
94 ◊	Nutrient transport by wading birds in the Everglades (Frederick and Powell, 1994)
94 ◊	Wading bird foraging patterns, colony locations, and hydrology in the Everglades (Bancroft *et al.*, 1994)
31-46, 74-89	Wading bird nesting colony dynamics (Ogden, 1994)

II.9. Anthropogenic events

Railroad construction
Highway construction
Drainage efforts
Turkey Point Nuclear Power Plant
Homestead Air Force Base
Jetport
Anecdotal information
Everglades National Park
Florida Keys Marine Sanctuary
Bahia Honda State Park
Legislation
PCB production
DDT use

APPENDIX III

Graphical presentation of historical events and published studies

[Chronological sequence of published studies is by date of sampling (if known) or in the case of calculated or inferred parameters by the earliest date determined. Geological studies describing formation of geological features in the area are listed by publication date. Publication date of a paper or report is noted with a dashed line.]

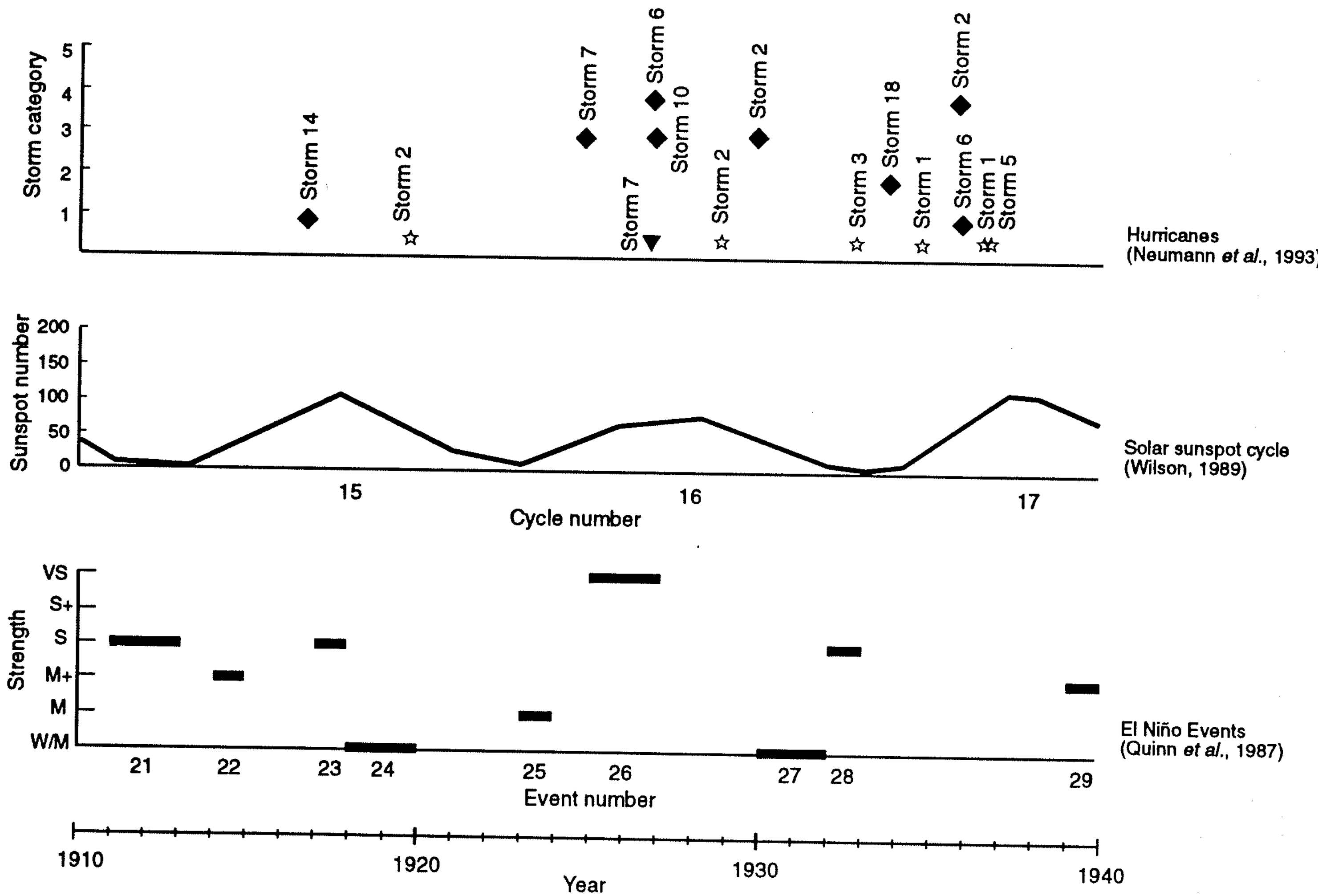


Figure III.1. Hurricane, sunspots, and El Niño events.

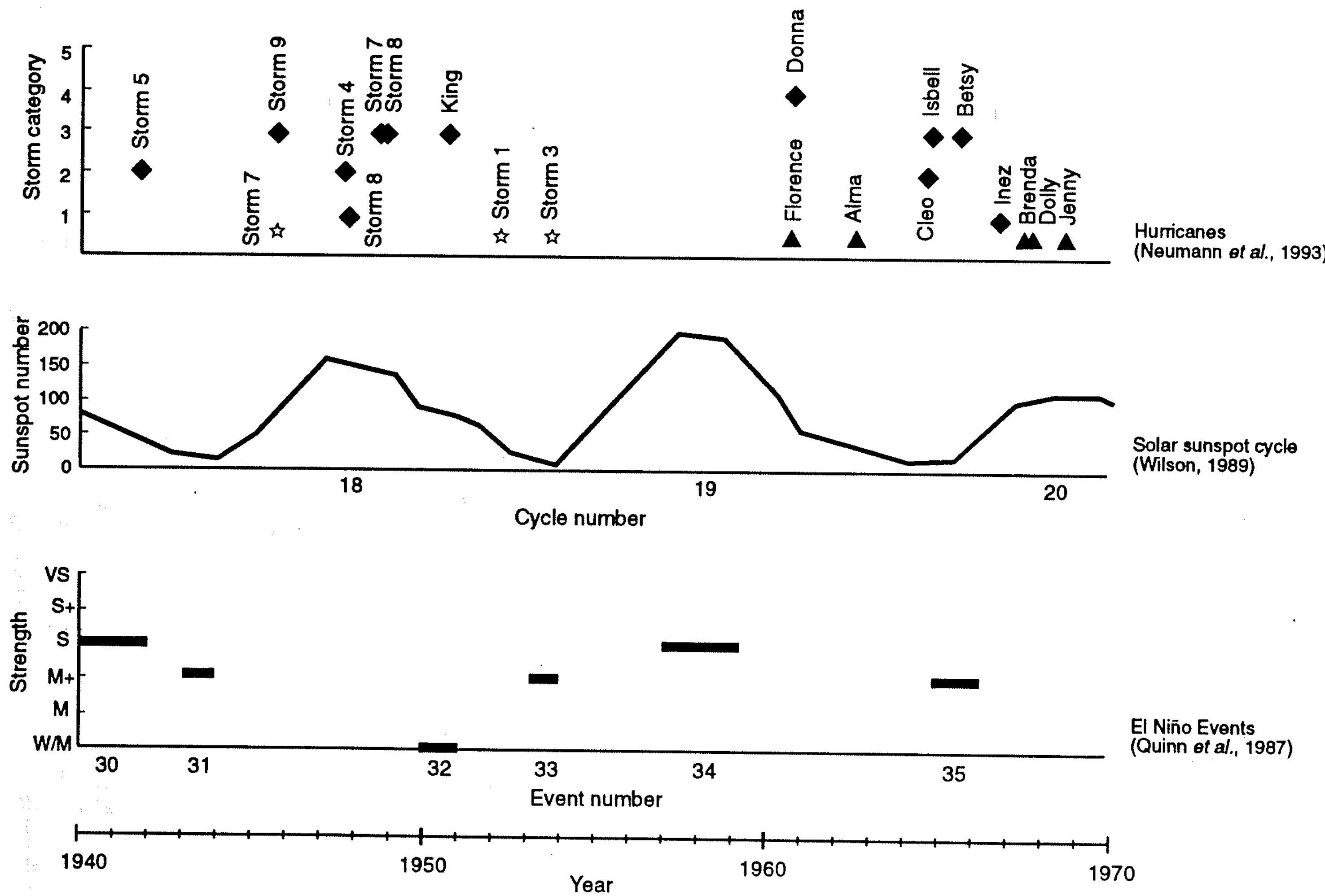


Figure III.1. Hurricane, sunspots, and El Niño events (cont.).

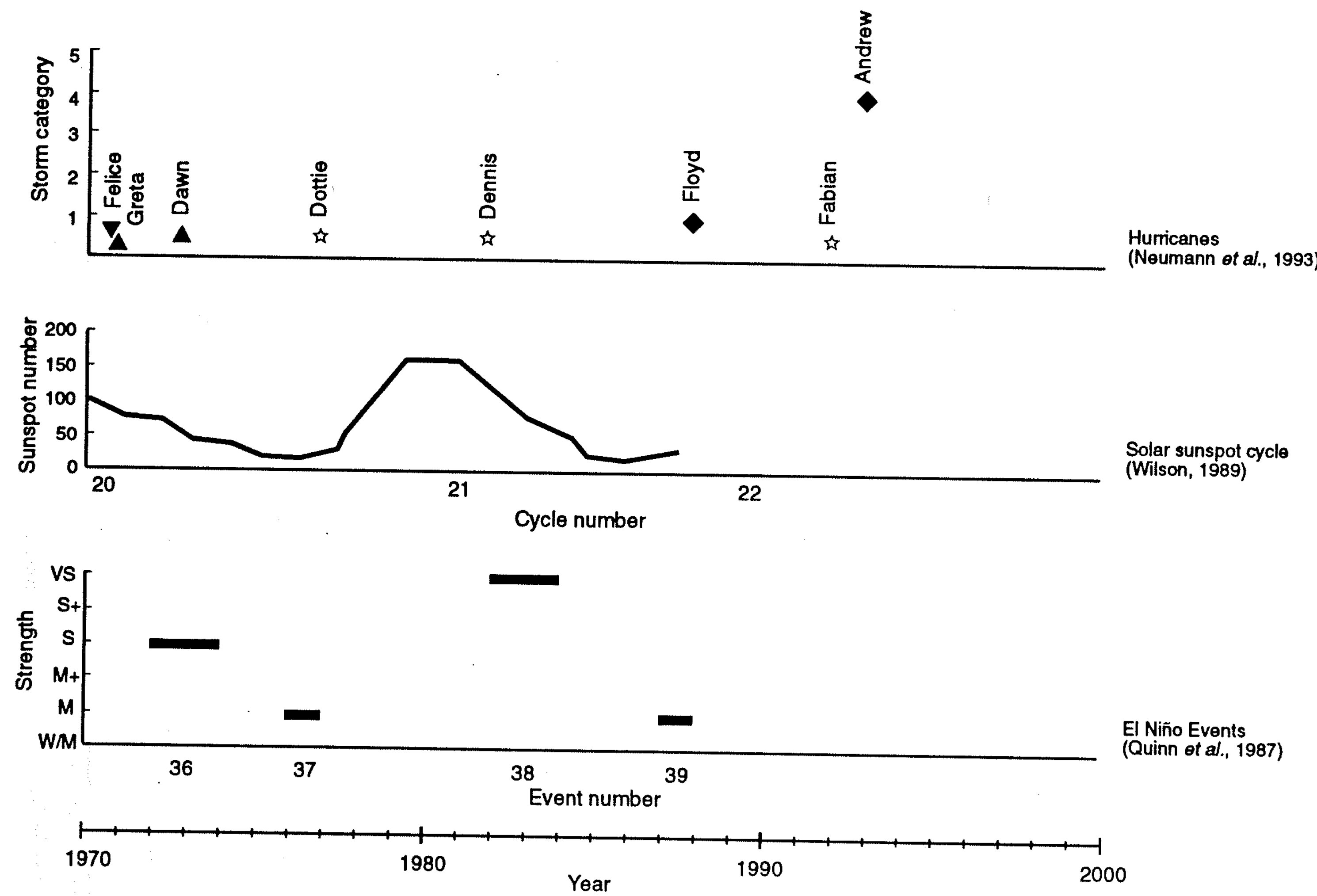


Figure III.1. Hurricane, sunspots, and El Niño events (cont.).

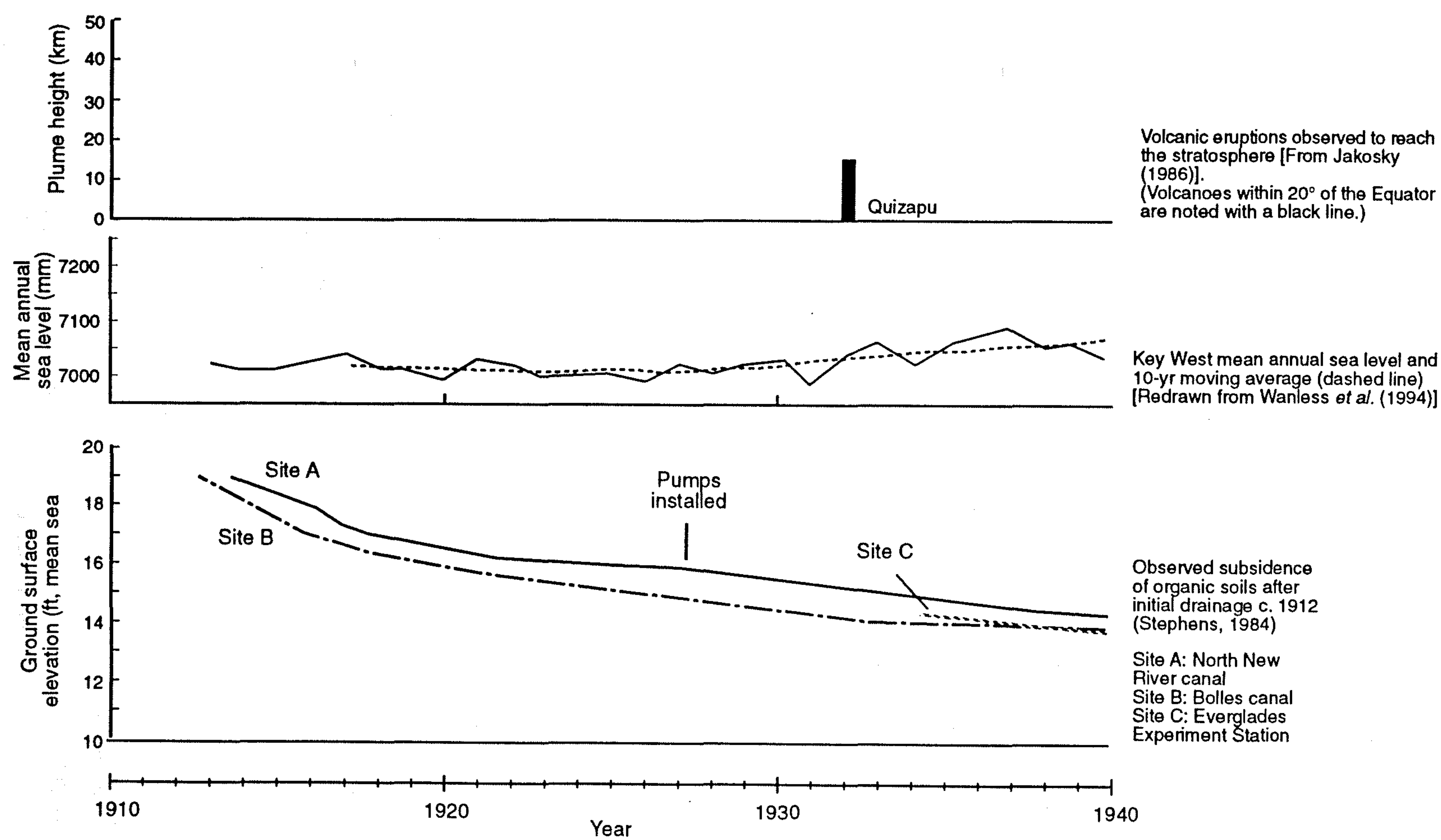


Figure III.2.Volcanoes,sea level rise, and soil subsidence.

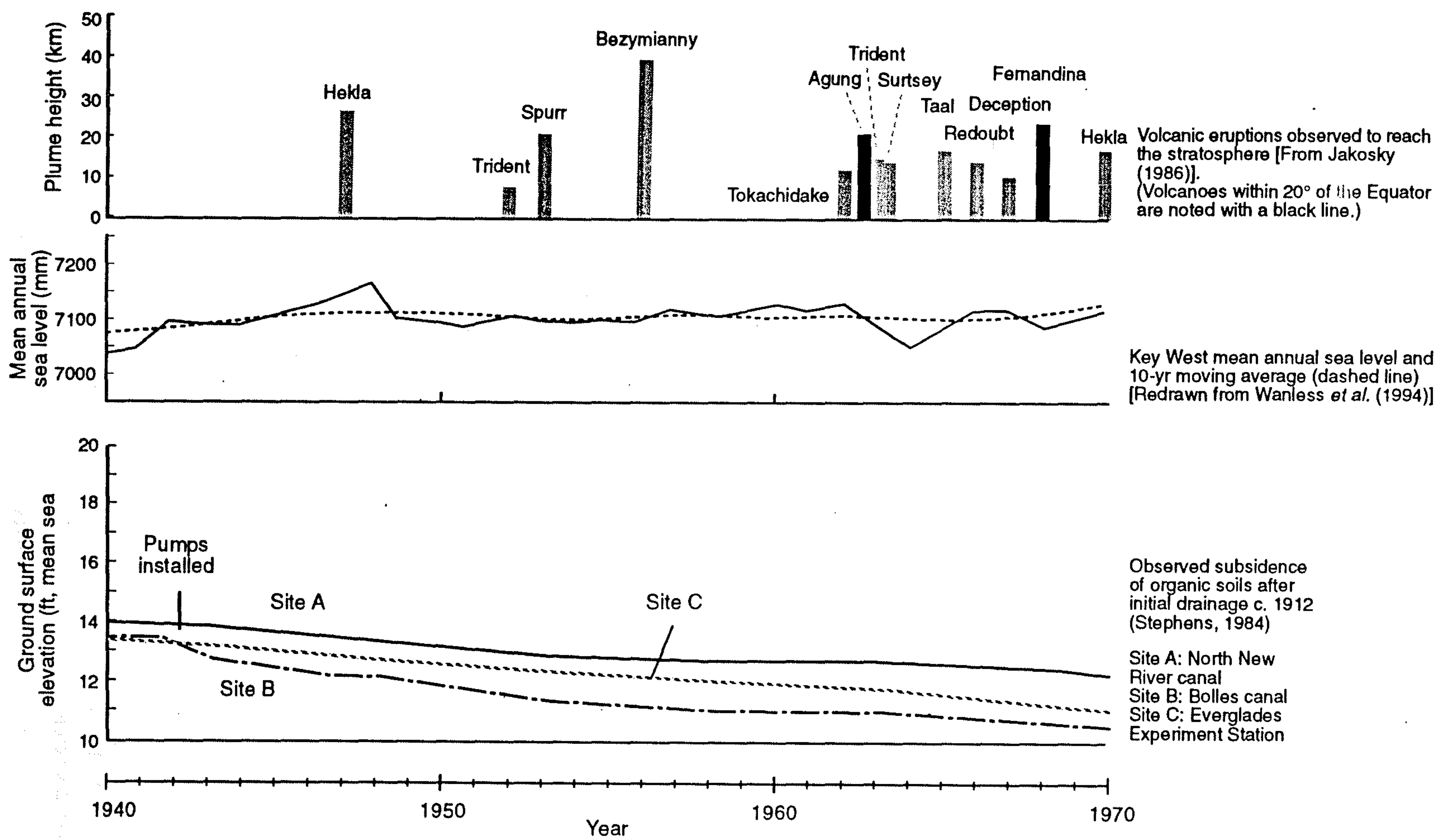


Figure III.2. Volcanoes, sea level rise, and soil subsidence (cont.).

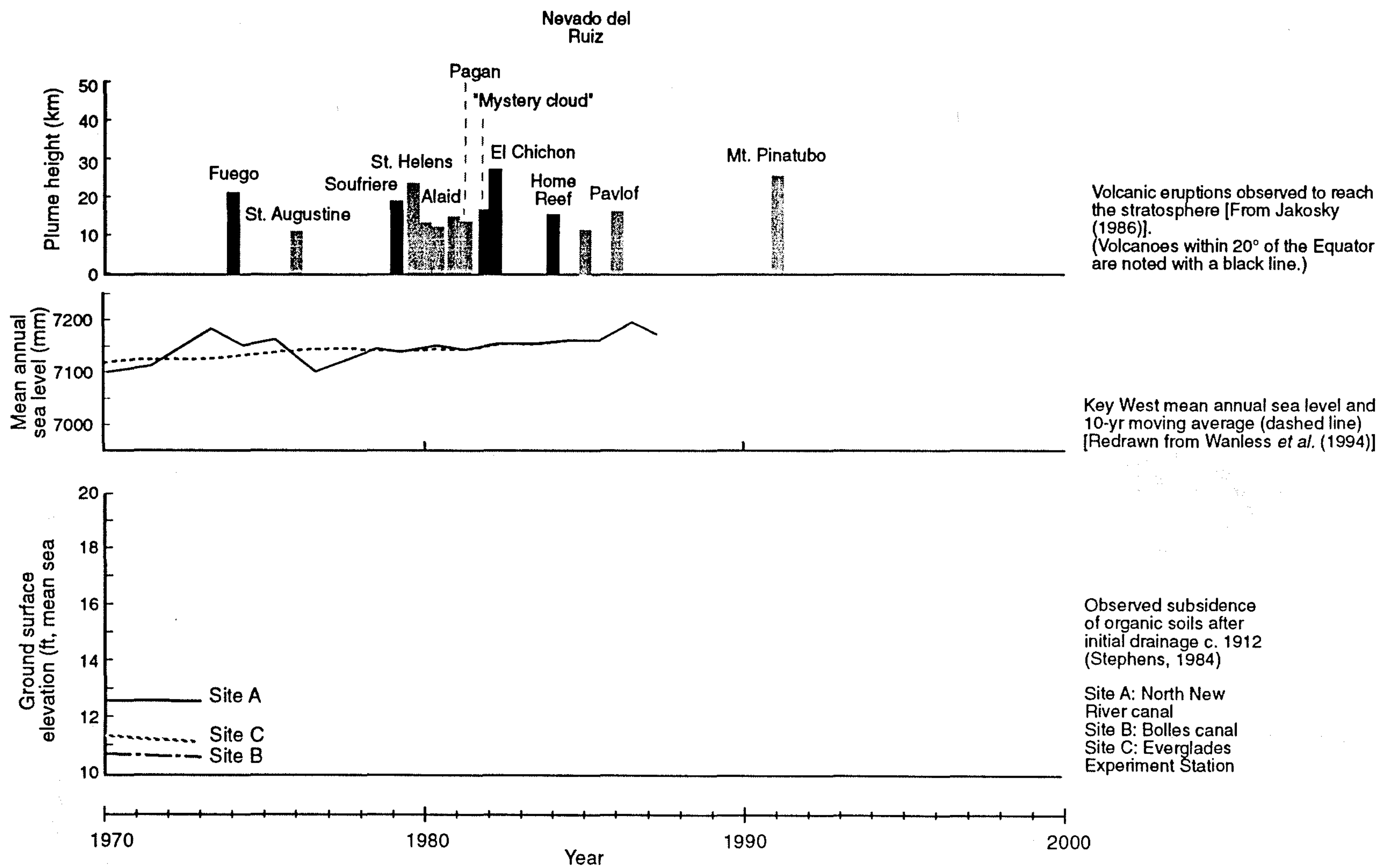


Figure III.2. Volcanoes, sea level rise and soil subsidence (cont.).

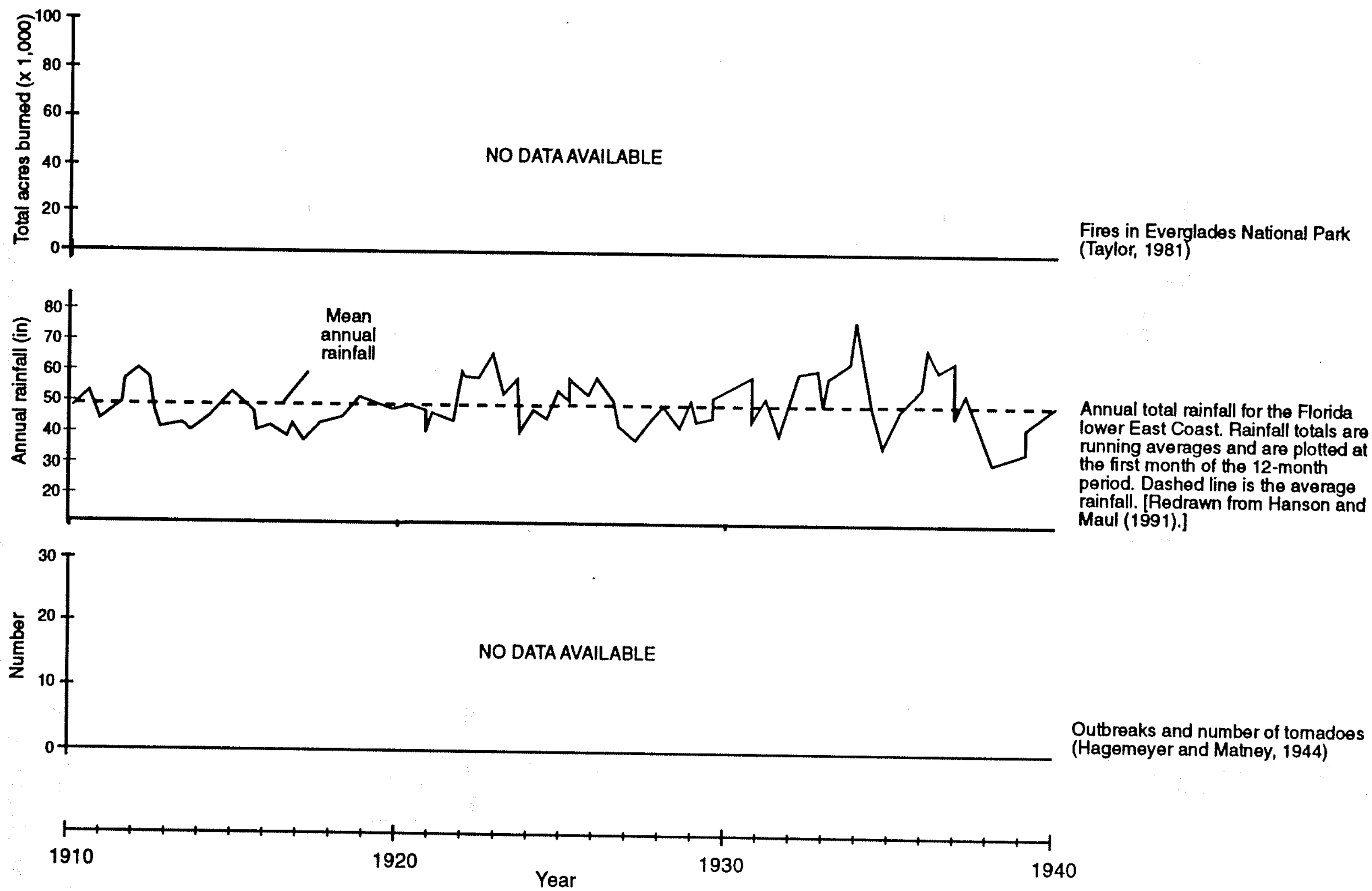


Figure II.3. Fires, rainfall and tornadoes.

