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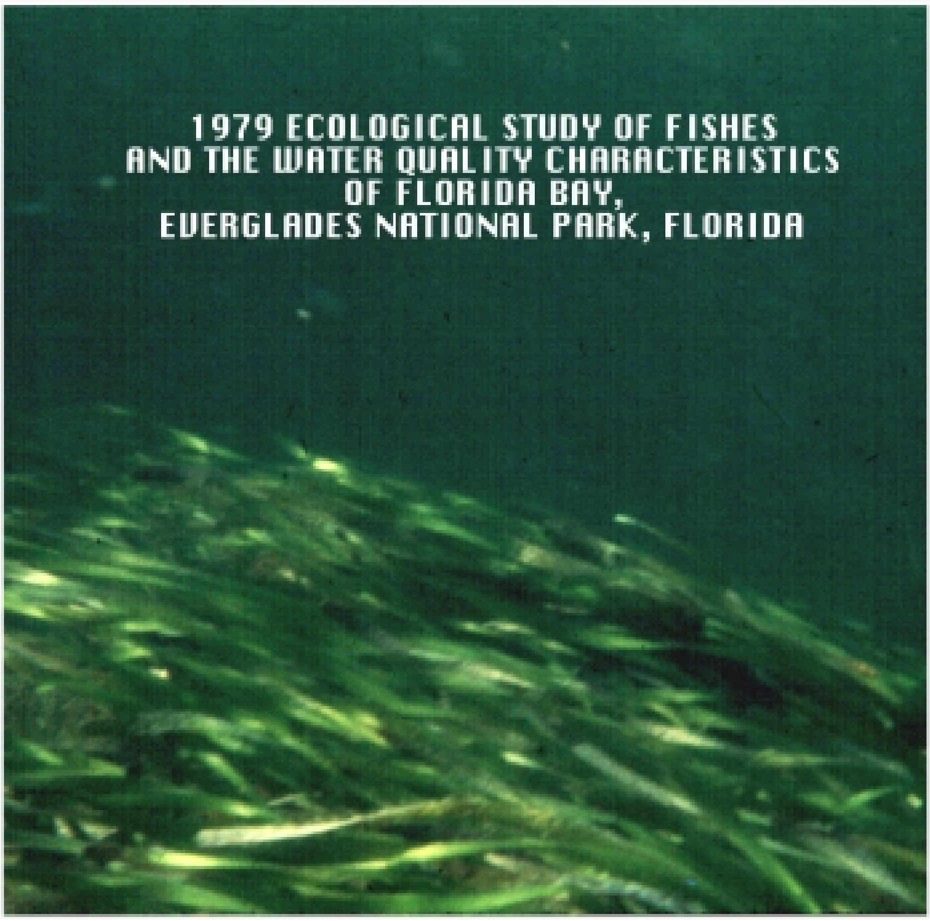
Coastal and Estuarine Data Archaeology and Rescue Program



Thalassia near entrance to Rabbit Key Basin (Iron Pipe Channel, trawl site T-4), Florida Bay (May 1976). Photographer: Tom Schmidt, Everglades National Park, National Park Service.

US Department of Commerce
National Oceanic and Atmospheric Administration
Silver Spring, MD

Everglades National Park
National Park Service
Homestead, FL

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Coastal and Estuarine Data Archaeology and Rescue Program

1979 ECOLOGICAL STUDY OF FISHES AND THE WATER QUALITY CHARACTERISTICS OF FLORIDA BAY, EVERGLADES NATIONAL PARK, FLORIDA

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SUMMARY

An ecological study conducted in Florida Bay from May 1973 to October 1976 was developed from a need to understand the distribution of Florida Bay fishes in relation to changing environmental conditions.

1. Annually, about 127 cm of rainfall falls on the Cape Sable region of Florida Bay. Based on historical rainfall data, calendar years 1973, 1975, and, 1976 were at near-normal levels while the drought year of 1974 experienced only 85 cm of rainfall. The pronounced, wet-dry seasonal rainfall patterns in the Florida Bay region are typical of a "tropical savannah." Eighty percent of the precipitation occurs during the warm, rainy season of May through November. An insufficient amount of rainfall occurs during the wet season and produces a significant water deficit during the mild dry season. This water loss has historically been made up from runoff north of Lake Okeechobee. Lunar tides vary from nearly 1 m in the Cape Sable area to less than 15 cm in northeastern Florida Bay. Wind direction and speed affects lunar tides, thus frequently producing fluctuations which exceed normal variations. Fall and winter northerly winds commonly produce high turbidities over the calcium carbonate substratum adjacent to the Florida Bay mainland.

2. Daytime dissolved oxygen concentrations observed in the study area generally displayed saturated to supersaturated conditions. The largest diurnal variations and highest values (13 - 15 ppm) occurred over shallow, intertidal seagrass communities in western Florida Bay. At certain times lowest daytime values occurred simultaneously across the Bay under varying ecological conditions. Critically low values (1 - 2 ppm) were detected in the restricted tidal zones of eastern Snake Bight during the early fall die-off and the decomposition of seagrasses (primarily *Thalassia testudinum*), and in northeast Florida Bay during the peak fall period of freshwater runoff through the Taylor River into Little Madeira Bay.

3. For the total period, pH ranged from 5.8 to 9.7 and varied directly with dissolved oxygen concentrations. Minimal values were consistently found during periods of peak freshwater runoff in northeast Florida Bay, and during the early morning over western Florida Bay seagrass flats. pH in the hypersaline waters of northeastern Florida Bay exhibited the least annual variation particularly where benthic vegetative cover was sparse. The highest pH values normally occurred in the hypersaline waters of south central Florida Bay over dense mats of green, carbonate-precipitating algae.

4. In general, Florida Bay turbidities varied with wind turbulence and runoff. In central and western Florida Bay, the lowest values were recorded offshore during the sustained drought period of 1974 - 1976. Irrespective of rainfall, minimal values occurred intertidally between Buttonwood and Blackwater Sounds, and from West Key southward to the park boundary. Seasonally, turbidity maximums occurred during the winter along the Florida Bay shoreline. Large portions of central and eastern Florida Bay were periodically characterized as "whitewater" regions. A locally described phenomena, "whitewater" usually occurred during periods of low runoff and hypersaline conditions.

5. During the study, water temperatures ranged from 11.9 to 34 °C, and as expected, varied seasonally; lowest values were observed during the winter in the deeper, tidally-influenced, channels of western Florida Bay whereas the highest values occurred during the summer over shallow, seagrass communities in the restricted tidal zones of central Florida Bay. No major, cold-induced fish kills were reported in the study area.

6. Large salinity variations were observed in association with freshwater runoff and local rainfall. Salinities fluctuated from 2 ppt during the peak runoff period in northeastern Florida Bay to 67 ppt during the 1974 - 1976 drought period in the open waters of Madeira Bay near the north central Bay shoreline. Not unexpectedly, along the northeast Bay shoreline the greatest monthly salinity variations occurred during and immediately following the severe drought of 1974 - 1976. Salinity circulation patterns and gradients shifted considerably within Florida Bay; north-south gradients occurred east of the Black Betsy Keys whereas an east-west seasonal gradient system generally characterized the region between the Betsy Keys and East Cape. In western Florida Bay, salinities were related inversely, but not significantly, with local rainfall. An important inverse relationship occurred between salinity and rainfall (1-month lag time at Tavernier) in northeastern Florida Bay; however, the association, unexpectedly, was not apparent between salinity and rainfall (Flamingo, Royal Palm, or Tavernier) in the north central section of the Bay. Freshwater runoff measured at the Taylor Slough Bridge was the most important factor in controlling the hypersaline conditions in north central Florida Bay. Continuous hypersaline conditions (>45 ppt) persisted for two years in large portions of central and eastern Florida Bay, notably from the spring of 1974 through the spring of 1976.

<u>Benthic Mapping</u>

7. The 1006 km^2 Florida Bay system supported benthic seagrass and macroalgal communities composed primarily of turtlegrass *Thalassia testudinum*, shoalgrass *Diplanthera* (= *Halodule*) *wrightii*, and the carbonateprecipitating green algae *Penicillus* sp. Mixed stands of turtlegrass and shoalgrass made up nearly 70% of the principal benthic macrofloral communities in the sampled areas of Florida Bay.

<u>Fish Distribution</u>

Ecological studies on the Florida Bay fishes were directed toward acquiring baseline information on their relative abundance by number and biomass, habitat types, and environmental conditions as they apply to and affect their distribution.

8. During the 40-month study, a total of 182,530 fishes representing 128 species and 50 families were taken in seines and otter trawls at 27 stations throughout Florida Bay. Their total biomass was 674.9 kg. An additional 21 species were identified from Flamingo sportfish surveys and supplemental observations. Due to the size and speed limitations of the collecting gear, most large fast-swimming species (snook, redfish, spotted seatrout, mullets, and sharks) were not taken.

9. Percentage compositions of the fishes varied markedly for both biomass and numbers. Overall, five species comprised 75% of the numerical total while eleven species made up 75% of the total biomass. In western Florida Bay, species dominating numerically were anchovies, specifically striped anchovy *Anchoa hepsetus* and bay anchovy *Anchoa mitchilli*; in the central portion of the Bay silver jenny *Eucinostomus gula* and pinfish *Lagodon rhomboides*; and in eastern Florida Bay, the hardhead silversides *Antherinomorus stipes* and gold-spotted killifish *Floridichthys carpio*. The silver jenny by biomass dominated throughout the Bay system. Excluding silver jennies, the most abundant species by weight in western Florida Bay were pinfish, southern stingray Dasyatis americana, and silver perch *Bairdiella chrysura*; in central Florida Bay, the pinfish, gray snapper *Lutjanus griseus*, and scrawled cowfish *Lactophrys quadricornis*;

and in eastern Florida Bay, the hardhead silversides and hardhead halfbeak *Chriodorus atherinoides*.

10. The distribution and abundance of the estuarine and coastal marine fishes were specifically related to the cyclic nature of the hydroperiod. 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 appeared during the dry season (winter and spring months).

11. Analyses of the fish catch data from the relative abundance studies indicated that the greatest abundance and diversity of fishes existed in western Florida Bay followed by eastern and central Bay regions, respectively.

12. Certain species and age-sizes of fish were abundant only in particular macrobiotic communities and habitats. The 0 age group pinfish, silver perch, and grunts seasonally dominated the shallow, seagrass flats whereas the older (age 1) fish were commonly found only in the seagrass-covered basin areas. The anchovies dominated the shallow rock and shell channels and the sparsely vegetated intertidal mud-flats of moderate salinities in western Florida Bay. The hardhead silversides and halfbeaks dominated the hypersaline, open water catches over stunted seagrass beds in eastern Florida Bay.

13. An analyses between measured physicochemical and biological attributes showed that salinity was the major environmental limiting factor affecting fish distribution, particularly in north central and northeastern Florida Bay. Reduced abundance and diversity indices were inversely related at significant levels with increased hypersaline conditions. Other physicochemical factors - pH, water temperature, turbidity, and dissolved oxygen - showed no variation beyond ranges considered normal for shallow, subtropical or tropical marine and estuarine environments; nor did they appear to have an important limitative relationship with the measured biological variables.

ABSTRACT

Fish collections under varying ecological conditions were made by trawling and seining, monthly and quarterly in depths of <1 m to depths of 3 m of the Florida Bay portion of Everglades National Park, Florida. From May 1973 through September 1976, a total of 182,530 fishes representing 128 species and 50 families were taken at 27 stations. An additional 21 species were identified from sportfish-creel surveys and supplemental observations. Most of the species collected were juveniles of species that occur as adults in the Florida Bay creel census survey, or were small species that were seasonal residents.

Marked temporal and spatial abundance of the catches was observed. The greatest numbers and biomass of the fishes occurred in the wet season (summer/fall), whereas lowest numbers and biomass appeared during the dry season (winter/spring) The greatest abundance and diversity of fishes was found in western Florida Bay followed by eastern and central Bay regions respectively.

Overall, five species comprised 75% of the numerical total while eleven species made up 75% of the total biomass. Collections were dominated numerically by anchovies (Engraulidae), especially *Anchoa mitchilli*, in western Florida Bay. Mojarras (Gerridae), mostly silver jenny *Eucinostomus gula,* and porgies (Sparidae), especially pinfish *Lagodon rhomboides*, dominated numerically in central and eastern portions of the Bay, respectively.

Except for salinity, other measured physico-chemical parameters (water temperature, pH, dissolved oxygen, and turbidity) showed no variation beyond ranges considered normal for shallow, tropical marine environments. Salinity varied from 0 to 66 ppt near the mainland. Nearshore hypersaline conditions (>45 ppt) persisted for nearly 2 years during the 1974 - 1975 severe drought period. Significant reductions in fish abundance/diversity were observed in relation to hypersaline conditions.

Bay-wide macrobenthic communities were mapped (presence/absence) and were primarily comprised of turtle grass (*Thalassia*), shoalgrass [(*Diplanthera* = (*Halodule*)], and/or green algae *Penicillus*. Seasonal dieoff of seagrasses was observed in north-central Florida Bay.

INTRODUCTION

Few estuarine and coastal marine fish inventories have been conducted in the extreme south Florida area. Historically, Lonnberg (1894), and Longley and Hildebrand (1941) provided a descriptive study of the ichthyofauna from the Florida Key and adjacent coastal areas; and Henshall (1891) prepared a list of fishes from the Cape Sable region. Tabb and Manning (1961) and Roessler (1970) prepared annotated checklists on the fish fauna of Whitewater Bay and northern Florida Bay, and in the Buttonwood Canal, respectively. Springer and McErlean (1962) described the seasonality of the nearshore fishes on the Atlantic Ocean side of the Middle Keys area. Hudson *et al.* (1970) produced a checklist on the fishes of a "lake" in south central Florida Bay.

More recently, the ichthyofauna of Florida's southwest Gulf coast has been determined from the combination of trawl and seine collections (Carter *et al.* 1973; Lindall *et al.* 1973; Harmick *et al.* 1974). A study conducted in the Ten Thousand Islands by Carter *et al.* (1973) provided the first systematic survey in Florida on the relative abundance of estuarine and marine shore fishes by number and biomass. However, information is lacking on the distribution and relative abundance of these fishes in the Florida Bay portion of Everglades National Park.

The importance of these waters as a sport and commercial fishery resource has been documented on numerous occasions by reports from the Rosenstiel School of Marine and Atmospheric Science of the University of Miami to the National Park Service (from Rosen and Dobkin, 1958 to Dooley and Higman, 1965) and by Davis (1977) of the National Park Service. Life history studies on important Everglades sportfishes have been conducted by Croker (1962) on grey snapper *Lutjanus griseus*; Stewart (1961) on spotted seatrout *Cynoscion nebulosus*; Yokel (1966 on red drum *Scianops ocellatus*; and Marshall (1958), and Fore and Schmidt (1973) on snook *Centropomus undecimalis*. In establishing the importance of the relationship between sportfish catch rates and environmental conditions in Everglades National Park, Higman (1967) suggested the initiation of additional fishery ecological studies.

The overall objectives of the current study were to obtain baseline ecological information on the estuarine and coastal marine fish populations and to determine the effects of environmental conditions on fish distribution in Florida Bay, Everglades National Park.

Specifically the objectives were as follows:

1. To determine the species composition, diversity, distribution, and relative abundance by number and biomass of the Florida Bay fish fauna.

2. To map the general distribution of the major benthic macrobiotic communities and to quantify the number and biomass of the fish by their representative habitats.

3. To provide observational data on the principal water quality parameters including salinity, temperature, oxygen, pH, and turbidity, and to relate such measurements to the distribution of the ichthyofauna.

4. To establish a park fish and macroinvertebrate reference collection.

The results will be used to assist in the evaluation of sport and commercial fisheries management programs and to compare with previous hydrobiologic investigations on the environmental quality of the Bay ecosystem.

METHODS

Water Quality

A total of 49 water quality and biological sampling stations were established in Florida Bay (Figure 1). Time series of 27 hydrobiologic stations are shown in Figure 3. The remaining 22 hydrographic stations were sampled monthly only (±3 days of the full moon), from August 1973 through September 1976. The significance of water quality data taken only during biological collections is discussed in the biology section and summarized statistically by sample mean, minima and maxima, standard deviation, standard error, skewness, and kurtosis. The remaining water quality data collected during the 40-month study are too extensive to be included in this document and are compiled in a separate oceanographic data report (Schmidt, 1979).

The distribution of mainland sampling stations recognized the most likely sources of freshwater runoff into Florida Bay. Additional sampling stations were located in tidal channels; mid-bay, semi-enclosed "lakes"; oceanic waters near the Florida Keys; and the Gulf of Mexico.

Subsurface salinities (ppt) and water temperatures (°C) were determined using a Beckman RS-5 induction salinometer. Since many of the Bay's water samples have high salinities out of the range of the RS-5 salinometer (>42 ppt), it was necessary to dilute the samples. Dilution was made by taking a known weight of the water sample, adding a known weight of distilled /tap water and mixing thoroughly. High salinity values (>43 ppt) were further verified by either an A/O optical refractometer or by the University of Miami's Institute of Marine Sciences marine water chemistry laboratory using a flow-through Beckman RS-7B salinometer. Dissolved oxygen (ppm) readings were measured with a Yellowsprings Model 54 oxygen meter. pH was determined by a Beckman Phistol pH meter. Turbidities were recorded by a Hach Laboratory Turbidimeter, Model 2100A. The unit of measure was Formazin Turbidity Units (FTU).

Cloud cover was estimated as the proportion of the sky covered by clouds. Wind direction was estimated to the nearest compass point. Wind speed was measured with a hand-held Dwyer wind gauge and calibrated in mph. Depth was measured with a metrically incremented pole. Water levels and rainfall data were taken from annual reports of the National Weather Service and park hydrological records. For the purposes of this report of water quality data taken from hydrobiological surveys are summarized by range* while salinity data are summarized by zones.

Previous studies (Ginsburg, 1956; McCallum and Stockman, 1959) conducted on variations in topographical and circulation-salinity patterns across Florida Bay suggested that the Bay can be divided into three generalized regions. They were described by Ginsburg (1956) as follows: an area of broad banks (western Florida Bay), a transitional area (central Florida Bay), and an area of broad depressions (eastern Florida Bay). In this study, biological subareas I, II, and III represented these regions, respectively (Figure 2).

* The extremes of certain water quality parameters may be lethal and can be more instructive than averages in the evaluation of aquatic habitats.

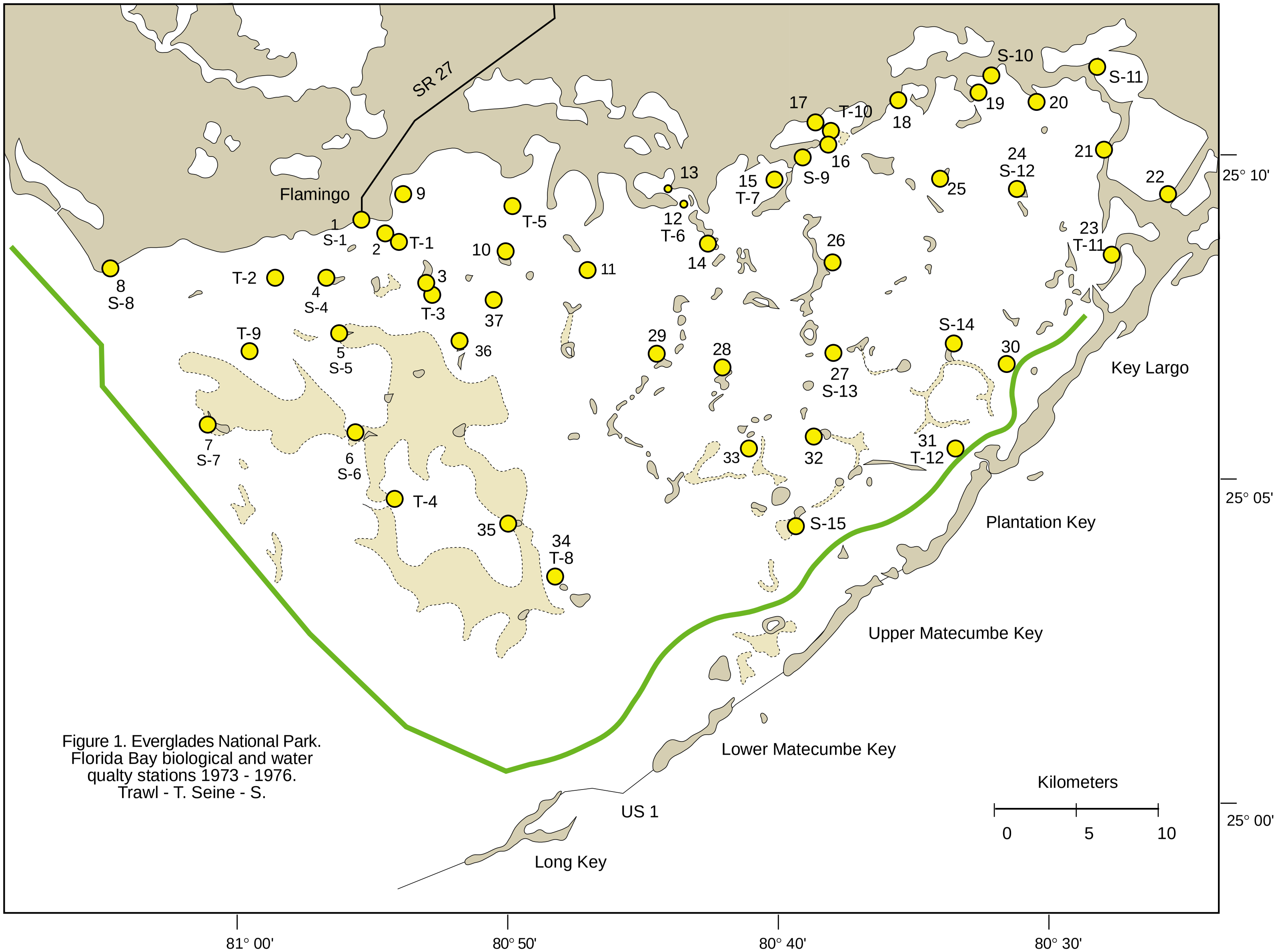


Figure 1. Everglades National Park.
Florida Bay biological and water
qualty stations 1973 - 1976.
Trawl - T. Seine - S.

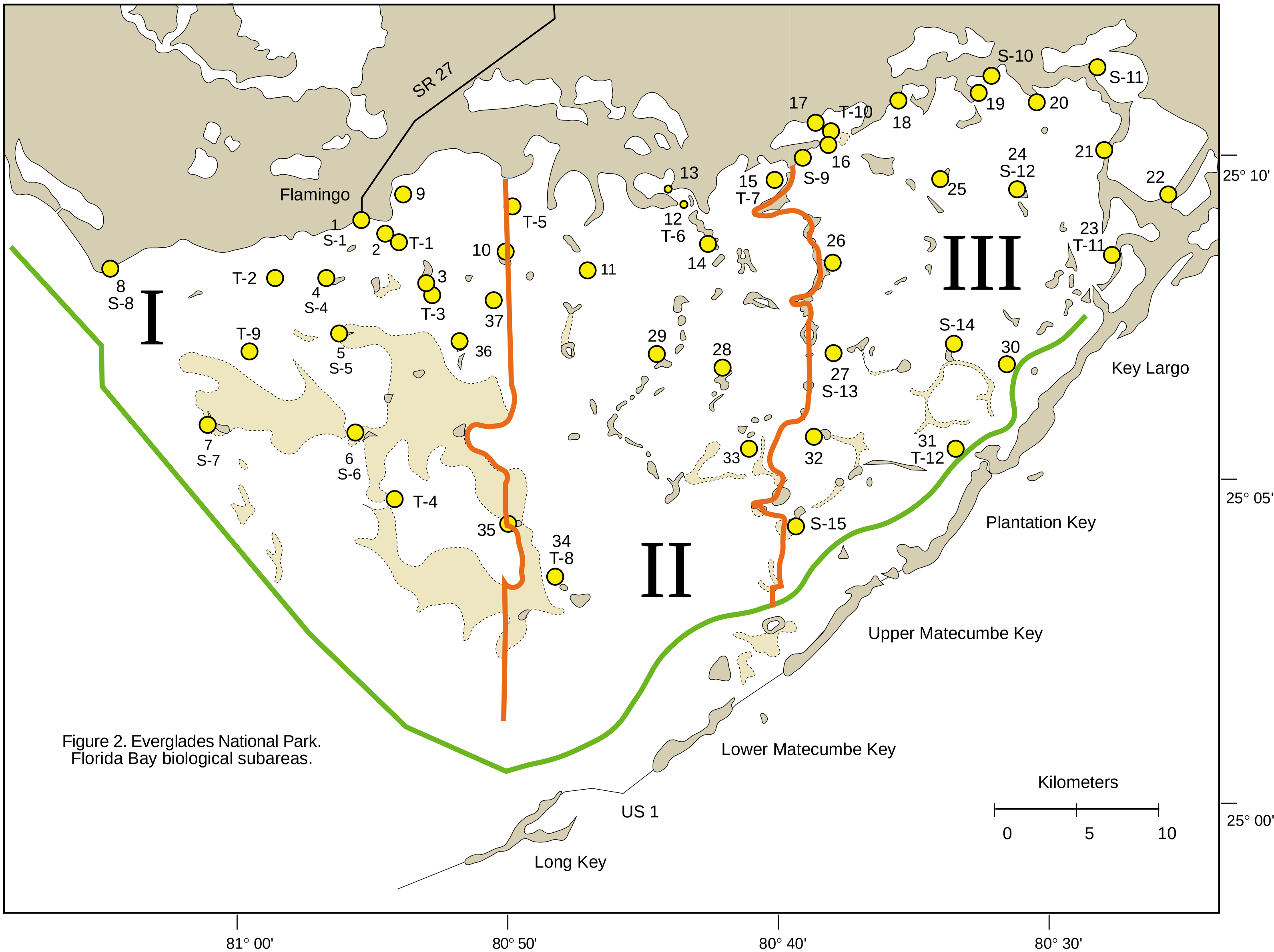


Figure 2. Everglades National Park.
Florida Bay biological subareas.

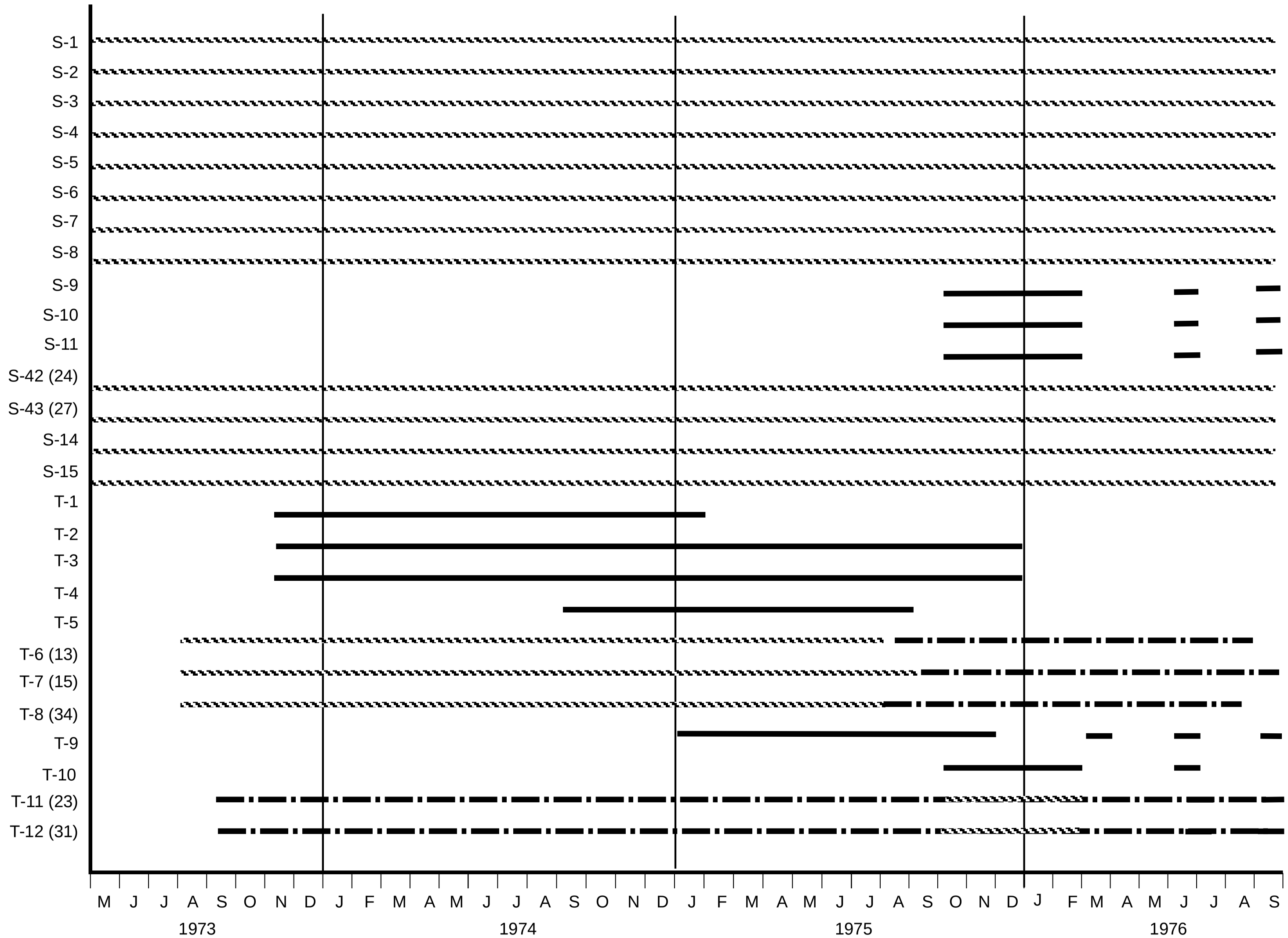


Figure 3. Time series of hydrobiological stations.

Benthic Mapping

Florida Bay benthic physical characteristics and submergent vegetative features were determined through the utilization of aerial (color IR 1973) photography, National Ocean Survey's Nautical Chart 141-SC, and ground-truth surveys with a 15-cm Ekman dredge and underwater traverses supplemented by otter trawl and bag seine collections. Area measurements of the benthic communities were determined by the dot grid method. A binary system (presence vs. absence) was used to map the general distribution of the benthonic macrobiota. The names of the major communities were identified by the predominant genus or genera of benthic macrophytes. A previous study by Tabb and Manning (1961) was used as comparative data to show shoreline and intertidal habitat changes in northern Florida Bay.

Fish Distribution

McHugh (1967) discussed some collecting gear limitations and biases, and the difficulties involved in estimating the size of coastal fish populations. McHugh concluded, however, that comprehensive and intensive fish faunal studies can be conducted through the combination of various types of scientific fish sampling methods and gear. For example, in a shallow water, coastal marine ecosystem study in the Caribbean, Edwards (1973) used single haul beach seine results to express fish biomass/m^2 while Oviatt and Nixon (1973) produced similar fish biomass/m^2 results in Narragansett Bay through the quantitative use of an otter trawl.

In this investigation, which represents the first comprehensive fish faunal study of Florida Bay, a trawl was used to sample the epibenthic fish inhabitating channels and basins of depths in excess of 1 m whereas the bag seine sampled the entire water column (<1 m) over nearshore grass beds and intertidal sand and mud flats. The bag seine was 15.2 m x 1.2 m long and 1.8 m deep, with 0.64 cm-bar mesh in the wings and 0.3 cm-bar mesh in the bag. The otter trawl was 4.2 m wide and consisted of 2.54 cm-bar mesh netting with a 0.64 cm-bar mesh liner in the cod end. Otter trawls were towed for 5 minutes in a straight line at a mean speed of 2.5 kph covering a distance of 200 meters. Trawling occurred during periods of high water on a flood tide. At the seining sites, the seine was spread parallel to the shoreline and pulled perpendicular to the shore over a measured course. Seining was usually conducted during early flood tides.

Indices of abundance were determined from the regular monthly collections as a standard unit-of-effort. The standard unit-of-effort for seine stations consisted of a single haul, and trawl samples consisted of duplicate 5 minute tows at each site.

In this study, each seine station's covered area was measured metrically by a graduated polypropylene rope. The effective width of the otter trawl, net mouth measured in operation was 2.4 m. The total area covered at each trawl station was 960 m^2 (2.4 x 400 m). As a result, estimates of fish biomass were defined in terms of gm/m and kg/h. A net catch efficiency of 100% was used. This assumption resulted in minimal estimates of population sizes.

Twenty-seven biological station (habitats) were selectively chosen from representative benthic macrobiotical communities and depth ranges (Figure 2). Beginning in May 1973, a standardized monthly/quarterly sampling schedule was followed based on tide tables (±3 days of the new moon). A time series of the schedule by sampling intervals and stations is presented in Figure 3.

Identifications of the fishes were made by the author. The common and scientific names of fishes and their phylogenetic order follow the recommendations of the American Fisheries Society (Bailey *et al.* 1970).

Fish samples were preserved in 10% formalin and returned to the laboratory for analysis. Fishes were identified, counted, measured, and weighed. Wet weights (biomass) of the fishes were taken with either a beam balance (20 kg capacity) or a trip balance (2 kg capacity) to the nearest 1.0 or 0.1 gm, respectively. Excluding anchovies, counts were made of the individuals (N) of each species. When anchovy sample counts exceeded 1,000, subsamples of 100 were weighed and divided into the remaining sample weight to yield (N). Total lengths (anterior extremity with the jaws closed to the tip of the compressed caudal lobes) were recorded to the nearest 1.0 mm. Excluding pinfish, a total length range was recorded for each species in a sample. All total lengths were recorded for pinfish.

An indicator of environmental quality, species diversity is used in comparing the abundance and distribution of species in estuarine and coastal marine ecosystems. An advantage of using the species richness index (Margalef, 1969) is that it is particularly sensitive to the influx of migratory species and therefore reflects the important nursery and feeding functions of the estuary. The species richness index is defined as: d = (S-I)/Iog N, where d is a measure of diversity which weighs the number of species(s) more than the total number of individuals (N). For each station, the species richness index (S-I) was computed.

In the correlation analysis, the monthly coding system devised by Roessler (1970) was used to determine the season variable. The months were coded as follows: August = 6; July and September = 5; June and October = 4; May and November = 3; April and December = 2; March and January = 1; and February = 0. This ranking system assumes maximum fish catches in winter or summer and intermediate catches in spring or fall.

DESCRIPTION OF THE AREA

This triangular, bimodally windy, tropical lagoon-bay lies in a shallow, rock-floored trough between the emergent barrier reefs of the upper Florida Keys and two series of mangrove-lined bays and sounds at the extreme southern end of the Florida Peninsula. The Florida Bay surface area from East Cape Sable to Key Vaca is 557,528 acres (2,256 km^2) with a diurnal tidal range of 0.5 m (McNulty *et al.* 1972). The Florida Bay portion of Everglades National Park consists of approximately 249,000 acres (1007 km^2). Water depths average about one to two meters over bank and basin regions and extend to four meters in tidal channels near the western margin of the Bay. The geologic history has been discussed by several authors (Ginsburg, 1956; Price, 1967; Taft, 1964).

Irregularly shaped sediment banks cover a large part of Florida Bay. Thick, luxuriant growths of seagrasses, chiefly turtlegrass *Thalassia testudinum* and shoalgrass *Diplanthera wrightii,* stabilize and bind with several species of algae, shells, and calcareous plant debris to form broad banks often several kilometers wide. The ecological and economic significance of these marine meadows is described by Odum and Brown, 1976.

Numerous islands or keys dot the bay environment. The typical key consists of mangrove vegetation, shell beaches, and an interior lake with a mud bottom covered by a blue-green algal mat.

The Florida Bay region is underlaid by "Miami's Oolite limestone." Calcium carbonate marl and organic muds with locally produced shell gravel and shell sand inclusions cover the oolite throughout the open bay bottoms (Tabb *et al.* 1962). Eastern Florida Bay consists of closely spaced, interconnecting, sub-oval, pan shaped basins, individually upwards of 16 km long and several kilometers wide (Price, 1967). Ginsburg (1956) and Stockman *et al.* (1967) described the sedimentology and the bank and basin topography as well as general hydrographic characteristics of the region. Additional data on East Bay hydrographic conditions were provided by McCallum and Stockman (1959). Western Florida Bay is characterized by extensive, shallow water, carbonate mud banks. They are broken by numerous tide channels. Two of these, Conchie and Joe Kemp channels, extend along the mainland from East Cape Sable to Joe Kemp Key off Flamingo. They contain mixtures of clear Gulf water and highly turbid Florida Bay water with a mixture of Florida Keys and west Florida shelf flora and fauna that fluctuates in abundance with seasonal salinity, turbidity, and temperature (Tabb *et al.* 1962).

DRAINAGE BASINS

Historically, the coastal waters of Florida Bay received freshwater drainage from the 22,500 km^2 watershed of the south Florida Everglades. This Everglades watershed has been reduced recently (1970) to approximately 7,800 km^2 through canalization and consists of three main 2 drainages - the Big Cypress, Shark River Slough, and Taylor Slough. The 1,800 km^2 Taylor Slough region, which has probably functioned as an independent basin throughout most of its history (Gleason, 1974), drains through depressions in the pineland ridge into the mangrove swamps which rim bays and sounds along the Florida Bay shoreline.

Only two small rivers flow directly into the Florida Bay system, the largest Taylor River and East River drain into Little Madeira Bay.

During the wet season, freshwater discharge through the Shark Slough system enters the nearshore waters of the Gulf of Mexico. The resultant movement of these tidally influenced coastal water masses occurs largely in an easterly direction thereby affecting the hydrography of western Florida Bay.

CLIMATE

The climate of the Florida Bay region is based on temperature and seasonal rainfall and has been described as a tropical savannah. In the extreme south Florida area (Cape Sable region), over 80% of the annual rainfall ($\bar{x}$ 127 cm) occurs from May through October and is known historically as the "rainy" season. However, the wet season does not provide enough rainfall to compensate for water loss from evaporation and transpiration during the long dry season (Tabb *et al.* 1962). Thus South Florida must depend on the vast northern Everglades watershed as an outside freshwater source to make up the shortage.

Monthly mean air temperatures generally vary no more than 9 °C between the winter and summer months. Occasional regional extremes such as cold and hurricanes occur thus resulting in mass mortality of the aquatic biota (Tabb *et al.* 1962). Wind conditions vary seasonally in south Florida. The winds blow primarily from the southeast during the summer while there is a northerly flow during the late fall and winter. Wind speed also varies seasonally with a general decrease from winter to spring and summer. Seasonal wind variations affect Florida Bay turbidities, particularly along the mainland. High turbid conditions often occur during the winter over the carbonate, marl mud bottoms in northwestern and eastern portions of the Bay.

RESULTS

Water Quality

Monthly rainfall data taken from the Florida Bay region are presented in Figure 4.

Water quality data taken only during biological collections are summarized statistically in Appendix E. The ranges of environmental parameters measured during hydrological and biological surveys are found in Table 1. Tri-monthly salinity means were used seasonally to identify the movement of water masses as shown in Figure 8.

For the total period, the greatest variations in salinities occurred in central and eastern Florida Bay while temperature, oxygen, pH, and turbidity extremes were greater in western Florida Bay. Overall Florida Bay ranges were: salinity (ppt), 1.7 to 66.6; temperature (°C) 11.9 to 34.0; dissolved oxygen (ppm), 1.1 to 15.2; pH, 5.8 to 9.7; turbidity (FTU), 0.3 to 72.0.

Benthic Mapping

Florida Bay was characterized by a variety of benthic macrobiotical communities (Figure 9). The general distribution of the macrophyte and coral assemblages by subarea, and their representative stations are found in Appendix F.

Nine macrophyte communities were recognizable and defined by their included dominant species. One community grouping was termed with a faunal component (*Thalassia-Porites*) to better differentiate this particular association from other strictly vegetative types. Six principal communities characterized western Florida Bay; four, central Florida Bay; and four, the eastern portion of the Bay. *Diplanthera-Thalassia*, the dominant community type, comprised over 70% of the Florida Bay sampled area. The total sampled area represented by biological stations was 100,278 hectares; 5,303 hectares in central Snake Bight and along Nine-Mile Bank were not represented by biological sampling stations.

Fish Distribution

A list of fishes collected from Florida Bay are presented in Appendix A. The identification of the spotted dragonet *Callionymus pauciradiatus* was verified by Dr. Thomas McKinney of the National Marine Fisheries Service, and Dr. Martin Roessler of Tropical Bio-Industries Company confirmed the identification of the marbled blenny *Paraclinus marmoratus*.

Appendices B and C list the fishes by seasonal abundance (percentage by total numbers and biomass, respectively). Appendix D presents the fishes by their developmental stages. Biological station descriptions appear in Tables 2 and 3.

The number of fish species; number of individuals; biomass; and mean biomass and related environmental parameters, including salinity, temperature, dissolved oxygen, pH, and water depth, are statistically summarized by sample mean, minima and maxima, standard deviation, standard error, skewness, and kurtosis and are presented in Appendix E.