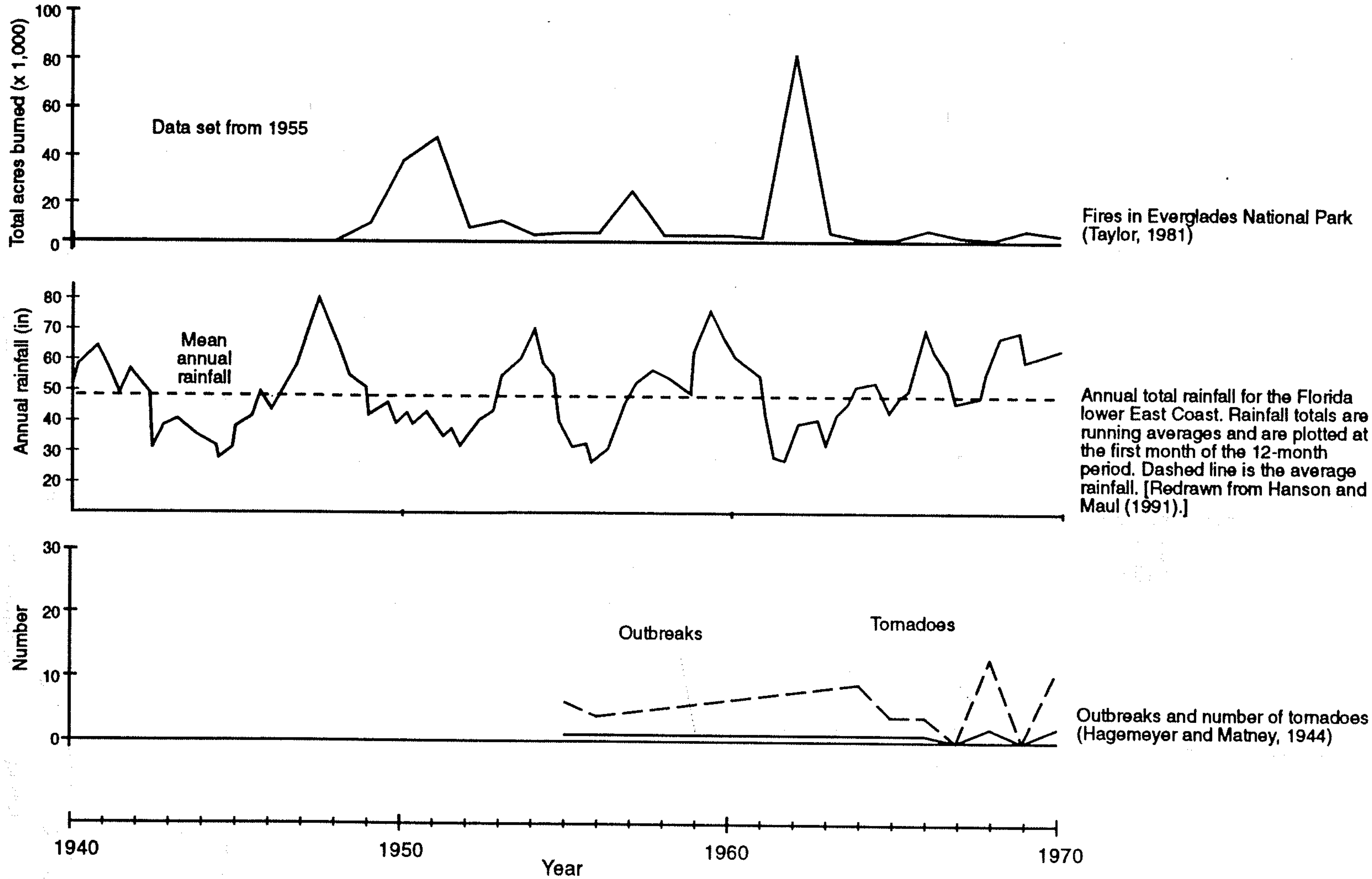


Figure II.3. Fires, rainfall and tornadoes (cont.).

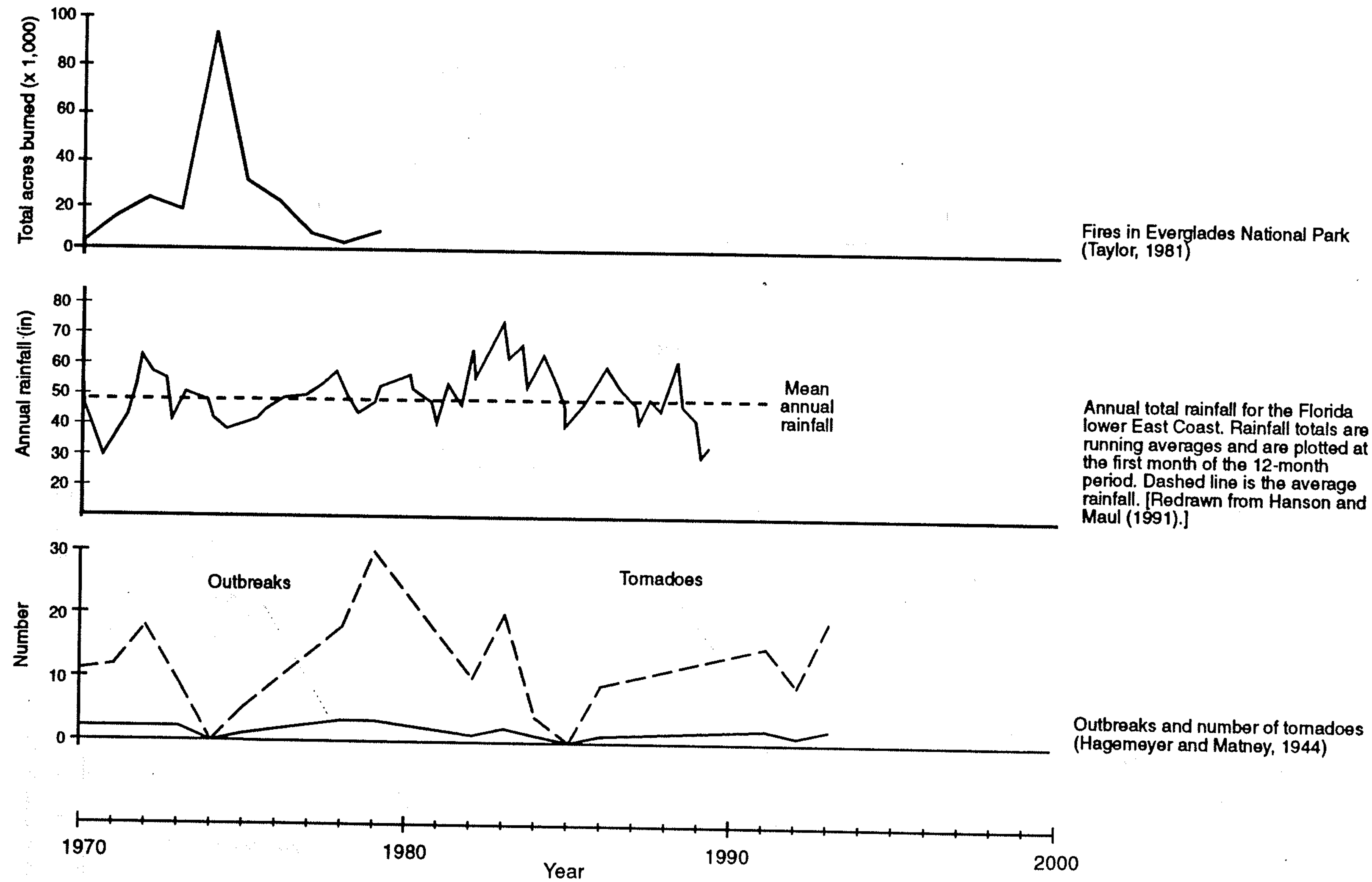


Figure II.3. Fires, rainfall and tornadoes (cont.).

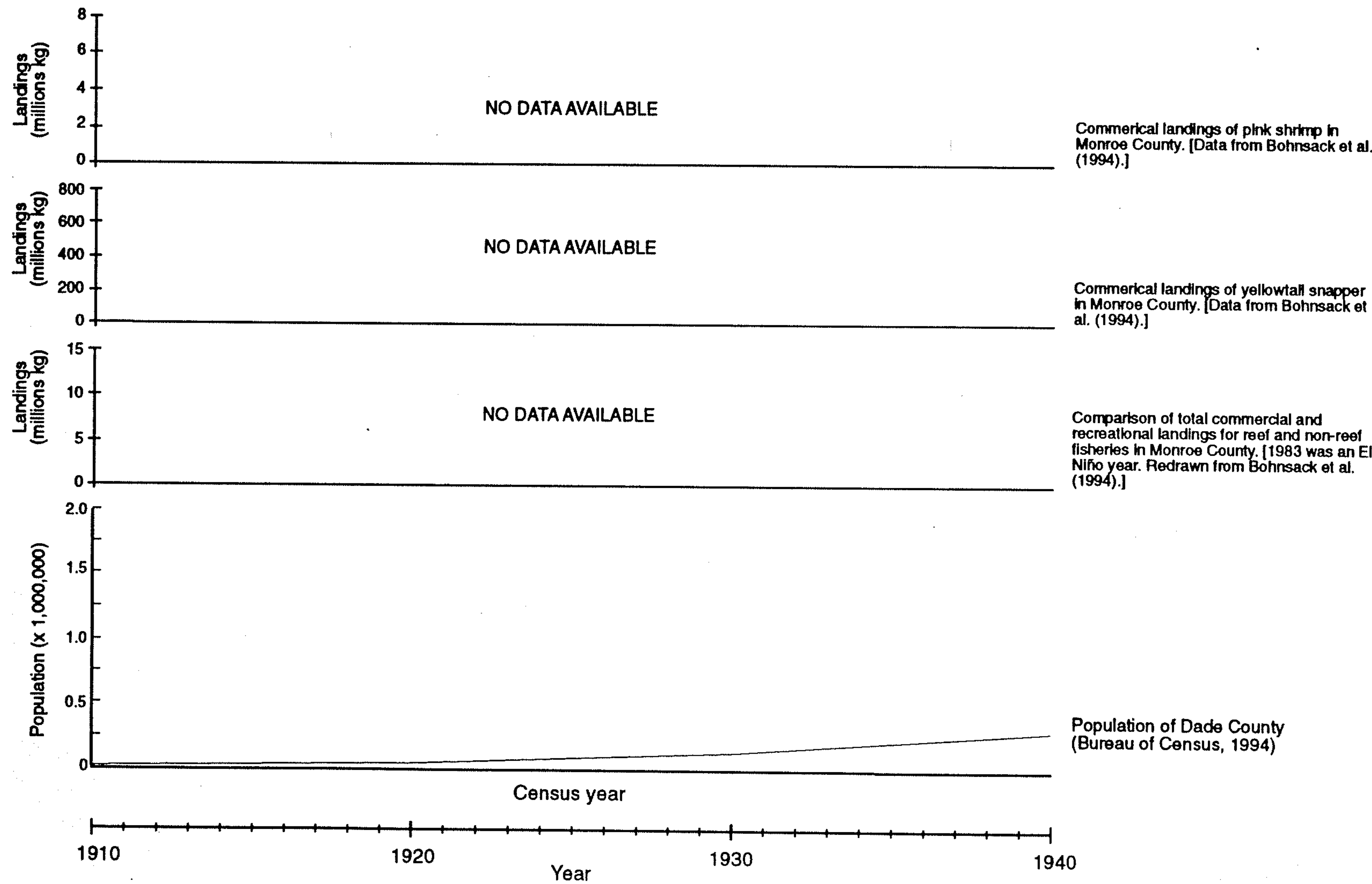


Figure III.4. Fishing trends and population.

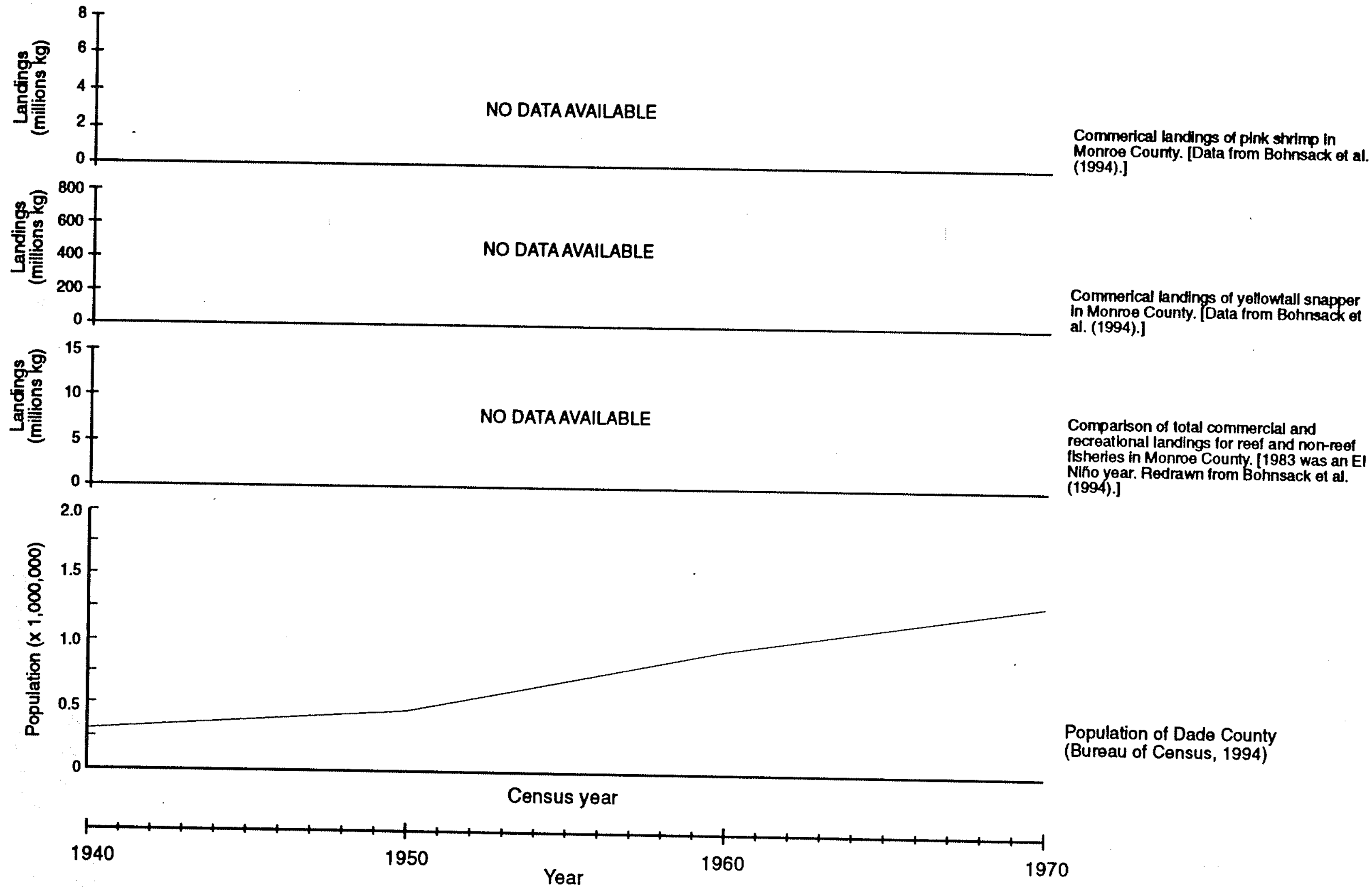


Figure III.4. Fishing trends and population (cont.).

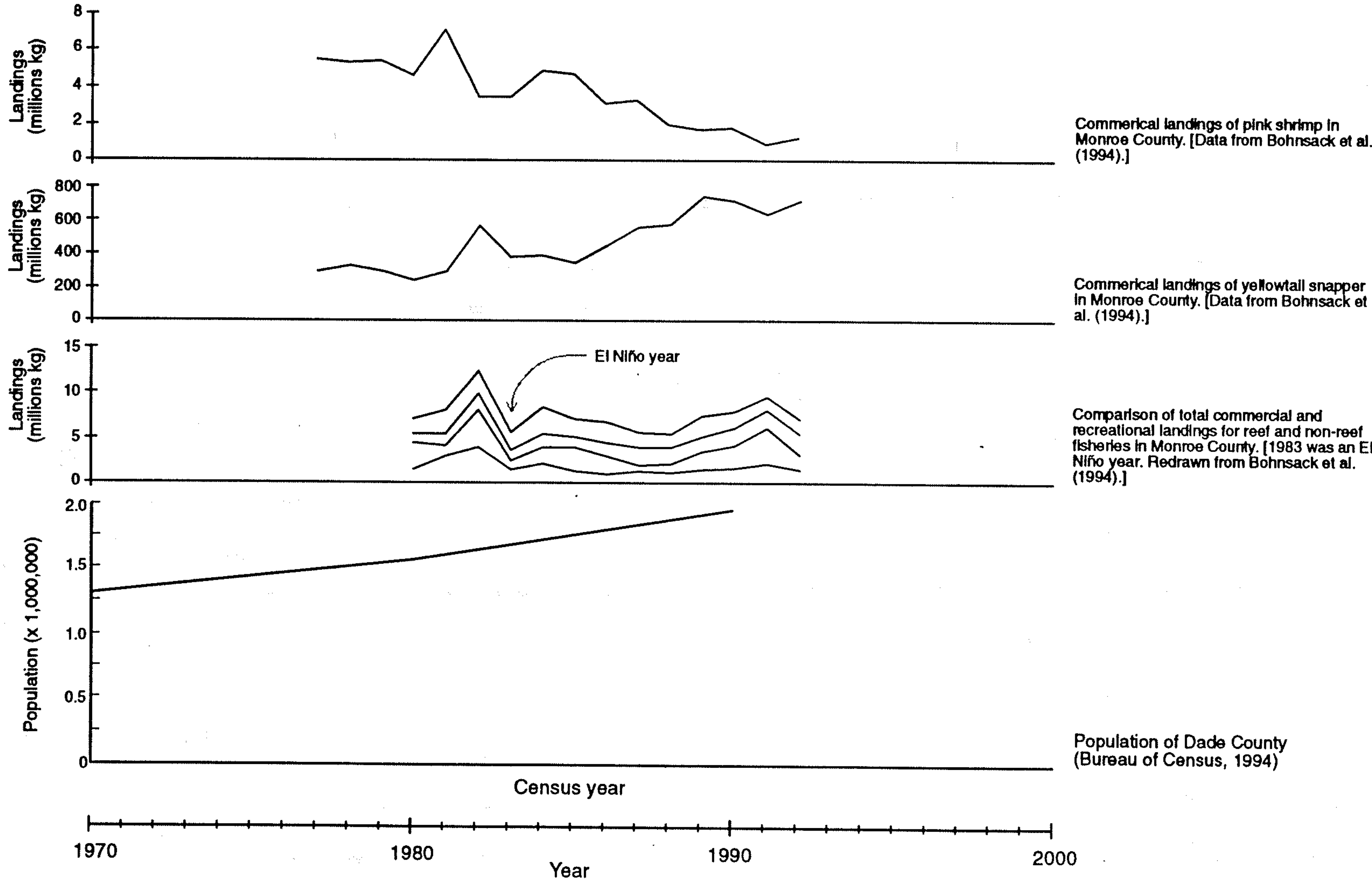


Figure III.4. Fishing trends and population (cont.).

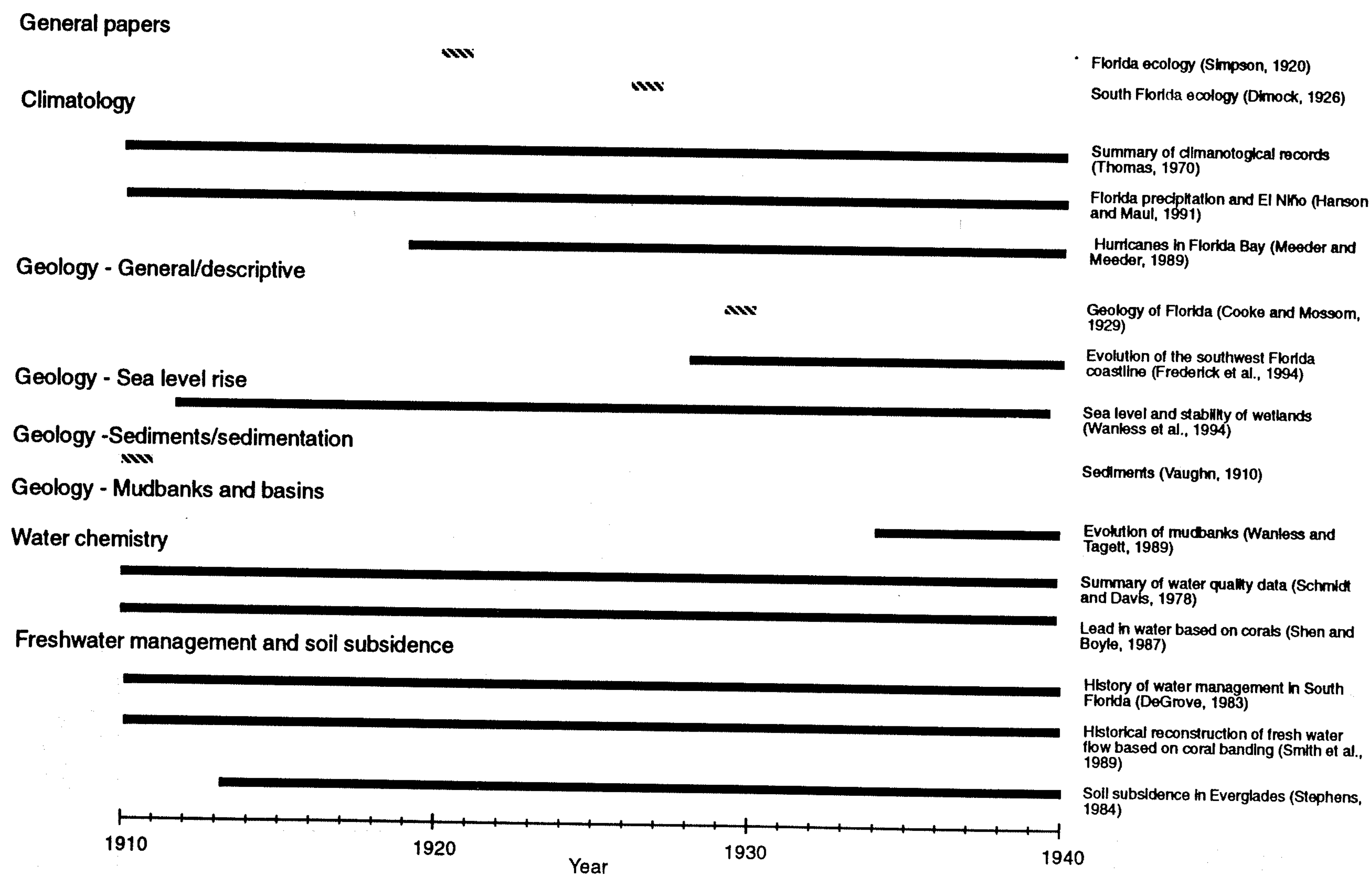


Figure III.5. Citations covering 1910 - 1940.

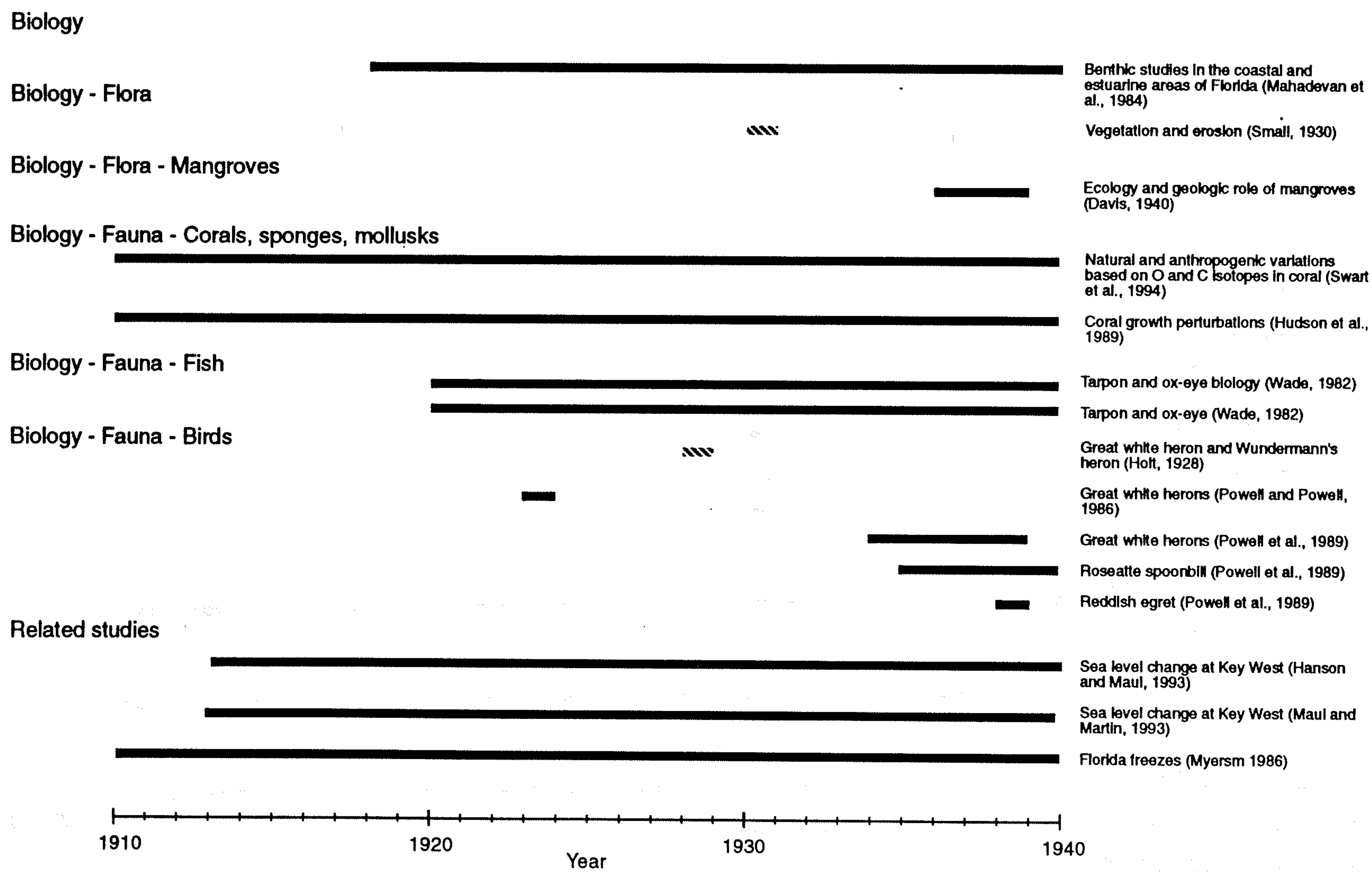


Figure III.5. Citations covering 1910 - 1940. (cont.)

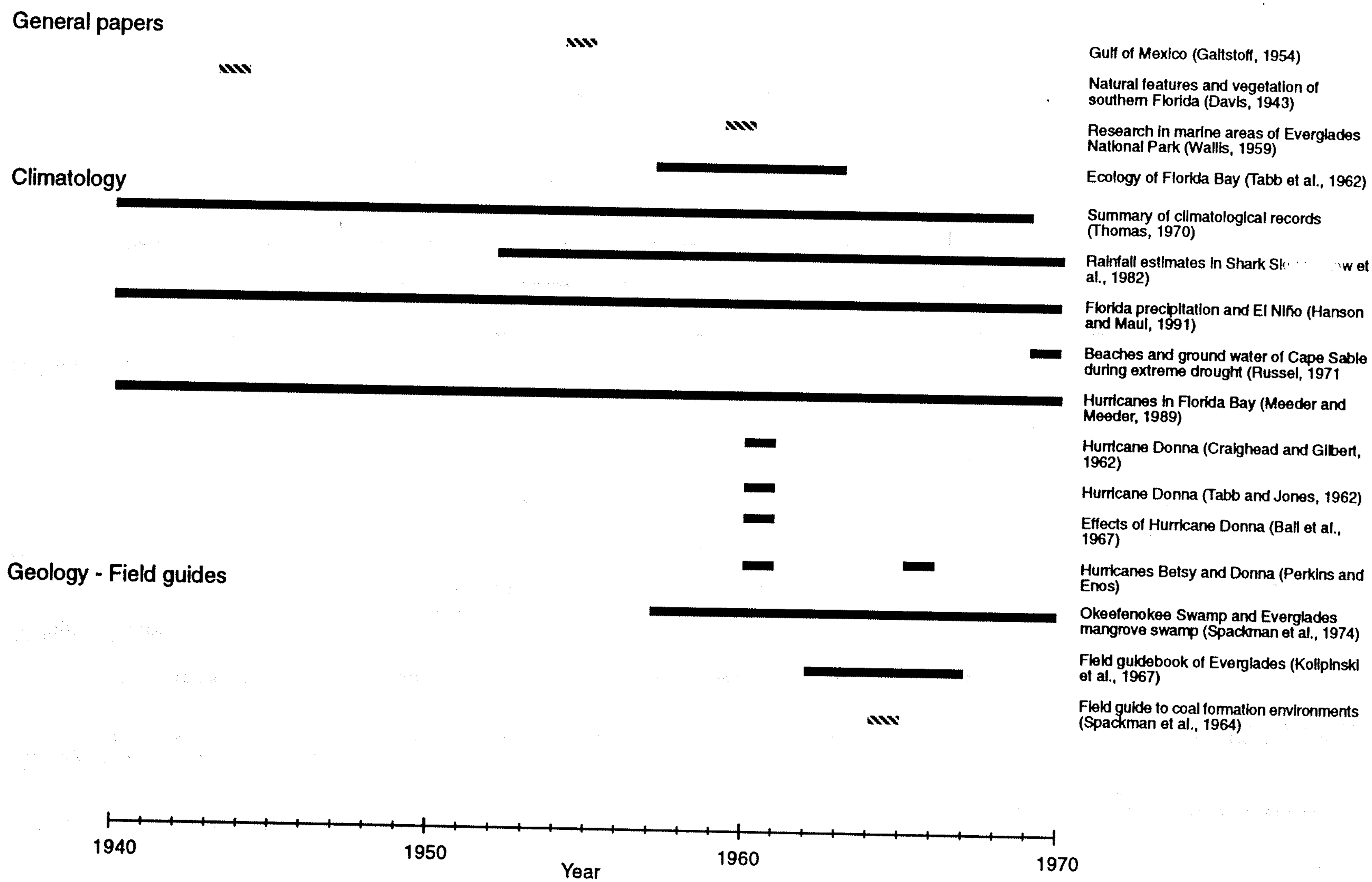


Figure III.6. Citations covering 1940 - 1970.

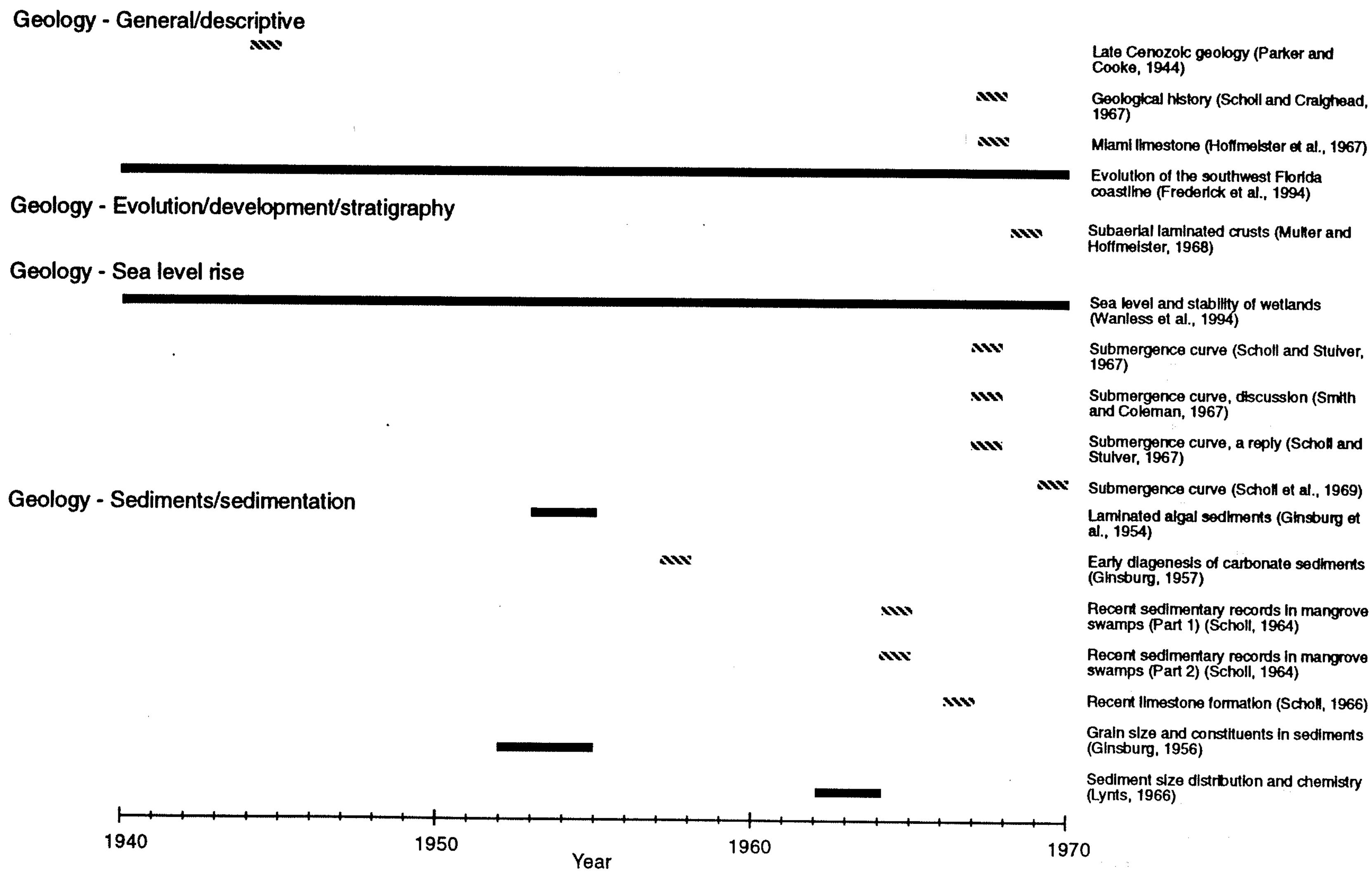


Figure III.6. Citations covering 1940 - 1970. (cont.)

Geology - Sediments/sedimentation

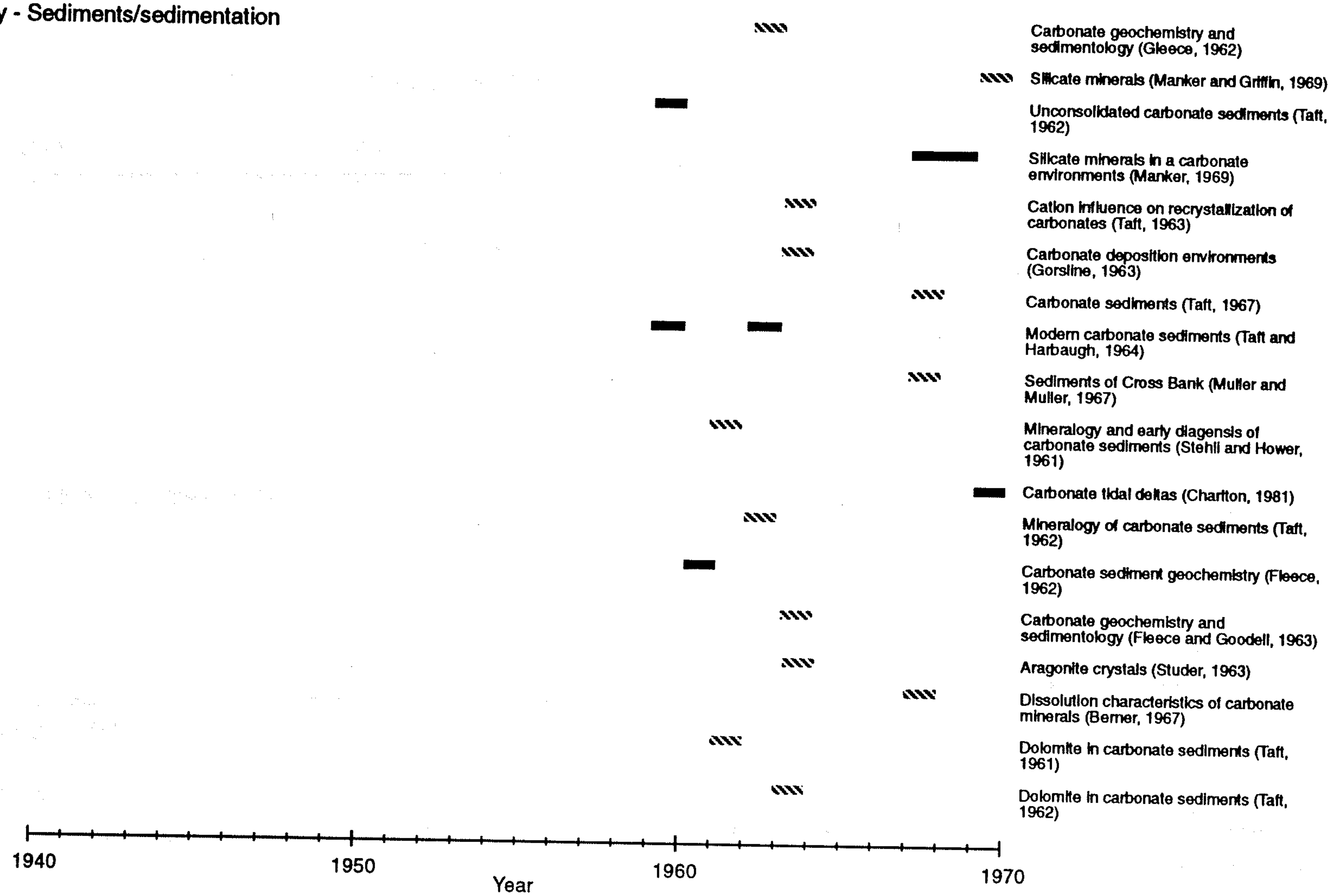


Figure III.6. Citations covering 1940 - 1970. (cont.)

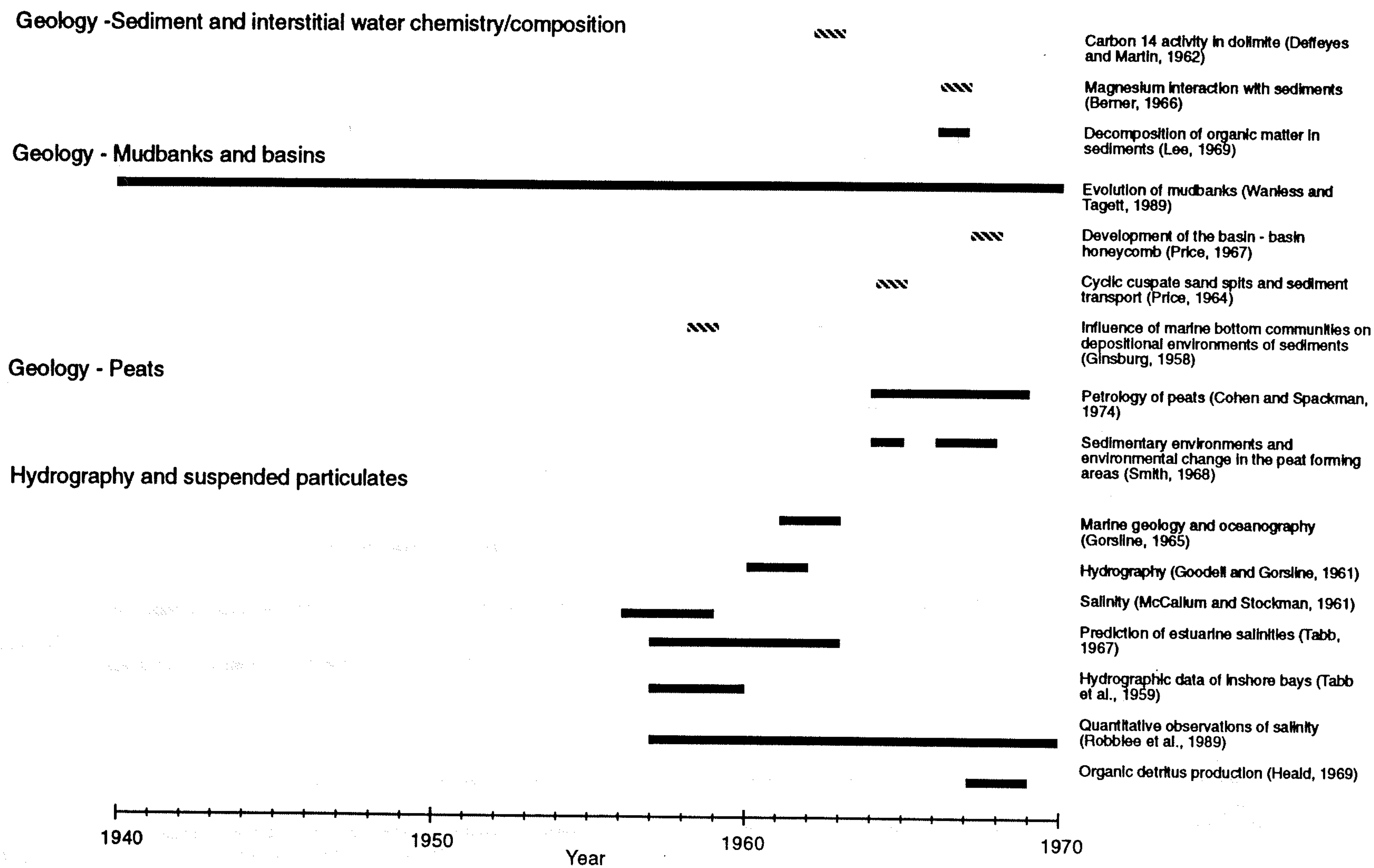


Figure III.6. Citations covering 1940 - 1970. (cont.)

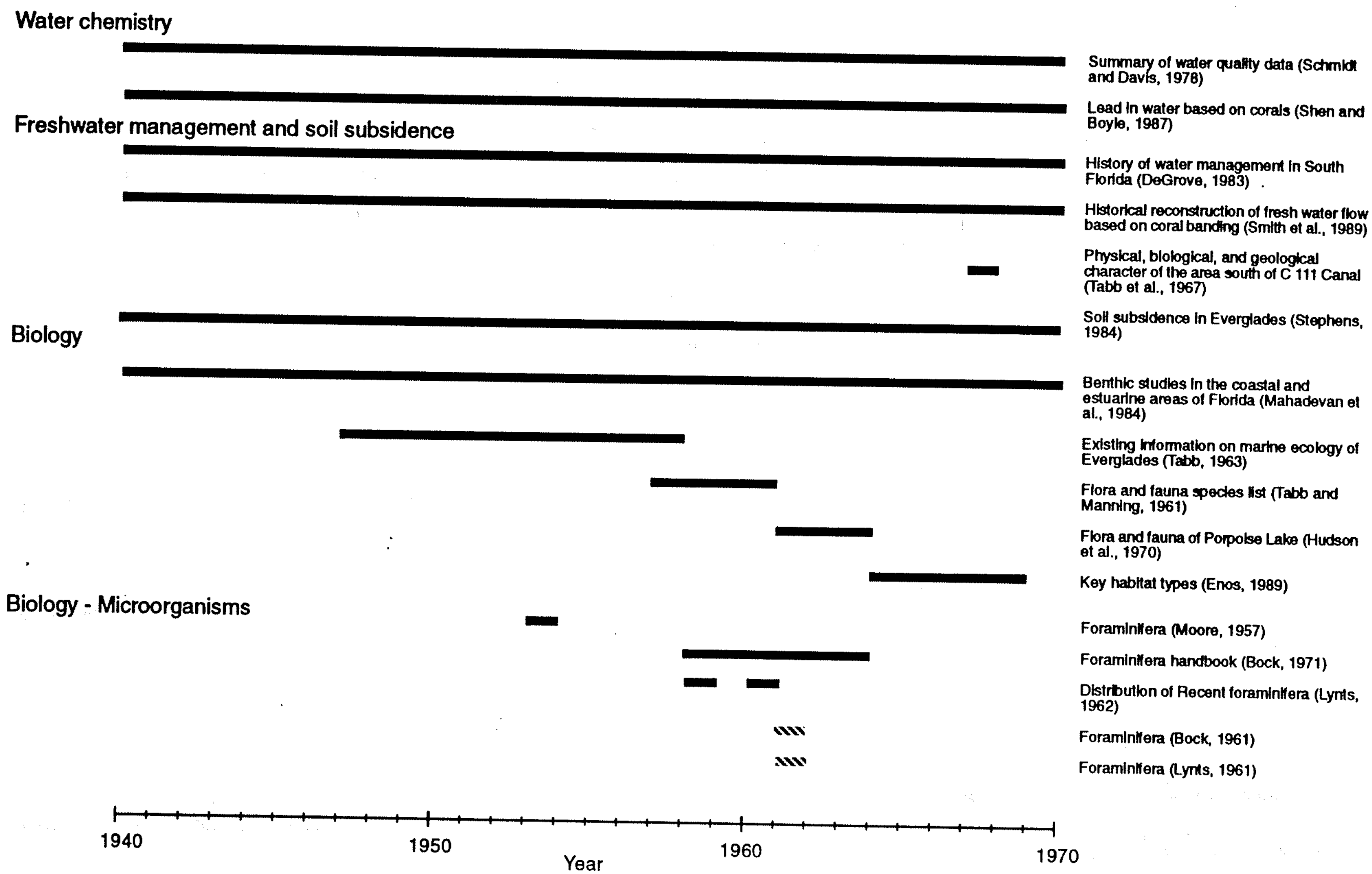
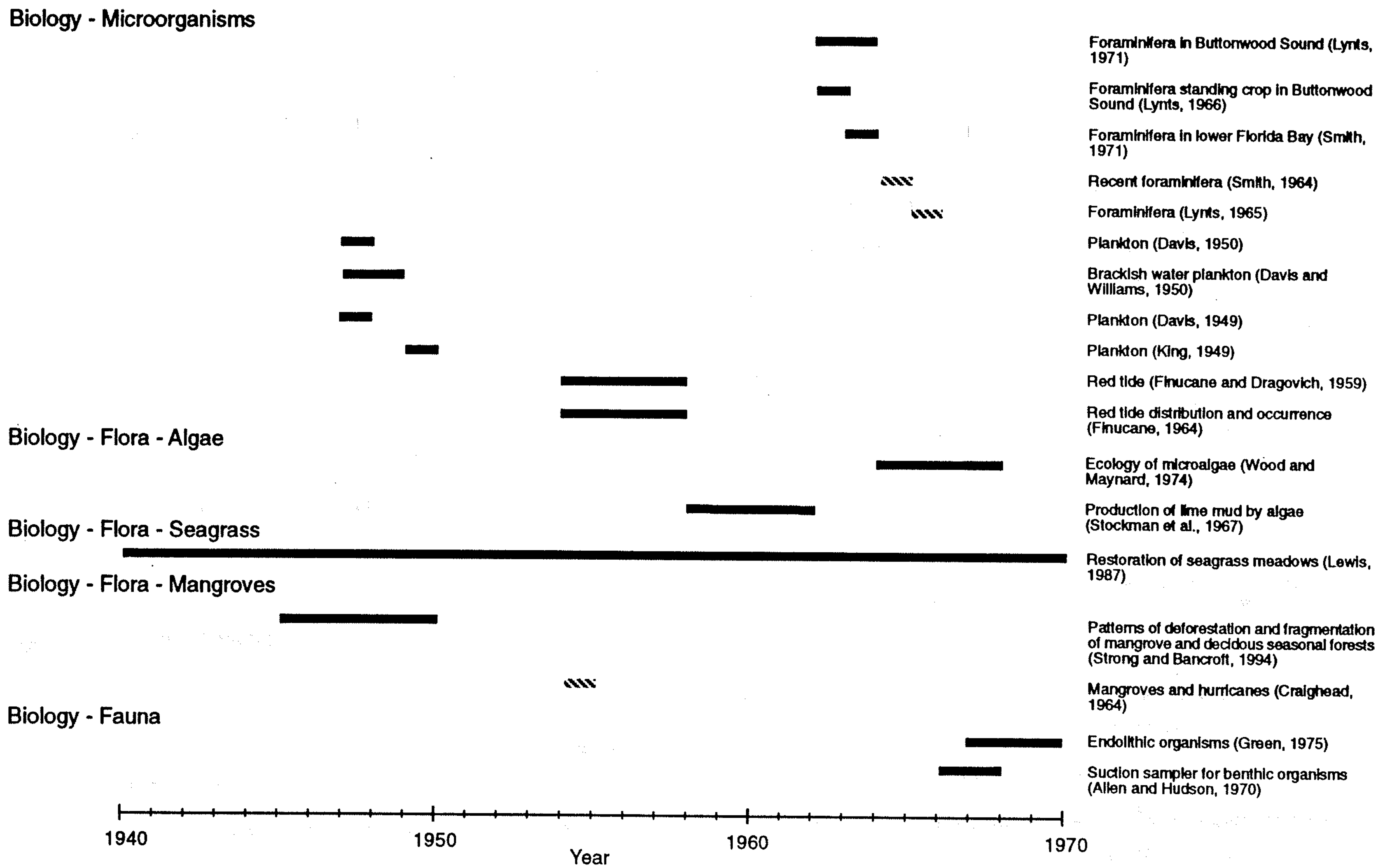


Figure III.6. Citations covering 1940 - 1970. (cont.)



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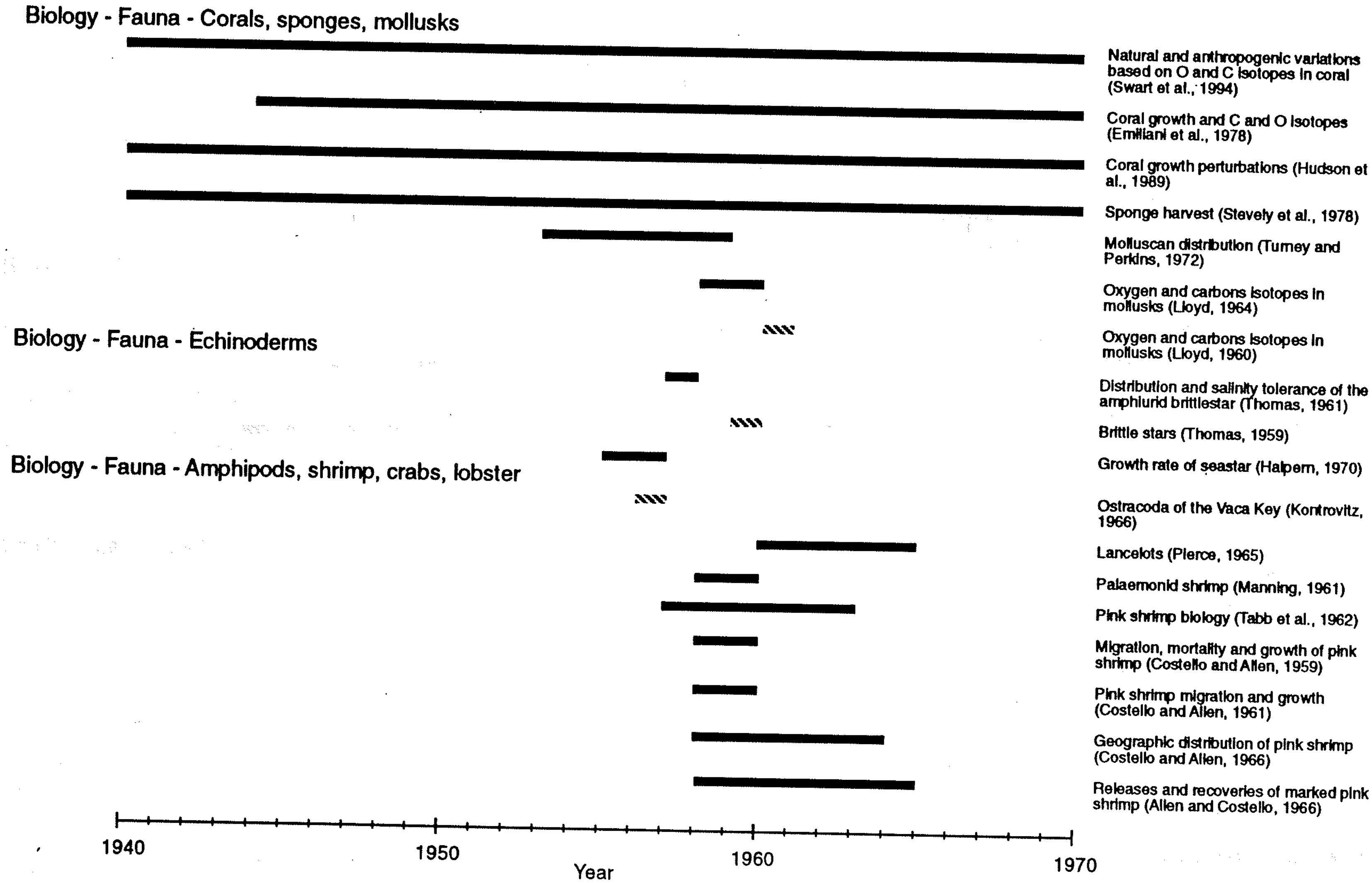

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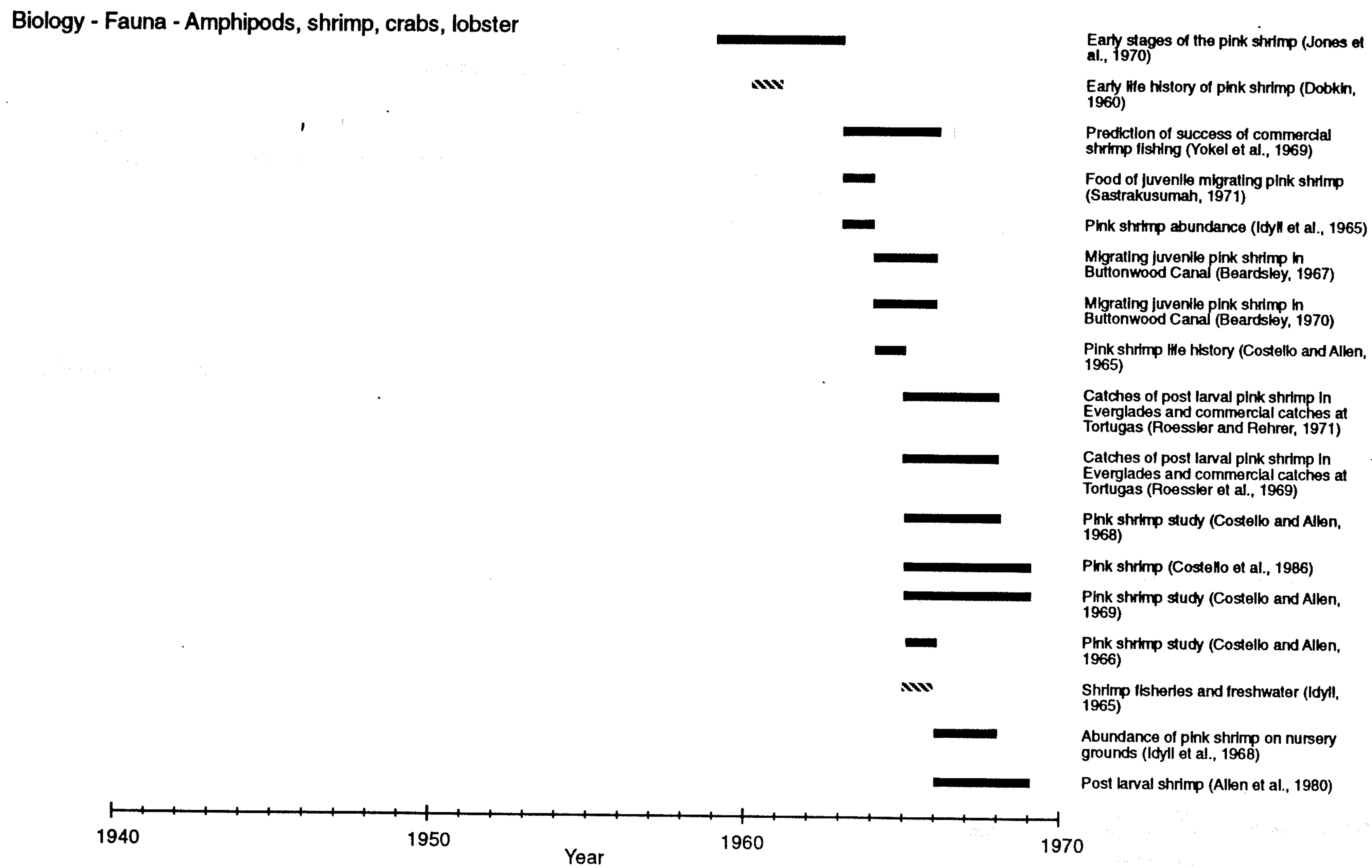