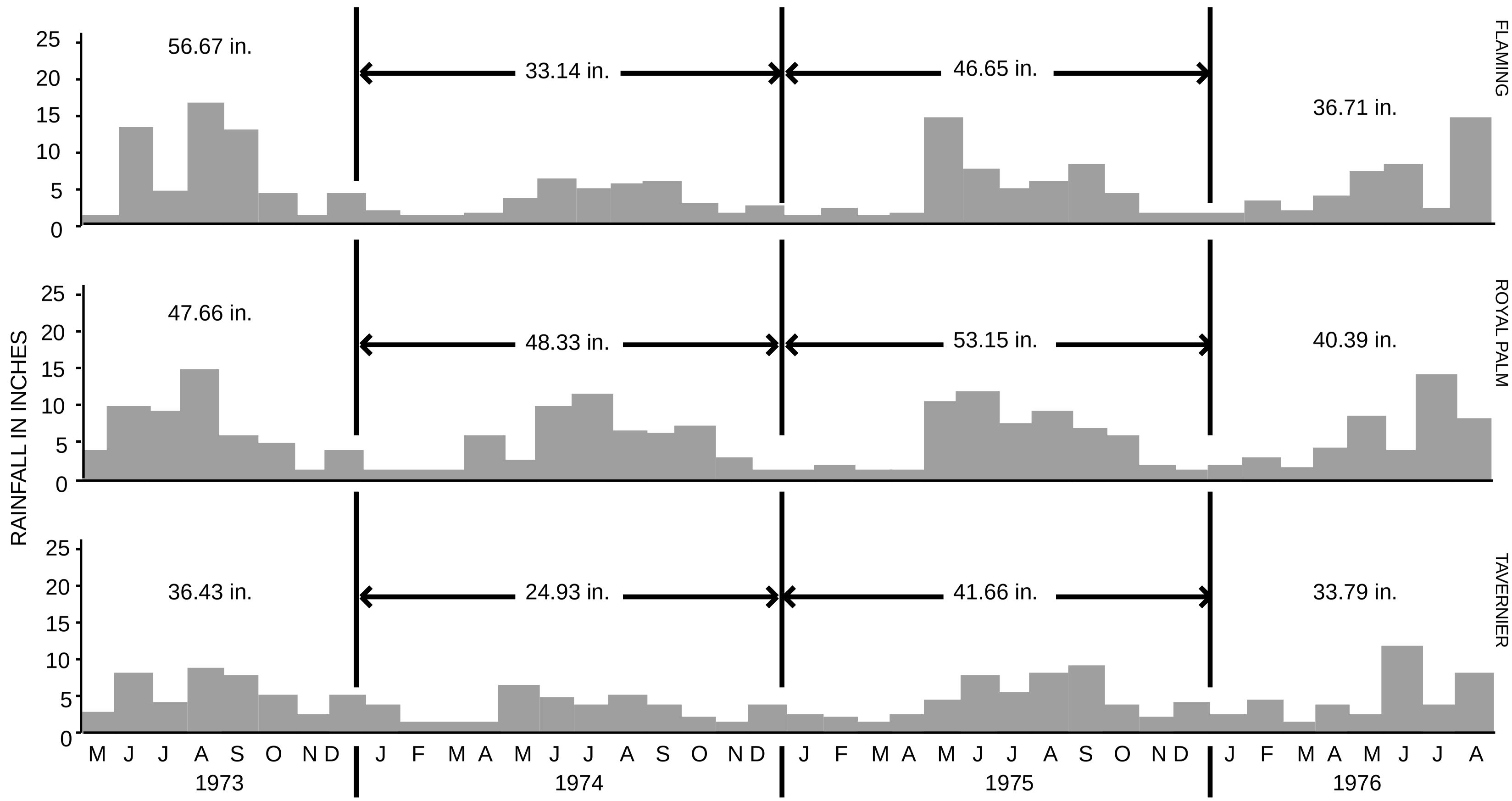
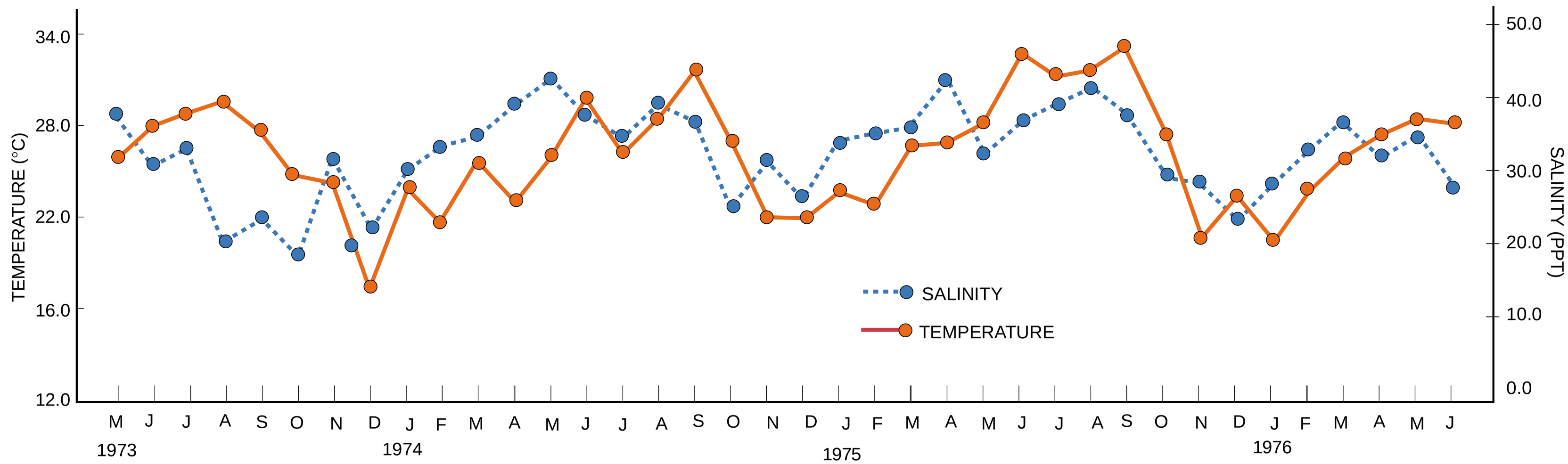


Figure 4. Monthly rainfall values from Flamingo ranger station, Royal Palm ranger station, Everglades National Park and



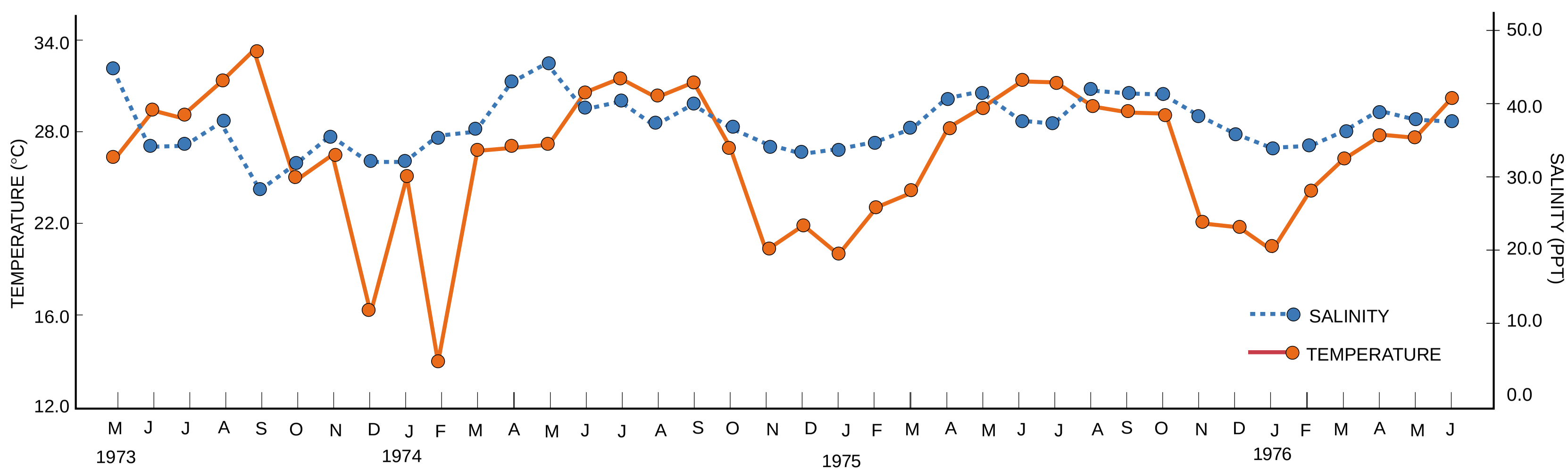


Figure 5. Water temperature and salinity measurements for western Florida Bay. Florida Bay entrance to the Buttonwood Canal at seine station S-1 (upper) and Palm Key Basin at trawl station T-3 (lower)

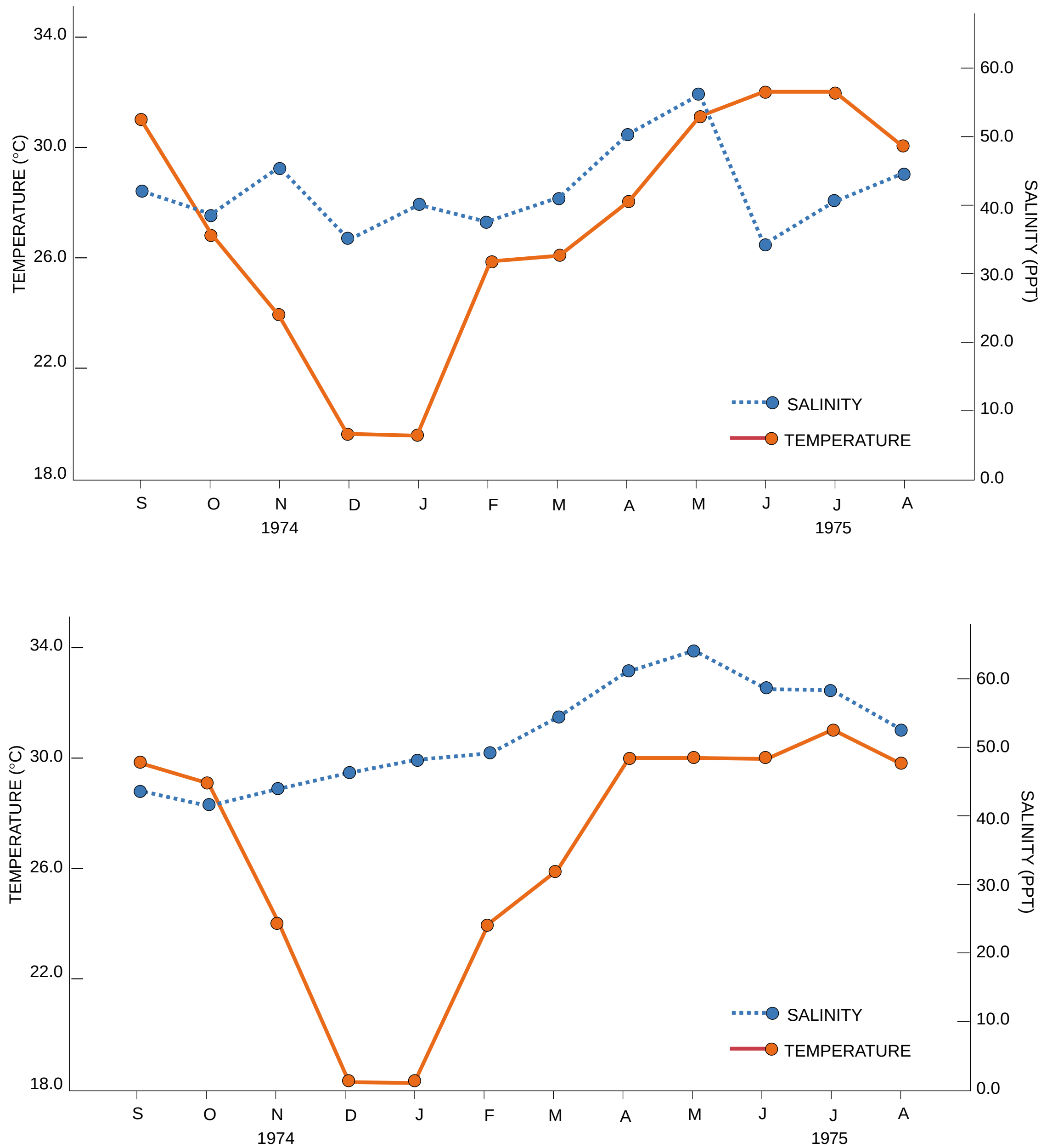


Figure 6. Water temperature and salinity measurements for central Florida Bay. East Snake Bight at trawl station T-5 (upper) and Madeira Bay at trawl station T-7 (lower).

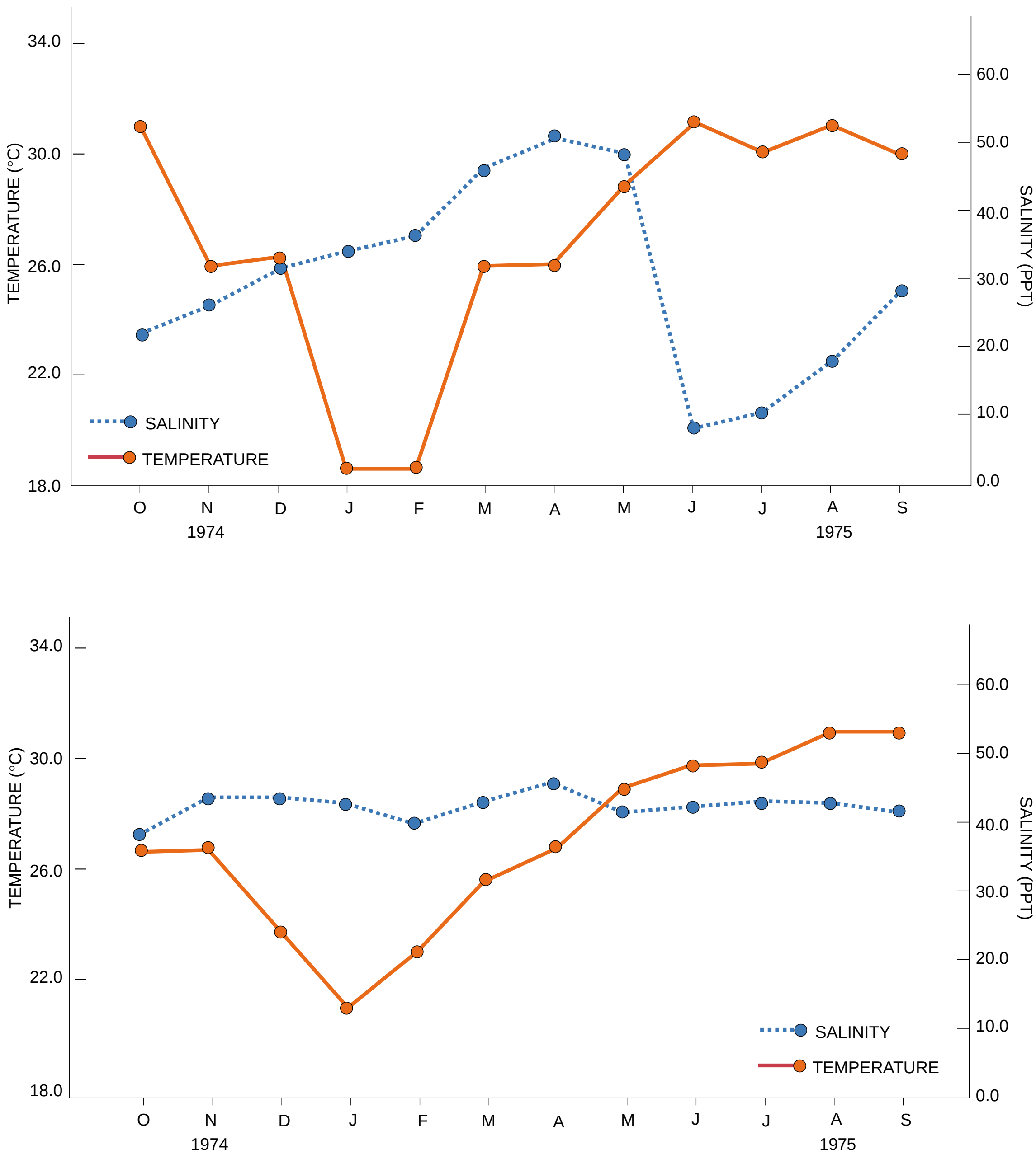


Figure 7. Water temperature and salinity measurements for eastern Florida Bay. Trout Creek at seine station S-10 (upper) and Tavernier (L 71) at trawl station T-12 .

Figure 8. Generalized Salinity Zones of Florida Bay, 1973 - 1976. [SCALE, STATION SYMBOLS AND NOTATIONS REMOVED FOR CLARITY. REFER TO FIGURE 1.]

The zones are coded as follows:

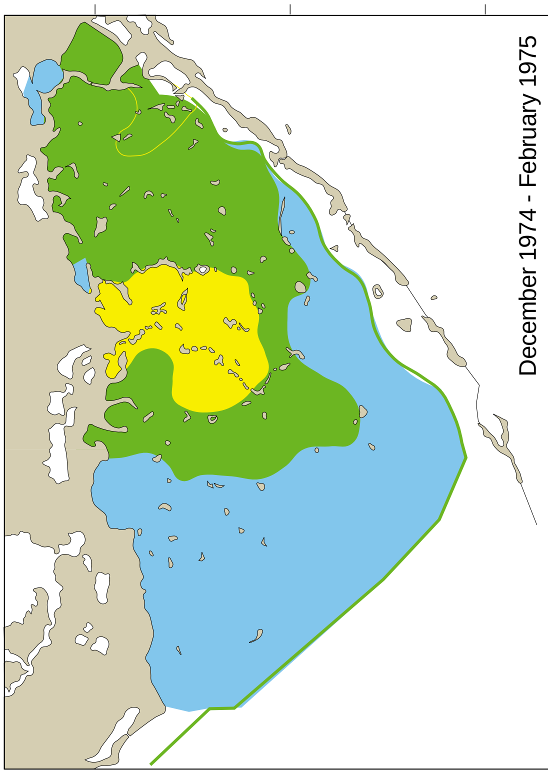
= (4 - 35 ppt)

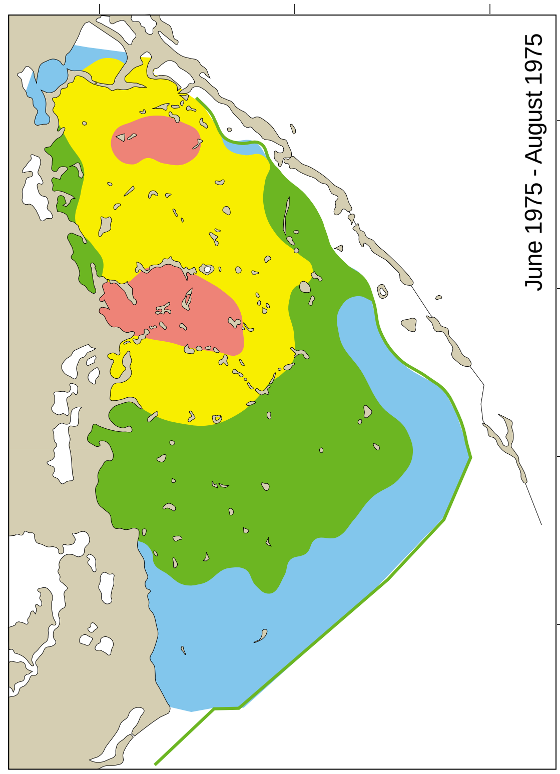
= (36 - 40 ppt)

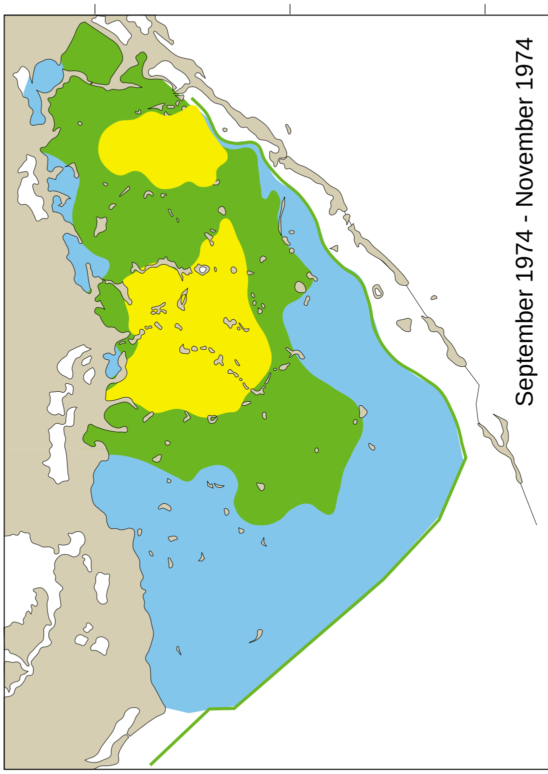
= (41 - 45 ppt)

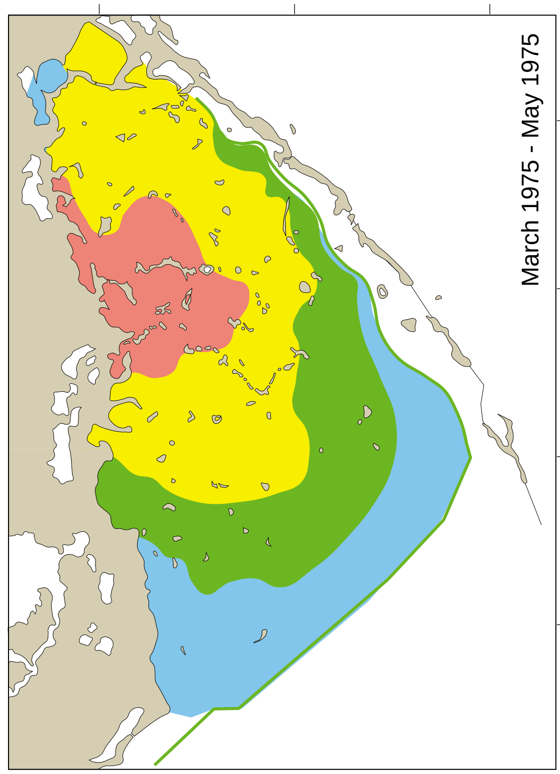
= (46 - 50 ppt)

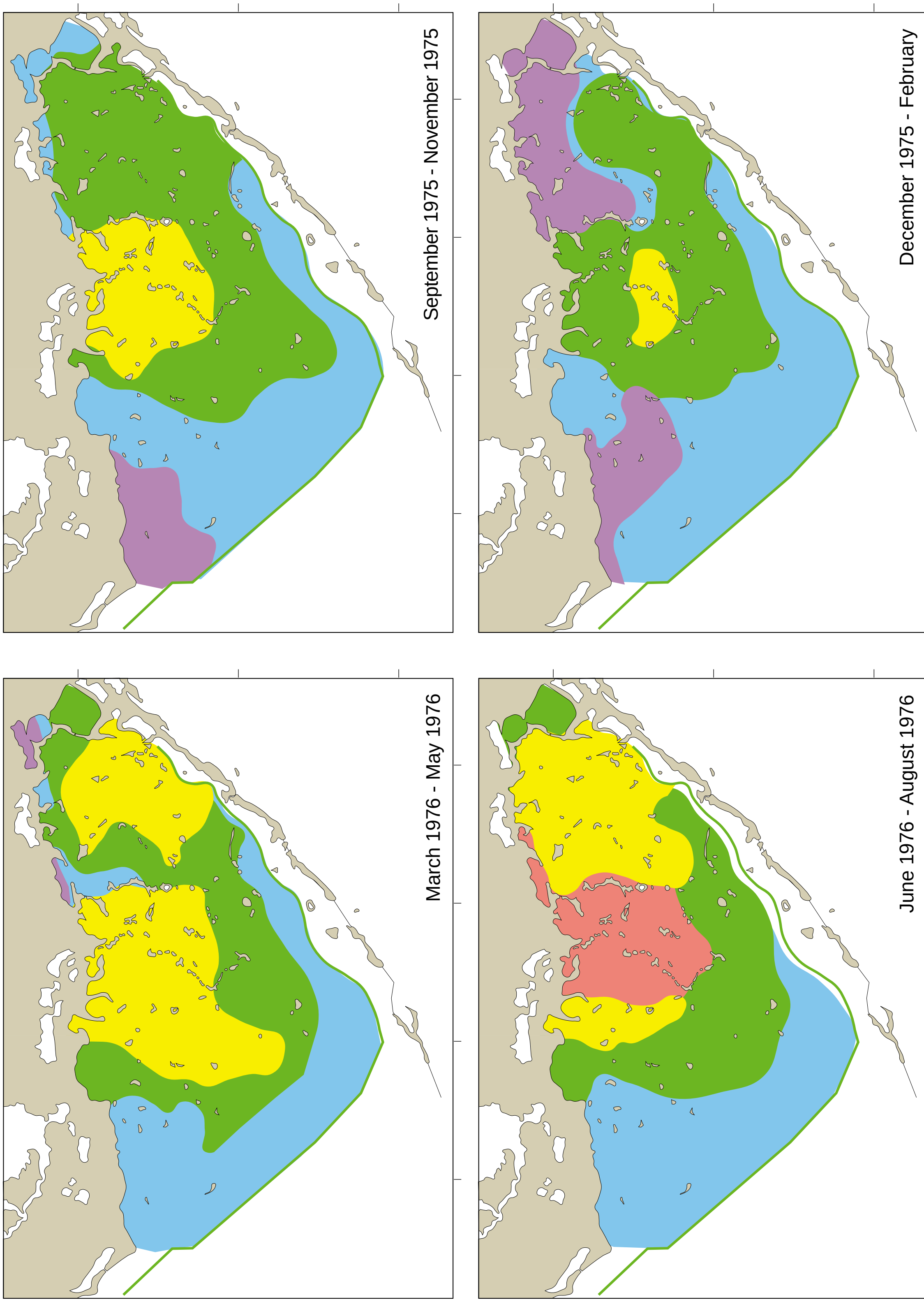
= (51 - 60 ppt)