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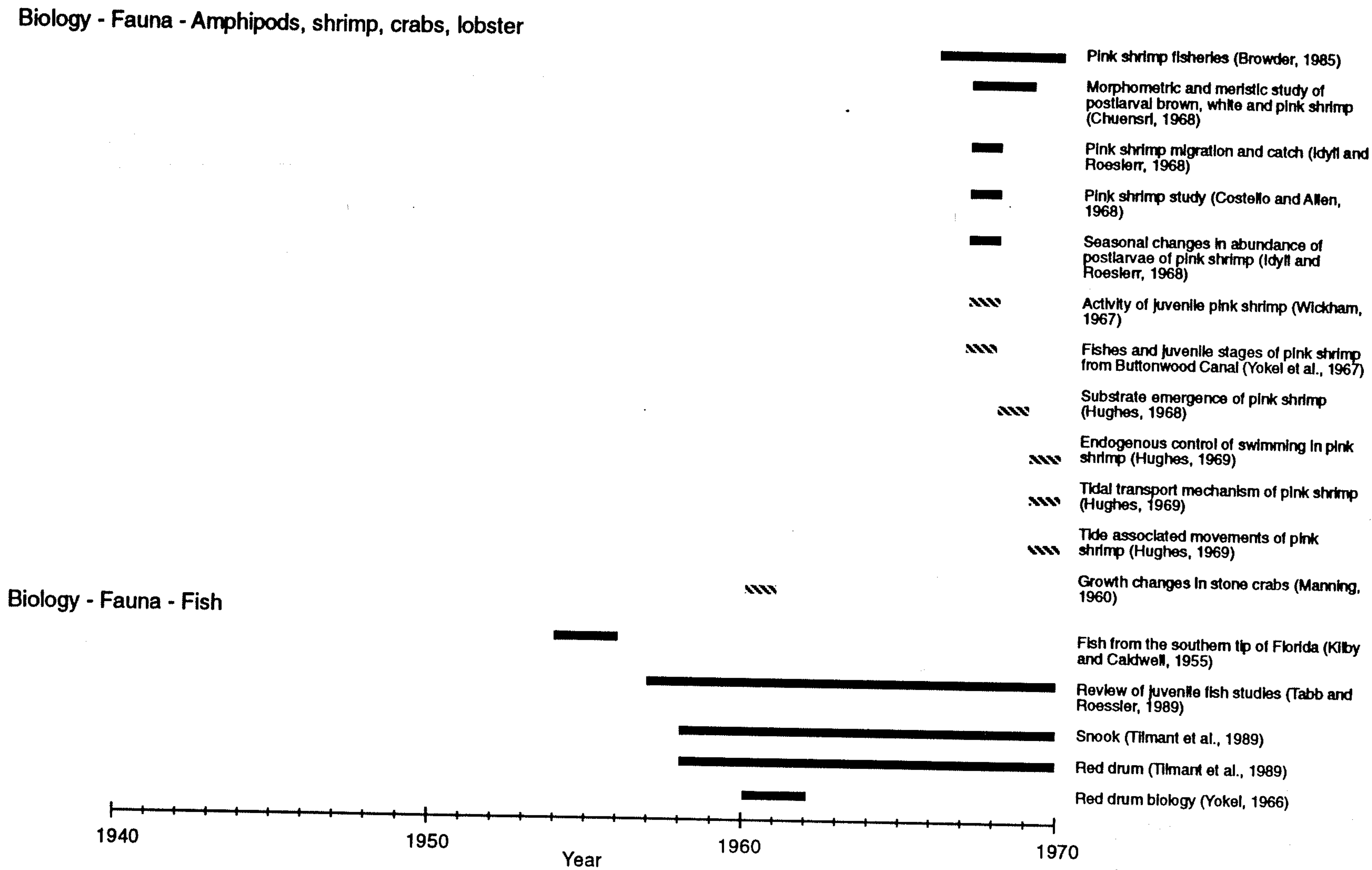

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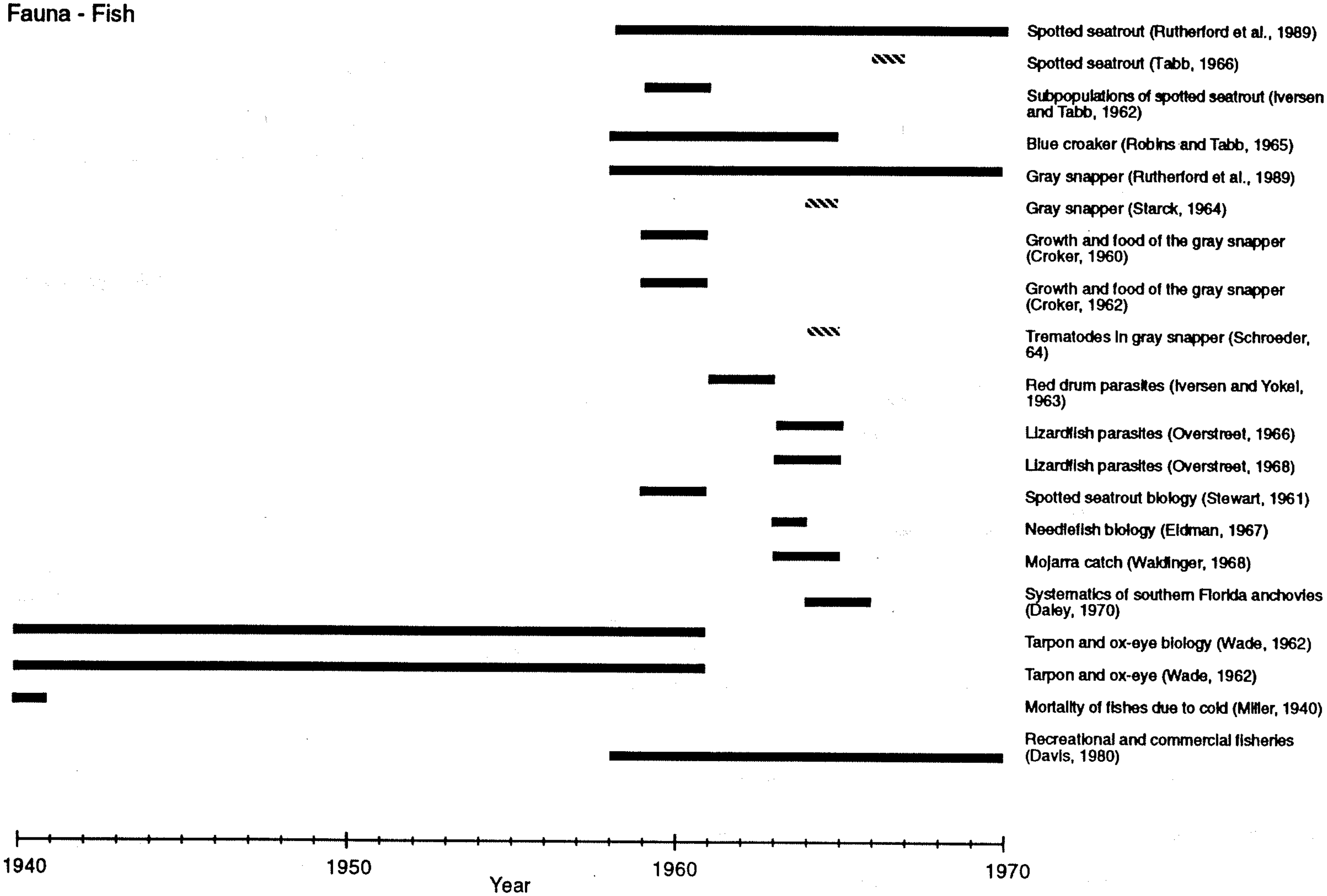
Biology - Fauna - Fish



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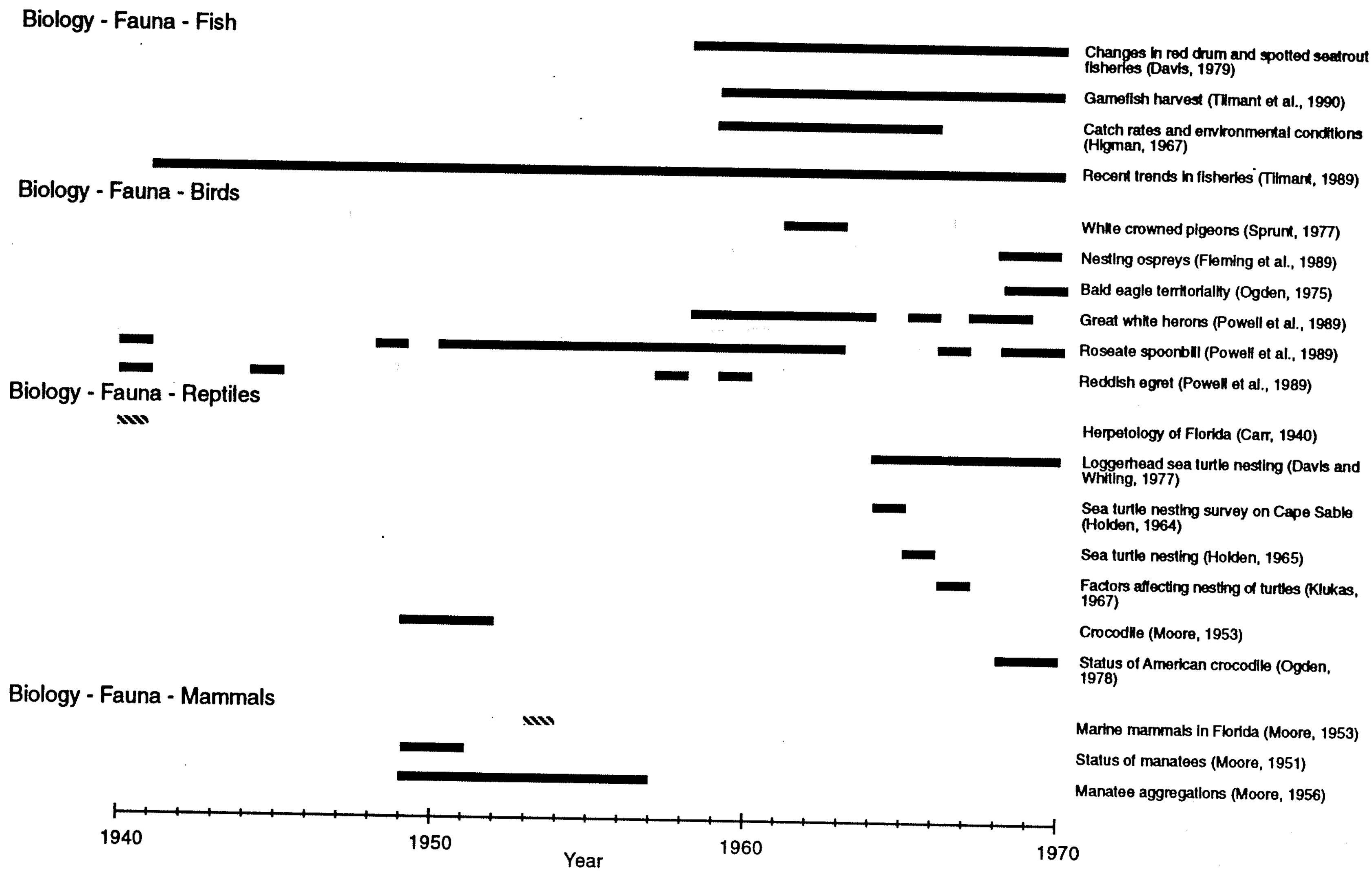

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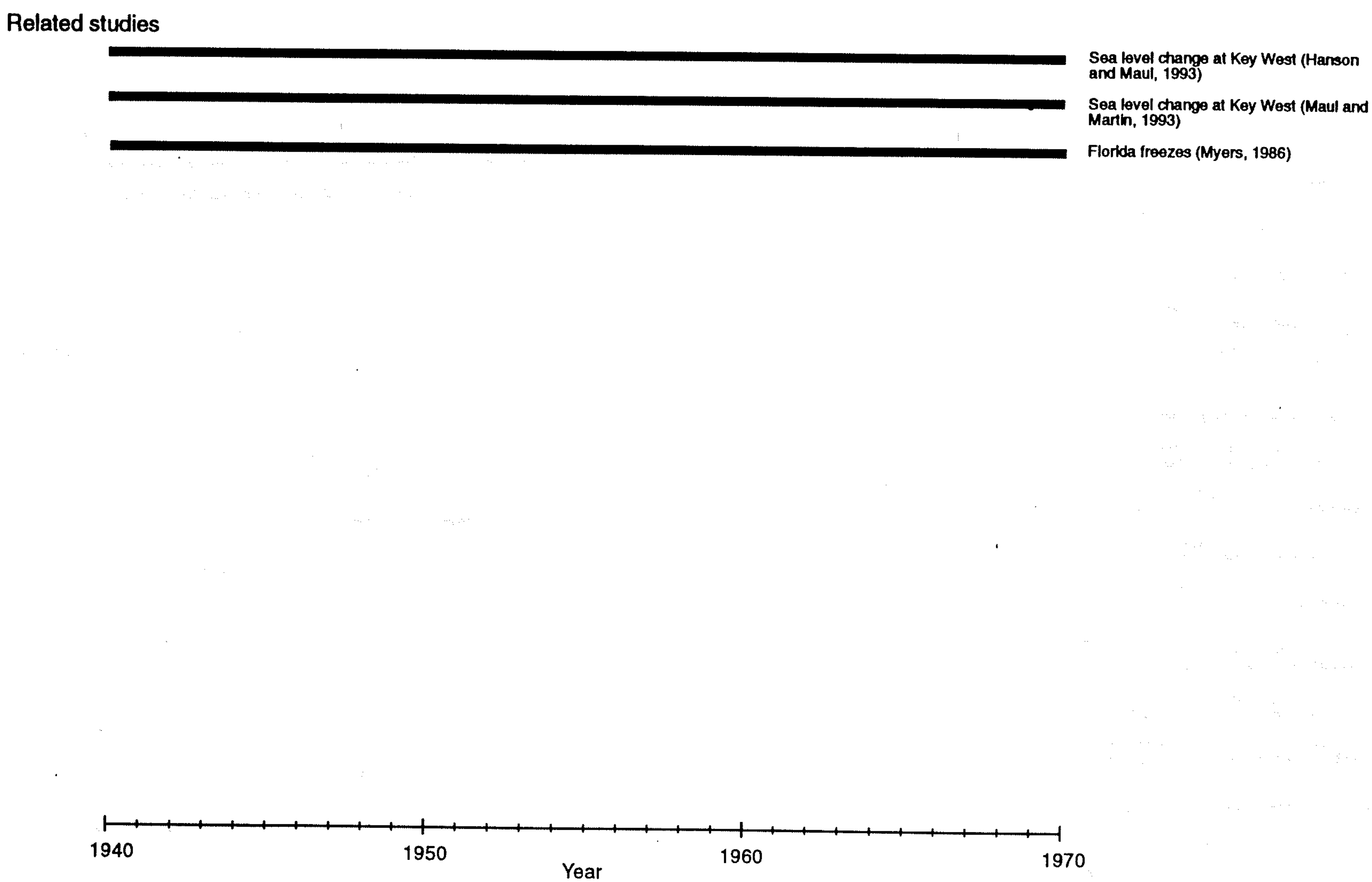

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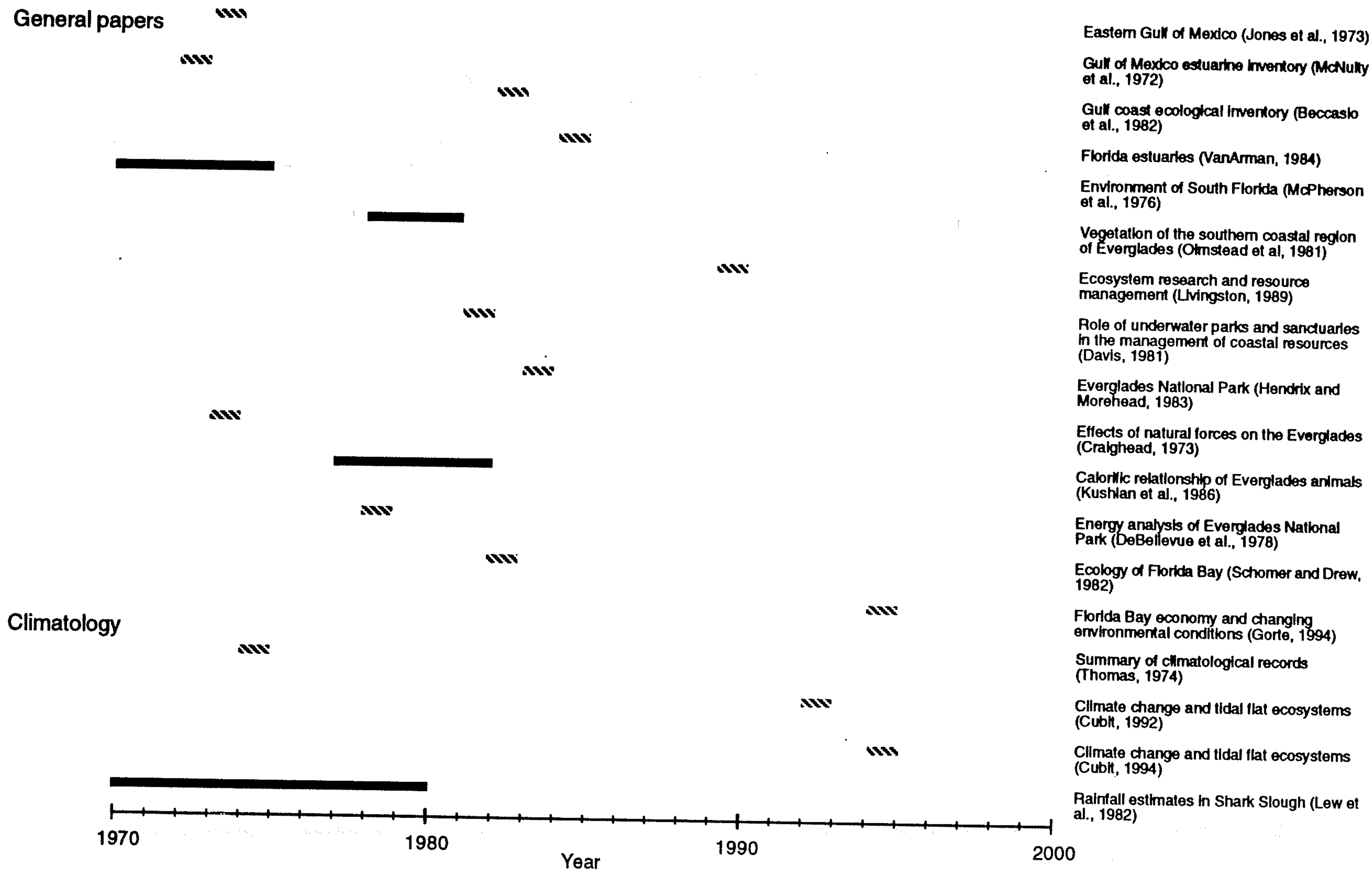

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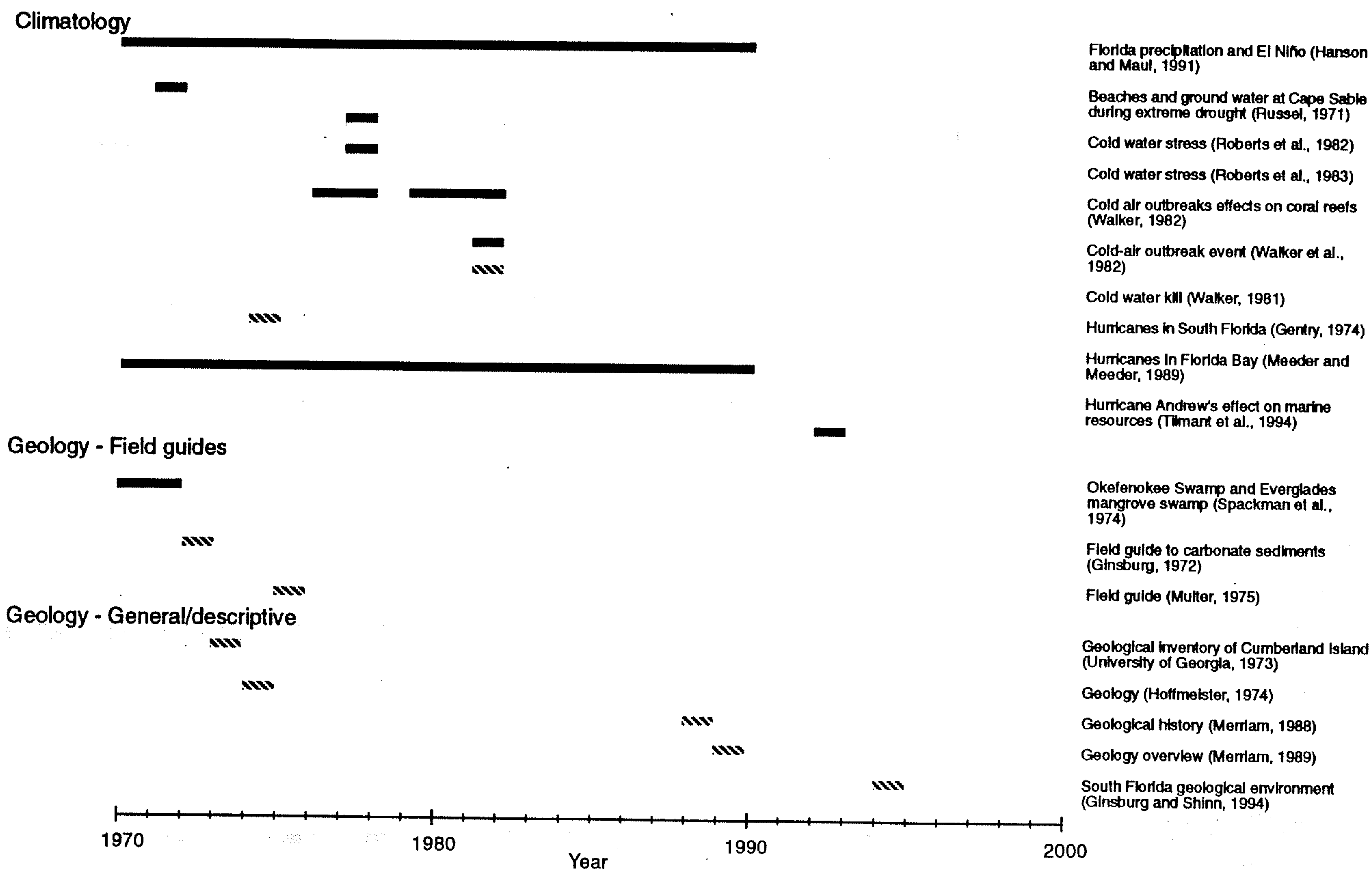

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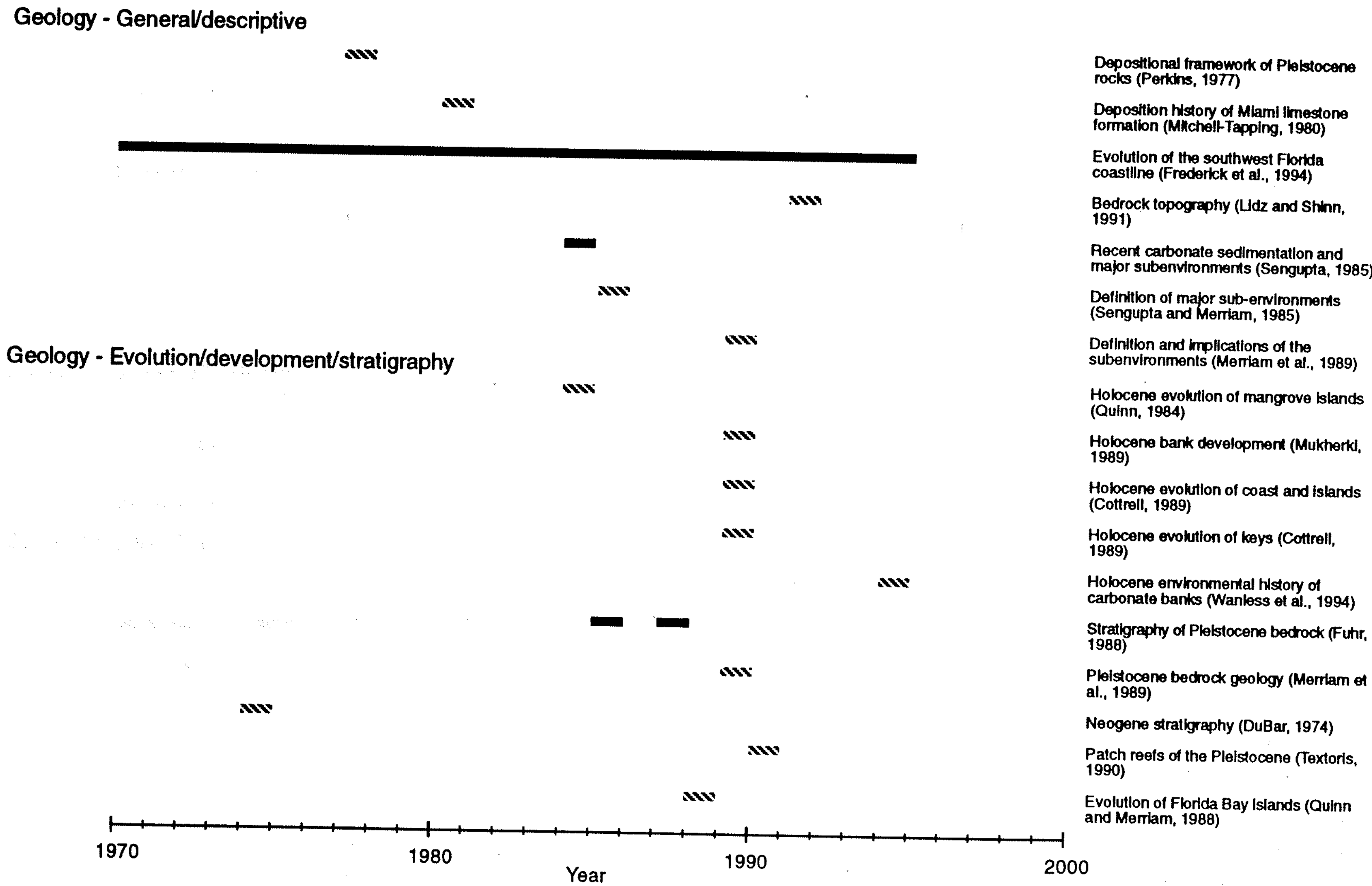

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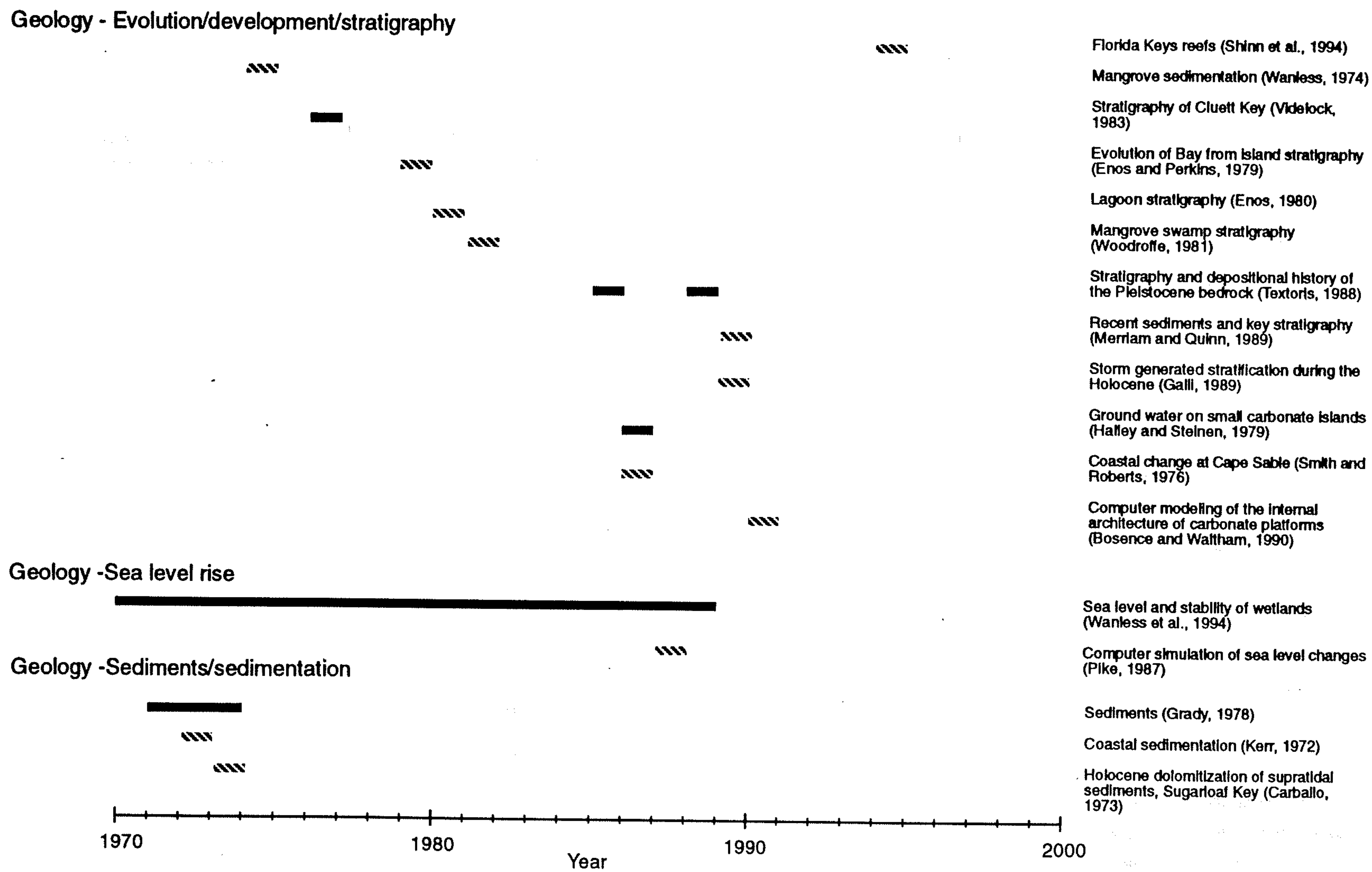

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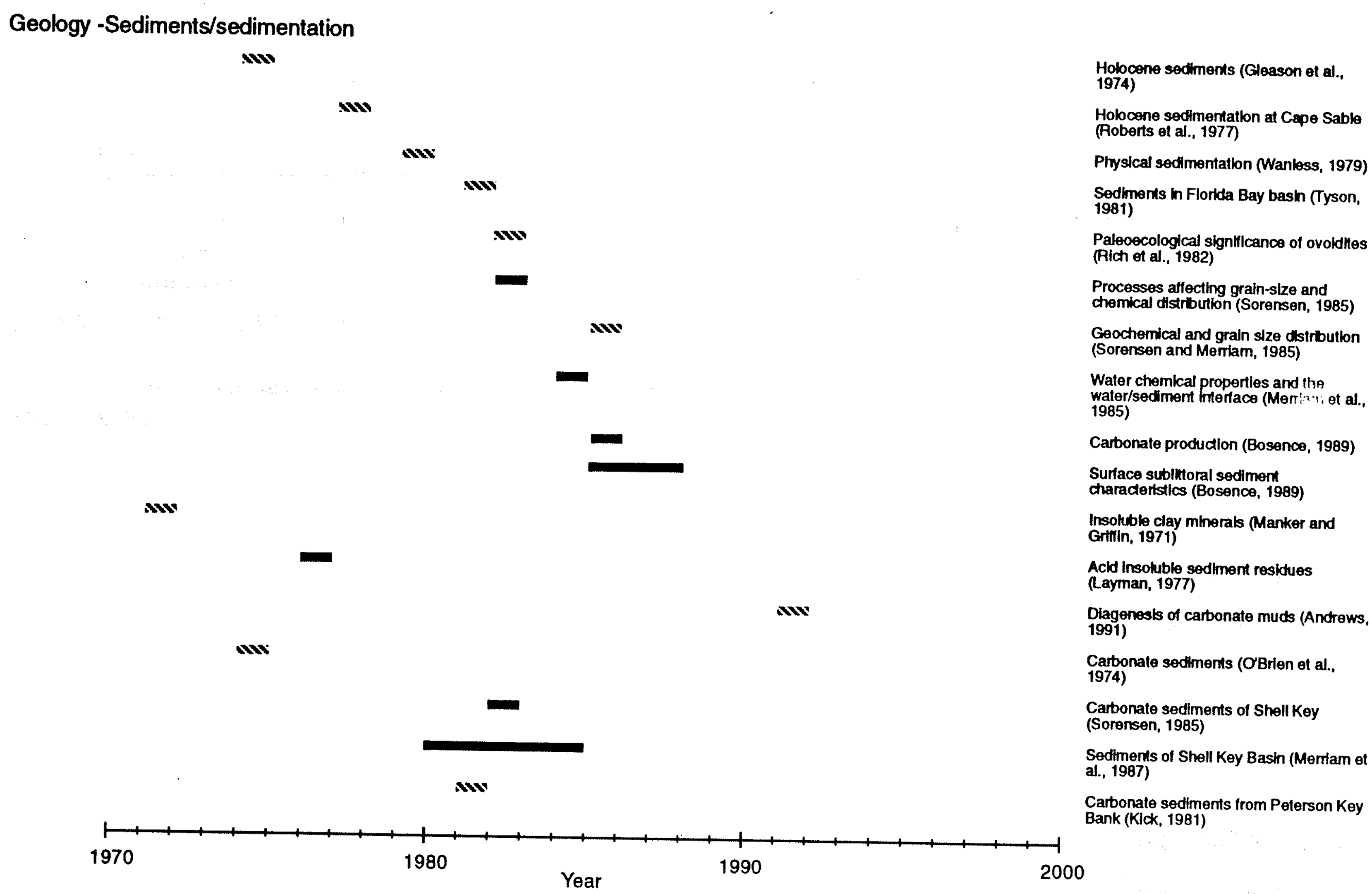

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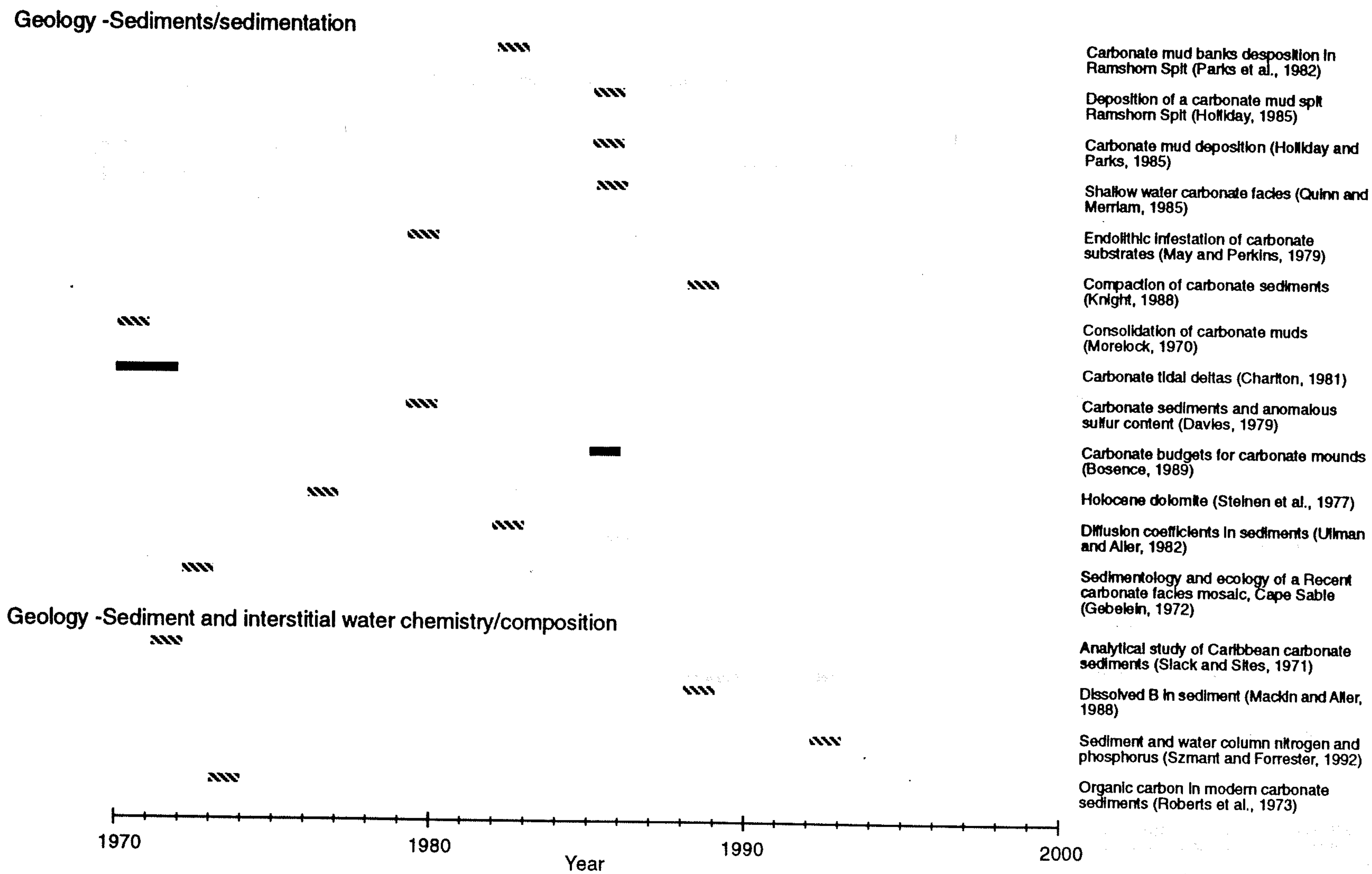

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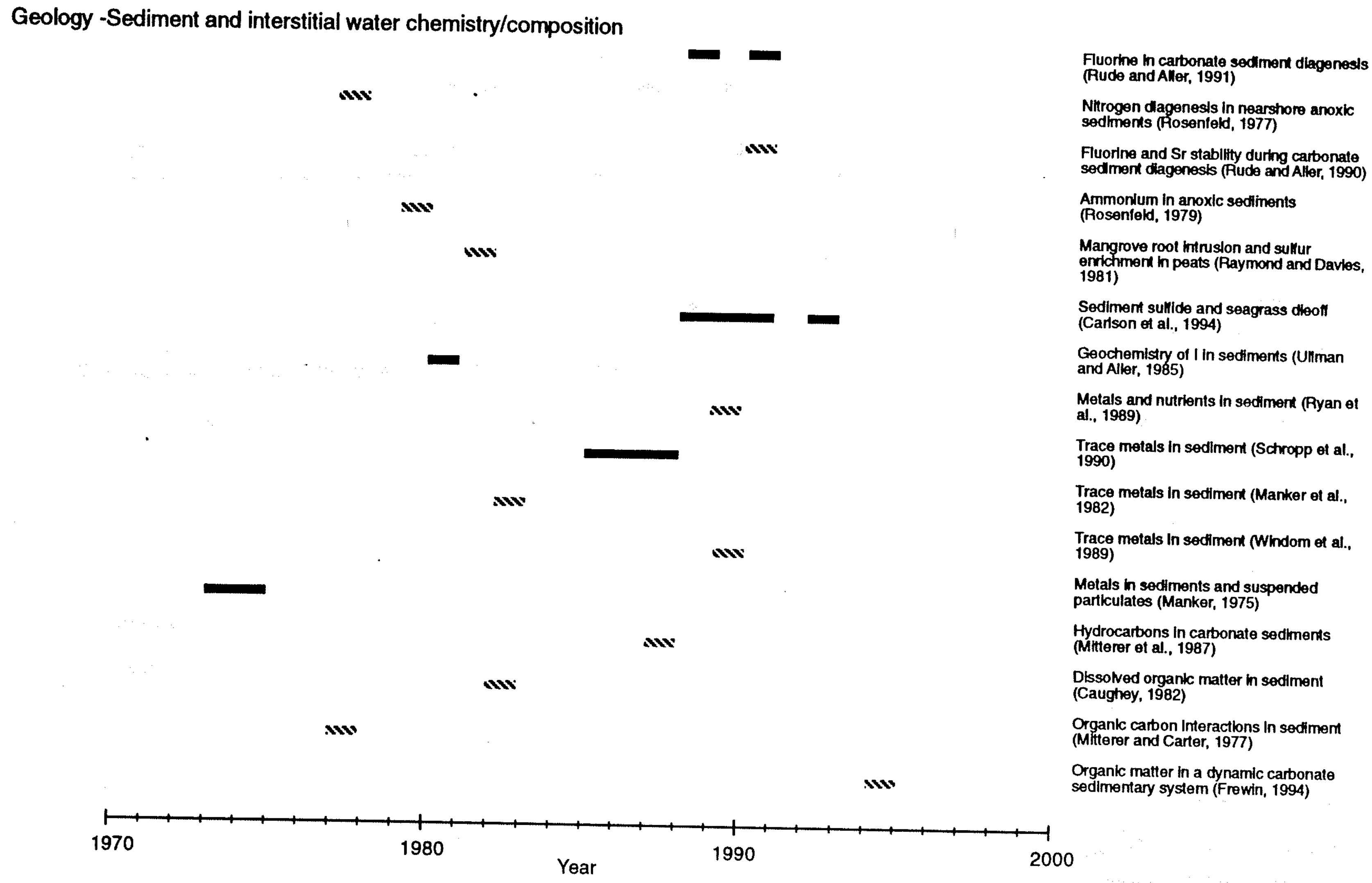

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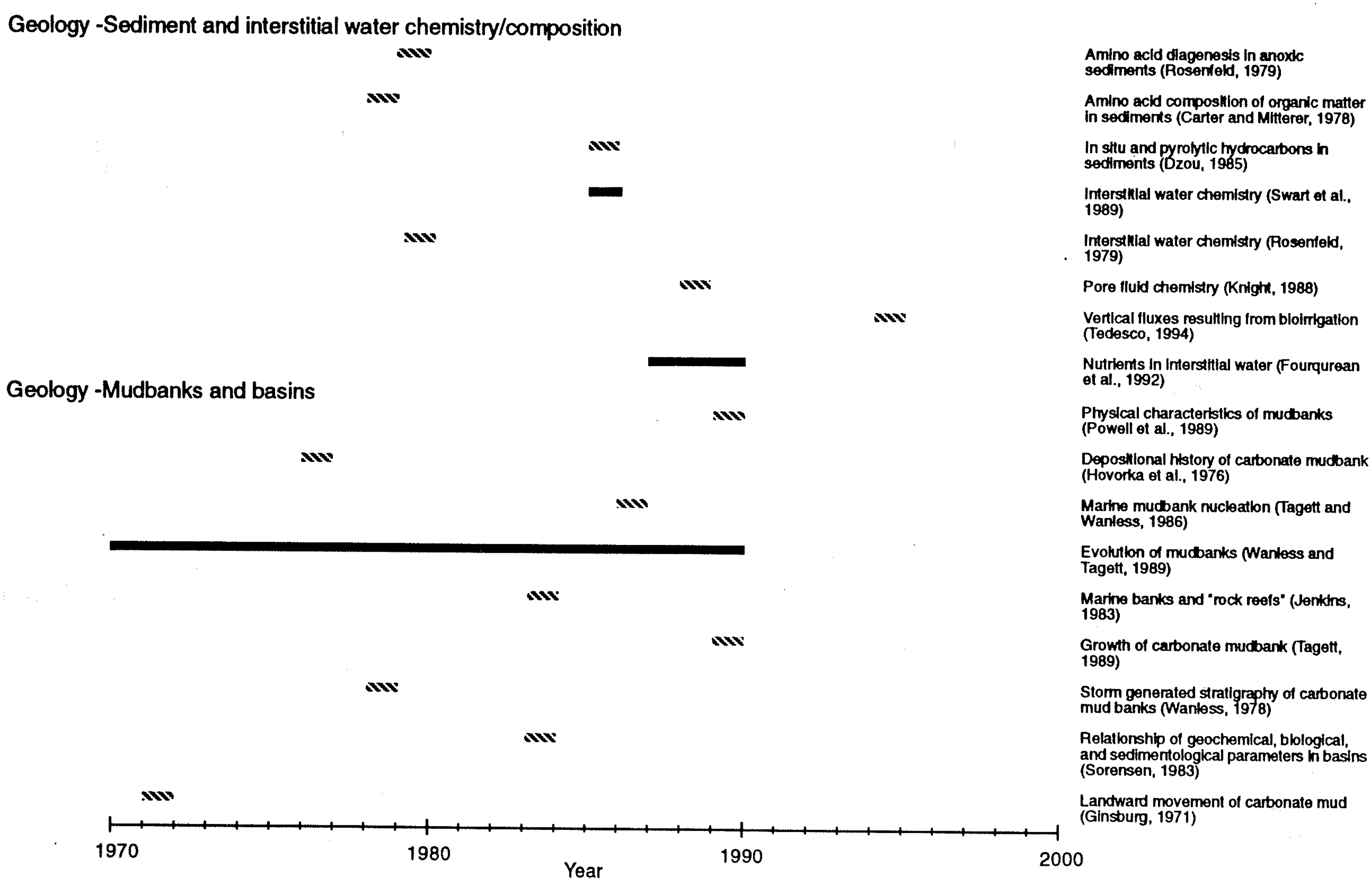

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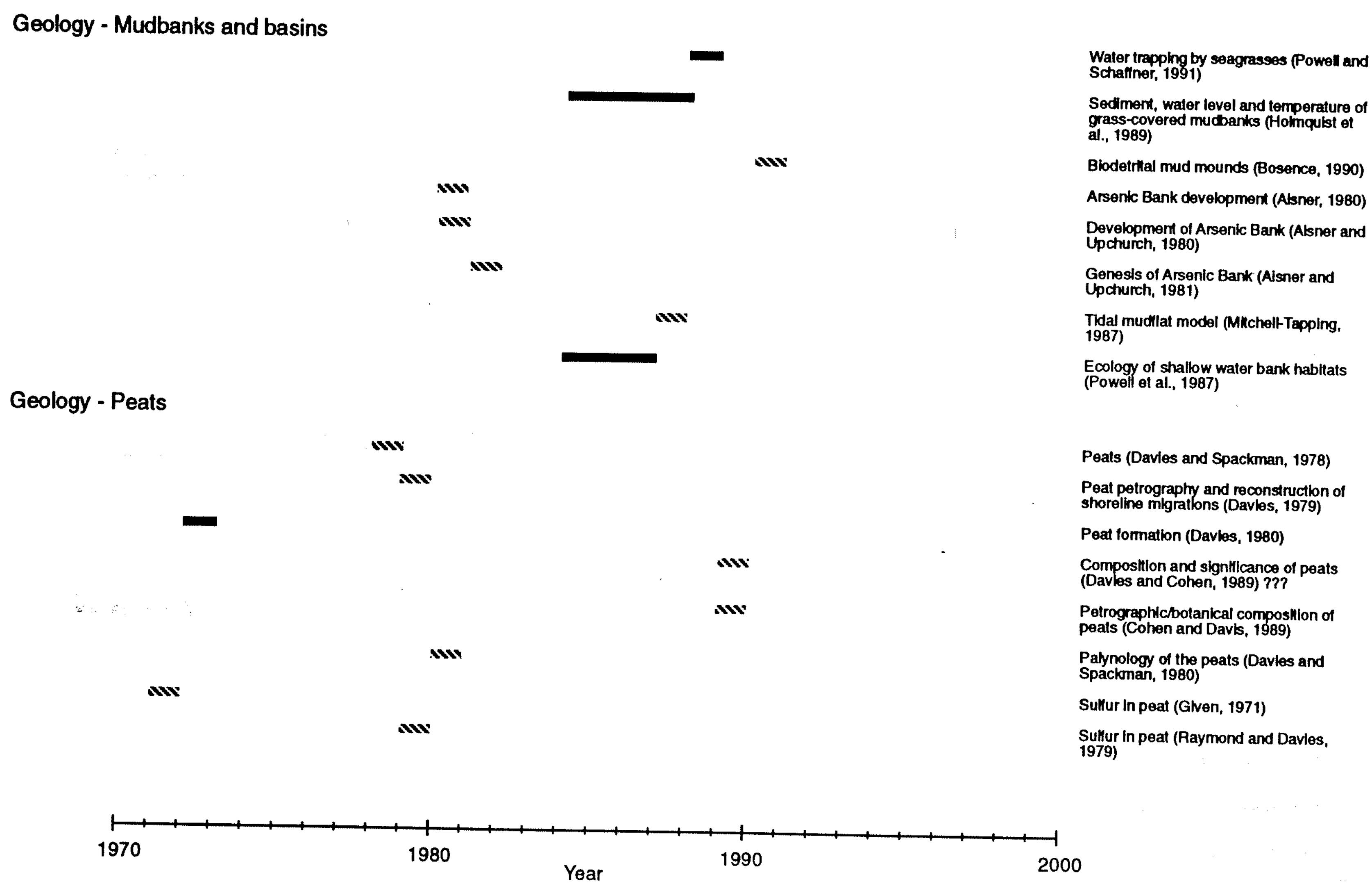

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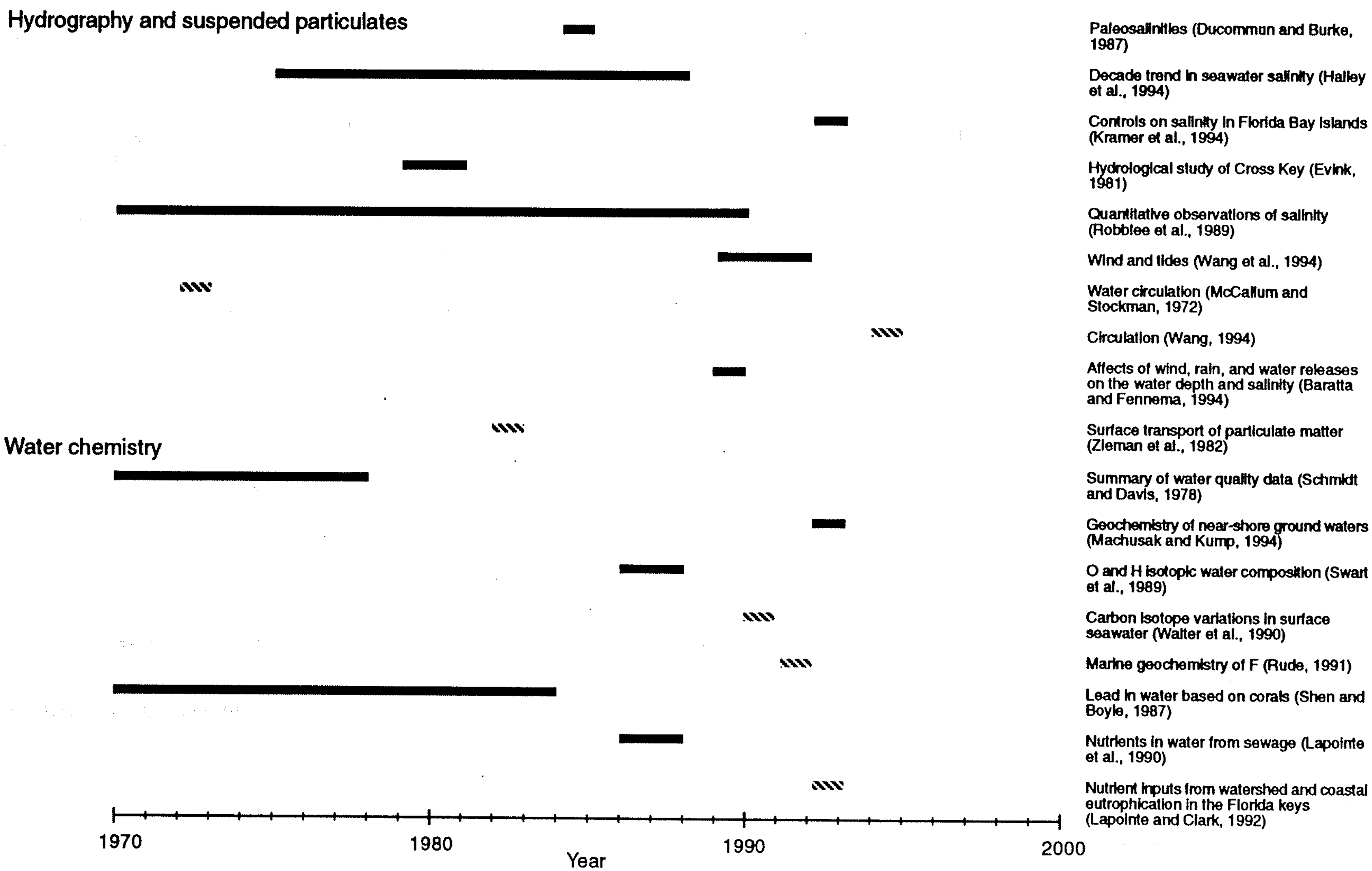