December 1974 - February 1975


June 1975 - August 1975


September 1974 - November 1974


March 1975 - May 1975


September 1975 - November 1975
December 1975 - February
March 1976 - May 1976
June 1976 - August 1976

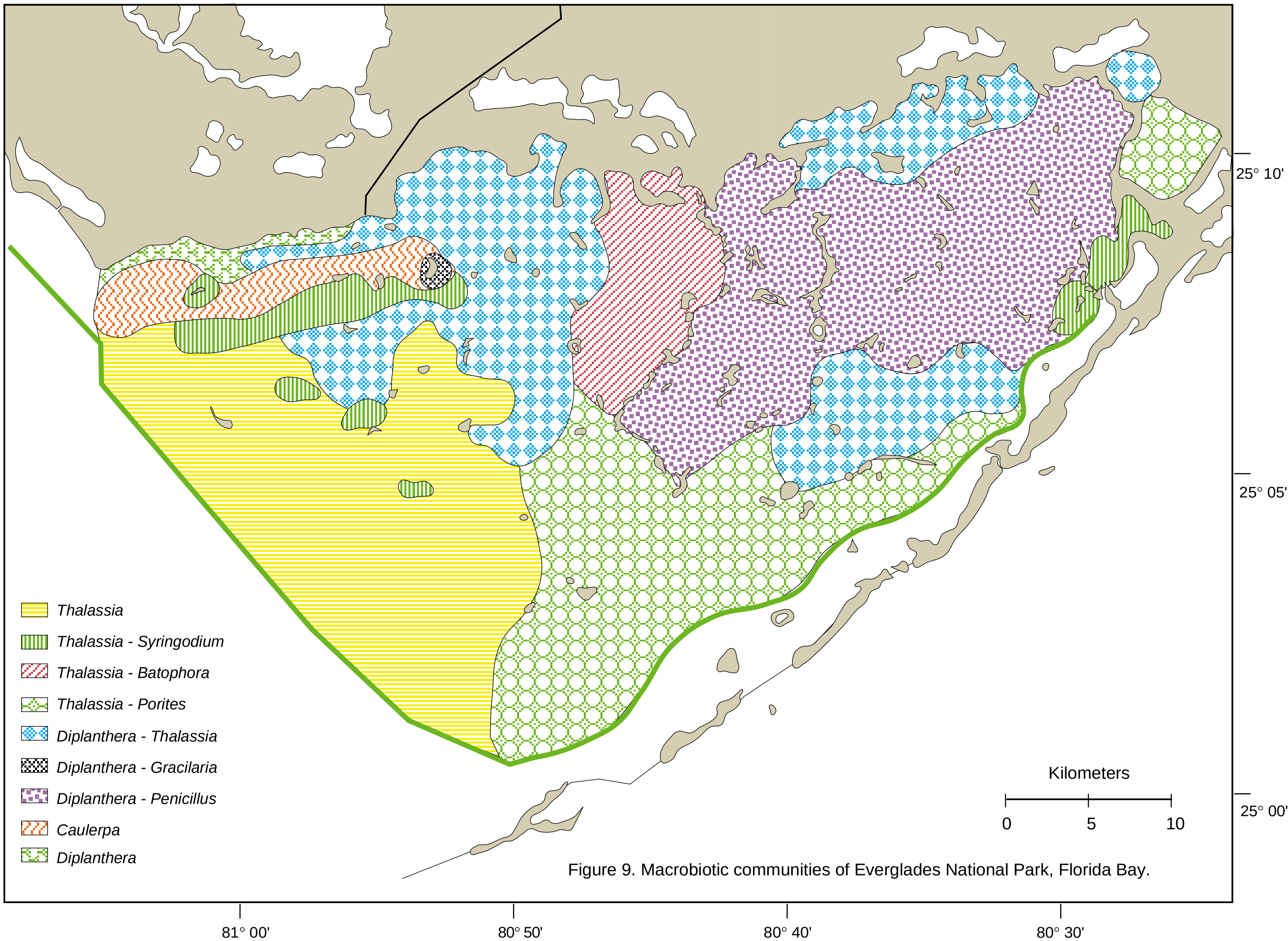


Figure 9. Macrobiotic communities of Everglades National Park, Florida Bay.

Table 1. The range of environmental factors in Florida Bay, May 1973 - September 1976.

	Western Florida Bay Stations	Central Florida Bay Stations	Eastern Florida Bay Stations
Salinity (ppt)			
minimum	18.2 (S-1)	14.1 (12)	1.7 (17)
maximum	56.4 (9)	66.6 (T-7)	57.6 (17)
Temperature (°C)			
minimum	11.9 (T-1)	14.6 (11)	17.6 (32)
maximum	34.0 (37)	32.6 (14)	32.4 (27)
Dissolved Oxygen (ppm)			
minimum	3.4 (S-1)	1.1 (10)	3.3 (17)
maximum	15.2 (S-3)	11.7 (35)	10.6 (S-15)
pH			
minimum	5.8 (S-5)	6.3 (27, 28)	6.5 (25)
maximum	9.7 (37)	9.8 (33)	8.9 (25)
Turbidity (FTU)			
minimum	0.3 (S-3)	0.6 (35)	0.3 (22)
maximum	72.0 (S-8)	20.1 (14)	53.0 (17)

Relative Abundance

Numbers

During the study an overall total of 182,530 fishes, representing 128 species and 50 families, were taken in seines and trawls from 569 monthly and quarterly collections at 27 biological stations. An additional 21 species were reported from preliminary or supplemental studies such as the sport fishing survey conducted weekly at the Flamingo Boat ramp.

In western Florida Bay, a total of 138,768 individuals distributed among 121 species and 50 families were collected. 351 monthly and quarterly collections were made during May 1973 through September 1976. An additional 21 species were reported from supplemental studies. Those families which occurred most often in the regular collections were the following: anchovies (Eugraulidae); killifish (Cyprinodontidae); mojarras (Gerridae); porgies (Sparidae); drums (Scianidae); grunts (Pomadasyidae); and mullet (Mugilidae) (Tables 4, 5, and 6). By number, striped and bay anchovies were the predominant fishes in western Florida Bay, accounting for over 48% of the total catch (Table 14). Excluding anchovies, numerically the most abundant fish, notably forage species, were silver jennies *Eucinostomus gula*; goldspotted killifish *Floridichthys carpio*; rainwater killifish *Lucania parva*; pinfish *Lagodon rhomboides*; and rough silverside *Membras martinica*.

In central Florida Bay, a total of 4,753 individuals distributed among 39 species and 25 families were corrected by otter trawling from a total of 109 monthly and quarterly collections from September 1974 through September 1976. Those families which occurred most often in the trawl collections were the following: mojarras; porgies; killifishes; anchovies; and drums. Those families comprised from 90 to 99% of the standard monthly catch from September 1974 through September 1975 (Table 7) (4,148 individuals). Numerically, silver jennies and pinfish made up over 86% of the total catch (Table 15).

In eastern Florida Bay, 89 fish collections were obtained monthly and quarterly at 10 regular stations from October 1975 through September 1976. A total of 38,008 individuals distributed among 61 species and 30 families were collected by otter trawl and beach seines. The anchovies, herrings (Clupeidae), halfbeaks (Exocoetidae), killifishes, silversides (Atherinidae), and mojarras yielded the greatest number of individuals. These families contributed from 74 to 98% of the standard catch during the period of observation (Table 8). Numerically, the eight most abundant fish in decreasing order of abundance were hardhead silverside *Atherinomorus stipes*, goldspotted killifish, silver jenny, hardhead halfbeak *Chriodorus atherinoides*, spotfin mojarra *Eucinostomus argenteus*, scaled sardine *Harangula jaguana*, bay anchovy and rainwater killifish. The hardhead silverside predominated in eastern Florida Bay, accounting for 47% of the total catch (Table 16). Seasonally, 82% of this species occurred during the fall periods (Appendix B).

Biomass

Most fish faunal surveys do not determine the occurrence or abundance of fish by biomass (Springer and Woodburn, 1960; Wang and Ramey, 1972; Tabb and Manning, 1961; Roessler, 1970; and Gunter and Hall, 1965). However, McFarland (1963) maintained that the biomass of fishes yielded more ecological information than numerical data. Carter *et al.* (1973) assessed the relative abundance of fishes by mean biomass in the Ten Thousand Islands. However, the current study represents the first time in Florida that measures of mean biomass were used to relate fishes by estuarine and coastal marine habitat types (kg/h). During the investigation, the total biomass of fishes collected at the regular stations was 674.9 kg.

By weight, the most abundant families of fishes in the regular western Florida Bay collections (total biomass 500.7 kg) were anchovies, stingrays (Dasyatidae), sharks (Carcharhinidae), porgies, mullet (Mugilidae), mojarras, killifishes, barracuda (Sphyraenidae), snappers (Lutjanidae), and spadefish (Ephippidae), (Tables 9, 10, and 11). The most numerous fish by total biomass in decreasing order of abundance, excluding sawfish, were pinfish, silver jenny, southern stingray *Dasyatis americana*, silver perch *Bairdiella chrysura*, spadefish *Chaetodipterus faber*, goldspotted killifish, and striped anchovy (Table 14).

By biomass, in central Florida Bay, the most numerous families of fishes in decreasing order of abundance were porgies, mojarras, snappers, boxfishes (Ostraciidae), and drums (Table 12). They formed 93% of the total biomass (37.2 kg) from September 1974 to October 1975. Species of importance by weight included pinfish, silver jenny, grey snapper, and silver perch, the most common sciaenid in the grassbed habitats (Table 15).

In eastern Florida Bay the most abundant families of fishes by biomass in the regular and collections were mojarras, killifishes, silversides, barracuda, halfbeaks, needlefishes, and snappers (Table 13). These families contributed from 60 to 80% of the total catch (71.6 kg) during the study period. By species, silver jennies and hardhead silversides comprised 40% of the total biomass (Table 16).

Seasonal Patterns of Abundance

The seasonality of the South Florida hydrological cycle has a pronounced effect on the salinity variations in Florida Bay. Nearshore Bay salinity fluctuations generally follow the onset of the rainy season by nearly one month (Figures 4, 5, 6, and 7). Consequently, biological data has been presented seasonally as defined by the hydroperiod of June through November (wet season), and December through May (dry season).

Abundance indices varied substantially between the wet and dry seasons. Numerically in western Florida Bay, 60% more individuals occurred during the hydroperiod (June - Nov 1973) than during the dry season (Dec 1973 - May 1974). However, more importantly, over 68% more biomass was taken during the wet season than during the December through May period of observation (Figure 10). Similarly, regular west Bay monthly and quarterly trawl collections tended to corroborate these findings for the September 1974 to October 1976 period of observation (Figure 11). The seasonal distribution of the mean catches in central and eastern Florida Bay (Figures 12 and 13 respectively) demonstrated comparable results.

Diversity

Number of species(s).

An overall total of 149 species were identified in Florida Bay, 90% of those species were in their early developmental stages. 142 species were recorded in the western portion of the Bay the Buttonwood Canal station accounted for the largest mean number (17), maximum number (29),and range of species (23), during the period of observation. In general, the mean number and range of species decreased on a southerly transect towards the open waters of the Gulf of Mexico. By species, the largest total numbers in the standard monthly collections was recorded in June (45 seines only); and October 1973 (38); and in the quarterly collections, June 1976 (45). Similar increases in S occurred in the same two months with both pieces of sampling gear. The fewest species in the monthly catches occurred between November and January.

A total of 58 species were taken in the regular collections or reported from supplemental surveys in the central Bay area. The largest mean (6), maximum number (16), and range (15) of S were recorded from the east Snake Bight station. The mean S and range increased on a westerly transect from Madeira Bay towards the tidally influenced Flamingo-Snake Bight area. In the standard monthly collections, the largest S were recorded in August and September, and the fewest S occurred in February and March.

Eastern Florida Bay collections and observations consisted of 75 species. The largest mean S (9) occurred at Trout Cove, Little Blackwater Sound, and West Key. The greatest S (15) and range (11) were recorded at the Little Blackwater Sound station. By month, the greatest S reported in the regular collections appeared in December (32), and the lowest in March (18).

Species Richness Diversity Index (S-I)

The numerical structure of fish populations can also be summarized, by the species richness diversity index (S-I), which is significantly affected by the seasonal flux of migratory species.

Spatial analysis. For the total period, species richness by station reached a pronounced peak (4.48) in western Florida Bay at the Buttonwood Canal seine station during June 1976 when the largest S (29) was recorded from either a Florida Bay monthly or quarterly seine collection. The largest S (26) recorded from a Bay trawl collection (Sandy Key Basin) was also reported in the same month, thereby, resulting in a species richness value of 4.42.

Combined S-I diversity values by stations are presented in Table 17 and 18. Diversity in depths of water less than 1 m was generally higher near the Buttonwood Canal area (Buttonwood Canal, Joe Kemp, and Murray Key stations). These values reflect mostly the distribution of the predominant nearshore grassbed species of the 0 age group (pinfish, silver perch, white grunts, and pigfish). Older individuals of the 0 age class and 1-year-old fish of the same species dominated catches from grassbed stations in Palm and Sandy Key Basins, thus resulting in high S-I values of 2.10 and 2.64, respectively. S-I measurements were considerably lower in the tidal channels southwest of Flamingo. Diversity during the period May 1973 to July 1974 ranged from 1.27 in Conchie Channel and 1.30 in Joe Kemp Channel, to 1.35 along the East Cape shoreline. Excluding the dominance of anchovies at East Cape, very few juvenile fishes (mostly batfish, bonnethead sharks, and lane snappers) were taken from these hard shell and rock outcrop areas. Western Florida Bay stations showed little variation in S-I values when compared over a three-year period.

In central Florida Bay, S-I diversity was generally higher near the east Snake Bight area 0.09) and declined towards Crocodile Point and Madeira Bay (0.40 and 0.41, respectively). The *Thalassia*, *Diplanthera* community was dominated by one-year-old pinfish, gray snapper, and silver perch.

In eastern Florida Bay, combined S-I diversity values by station ranged from 0.66 at Bottle Key to 1.49 at Little Blackwater Sound (Table 18). The northeast Bay stations, Little Madeira, Little Madeira Beach, Trout Cove, and Little Blackwater Sound exhibited uniform, moderately high values ranging from 1.01 to 1.49. The S-I values were considerably reduced in areas influenced by "whitewater" conditions. Manatee, Bottle and Nest Keys, and west Buttonwood Sound stations in the central portion of eastern Florida Bay produced similar values ranging from 0.66 to 0.95. Diversity was characterized by a low S accompanied by a large number of individuals, a biological. situation often representing hypersaline areas. For example, mostly hardhead silversides and halfbeaks dominated the catch by numbers of individuals and biomass particularly during the dry season. Southeastern Florida Bay stations representing the *Thalassia* communities west of Tavernier Creek and east of West Key yielded comparable high values of 1.20 and 1.39, respectively.

Temporal analysis. By month, western Florida Bay combined seine S-1 values reached a peak in June 1976 of 3.32, and a low of 1.47 in June 1973 while monthly trawl station S-1 values ranged from 1.27 in December 1974 to 3.05 in June 1976 (Figure 14).

In central Florida Bay, monthly trawl S-I values ranged from 0 to 1.2 (Figure 15).

Eastern Florida Bay trawl and seine monthly values ranged from 0.4 to 1.4 (Figure 16).

Seasonal Population Fluctuations As Related to Environmental Conditions

In the 1963 - 1964 Buttonwood Canal study, Roessler (1970) analyzed salinity, temperature, rainfall, and season by single and partial correlation coefficients to determine the cause of changes in seasonal abundance of eight dominant fish species. He concluded that the most important environmental factors related to the catch of forage fishes in the Buttonwood Canal were rainfall and season, while salinity was not useful for predicting catches of fish.

In western Florida Bay, May 1973 to October 1976, salinity, temperature, rainfall, and season were correlated with the number of fish species, biomass/m^2, and numbers of individuals/m to determine the cause of overall population variations. Single correlation coefficients were calculated between fish species, biomass/m^2 and numbers/m^2.

Actual monthly values of subsurface salinities and temperatures, and 1-month lag rainfall data collected at the Flamingo Ranger station were used in the correlation analysis. Single correlation coefficients were calculated between the three biological variables and each of the environmental parameters. In the current study, as in the Buttonwood Canal study (Roessler, 1970), significant correlation coefficients were observed between fish catch data and temperature, rainfall, and season (Table 19) at the Buttonwood Canal station. There was no significant correlation with salinity. Temperature, season, and rainfall were significantly interrelated (Table 19). Therefore it was necessary to use a partial correlation analysis to separate the parameters which significantly influence the other environmental factors and, in turn, the biological variables. In the partial correlation coefficient analysis, the most important association was season and temperature, with rainfall held constant, which showed a highly significant partial correlation coefficient of 0.631 (Table 20).

By comparison, the three-year fish catch data from Palm Key Basin were not significantly correlated with monthly salinity, temperature, rainfall, or seasonal values (Table 21), with the exception of a negative correlation between fish species and season.

A single correlation coefficient analysis was performed on central Florida Bay fish catch data (1974 - 1975) and the four major environmental parameters which were used in the western Florida Bay correlation matrix. As in west Bay, single correlation coefficients were calculated between fish catch data and each of the environmental parameters.

At the nearshore trawl station Crocodile Pt. (T-6), which experienced salinity variations from 41 to 60 ppt, a highly significant inverse association was determined between salinity and fish species and biomass/m^2 at the 95% level, and numbers/m^2 at the 99% level (Table 22). Rainfall* and temperature were not significantly related. Season was correlated at the 99% level with the number of fish species and biomass/m^2.

Another correlation analysis was performed on hydrobiological data from Madeira Bay where salinity varied during the period of observation from 41 to 63 ppt. As expected, a high

* Monthly rainfall values from all 3 locations were analyzed. Highest related values were obtained from Royal Palm.

negative relationship existed between salinity and each of the following: fish species (r = -0.802); biomass/m (r = -0.658); and numbers/m^2 (r = -0.708). However, temperatures and season were related with numbers/m^2 and biomass/m^2, respectively. Rainfall was not significantly related (Table 23).

A partial correlation coefficient analysis was performed on the above data; the results indicated that salinity and season were inversely related at the 95% level when temperature was held constant, and salinity and temperature were highly related at the 99% level when season was held constant. Season and temperature produced a highly significant correlation coefficient of 0.780 when salinity was held constant (Table 24). Thus, season, and temperature in particular, interact to influence salinity.

At an offshore trawl station (Barnes Key Basin) salinity varied from 36 to 46 ppt and was not associated directly with the community parameters (Table 25).

Another correlation analysis was performed to determine if there was an association between freshwater runoff and nearshore hypersaline conditions. Single correlation coefficients were calculated between mean monthly water levels (gauge height) at the Taylor Slough Bridge and pooled mean monthly salinities at the nearshore trawl stations in north central Florida Bay, which receives the southerly drift of water through Taylor Slough. When data were compared from identical months no significant association was found; however, when a 1-month lag time on runoff was used, a highly significant inverse relation (r = -0.960) was determined between water level and salinity at the 99% level (Figure 23).

In the correlation analysis performed on eastern Florida Bay fish catch data, salinity appeared to 2 have an important relationship to numbers of species, individuals, and biomass/m being negatively correlated with the three variables, significantly at the 99% level with biomass/m (salinity range 10 - 41 ppt); and at the 95% level with the number of fish species.

The environmental parameters-temperature, season, and rainfall were related positively to the variable biomass/m^2. During the late spring, an abrupt drop of salinity from hypersaline (50 ppt) along the mainland (Figure 6) to brackish conditions (8 - 10 ppt) partially accounted for a secondary (minor) peak of abundance in number of species, number of individuals, and biomass during the summer period. However, with the continued seasonal increase of rainfall accompanied by a drop in sea level during October (Marmer, 1950), which allowed low salinity water masses to move in a southerly direction toward the Gulf of Mexico, a major seasonal peak of abundance was observed during both fall periods of 1975 and 1976 (Figure 13).

Seasonal Fluctuations of Dominant Species

The relative importance of four dominant fish species by numbers and by biomass is presented as percentage of the total catch from May 1973 through September 1976 (Figures 17 and 18). Except for 1974, anchovies by number were predominant during spring and silver jennies during the fall and winter months while the goldspotted killifish showed a decline in dominance after 1974. Pinfish, although never dominating by number, appeared in large numbers during the late spring and summer months. By biomass, the fish catch by month exhibited smaller peaks of abundance than when compared to central and eastern Florida Bay results. This pattern suggests a wider and more even dispersal of species by weight within western Florida Bay. While anchovies prevailed during the spring months of 1975, and 1976 pinfish dominated the summers of 1974 through 1976. The relative occurrence of the silver jenny was high during the fall and winter months while goldspotted killifish exhibited a decline in dominance following the spring of 1974.

Over a one-year period of observation in central Florida Bay, interrelationships between abundance indices of four dominant fishes are presented in Figures 19 and 20. The relative occurrence of the ubiquitous silver jenny was high during all months except for a decline during the late winter accompanied by an abrupt increase in April. By number, pinfish peaked in abundance during the spring quarter. However, by biomass, snappers dominated during December and silver jennies prevailed in the fall with a smaller peak of abundance during the end of winter. Pinfish predictably dominated during the spring and summer.

Figures 21 and 22 indicate the abundance by number and by biomass of the four dominant species from eastern Florida Bay catch data from October 1975 through September 1976. By number, hardhead silversides prevailed during the fall, while hardhead halfbeaks dominated during the spring period. The silver jenny dominated during the winter months. Similar peaks of abundance were found by biomass.

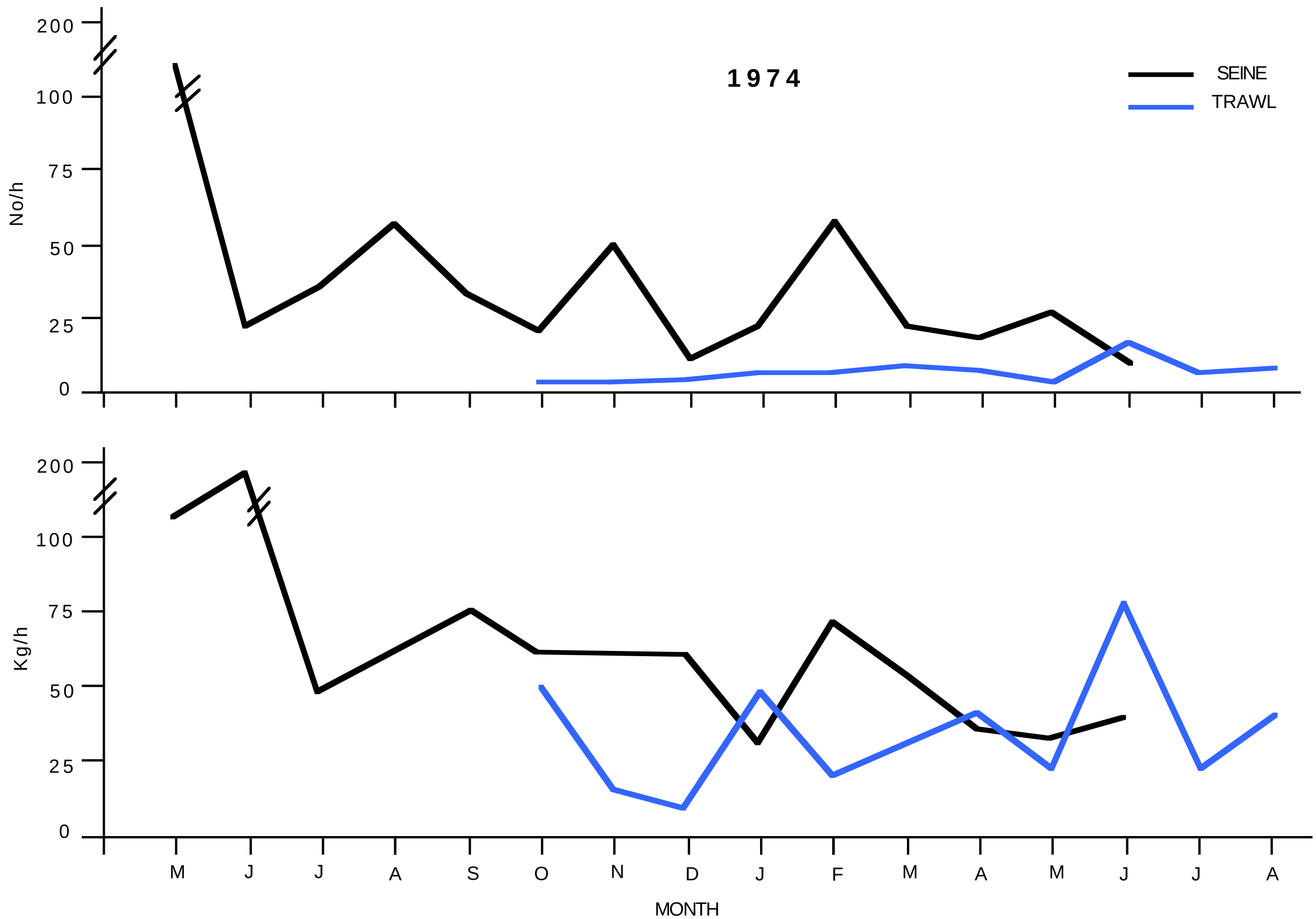


Figure 10. Distribution of the mean catches by biomass and number at the regular seine and trawl stations in western Florida Bay, May 1973 through August 1974.

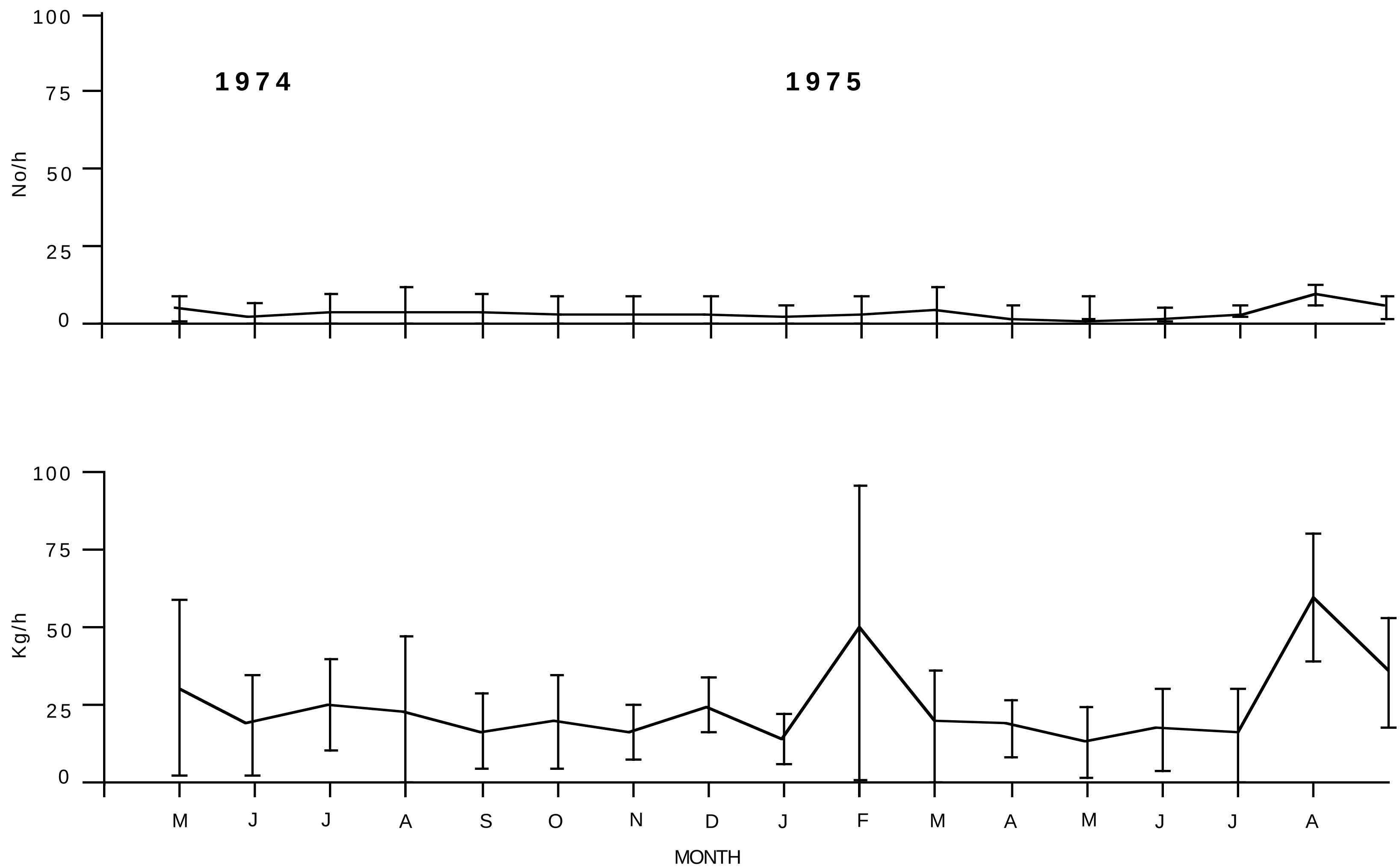


Figure 11. Distribution of the mean catches by biomass and number at the regular trawl stations in western Florida Bay, 1974 1976 ± 1 standard deviation.

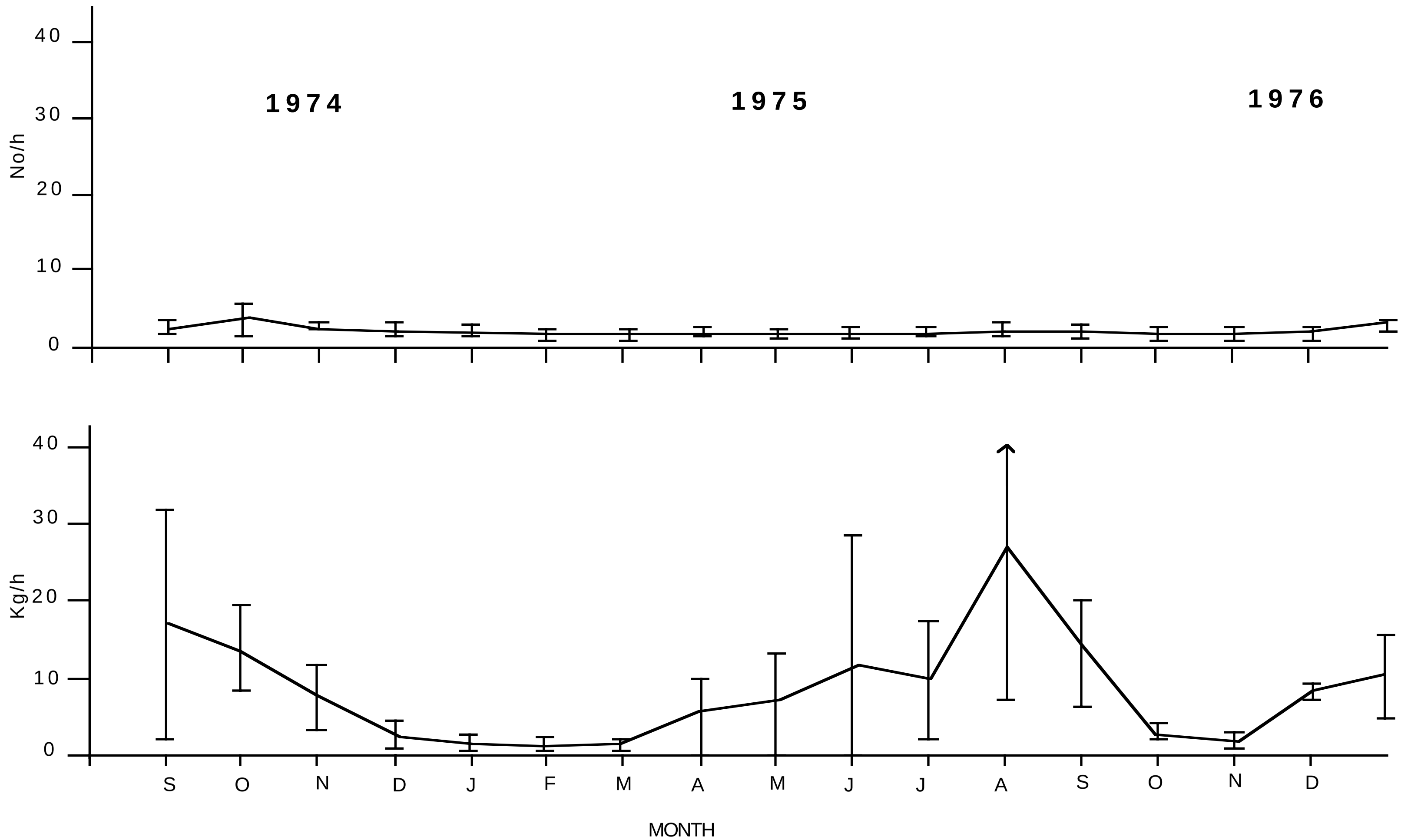


Figure 12. Distribution of the mean catches by biomass and numbers at the regular trawl stations in central Florida Bay, 1974 1976 ± 1 standard deviation.

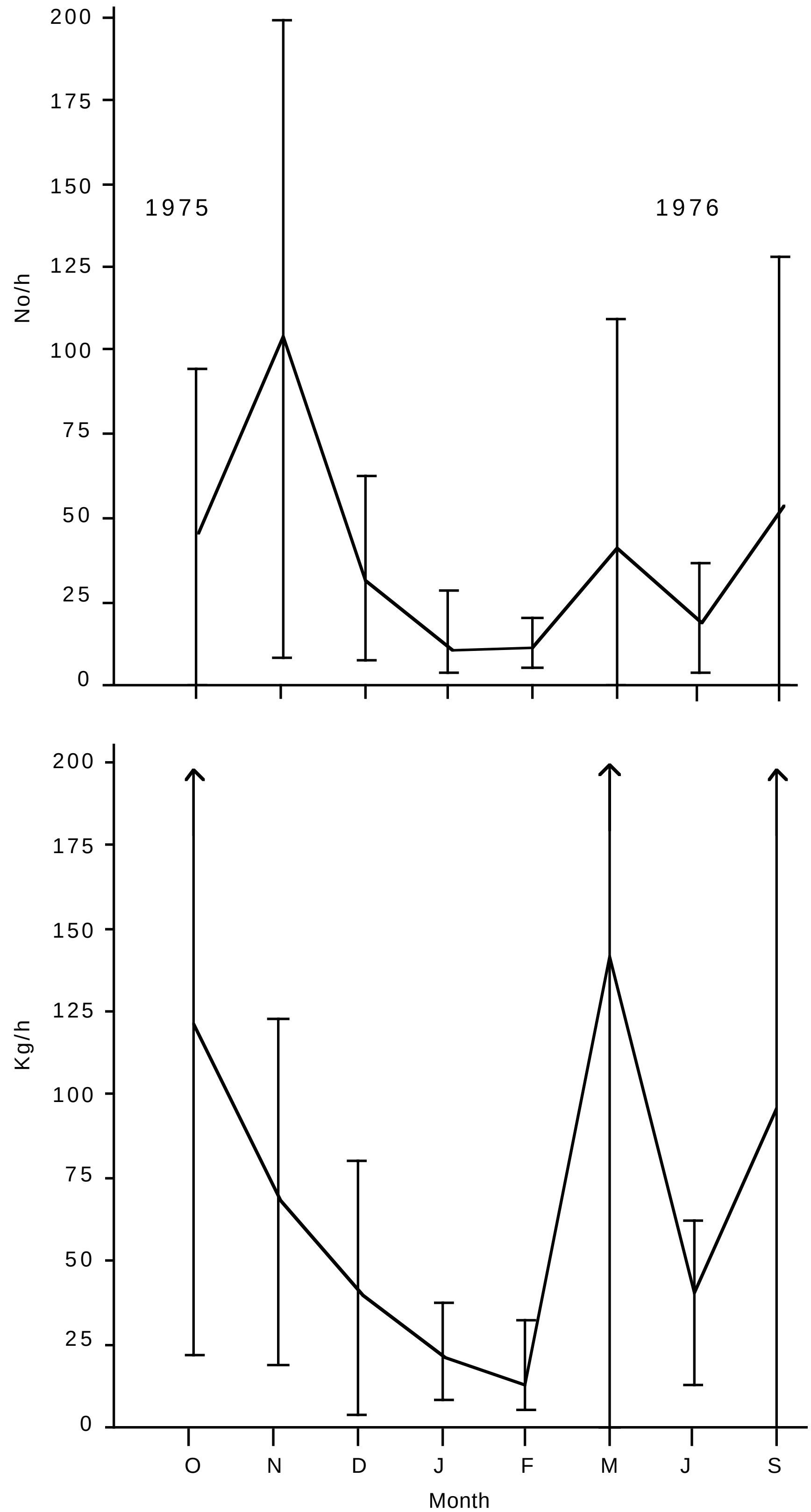


Figure 13. Distribution of the mean catches by biomass and numbers at the regular seine stations in eastern Florida Bay, 1975 - 1976 ± 1 standard deviation.

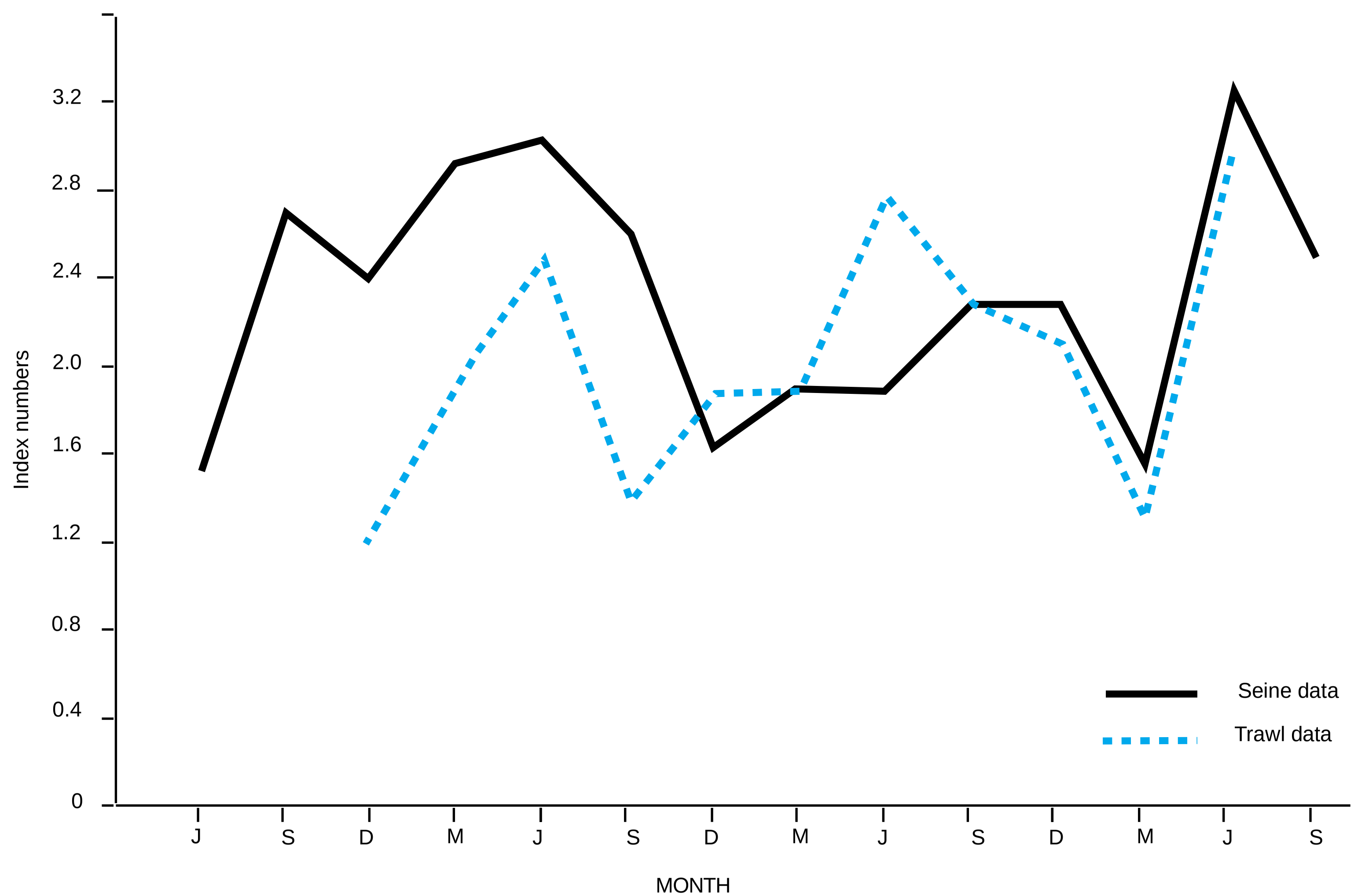


Figure 14. Three year cycle of species richness diversity index (S-I) in western Florida Bay, 1973-1976).

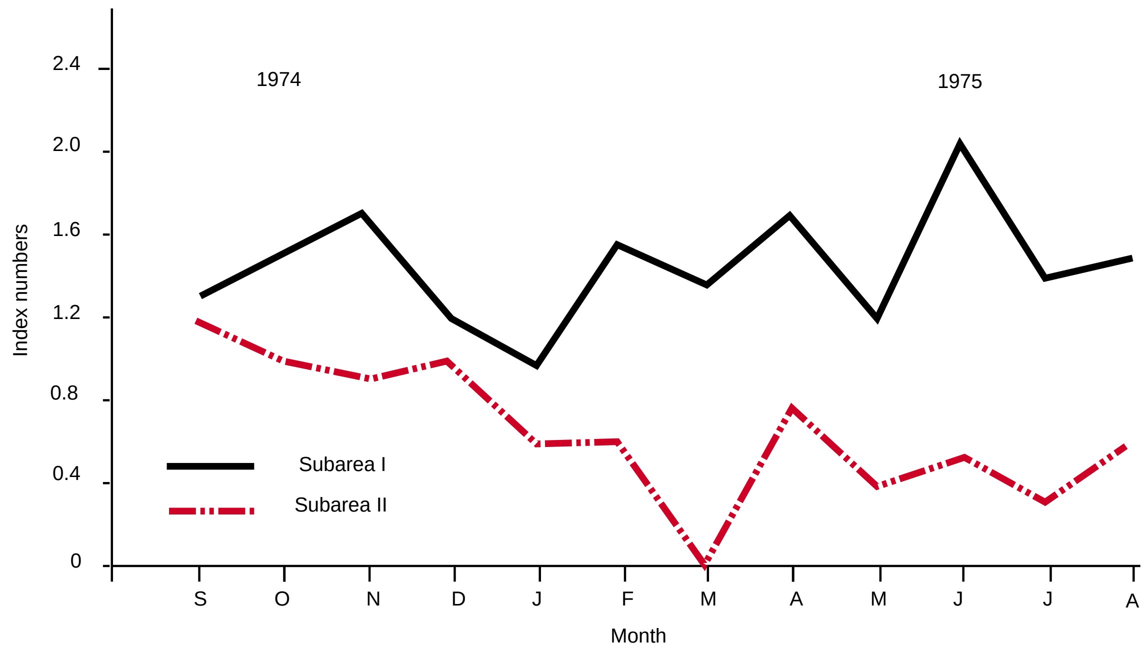


Figure 15. Annual cycle of species richness diversity index (S-I) in western and central Florida Bay, 1974 - 1975.