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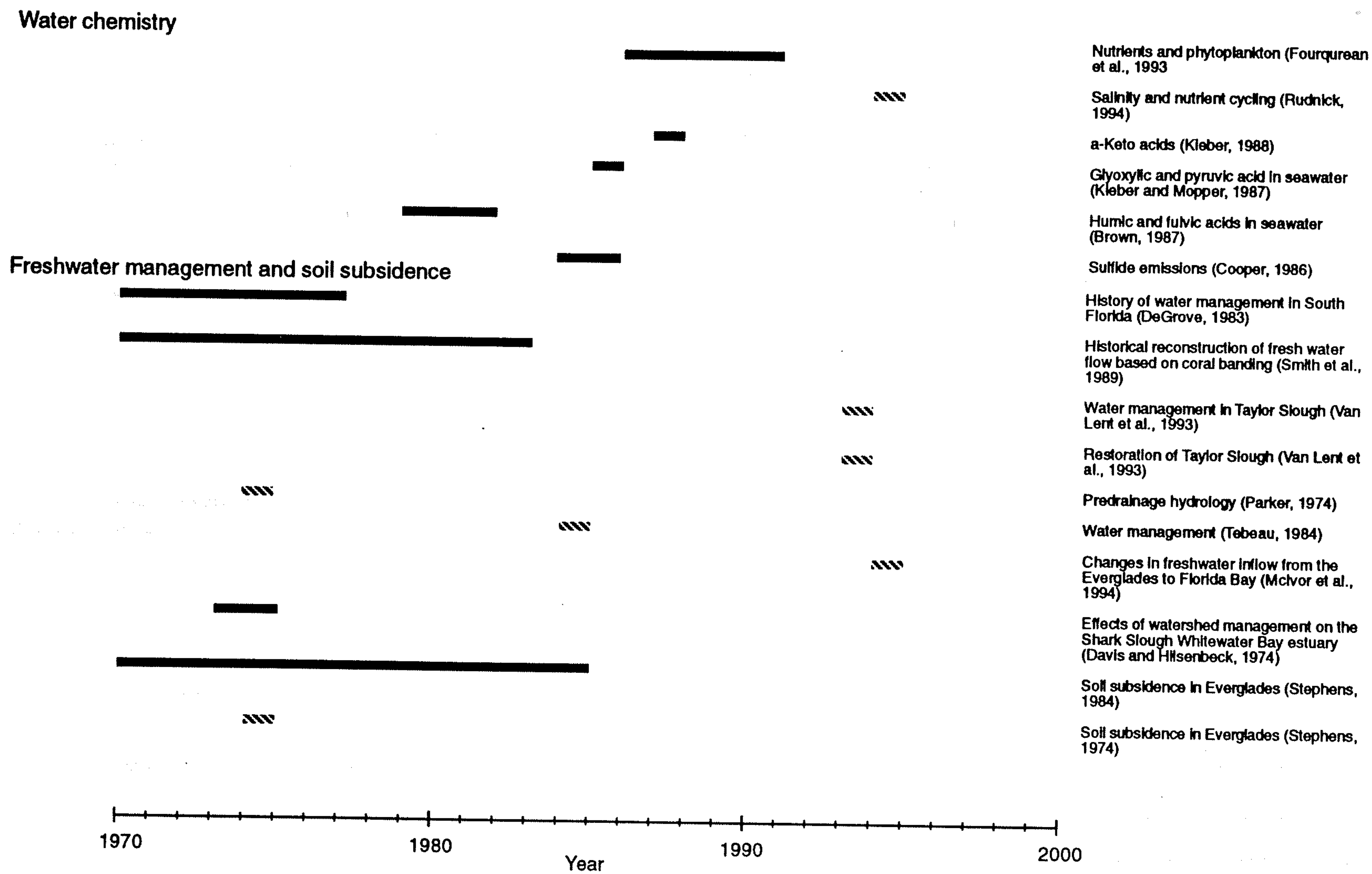

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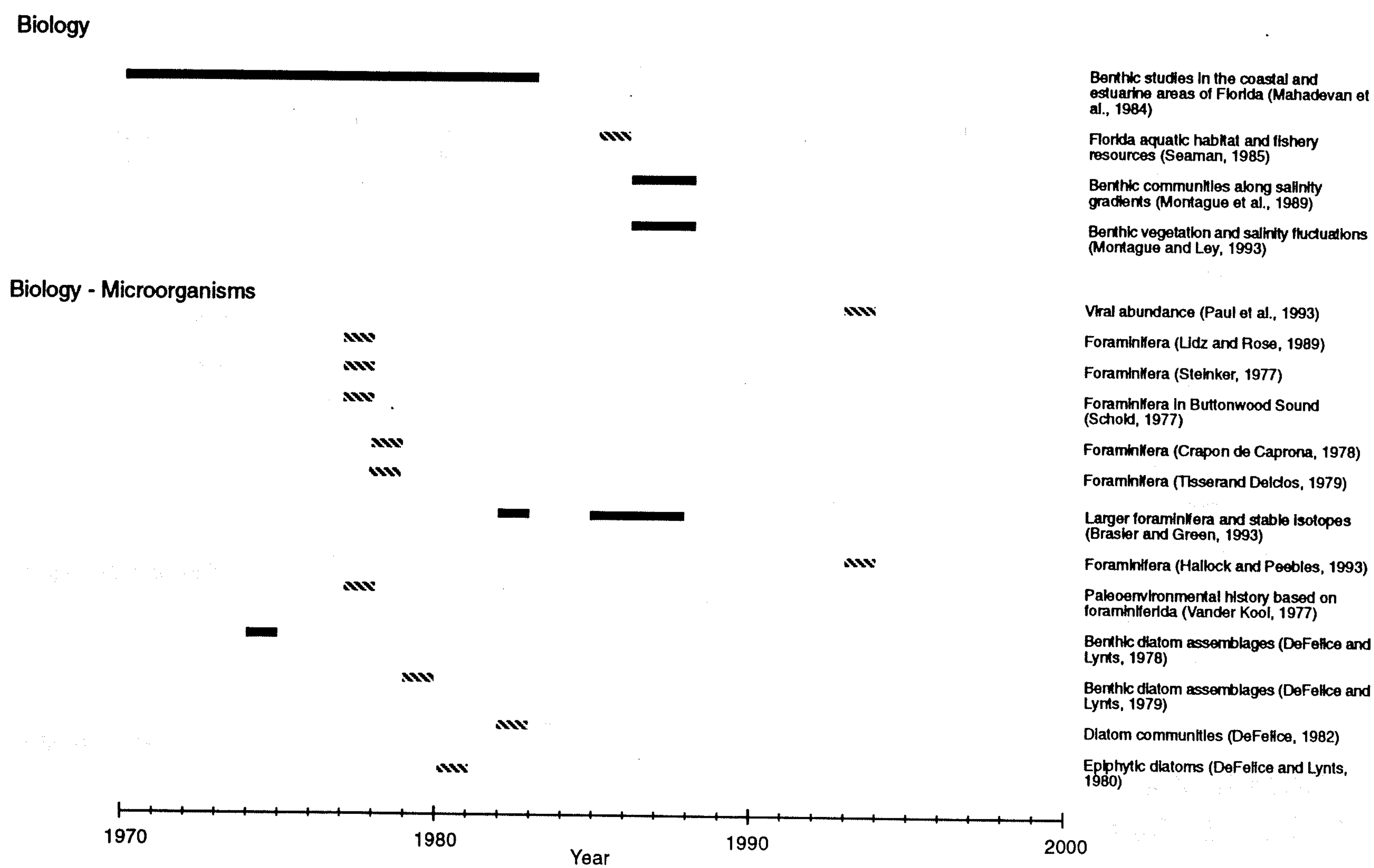

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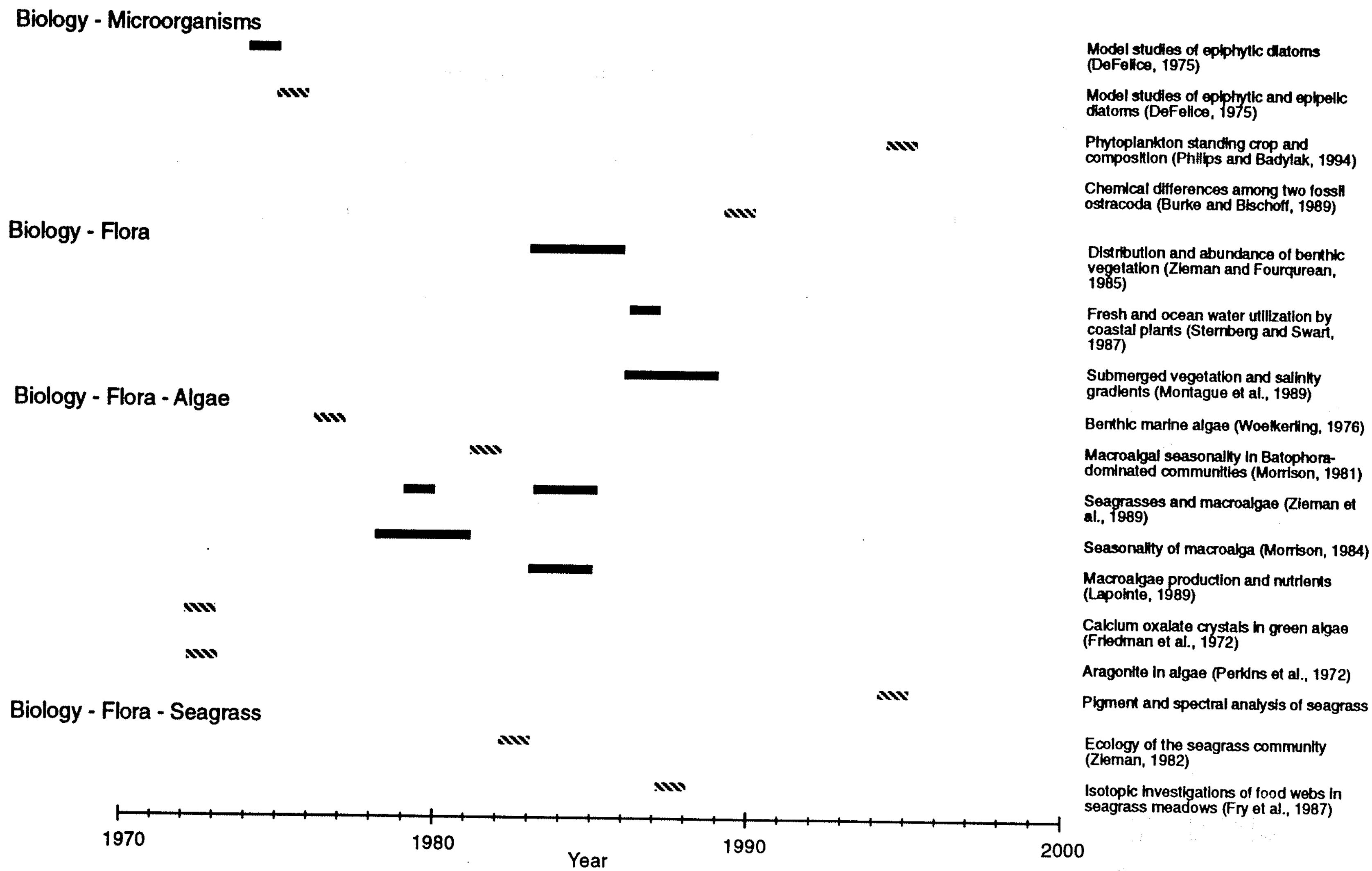
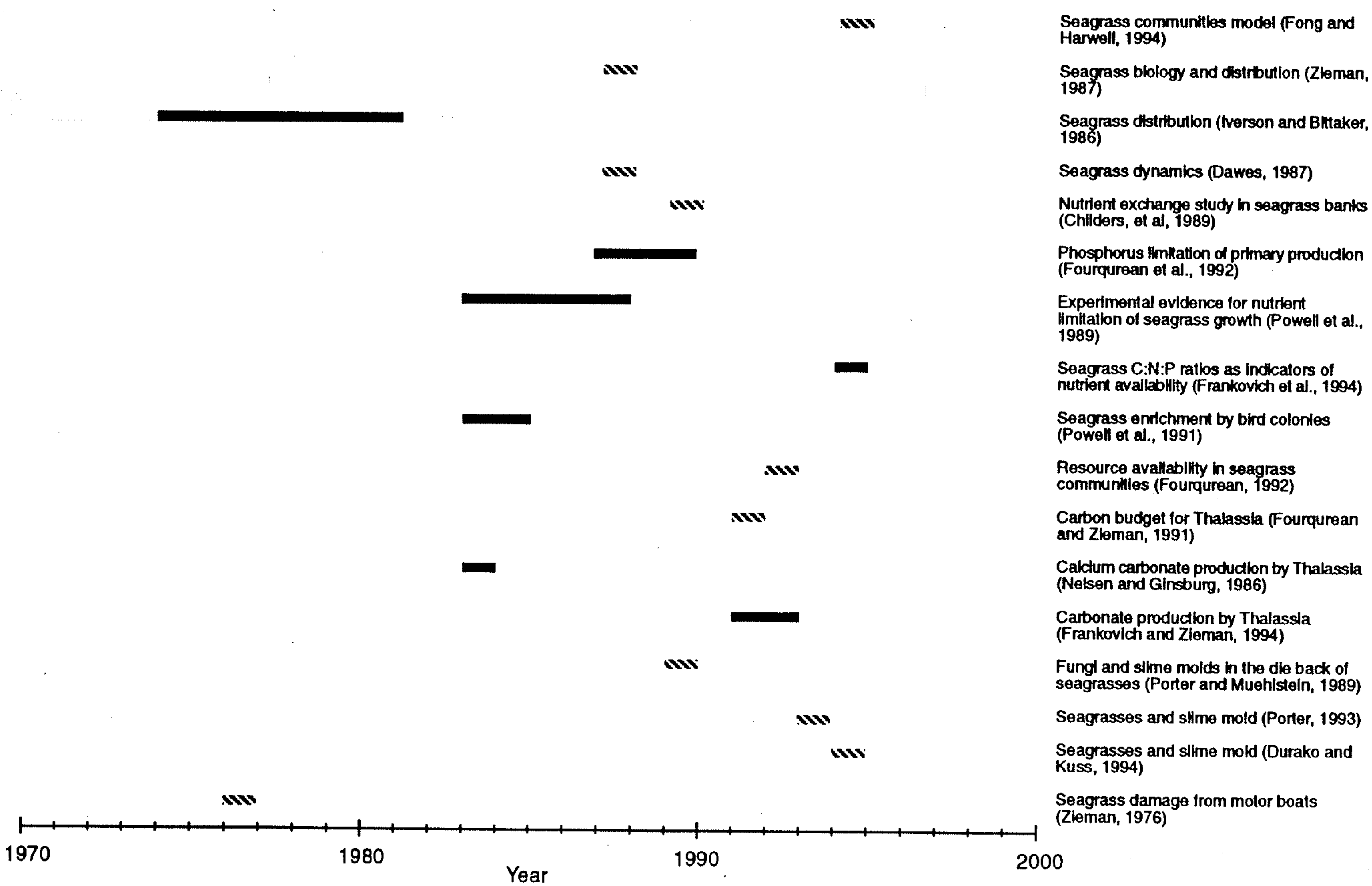


Figure III.7. Citations covering 1970 - 2000. (cont.)

Biology - Flora - Seagrass



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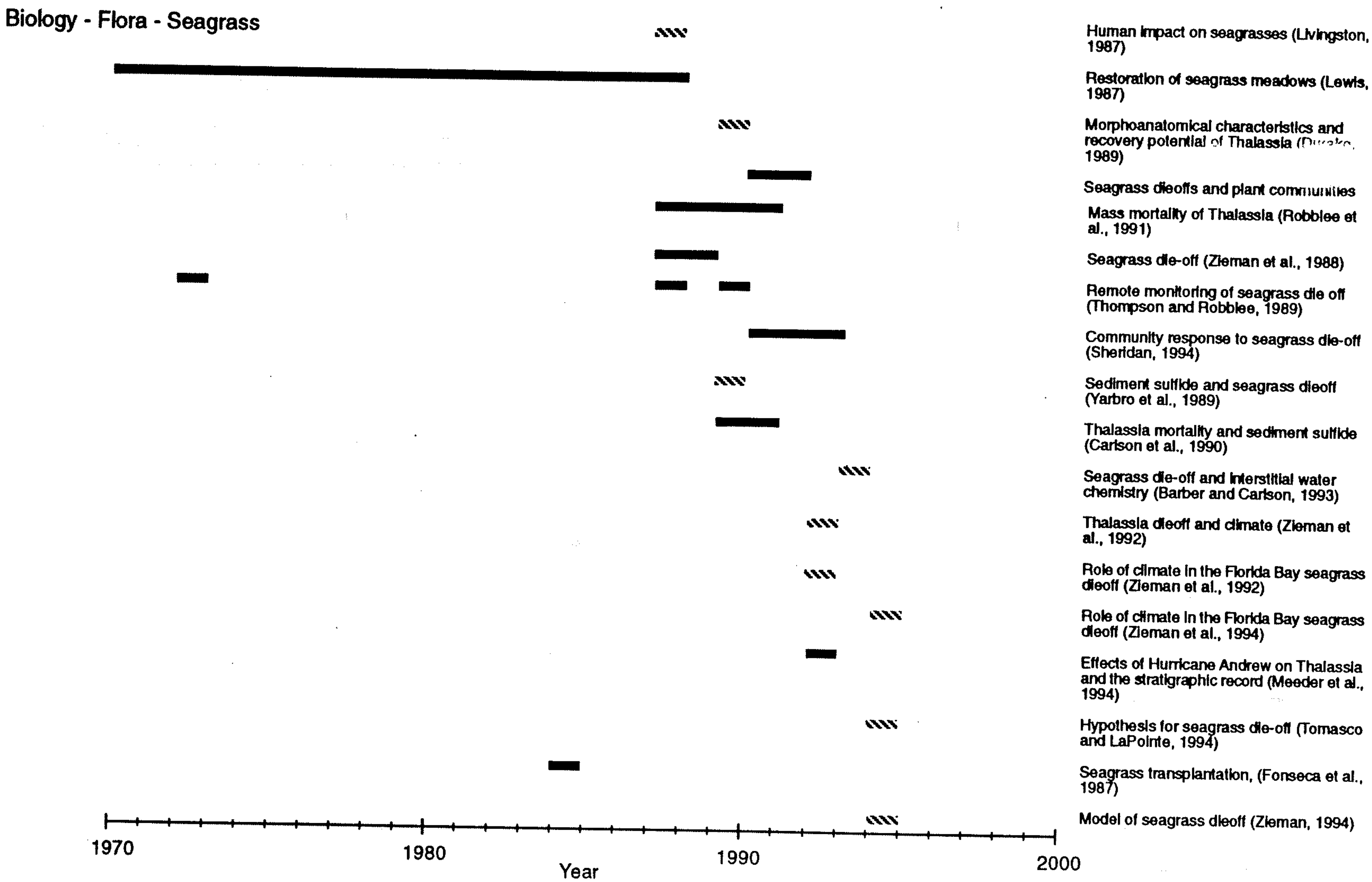

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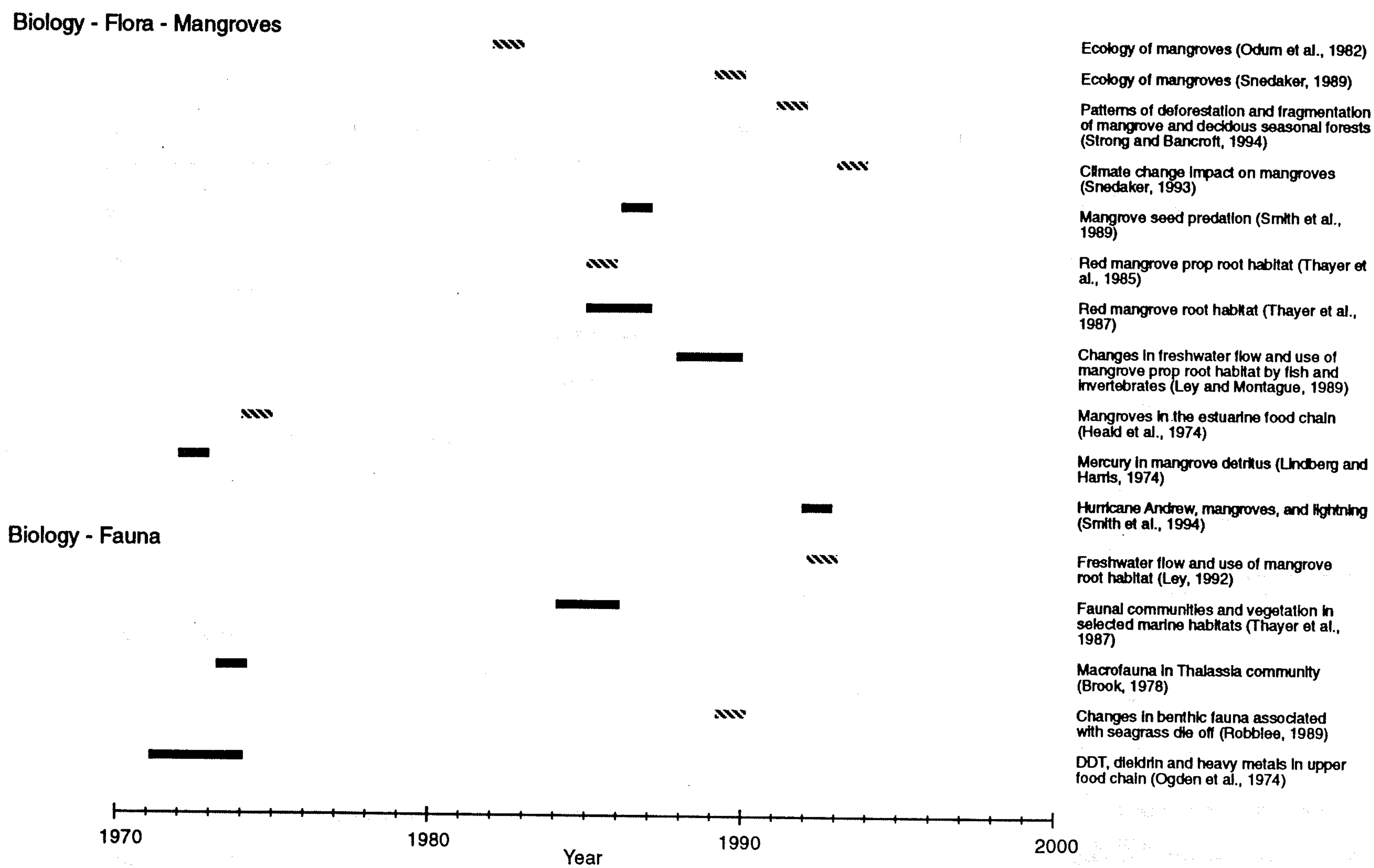

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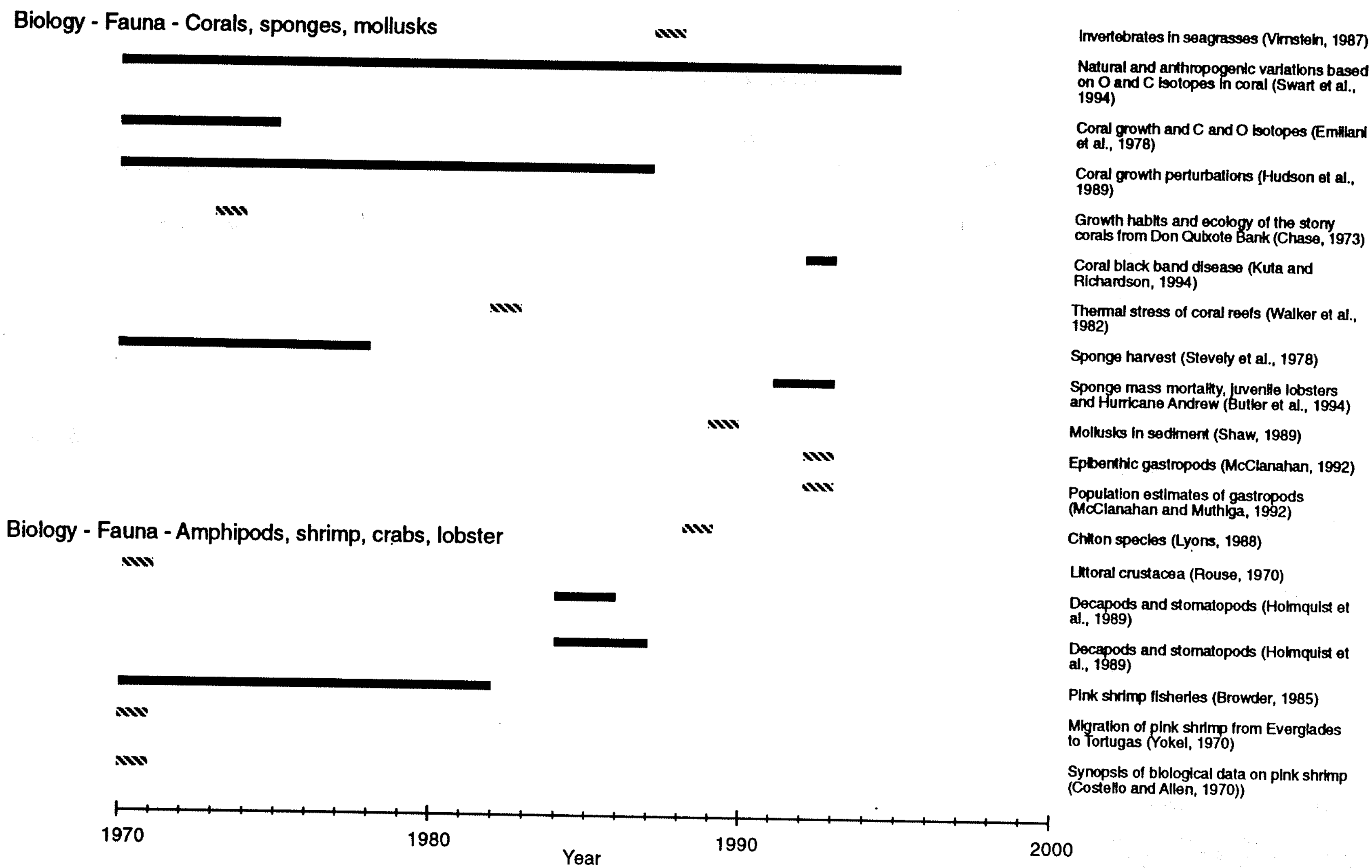