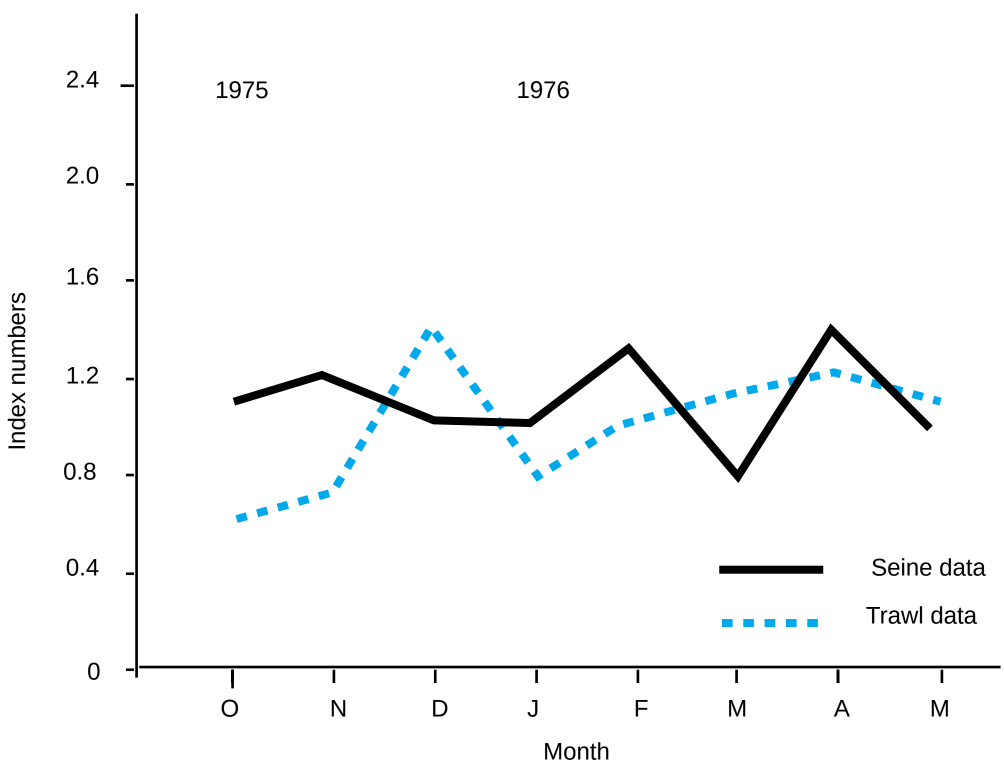


Figure 16. Annual cycle of species richness diversity index (S-I) in eastern Florida Bay, 1975 - 1976.

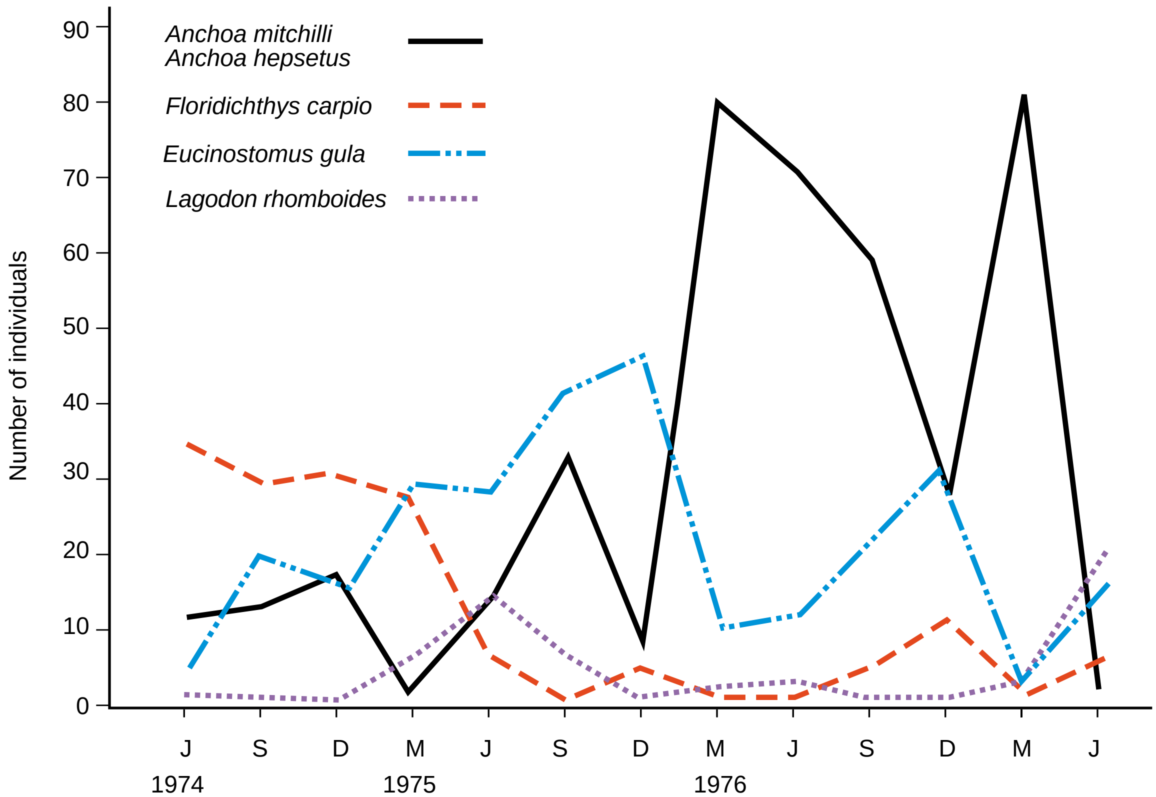


Figure 17. Relative importance (% of total) of the dominant fish by number from the regular stations in western Florida Bay, June 1973 through September 1976. Months displayed quarterly.

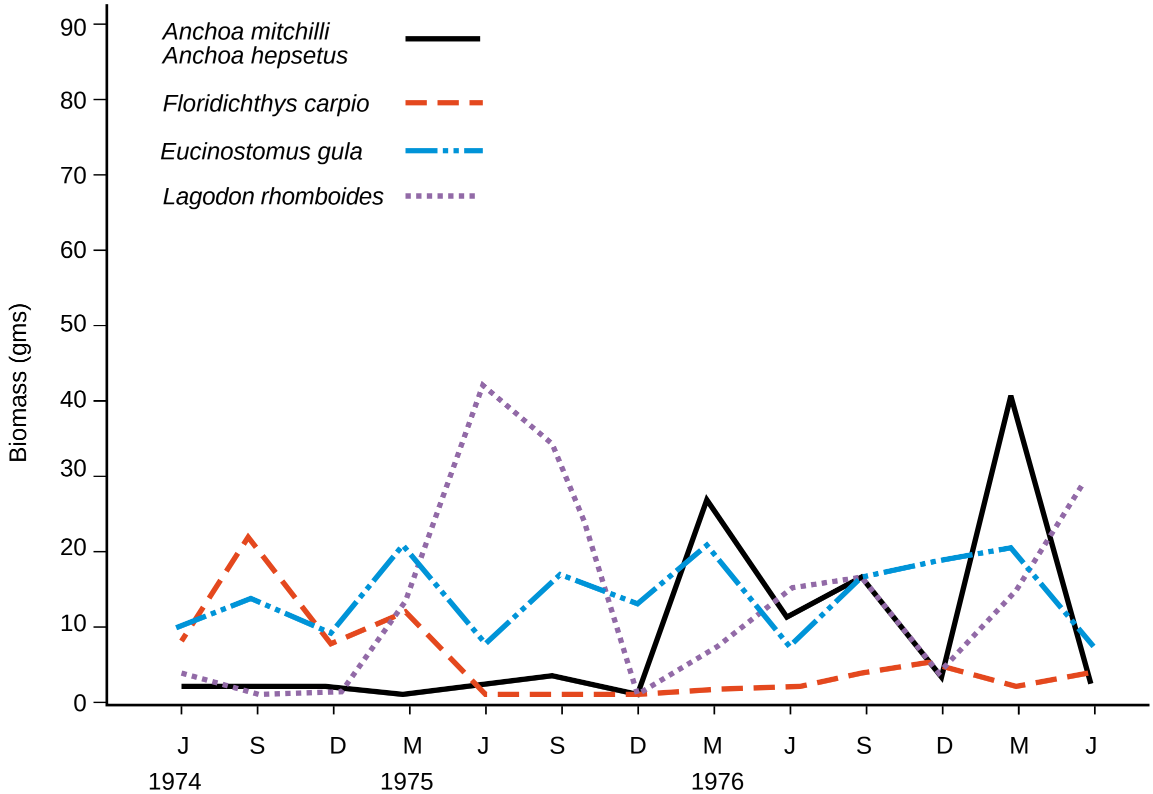


Figure 18. Relative importance (% of total) of the dominant fish by biomass from the regular stations in western Florida Bay, June 1973 through September 1976. Months displayed quarterly.

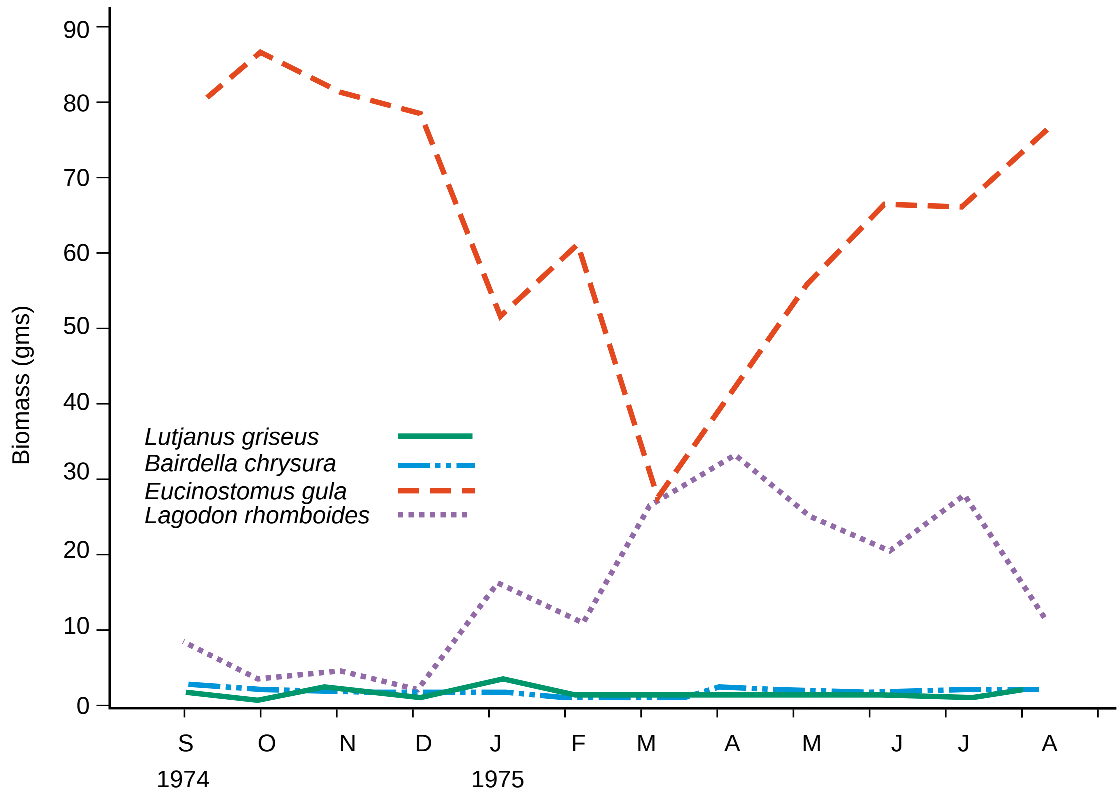


Figure 19. Relative importance (% of total) of the dominant fish by number from the regular stations in central Florida Bay, September 1974 through August 1975.

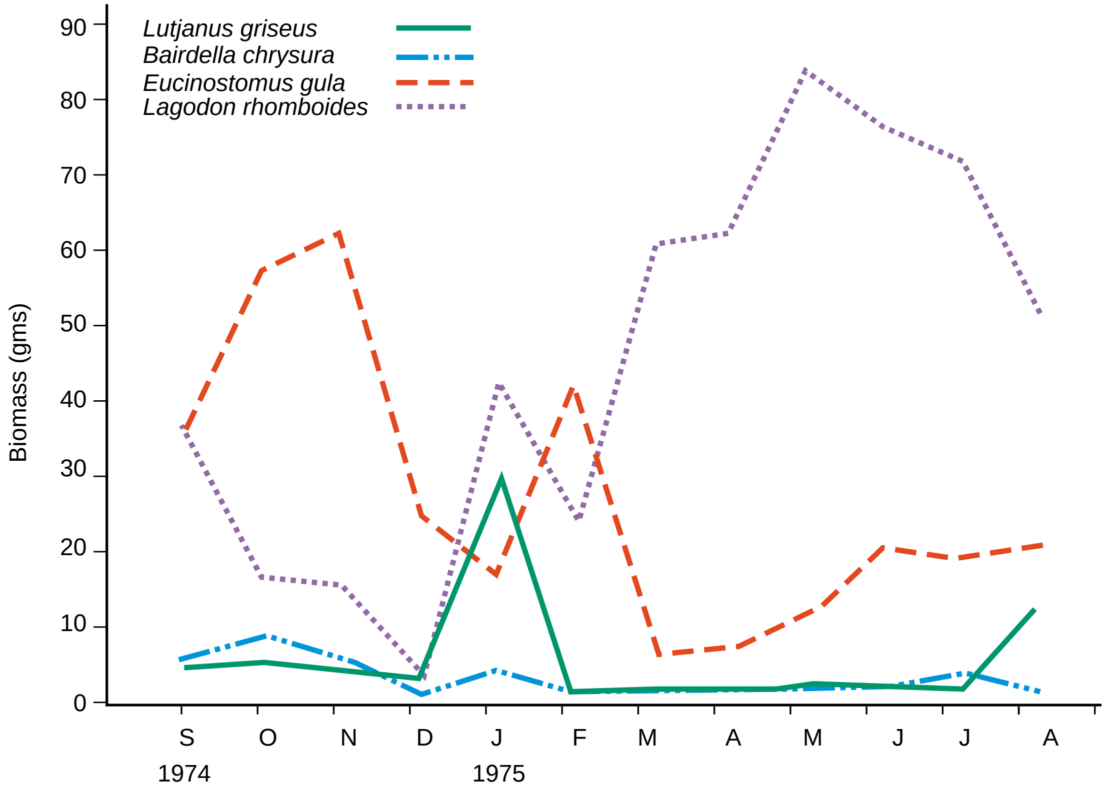


Figure 20. Relative importance (% of total) of the dominant fish by biomass at the regular stations in western Florida Bay, June 1973 through September 1976. Months displayed quarterly

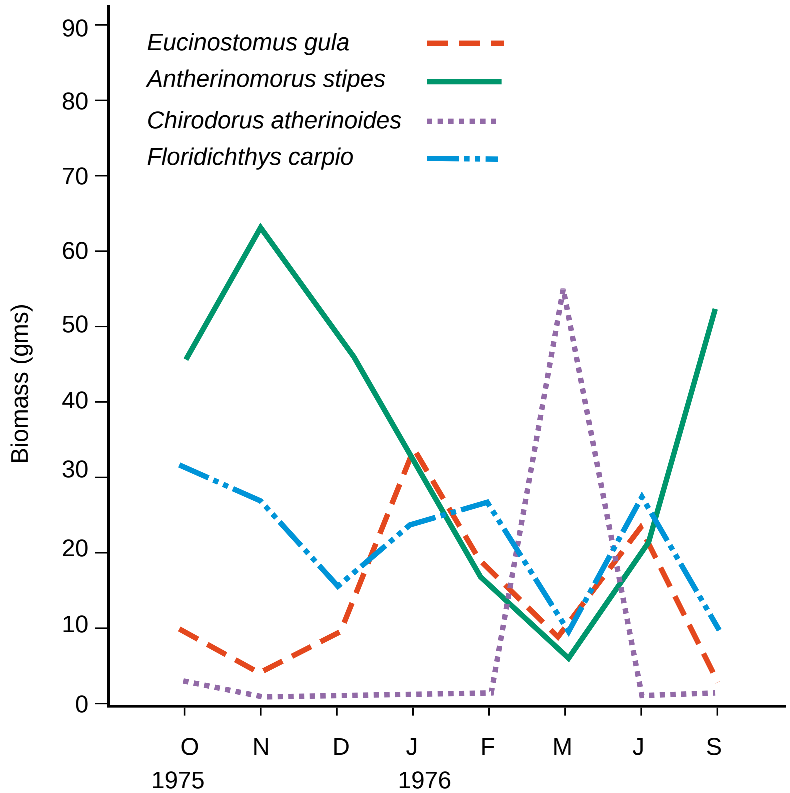


Figure 21. Relative importance (% of total) of the dominant fish by number from the regular stations in central Florida Bay, September 1974 through August 1975.

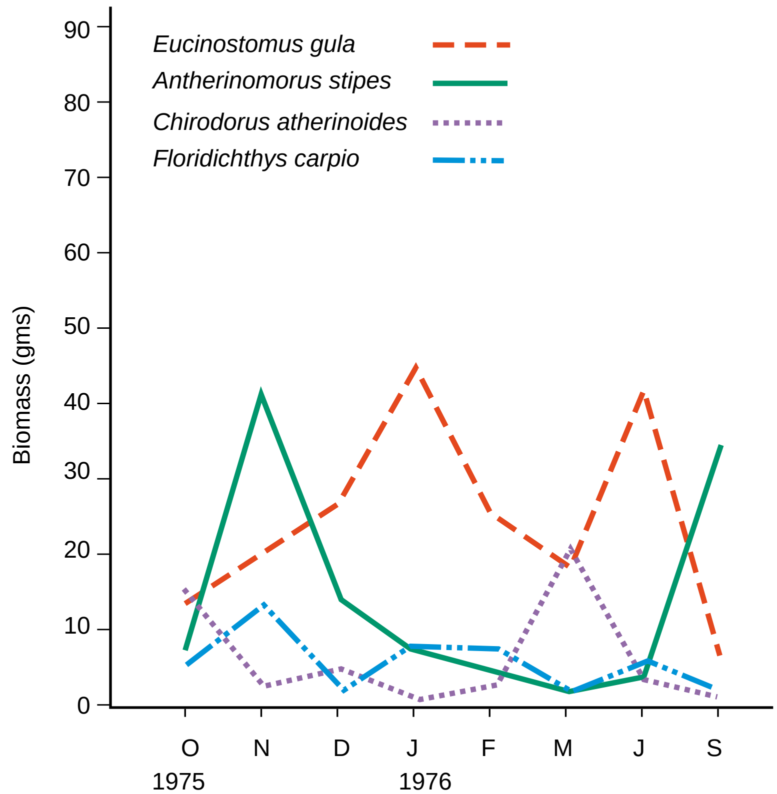


Figure 22. Relative importance (% of total) of the dominant fish by biomass from the regular stations in eastern Florida Bay, October 1975 through September 1976.