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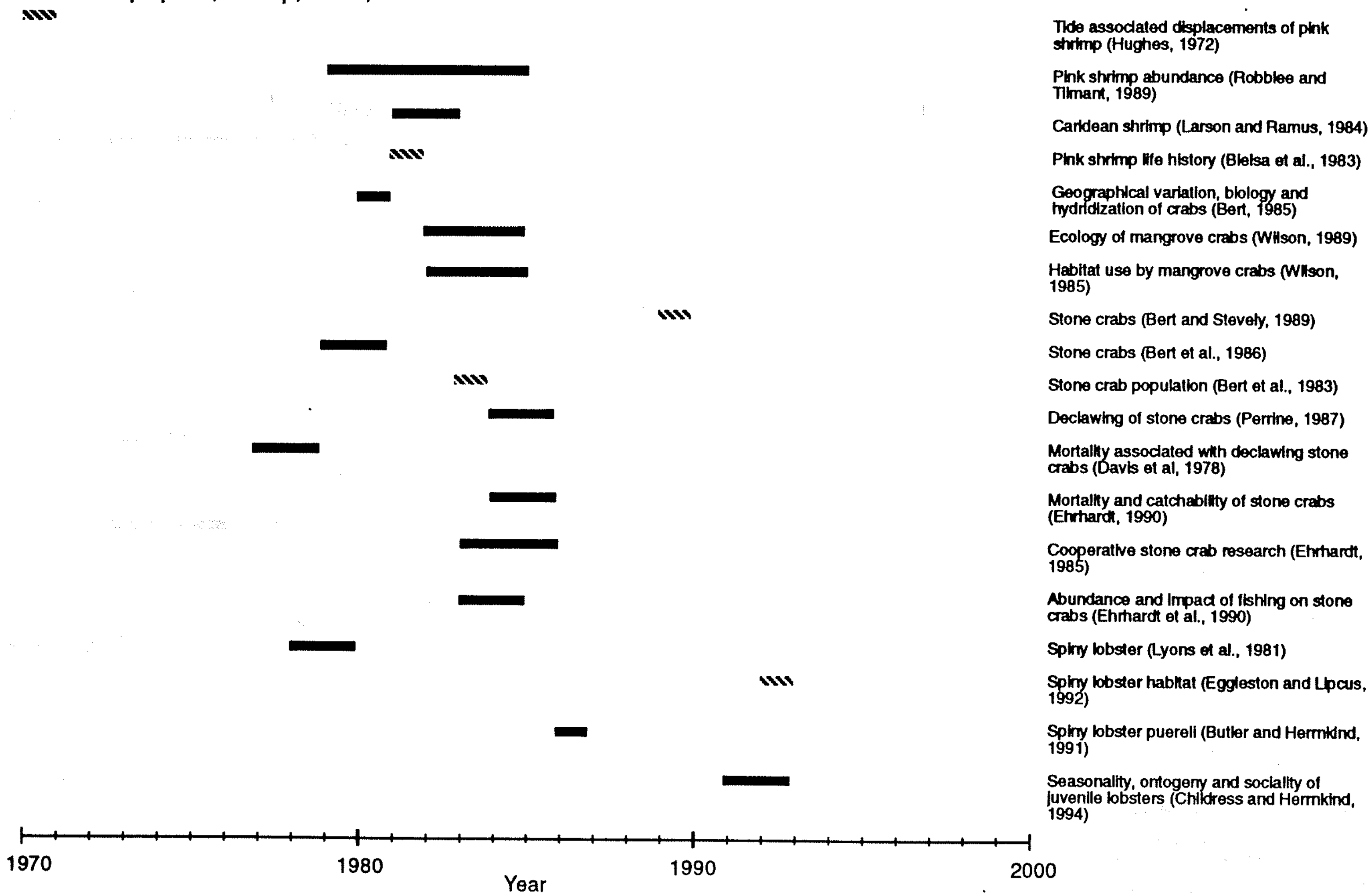
Biology - Fauna - Amphipods, shrimp, crabs, lobster



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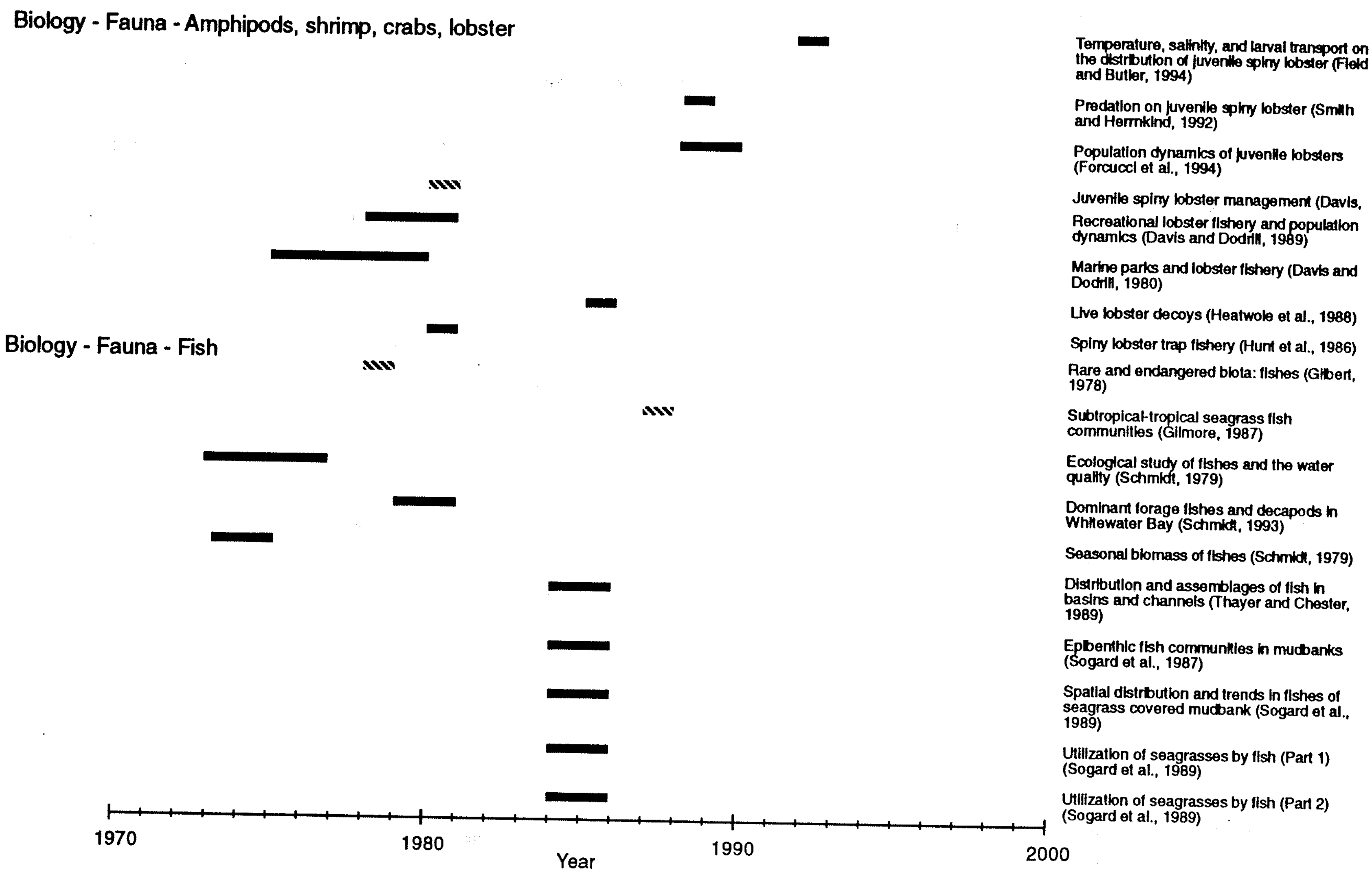
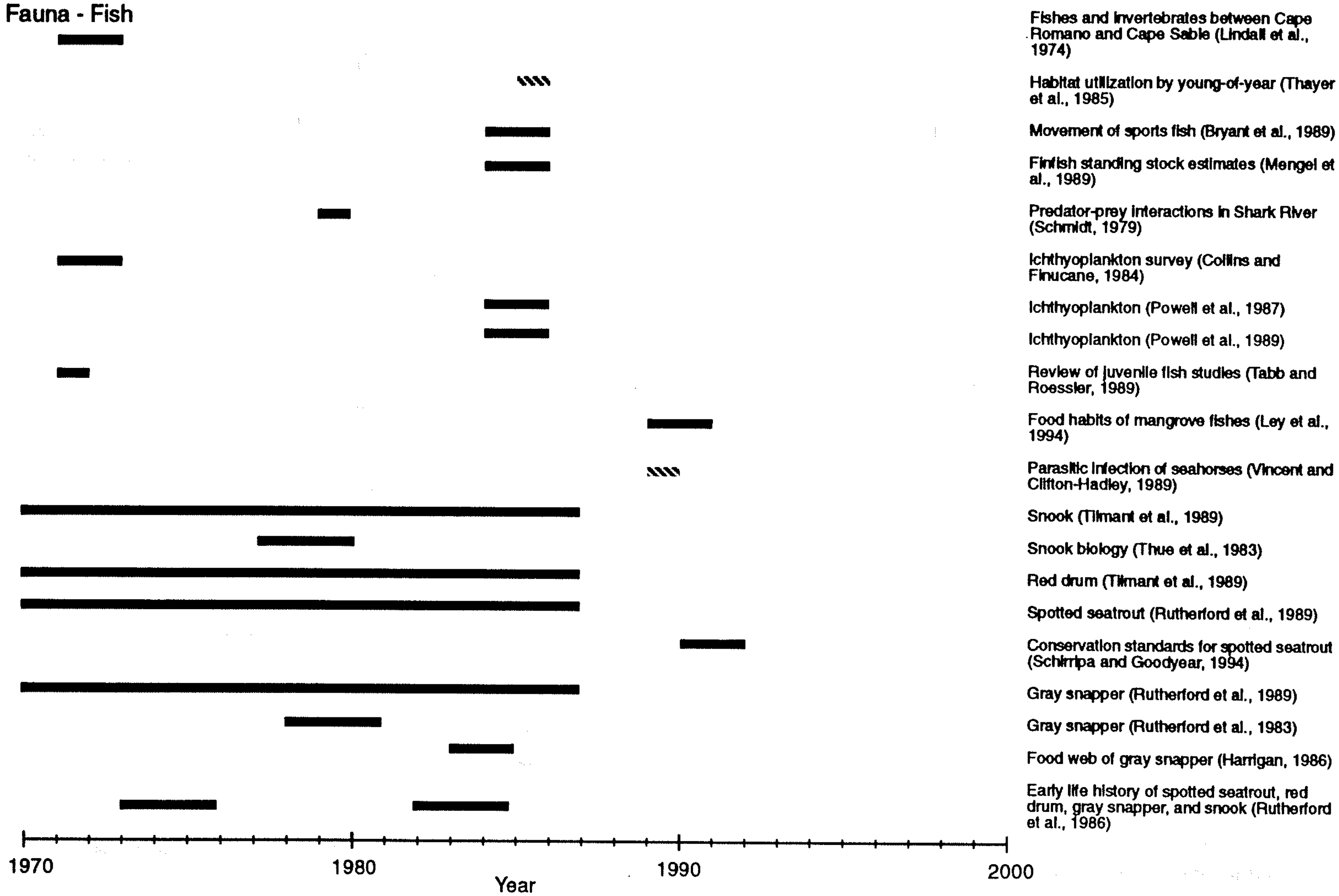


Figure III.7. Citations covering 1970 - 2000. (cont.)

Biology - Fauna - Fish



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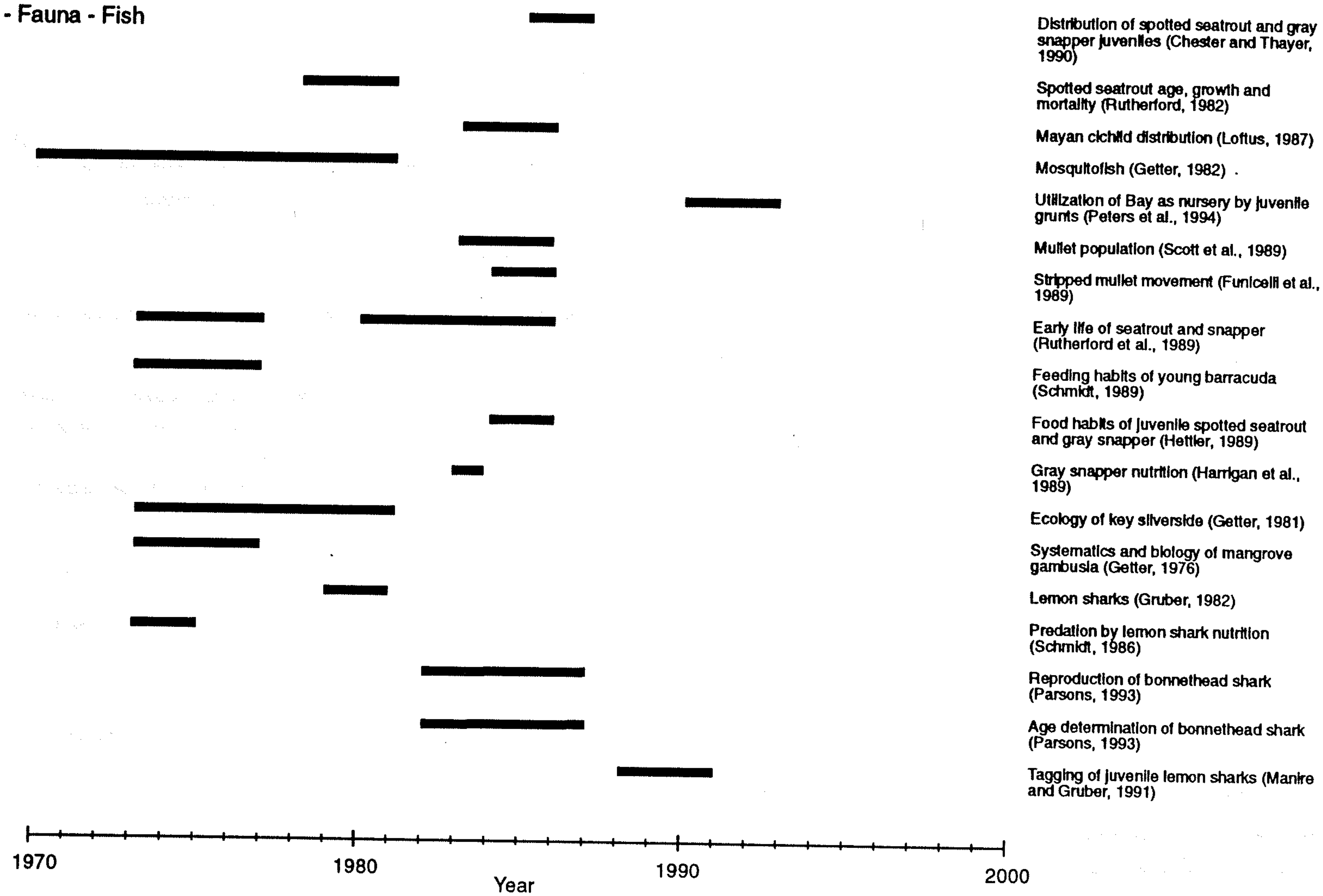
Biology - Fauna - Fish



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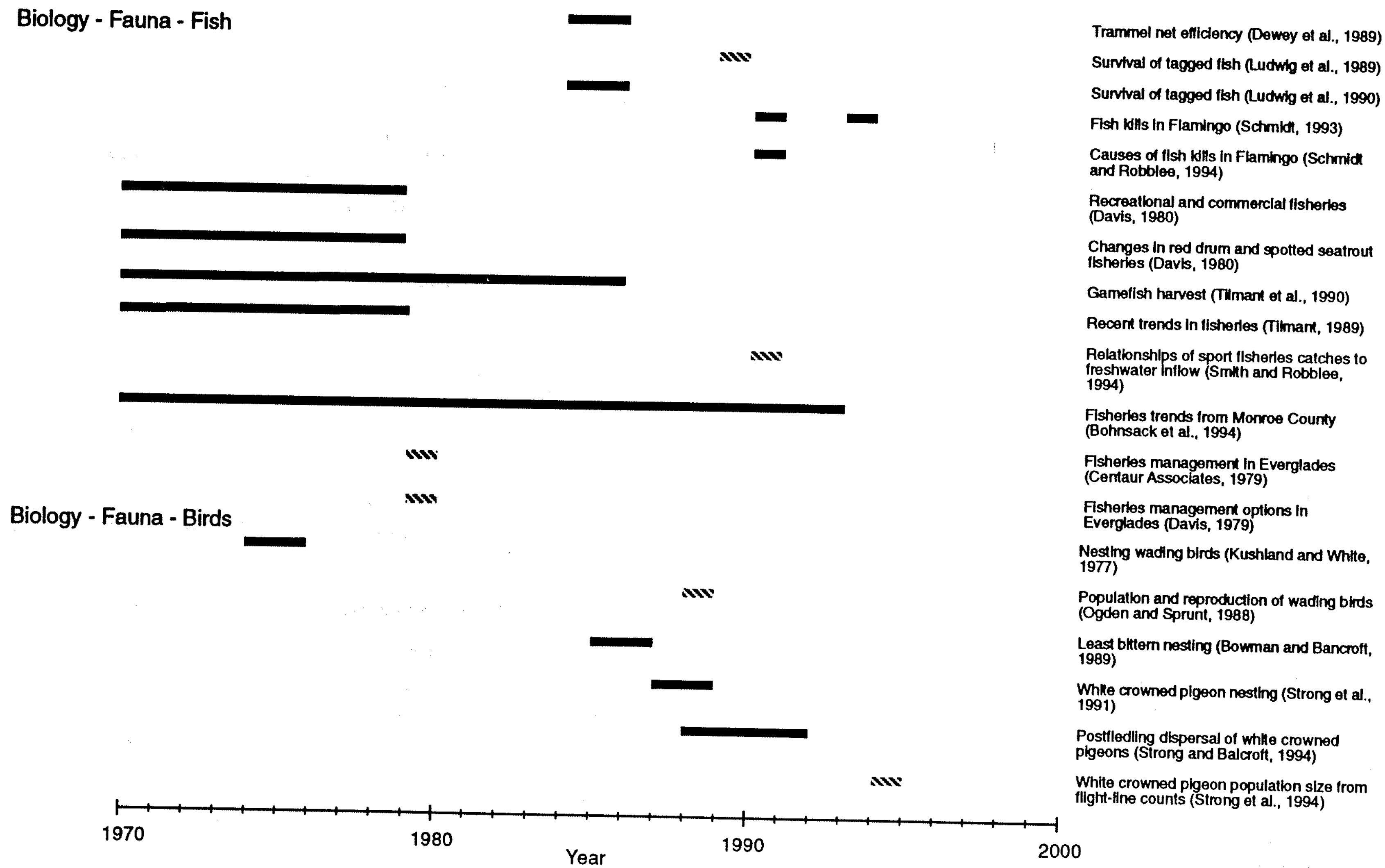

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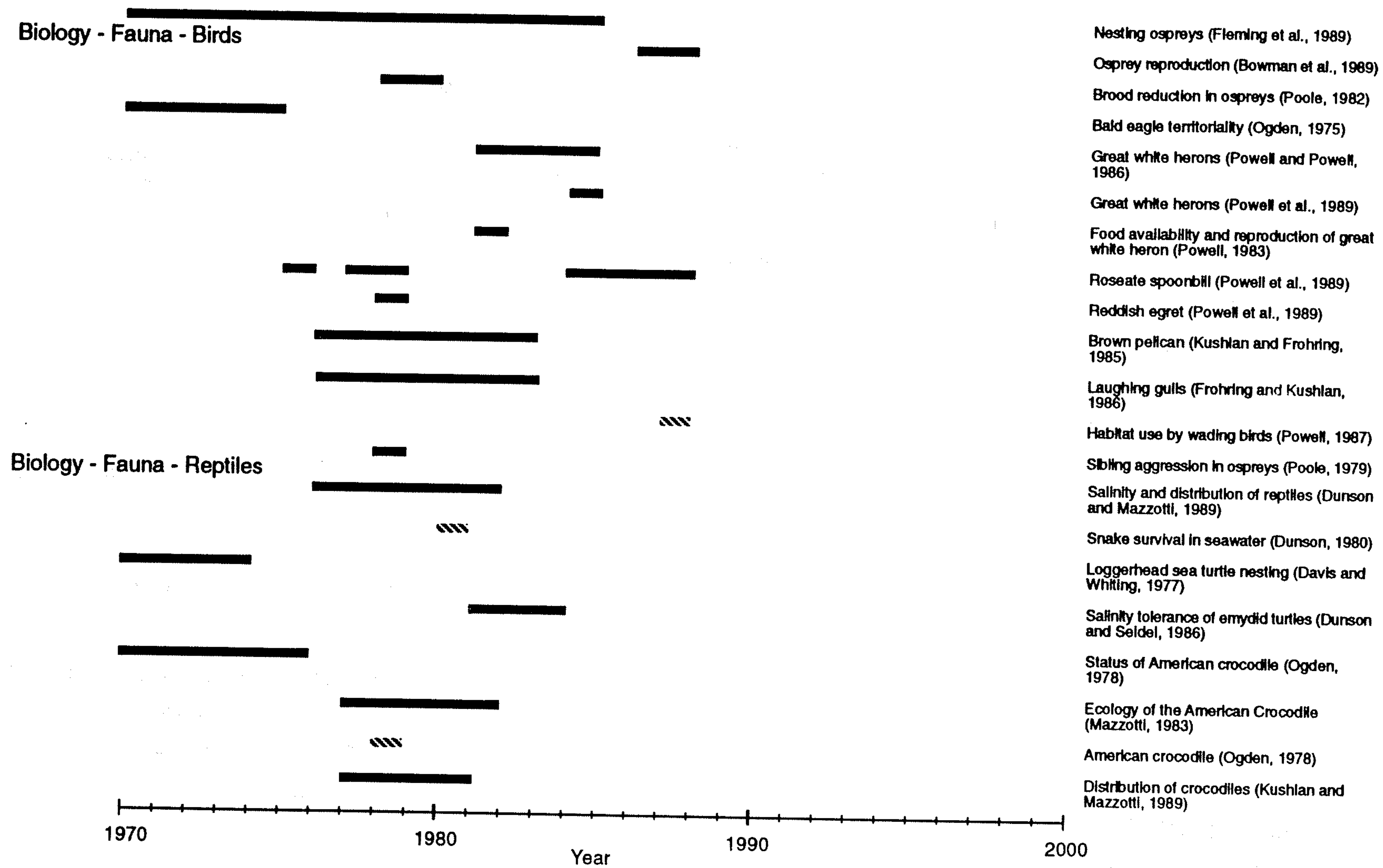

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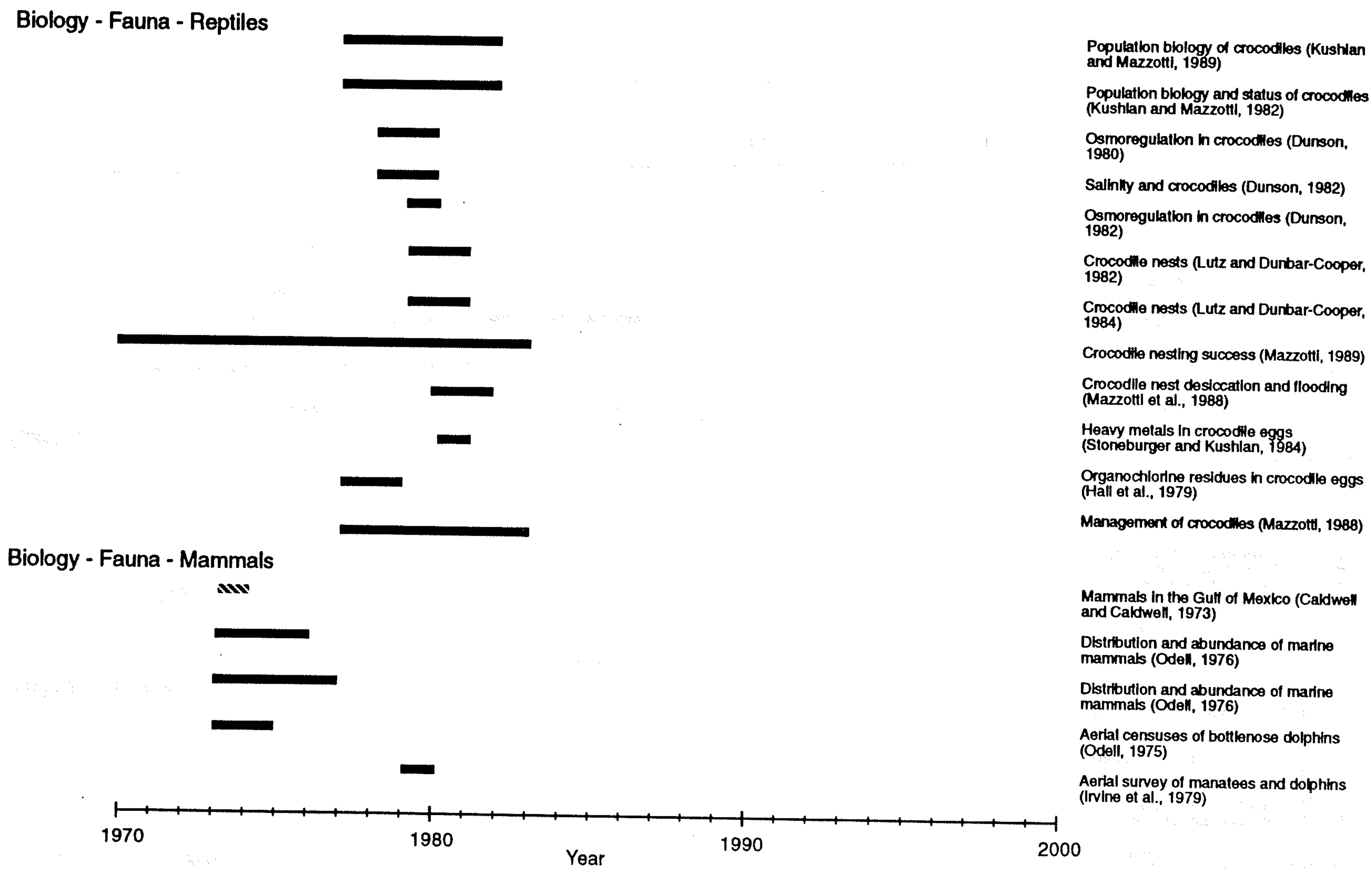
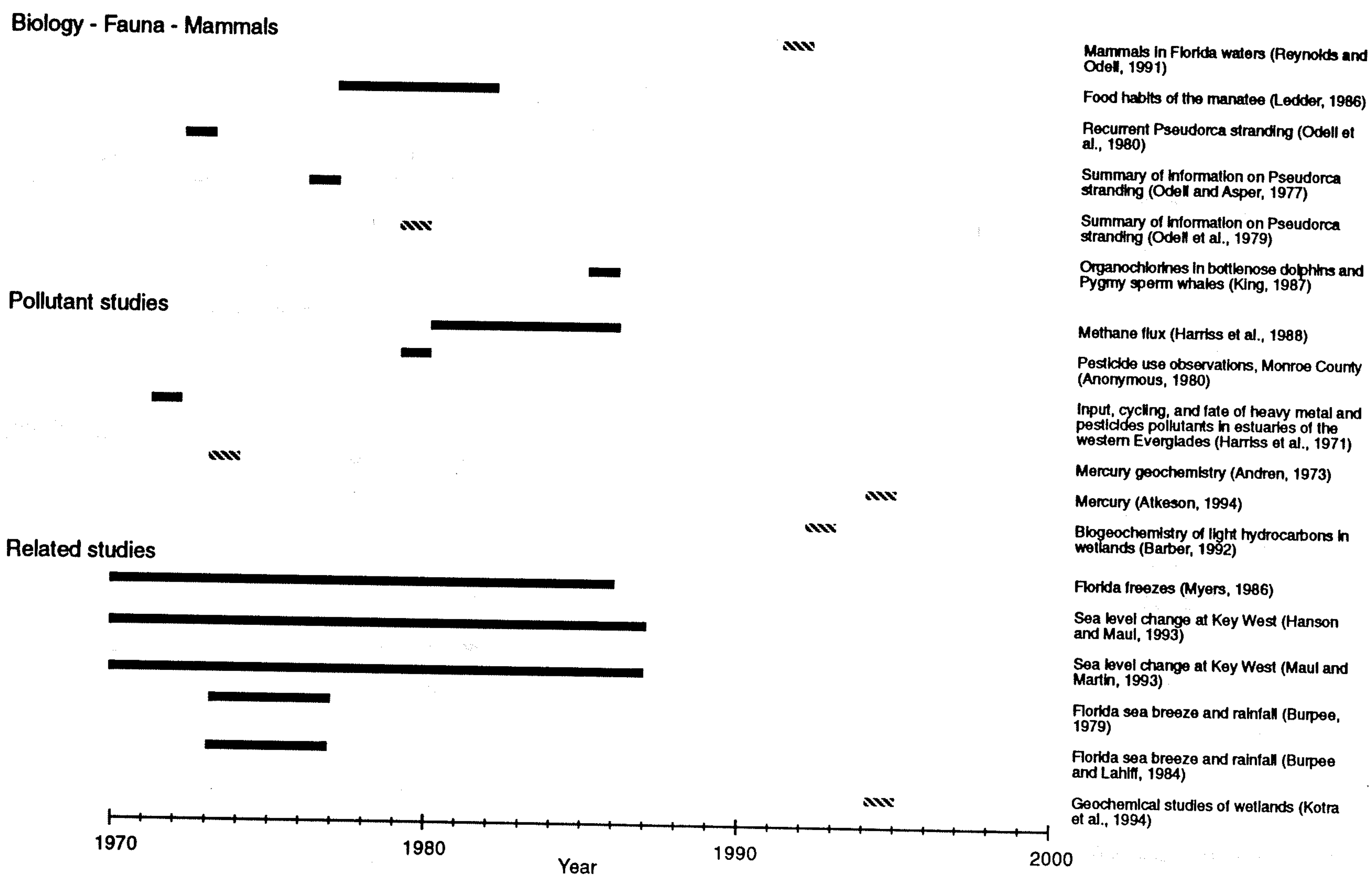


Figure III.7. Citations covering 1970 - 2000. (cont.)