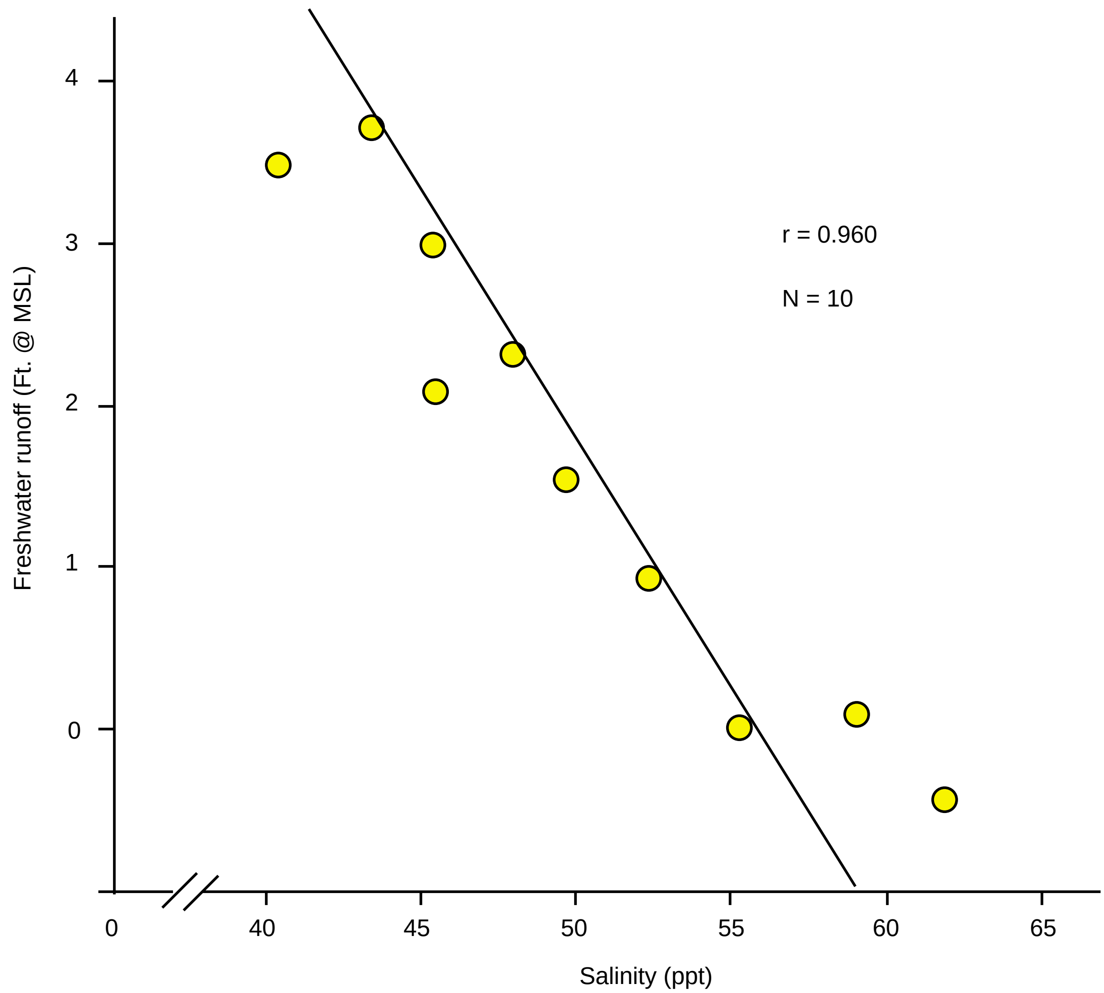


Figure 23. Correlation between Florida Bay salinities and water levels at the Taylor Slough Bridge.

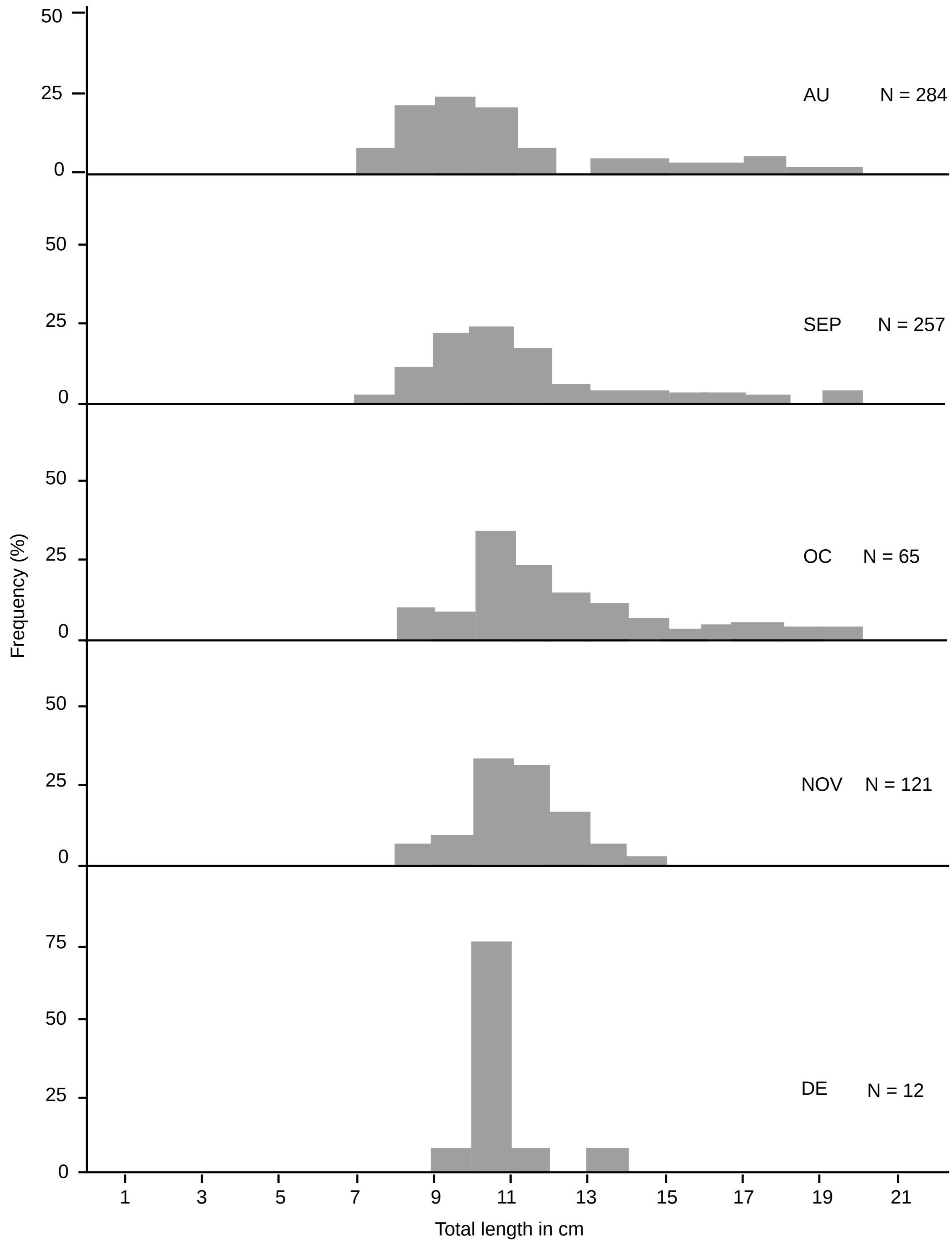


Figure 24. Length-frequency distribution of pinfish, *Lagodon rhomboides* collected at the regular stations in western Florida Bay, 1974.

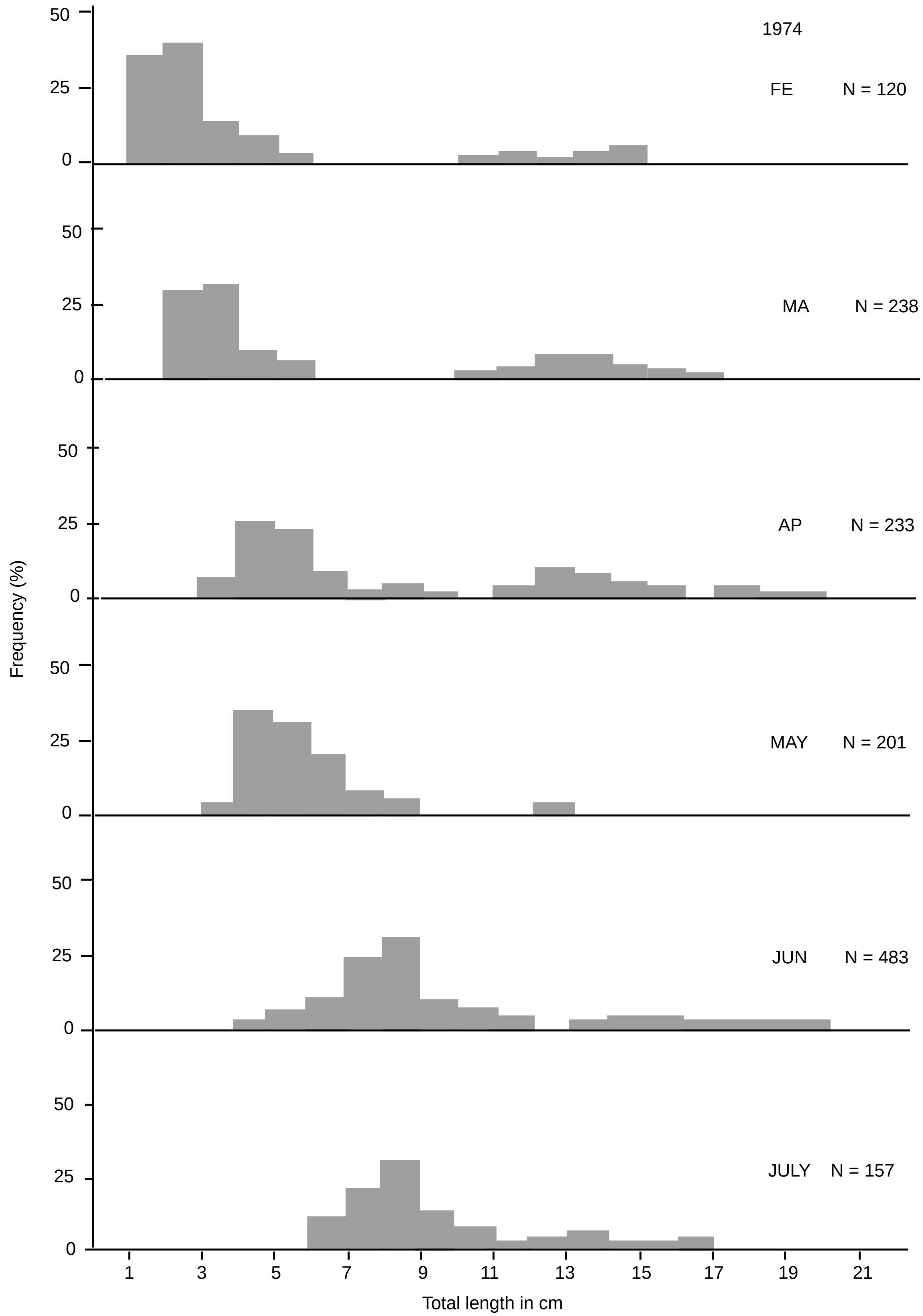


Figure 24. Length-frequency distribution of pinfish, *Lagodon rhomboides* collected at the regular stations in western Florida Bay, 1974 (cont.).

Table 2. Description of Florida Bay seine stations.

Sub Area	Station	Location	Depth (mean-M)	Bottom Type	Benthic Vegetation	Salinity* (range ppt)	Water Temperature* (range °C)	Period of Record
West								
I	S-1	Buttonwood Canal	0.8	Soft mud	*Diplanthera*	29-36	24-28	May 73 - June 76
I	S-2	Joe Kemp Key	0.8	Soft mud	*Thalassia*	33-39	24-28	May 73 - June 74
I	S-3	Palm Key	0.6	Soft mud	*Diplanthera* *Gracilaria*	35-41	25-29	May 73 - June 74
I	S-4	Murray Key	0.6	Soft mud-marl	*Diplanthera*	34-38	24-27	May 73 - June 76
I	S-5	Clive Key	0.7	Soft-hard mud-sand	*Thalassia*	35-41	23-27	May 73 - June 74
I	S-6	Man-O-War Key	0.9	Soft mud hard sand	*Diplanthera*	35-41	24-28	May 73 - June 74
I	S-7	Sandy Key	0.7	Soft mud hard sand	*Thalassia*	35-38	25-29	May 73 - June 74
I	S-8	East Cape	0.9	Shell on hard mud	*Diplanthera*	35-37	24-28	May 73 - June 76
East								
III	S-9	Madeira Beach	0.5	Soft mud marl	*Diplanthera*	27-41	23-27	Oct 75 - Sept 76
III	S-10	Trout Cove	0.5	Soft mud	*Diplanthera*	22-38	23-27	Oct 75 - Sept 76
III	S-11	Little Blackwater Sound	0.8	Soft mud marl/sand	*Diplanthera*	21-37	23-27	Oct 75 - Sept 76
III	S-12	North Nest Key	0.9	Soft lime mud/sand	*Penicillus*	43-47	23-28	Oct 75 - Sept 76
III	S-13	Manatee Key	0.8	Lime and sand	*Thalassia*	43-47	23-29	Oct 75 - Sept 76
III	S-14	Bottle Key	0.7	Hard-lime mud/sand	*Thalassia*	45-47	24-28	Oct 75 - Sept 76
III	S-15	West Key	0.8	Soft/hard mud	*Thalassia*	37-41	23-30	Oct 75 - Sept 76

* Mean ±2 SE.

Table 3. Description of Florida Bay trawl stations.

Sub Area	Station	Location	Depth (mean-M)	Bottom Type	Benthic Vegetation	Salinity* (range ppt)	Water Temperature* (range °C)	Period of Record
West								
I	T-1	Joe Kemp Channel	1.9	Hard mud	*Diplanthera* *Caulerpa*	37-41	23-27	Oct 73 - Dec 75
I	T-2	Conchie Channel	2.5	Hard mud/sand	*Caulerpa*	36-39	22-26	Oct 73 - Feb 75
I	T-3	Palm Key Basin	1.3	Soft-mud	*Syringodium* *Thalassia*	38-40	25-28	Oct 73 - Sept 76
I	T-4	Rabbit Key Basin	1.8	Hard mud	*Thalassia*	39-43	23-27	Oct 73 - Dec 75
Central								
II	T-5	East Snake Bight	1.0	Soft-mud	*Thalassia*	38-45	25-29	Sept 74- Sept 76
II	T-6	Crocodile Point	1.0	Soft lime mud	*Thalassia*	47-51	25-29	Sept 74- Sept 76
II	T-7	Madeira Bay	1.1	Hard-mud sand	*Diplanthera*	48-54	25-29	Sept 74- Sept 75
II	T-8	Barnes Key Basin	1.9	Hard-mud sand	*Thalassia*	42-44	24-28	Sept 74- Sept 75
West								
I	T-9	Sandy Key Basin	2.0	Hard-mud sand	*Syringodium* *Thalassia*	37-39	25-28	Jan 75- Sept 76
East								
III	T-10	Little Madeira Bay	1.7	Soft-mud	*Diplanthera*	20-34	25-28	Oct 75-Sept 76
III	T-11	Buttonwood Sound	2.7	Hard-mud	*Thalassia*	43-45	24-27	Oct 75-Sept 76
III	T-12	Tavernier Creek	2.4	Hard-mud	*Thalassia*	42-44	23-27	Oct 75-Sept 76

* Mean ±2 SE.

Table 4. Most abundant families of fishes by number as percent of monthly catch from the regular stations in western Florida Bay, 1973 - 1974.

Family	May	June	July	Aug	Sept	Oct	Nov
Engraulidae (anchovies)	94.0	12.0	4.5	30.0	12.5	7.0	4.0
Cyprinodontidue (killifishes)	1.9	41.5	86.0	23.0	53.0	43.0	70.5
Gerridae (mojarras)	2.0	9.0	8.0	25.5	27.0	26.5	20.0
Pomadasyidae (grunts)	0.2	0.1		0.1	1.0	1.1	1.0
Mugilidae (mullet)	0.7	14.4		0.2	0.3	0.3	0.2
Sparidae (porgies)	0.2	2.0	0.3	0.6	0.3	4.0	3.0
Scianidae (drums)	0.1	0.1		0.2	0.8	0.6	0.8
Total	99.1	82.0	98.8	79.6	94.8	82.5	99.5

Family	Dec	Jan	Feb	Mar	Apr	May	June
Engraulidae (anchovies)	17.0	25.0	56.3	2.7	0.8	9.8	12.6
Cyprinodontidue (killifishes)	43.1	38.0	24.6	41.1	39.3	32.4	18.1
Gerridae (mojarras)	16.0	22.0	10.2	29.6	27.9	27.7	30.9
Pomadasyidae (grunts)	0.1	2.0	1.2	7.4	5.2	3.5	7.0
Mugilidae (mullet)	3.0	0.4	0.2	0.1	0.2	0.7	0.2
Sparidae (porgies)	0.2	0.8	1.4	7.5	10.1	14.8	17.2
Scianidae (drums)	0.1	2.0	0.2	1.4	2.0	2.1	4.1
Total	79.5	90.2	94.1	89.8	85.5	91.0	90.1

Table 5. Most abundant families of fishes by number as percent of monthly catch from the regular stations in western Florida Bay, 1974 - 1975.

Family	July	Aug	Sept	Oct	Nov	Dec	Jan
Engraulidae (anchovies)			32.5		4.5	0.9	2.0
Cyprinodontidue (killifishes)	28.4	15.2	25.6	58.8	30.8	47.8	30.5
Gerridae (mojarras)	7.5	19.6	0.6	1.2	12.6	0.8	55.2
Pomadasyidae (grunts)	41.5	38.0	6.4	6.3	10.3	1.0	2.5
Mugilidae (mullet)	4.6	3.9	2.3	6.6	4.5	0.8	7.5
Sparidae (porgies)	11.6	11.4	6.4	6.3	10.3	1.0	1.1
Scianidae (drums)	6.9	5.9	2.3	6.6	4.5	0.8	1.1
Total	93.0	74.4	74.9	92.5	94.7	92.1	98.8
Family	Feb	Mar	Apr	May	June	July	Aug
Engraulidae (anchovies)		80.5			72.9		
Cyprinodontidue (killifishes)	29.3	5.1	1.1	25.3	2.0	30.7	6.5
Gerridae (mojarras)	48.0	9.3	31.0	28.4	10.1	42.8	38.2
Pomadasyidae (grunts)	4.6	0.5	5.1	4.1	3.4	1.9	3.6
Mugilidae (mullet)	8.4	1.2	16.3	15.9	2.3	9.6	25.1
Sparidae (porgies)	5.0	0.6	5.7	5.2	0.6	4.3	7.5
Scianidae (drums)	5.0	0.6	5.7	5.2	0.6	4.3	7.5
Total	95.8	97.2	59.2	78.9	91.3	89.3	80.9

Table 6. Most abundant families of fishes by number as percent of monthly catch from the regular stations in western Florida Bay, 1975 - 1976.

Family	Sept	Oct	Nov	Dec	Mar	Jun	Sept
Engraulidae (anchovies)	57.7			28.1	81.5	0.3	
Cyprinodontidue (killifishes)	7.0	1.0	18.1	19.1	3.8	25.8	10.5
Gerridae (mojarras)	21.1	23.7	34.3	32.3	3.5	15.7	40.7
Pomadasyidae (grunts)	0.4	8.3	10.5	1.7	0.8	10.7	17.1
Sparidae (porgies)	1.2	36.4	14.9	0.9	2.8	19.5	6.0
Scianidae (drums)	0.8	10.3	15.5	2.6	0.1	4.8	2.2
Total	88.2	79.7	93.3	84.7	92.5	76.8	76.5

Table 7. Most abundant families of fishes by number as per cent of monthly catch from the regular stations in central Florida Bay, 1974 - 1975.

Family	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Engraulidae (anchovies)	0.7	3.0	2.6	3.4	21.7		
Cyprinodontidue (killifishes)	4.4	3.4	8.7	11.0	4.8	19.0	42.1
Gerridae (mojarras)	79.0	86.2	81.0	74.5	53.2	61.9	26.3
Sparidae (porgies)	9.5	2.8	4.0	0.8	15.7	9.5	26.3
Scianidae (drums)	1.4	1.1	0.7		1.0		
Total	93.6	96.5	97.0	89.7	96.4	90.4	94.7

Family	Apr	May	June	July	Aug
Engraulidae (anchovies)					
Cyprinodontidue (killifishes)	11.9	11.5	11.8	2.7	10.0
Gerridae (mojarras)	42.2	58.6	65.7	66.2	76.0
Sparidae (porgies)	34.3	25.0	20.6	28.3	11.4
Scianidae (drums)	1.5		0.3	0.9	
Total	89.9	95.1	98.4	99.1	97.4

Table 8. Most abundant families of fishes by number as percent of monthly catch from regular stations.

Family	Oct	Nov	Dec	Jan	Feb	Mar	June	Sept
Engraulidae (anchovies)	1.3	0.1	2.6	0.1	9.3	1.9	11.6	1.5
Cyprinodontidue (killifishes)	2.5	0.2	1.0	0.3	0.6	55.2	0.7	0.2
Gerridae (mojarras)	32.7	28.1	21.8	28.4	32.0	9.6	28.8	11.0
Sparidae (porgies)	46.0	64.7	50.2	32.3	16.3	5.1	7.2	55.2
Scianidae (drums)	15.2	4.7	17.5	33.8	32.5	25.4	25.3	6.6
Total	97.7	97.8	93.1	94.9	90.7	97.2	73.6	74.5

Table 9. Most abundant families of fishes by biomass as per cent of monthly catch from the regular stations in western Florida Bay, 1973 - 1974.

Family	May	June	July	Aug	Sept	Oct	Nov
Dasyatidae (rays)		57.0	54.2				
Carcharhinidae (sharks)	12.3	2.3	32.3			18.0	1.0
Engraulidae (anchovies)	52.0	0.5	0.1	5.2	1.6	0.2	0.4
Cyprinodontidue (killifishes)	4.4	3.1	8.0	7.9	24.1	4.2	22.4
Gerridae (mojarras)	10.1	6.7	3.1	32.3	16.9	12.8	14.1
Mugilidae (mullet)	0.6	7.5		10.0	16.0	1.9	18.6
Sparidae (porgies)	1.1	2.0	0.1	9.0	1.1	24.2	15.7
Sphyraenidae (barracuda)	1.3	6.3	0.2	10.3	9.0	10.2	3.0
Total	81.8	85.4	98.1	74.7	68.7	71.5	75.2

Family	Dec	Jan	Feb	Mar	April	May	June
Dasyatidae (rays)							6.7
Carcharhinidae (sharks)	1.1		9.2				2.5
Engraulidae (anchovies)	1.2	6.1	20.3	0.6	0.1	1.3	1.2
Cyprinodontidue (killifishes)	8.8	7.1	15.8	13.8	11.1	4.2	1.8
Gerridae (mojarras)	9.0	15.0	16.5	23.3	20.3	20.2	6.6
Mugilidae (mullet)	51.0	0.2	1.7	4.7	4.4	12.2	0.6
Sparidae (porgies)	3.6	6.5	3.0	15.5	31.5	26.7	44.8
Sphyraenidae (barracuda)	3.7	1.8	1.6	1.0	0.3	4.6	2.5
Total	78.4	36.7	68.1	58.9	67.7	69.2	66.7

Table 10. Most abundant families of fishes by biomass as per cent of monthly catch from the regular stations in western Florida Bay, 1974 - 1975.