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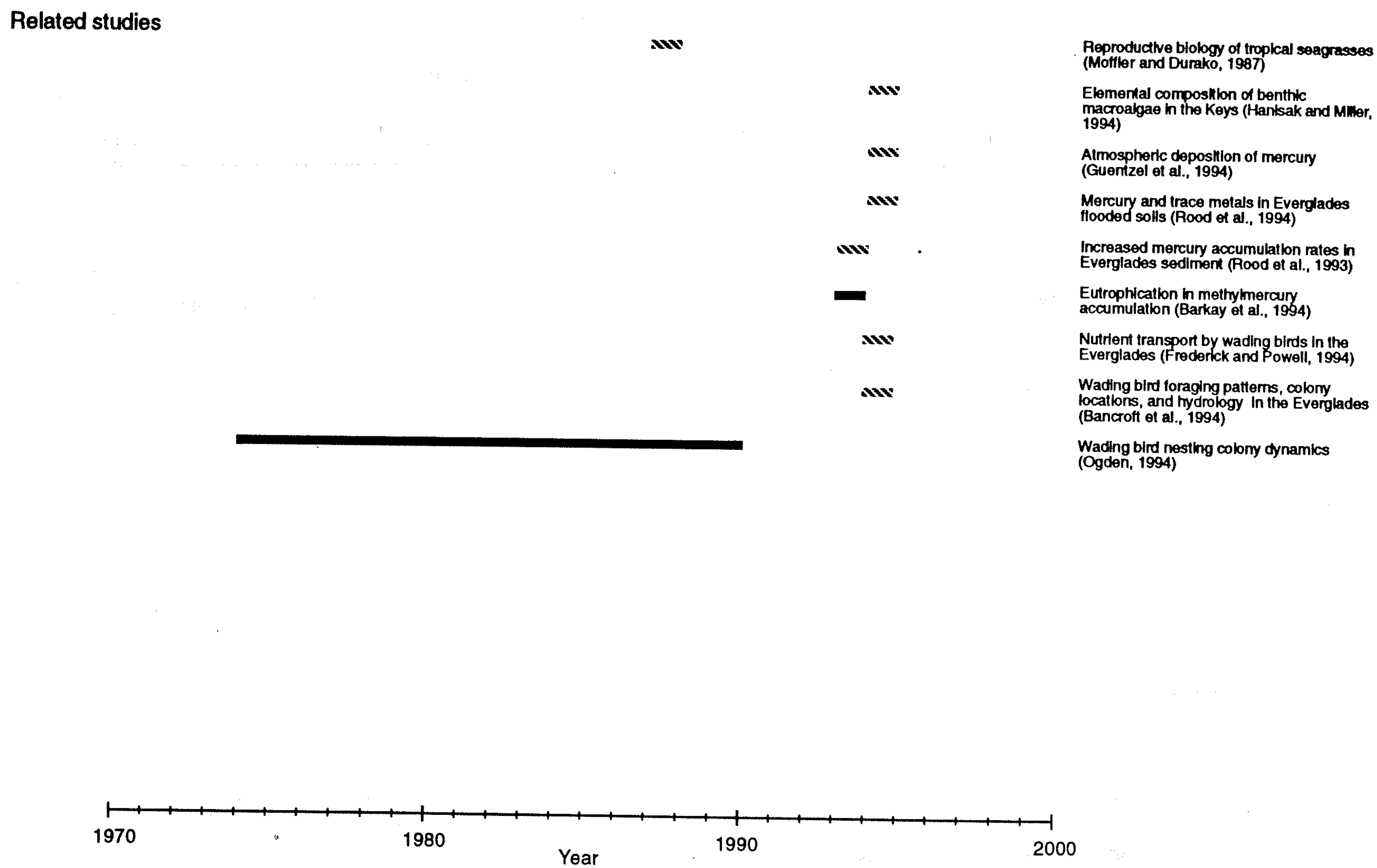

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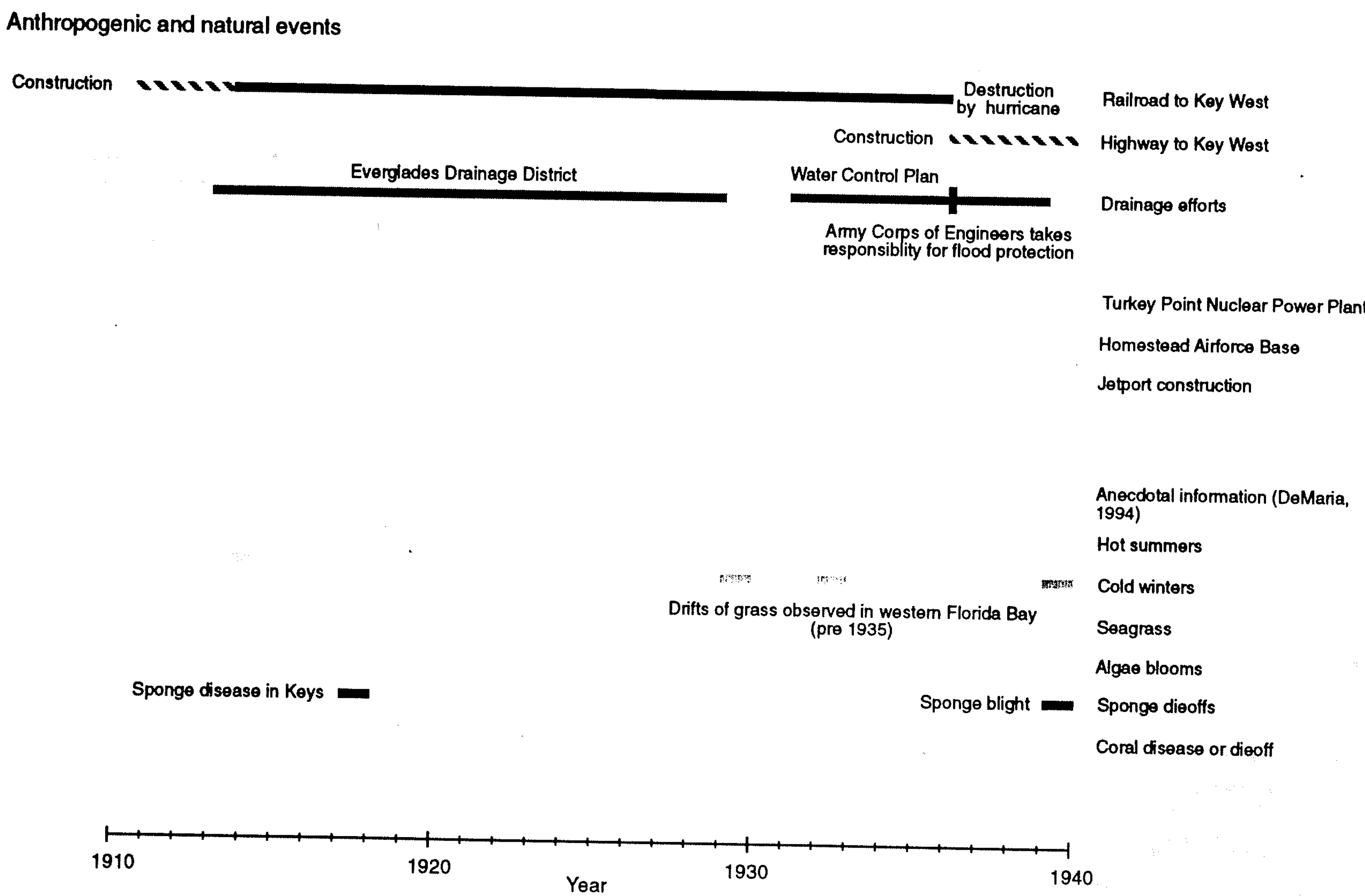


Figure II.8. Anthropogenic and natural events.

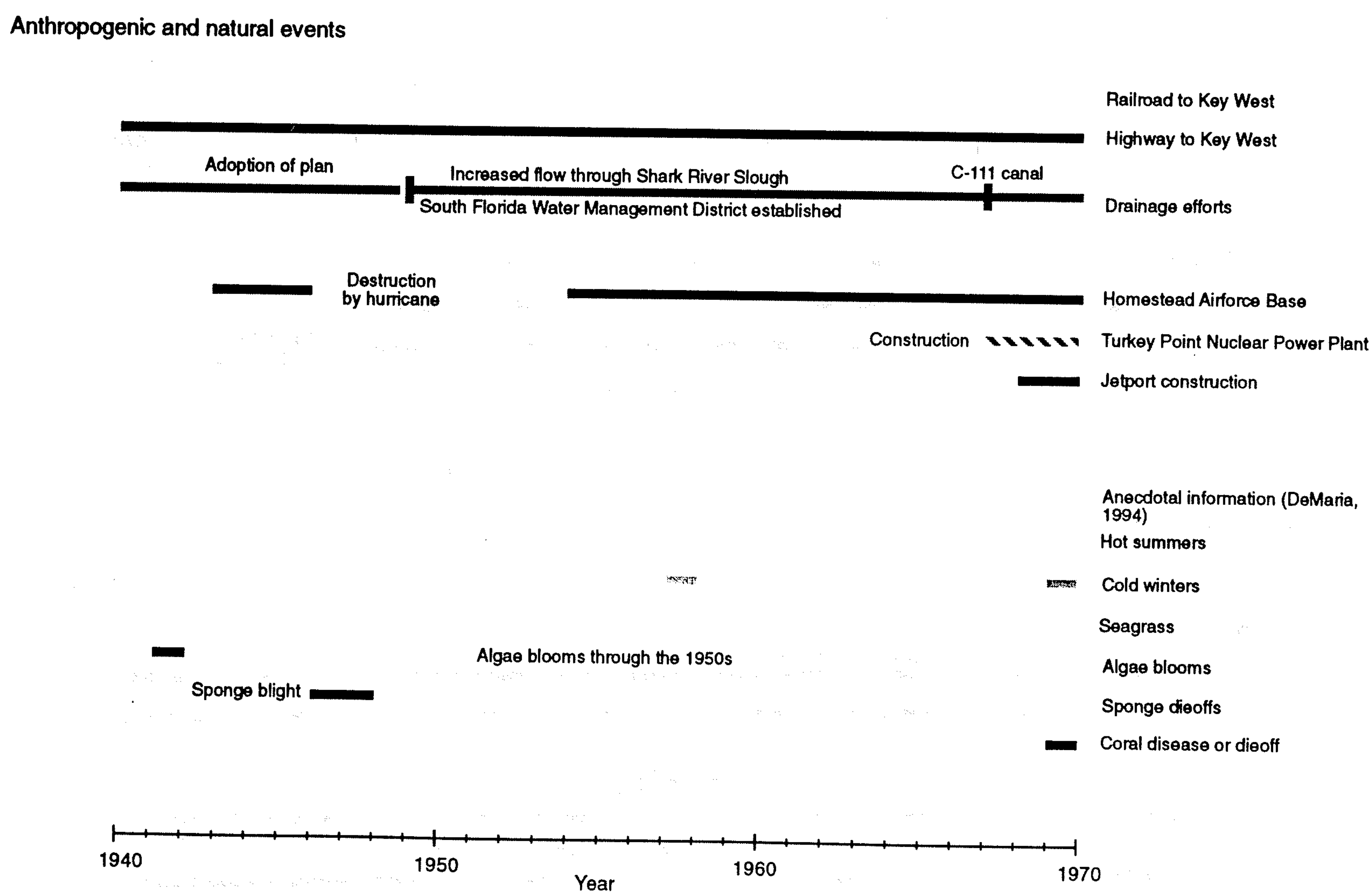
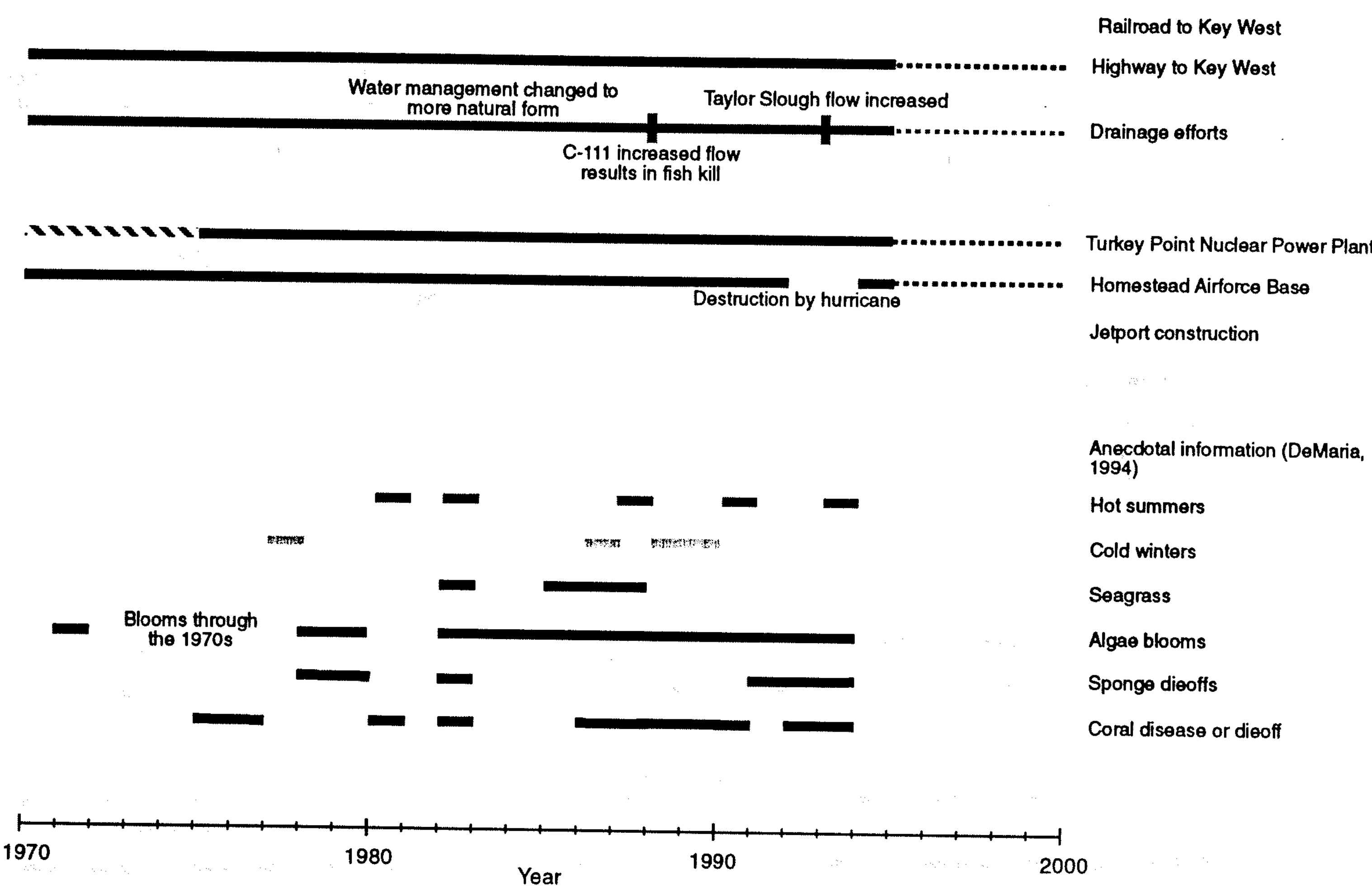


Figure II.8. Anthropogenic and natural events (cont.).

Anthropogenic and natural events



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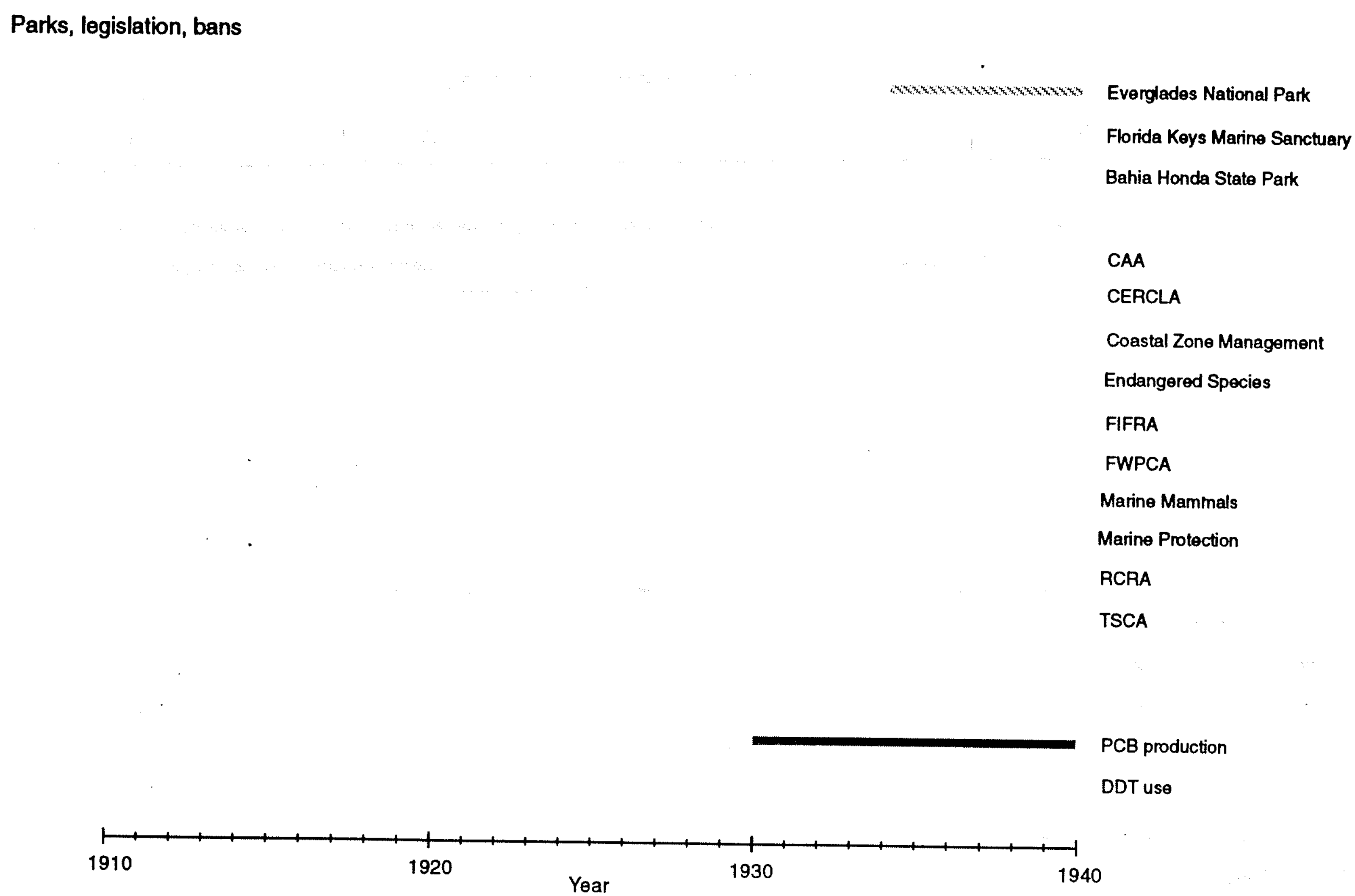

Figure II.9. Parks, legislature and bans.

Parks, legislation, bans

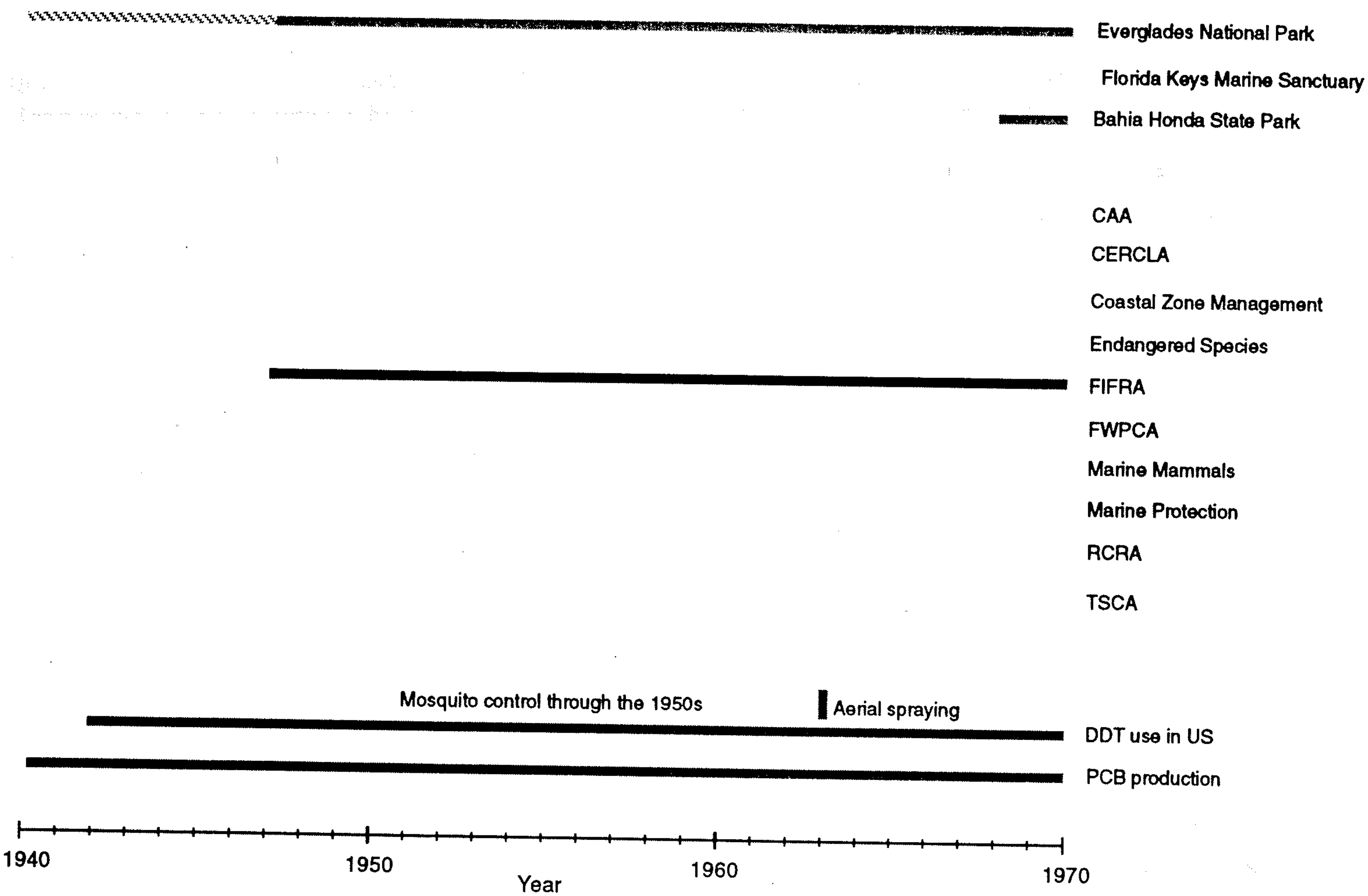

Figure II.9. Parks, legislature and bans.

Parks, legislation, bans

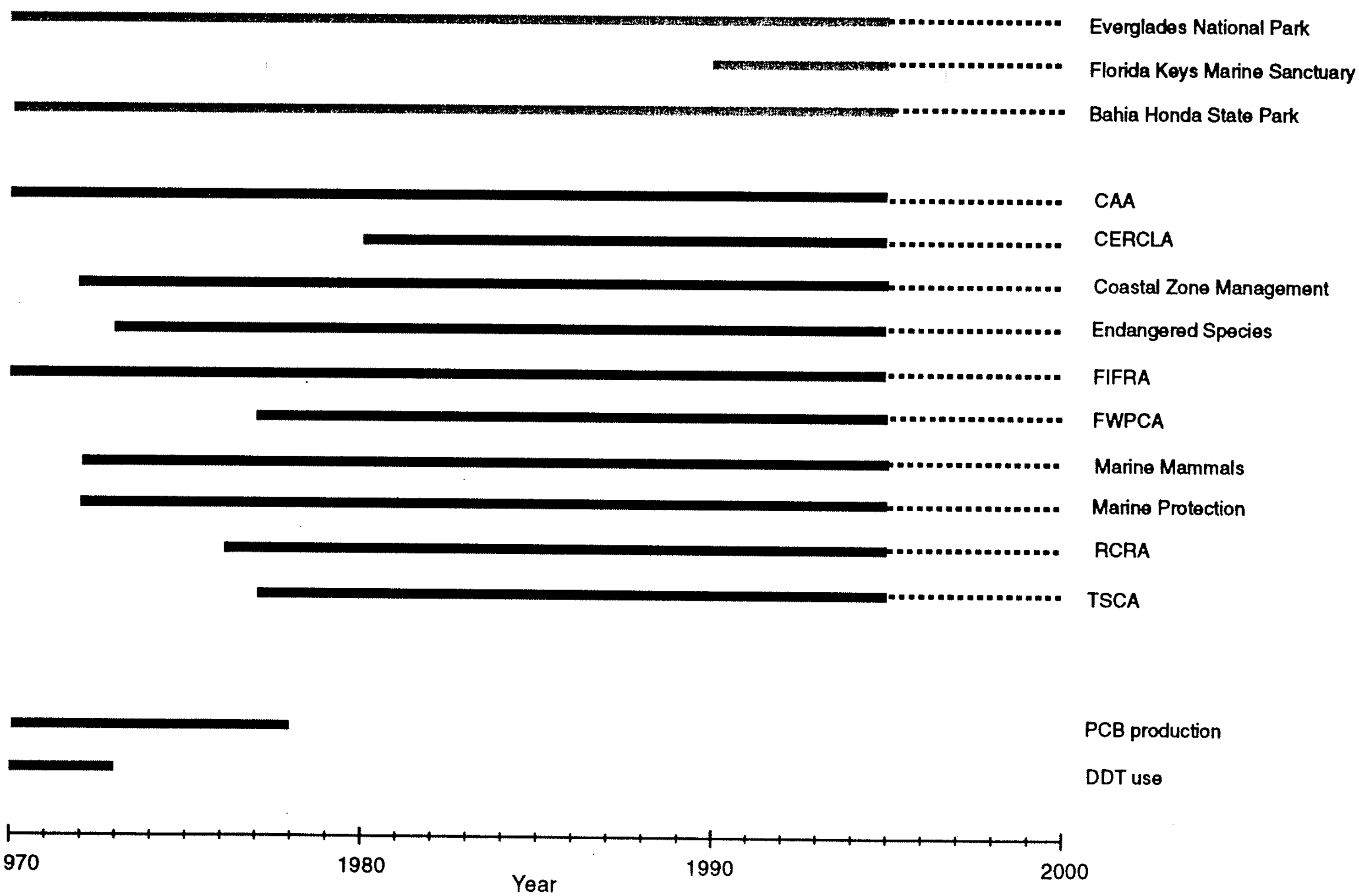

Figure II.9. Parks, legislature and bans.

APPENDIX IV

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