Family	July	Aug	Sept	Oct	Nov	Dec	Jan
Engraulidae (anchovies)		0.4	3.1		0.4	0.2	0.2
Batrachoididae (toadfish)	4.7	4.3	6.3	1.0	1.1	1.9	0.3
Lutjanidae (snappers)	7.5	3.8	5.3	8.8	4.1	6.1	3.3
Gerridae (mojarras)	8.5	11.8	5.9	9.6	4.8	12.6	12.8
Pomadasyidae (grunts)	9.0	11.7	2.8	2.0	33.0	0.1	3.4
Sparidae (porgies)	42.5	50.4	35.2	25.1	26.0	2.4	32.2
Scianidae (drums)	4.0	7.5	5.6	9.6	9.3	18.1	6.4
Mugilidae (mullet)			5.3			1.5	
Ephippidae (spadefish)	12.3		10.6	11.4	3.8	36.4	19.4
Diodontidae (porcupinefishes)	4.9	2.4	0.3	4.6	2.7	5.9	5.9
Total	93.4	92.3	80.4	72.1	85.2	85.2	83.9
Family	**Feb**	**Mar**	**April**	**May**	**June**	**July**	**Aug**
Engraulidae (anchovies)		27.4			8.8		
Batrachoididae (toadfish)	4.3	4.6	8.1	13.0	7.8	1.2	16.6
Lutjanidae (snappers)	1.0	2.8	9.9	7.1	4.8	14.0	1.0
Gerridae (mojarras)	12.0	19.7	6.5	4.9	5.9	6.5	2.5
Pomadasyidae (grunts)	0.5	1.3	4.8	3.3	22.6	8.1	5.6
Sparidae (porgies)	29.3	6.2	25.5	27.4	11.8	40.9	45.5
Scianidae (drums)	20.4	15.0	6.1	6.3	4.2	14.5	5.8
Mugilidae (mullet)		0.2			0.9		
Ephippidae (spadefish)	21.4	6.9	20.5		11.4		
Diodontidae (porcupinefishes)	6.2	4.7	8.9	4.8	1.2	0.3	7.6
Total	95.1	88.8	90.3	66.8	79.4	85.5	84.6

Table 11. Most abundant families of fishes by biomass as per cent of monthly catch from the regular stations in western Florida Bay, 1975 - 1976.

Family	Sept	Oct	Nov	Dec	Mar	June	Sept
Engraulidae (anchovies)	15.5			1.8	39.5	0.2	
Batrachoididae (toadfish)	2.5	3.2	3.9	11.9	4.0	13.8	3.1
Lutjanidae (snappers)	0.8	1.3	4.1	3.3	5.7	3.5	5.3
Gerridae (mojarras)	15.7	3.0	2.8	17.3	20.2	5.7	16.8
Pomadasyidae (grunts)	3.0	9.6	8.9	4.9	1.9	14.9	9.7
Sparidae (porgies)	22.1	49.9	10.4	4.2	12.7	28.9	30.2
Scianidae (drums)	9.0	11.5	19.4	33.6	1.5	11.6	7.4
Mugilidae (mullet)	1.7			6.9		1.2	
Ephippidae (spadefish)			28.5			0.1	
Diodontidae (porcupinefishes)	3.8	10.2	2.2	2.5	1.5	1.1	1.5
Total	74.1	88.7	80.2	86.4	87.0	81.0	74.0

Table 12. Most abundant families of fishes by biomass as per cent of monthly catch from the regular stations in central Florida Bay, 1974 - 1975.

Family	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Cyprinodontidae (killifishes)	0.6	0.3	0.4	1.0	0.2	1.4	0.8
Syngnathidae (pipefishes seahorses)	1.4	0.1	1.5	5.5	0.1	0.1	
Lutjanidae (snappers)	5.6	5.0	3.6	7.0	30.8		
Gerridae (mojarras)	35.4	57.5	62.2	25.1	16.0	42.4	6.0
Sparidae (porgies)	38.5	6.5	15.3	3.9	42.0	23.6	59.1
Scianidae (drums)	6.5	8.0	6.2		3.5		
Diodontidae (porcupinefish)	3.2	2.8	7.8	9.0	1.7		
Total	91.2	80.2	97.0	51.5	94.3	67.5	65.9

Family	April	May	June	July	Aug
Cyprinodontidae (killifishes)	0.3	0.5	0.5	0.2	0.2
Syngnathidae (pipefishes seahorses)		0.4			
Lutjanidae (snappers)					11.9
Gerridae (mojarras)	7.1	10.7	19.0	18.6	20.0
Sparidae (porgies)	62.1	84.8	76.8	72.7	50.4
Scianidae (drums)	0.2		0.1	1.4	
Diodontidae (porcupinefish)	5.6	0.3		4.1	2.1
Total	75.3	96.2	96.4	97.0	84.6

Table 13. Most abundant families of fishes by biomass as percent of monthly catch from regular stations in eastern Florida Bay, 1975 - 1976.

Family	Oct.	Nov.	Dec.	Jan.	Feb.	March	June	Sept.
Exocoetidae	16.0	2.7	5.3	0.1	2.9	21.9	3.4	1.3
Atherinidae	7.6	41.7	15.0	7.5	5.0	1.4	1.7	35.3
Gerridae	25.1	23.0	34.4	51.7	43.5	45.1	52.1	11.5
Cyprinodontidae	5.7	10.3	5.7	16.8	9.4	3.5	5.4	2.7
Belonidae	0.9	0.5	2.7	3.8	0.9	12.5	2.9	16.3
Lutjanidae	2.3	3.9	0.8	2.1	1.8	0.1	3.7	1.3
Sphyraenidae	1.9	5.6	12.0	6.7	5.3	5.3	7.7	3.0
Total	59.5	88.1	75.9	88.7	68.8	88.9	76.9	71.4

Table 14. Percent species and biomass composition of the 40 most abundant fishes from the regular stations in western Florida Bay, 1973 - 1976.

Species	Composition by number (%)	Rank	Species	Composition by number (%)	Rank
Anchoa hepsetus	24.39	1	*Lagodon rhomboides*	17.63	1
Anchoa mitchilli	22.31	2	*Eucinostomus gula*	10.90	2
Eucinostomus gula	17.73	3	*Dasyatis americana*	8.91	3
Floridichthys carpio	12.43	4	*Bairdiella chrysura*	5.40	4
Lucania parva	5.10	5	*Chaetodipterus faber*	4.71	5
Lagodon rhomboides	4.02	6	*Floridichthys carpio*	4.31	6
Membras martinica	1.41	7	*Anchoa hepsetus*	3.94	7
Eucinostomus argenteus	1.34	8	*Orthopristis chrysoptera*	3.40	B
Orthopristis chrysoptera	1.27	9	*Mugil cephalus*	3.19	9
Bairdiella chrysura	1.18	10	*Anchoa mitchilli*	3.16	10
Harangula jaguana	1.04	11	*Opsanus beta*	3.04	11
Haemulon plumieri	0.82	12	*Negaprion brevirostris*	2.80	12
Syngnathus scovelli	0.61	13	*Haemulon plumieri*	2.40	13
Mugil trichodon	0.57	14	*Lutjanus griseus*	2.21	14
Syngnathus floridae	0.51	15	*Sphyraena barracuda*	2.15	15
Synodus foetens	0.41	16	*Chilomycterus schoepfi*	1.89	16
Opisthonema oglinum	0.40	17	*Strongylura notata*	1.79	17
Cyprinodon variegatus	0.36	18	*Airus felis*	1.76	18
Strongylura notata	0.35	19	*Mugil trichodon*	1.52	19
Monocanthus ciliatus	0.29	20	*Centropomus undecimalis*	1.11	20
Monocanthus hispidis	0.23	21	*Ogcocephalus radiatus*	1.09	21
Spheorides nephaleus	0.22	22	*Lucania parva*	1.02	22
Calamus arctifrons	0.18	23	*Lutjanus synagris*	0.95	23
Lutjanus synagris	0.16	24	*Eucinostomus argenteus*	0.80	24
Chaetodipterus faber	0.14	25	*Lactophrys quadricornis*	0.73	25
Symphurus plagiusa	0.14	26	*Scions ocellatus*	0.69	26
Brevoortia smithi	0.11	27	*Synodus foetens*	0.64	27
Chilomycterus schoepfi	0.11	28	*Monocanthus hispidis*	0.61	28
Trachonotus falcatus	0.09	29	*Monocanthus ciliatus*	0.56	29
Lutjanus griseus	0.08	30	*Nicholsina usta*	0.45	30
Mugil curema	0.07	31	*Calamus arctifrons*	0.43	31
Sphyraena barracuda	0.07	32	*Pogonias cromis*	0.40	32
Cynoscion nebulosus	0.07	33	*Syngnathus floridae*	0.34	33
Lactophrys quadricornis	0.06	34	*Membras martinica*	0.30	34
Gobiosoma robustum	0.06	35	*Sphyrna tiburo*	0.27	35
Mugil cephalus	0.05	36	*Elops saurus*	0.23	36
Syngnathus louisianae	0.05	37	*Hyporamphrus unifasciatus*	0.22	37
Nicholsina usta	0.04	38	*Archeosargus probatocephalus*	0.22	38
Ogcocephalus radiatus	0.04	39	*Spheorides nephelus*	0.21	39
Chriodorus atherinoides	0.04	40	*Harangula jaguana*	0.19	40
Total number	139,768		Total biomass	500,759 gms	

Table 15. Percent species and biomass composition of the 30 most abundant fishes from the regular stations in central Florida Bay, 1974 - 1975.

Species	Composition by number (%)	Rank	Species	Composition by number (%)	Rank
Eucinostomus gula	75.50	1	*Lagodon rhomboides*	46.78	1
Lagodon rhomboides	10.01	2	*Eucinostomus gula*	28.56	2
Lucania parva	4.80	3	*Lutjanus griseus*	7.05	3
Anchoa mitchilli	3.00	4	*Lactophrys quadricornis*	3.02	4
Floridichthys carpio	2.10	5	*Bairdiella chrysura,*	2.90	5
Bairdiella chrysura	0.84	6	*Chilomycterus schoepfi*	2.72	6
Hippocampus zosterae	0.43	7	*Synodus foetens*	2.37	7
Lactophrys quadricornis	0.41	8	*Chaetodipterus faber*	1.65	8
Lutjanus griseus	0.38	9	*Orthopristis chrysoptera*	0.65	9
Chilomycterus schoepfi	0.34	10	*Airus felis*	0.54	10
Syngnathus floridae	0.31	11	*Lucania parva*	0.48	11
Syngnathus scovelli	0.24	12	*Monocanthus hispidis*	0.48	12
Synodus foetens	0.22	13	*Opsanus beta*	0.41	13
Opsanus beta	0.22	14	*Archeosargus probatocephalus*	0.36	14
Sphyraena barracuda	0.22	15	*Syngnathus floridae*	0.30	15
Hippocampus erectus	0.14	16	*Sphyraena barracuda*	0.29	16
Cynoscion nebulosus	0.12	17	*Hippocampus erectus*	0.26	17
Opisthonema oglinum	0.07	18	*Anchoa mitchilli*	0.22	18
Syngnathus louisianae	0.07	19	*Cynoscion nebulosus*	0.20	19
Orthopristis chrysoptera	0.07	20	*Sphoeroides nephelus*	0.17	20
Archeosargus probatocephalus	0.07	21	*Floridichthys carpio*	0.16	21
Airus felis	0.05	22	*Lutjanus synagris*	0.15	22
Chriodorus atherinoides	0.05	23	*Chriodorus atherinoides*	0.06	23
Haemulon plumieri	0.05	24	*Syngnathus louisianae*	0.06	24
Monocanthus hispidis	0.05	25	*Opisthonema oglinum*	0.04	25
Spheorides nephelus	0.05	26	*Haemulon plumieri*	0.03	26
Anchoa hepsetus	0.02	27	*Chasmodes saburrae*	0.03	27
Selene vomer	0.02	28	*Anchoa hepsetus*	0.02	28
Lutjanus synagris	0.02	29	*Syngnathus scovelli*	0.02	29
Eucinostomus argenteus	0.02	30	*Eucinostomus argenteus*	0.01	30
Total number	4,148		Total biomass	37,276 gms	

Table 16. Percent species and biomass composition of the 40 most abundant fishes from the regular stations in eastern Florida Bay, 1975 - 1976.

Species	Composition by number (%)	Rank	Species	Composition by number (%)	Rank
Atherinomorus stipes	46.78	1	*Eucinostomus gula*	23.31	1
Floridichthys carpio	21.63	2	*Atherinomorus stipes*	16.35	2
Eucinostomus gula	8.55	3	*Chriodorus atherinoides*	9.47	3
Chriodorus atherinoides	6.31	4	*Eucinostomus argenteus*	8.22	4
Eucinostomus argenteus	4.63	5	*Floridichthys carpio*	5.84	5
Harangula jaguana	3.72	6	*Sphyraena barracuda*	5.24	6
Anchoa mitchilli	1.88	7	*Strongylura notata*	3.97	7
Lucania parva	1.24	8	*Mugil trichodon*	3.58	3
Menidia Berlin	0.69	9	*Chilomycterus schoepfi*	3.09	9
Strongylura notata	0.67	10	*Harangula jaguana*	2.89	10
Cyprinodon variegatus	0.46	11	*Lagodon rhomboides*	2.21	11
Opisthonema oglinum	0.42	12	*Pogonias cromis*	2.05	12
Lagodon rhomboides	0.42	13	*Lutjanus griseus*	1.72	13
Membras martinica	0.26	14	*Negaprion brevirostris*	1.70	14
Syngnathus scovelli	0.22	15	*Diapterus plumieri*	1.52	15
Poecilia latipinnia	0.09	16	*Lactophrys quadricornis*	1.12	16
Sphyraena barracuda	0.09	17	*Anchoa mitchilli*	0.91	17
Fundulus similis	0.06	18	*Ginglymostoma cirratum*	0.72	18
Mugil trichodon	0.06	19	*Haemulon sciurus*	0.65	19
Gobiosoma robustum	0.06	20	*Fundulus similis*	0.59	20
Chilomycterus schoepfi	0.05	21	*Caranx hippos*	0.58	21
Haemulon sciurus	0.05	22	*Sphyrna tiburo*	0.53	22
Opsanus beta	0.04	23	*Haemulon plumieri*	0.37	23
Lutjanus griseus	0.04	24	*Lucania parva*	0.31	24
Haemulon plumieri	0.29	25	*Sparisoma rubripinne*	0.29	25
Sardinella spp.	0.02	26	*Gerres cinereus*	0.25	26
Fundulus confluentus	0.02	27	*Synodus foetens*	0.24	27
Hippocampus zosterae	0.02	28	*Cyprinodont variegatus*	0.23	28
Fundulus grandis	0.02	29	*Opisthonema oglinium*	0.22	29
Trachinotus falcatus	0.02	30	*Calamus arctifrons*	0.20	30
Syngnathus floridae	0.02	31	*Fundulus grandis*	0.19	31
Gerres cinereus	0.01	32	*Spheorides nephelus*	0.17	32
Diapterus plumieri	0.01	33	*Menidia beryllina*	0.16	33
Lutjanus apodus	0.01	34	*Lutjanus synagris*	0.15	34
Haemulon aurolineatum	0.01	35	*Microgobius gulosus*	0.13	35
Cynoscion nebulosus	0.01	36	*Opsanus beta*	0.12	36
Sphoeroides nephelus	0.01	37	*Lutjanus apodus*	0.10	37
Lactophrys quadricornis	0.01	38	*Membras martinica*	0.07	38
Lutjanus synagris	0.01	39	*Syngnathus scovelli*	0.06	39
Micrognathus crinigerus	0.01	40	*Trachinotus falcatus*	0.04	40
Total number	38,008	Total	biomass	71,554 gms	

Table 17. Species richness diversity index (S-I) by station habitats in western Florida Bay (a) May 1973 - July 1974, (b) May 1973 - July 1976, and Central Florida Bay (c) Sept. 1974 - August 1975.

	a	b	c
Station-habitat	$\bar{x}$ (S-I)	$\bar{x}$ (S-I)	$\bar{x}$ (S-I)
S-1	2.423	2.510	
S-2	2.135		
S-3	1.216		
S-4	2.619	2.602	
S-5	1.688		
S-6	1.557		
S-7	1.511		
S-8	1.354	1.412	
T-I	1.306		
T-2	1.273		
T-3	2.321	2.107	
T-4	1.918		
T-9		2.649	
T-5			1.099
T-6			0.401
T-7			0.496
T-8			0.835

Table 18. Species richness diversity index (S-I) by station-habitats in eastern Florida Bay, 1975 - 1976.

Station-habitat	$\bar{x}$ (S-I)	Status-habitat	$\bar{x}$ (S-I)
S-9	1.027	T-10	1.005
S-10	1.251	T-11	0.867
S-11	1.485	T-12	1.197
S-12	0.952		
S-13	0.870		
S-14	0.660		
S-15	1.385		

Table 19. Matrix of simple correlation coefficients used in computing partial correlation coefficients for temperature, rainfall and season at a regular nearshore seine station in western Florida Bay (Florida Bay entrance to the Buttonwood Canal) 1973 - 1976.

	Salinity	Water temperature	Famingo rainfall	Season
Fish species	0.195	0.560**	0.506*	0.579**
Biomass/m^2	0.030	0.829**	0.049*	0.635**
Numbers/m^2	0.007	0.539**	0.535**	0.599**
Temperature		1.000	0.520*	0.736**
Rainfall			1.000	0.549**
Season				1.000

* Significant at the 95% level, 19 df, 4 independent variables.
** Significant at the 99% level, 19 df, 4 independent variables.

Table 20. Partial correlation coefficients between season, temperature and rainfall at a regular nearshore seine station in western Florida Bay (Florida Bay entrance to the Buttonwood Canal) 1973 - 1976.

	Water temperature	Famingo rainfall	Season
Water temperature	1.000	0.204	0.631**
Rainfall (Flamingo)	-	1.000	0.549
Season	-	-	1.000

** Significant at the 99% level with 18 df.
\- Value held constant.

Table 21. Matrix of simple correlation coefficients between fish catch data and salinity, temperature, rainfall and season at a regular nearshore trawl station in western Florida Bay (Palm Key Basin) 1973 - 1976.

	Salinity	Water temperature	Famingo rainfall	Season
Fish species	0.014	-0.029	-0.189	-0.277*
Biomass/m^2	0.031	-0.068	0.146	-0.012
Numbers/m^2	-0.067	0.131	-0.247	0.155

** Significant at the 95% level, 58 df, 4 independent variables.

Table 22. Matrix of simple correlation coefficients between fish catch data and salinity, temperature, rainfall and season at a regular nearshore trawl station in central Florida Bay (Crocodile Point) 1973 - 1976.

	Salinity	Water temperature	Famingo rainfall	Season
Fish species	-0.499*	0.357	0.398	0.585**
Biomass/m^2	-0.474	0.419*	0.325	0.663**
Numbers/m^2	-0.711**	0.161	0.224	0.361

* Significant at the 95% level, 22 df, 4 independent variables.
** Significant at the 99% level, 22 df, 4 independent variables.

Table 23. Matrix of simple correlation coefficients used in computing partial correlation coefficients for salinity, temperature, rainfall and season at a regular nearshore trawl station in central Florida Bay (Madeira Bay) 1974 - 1975.

	Salinity	Water temperature	Famingo rainfall	Season
Fish species	-0.802**	0.032	0.139	-0.053
Biomass/m^2	-0.658**	0.096	0.240	0.431
Numbers/m^2	-0.708**	0.532*	0.218	0.315
Salinity	1.000	0.453*		-0.063
Water temperature		1.000		0.666**
Season				1.000

* Significant at the 95% level, 19 df, 4 independent variables.
** Significant at the 99% level, 19 df, 4 independent variables.

Table 24. Partial correlation coefficients between salinity, temperature and season at a regular trawl station in central Florida Bay (Madeira Bay) 1974 - 1975.

	Salinity	Water temperature	Season
Salinity	1.000	0.664*	-0.548*
Water temperature	-	1.000	0.780**
Season	-	-	1.000

* Significant at the 95% level with 18 df.
** Significant at the 99% level with 18 df.
- Value held constant.

Table 25. Matrix of simple correlation coefficients between fish catch data and salinity, temperature, rainfall and season at a regular offshore trawl station in central Florida Bay (Barnes Key Basin) 1974 - 1975.

	Salinity	Water temperature	Famingo rainfall	Season
Fish species	-0.008	0.014	-0.134	0.245
Biomass/m^2	0.064	0.282	0.405*	-0.099
Numbers/m^2	0.097	0.239	0.499*	0.628**

* Significant at the 95% level, 22 df, 4 independent variables.
** Significant at the 99% level, 22 df, 4 independent variables.

Table 26. Annual patterns of numbers and biomass of fishes in Florida Bay.

Station-Habitat	Surface area sampled (m^2)	Biomass (g/m^2)	Biomass (Kg/h)	Relative abundance No. of fish/m^2	Relative abundance No. of fish /h
Subarea I*					
S-1	180	4.7 ± 4.3	47 ± 43	4.1	41 ± 49
S-2	360	3.4 ± 3.8	34 ± 38	0.4	4 ± 2
S-3	180	5.4 ± 4.6	54 ± 46	4.5	45 ± 30
S-4	273	6.2 ± 5.9	62 ± 59	0.7	7 ± 4
S-5	450	1.8 ± 0.9	18 ± 9	1.9	19 ± 15
S-6	78	14.6 ± 10.7	146 ±107	8.3	83 ± 82
S-7	450	5.3 ± 5.7	53 ± 57	0.6	6 ± 6
S-8	273	15.9 ± 26.4	159 ±264	10.0	100 ± 241
Subarea II$^\Delta$					
T-5	960	2.0 ± 1.7	20 ± 17	0.1	1.0 ± 1
T-6	960	1.1 ± 1.6	11 ± 16	0.1	1.0 ± 1
T-7	960	0.6 ± 0.7	6 ± 7	0.07	0.7 ± 0.9
T-8	960	0.6 ± 0.3	6 ± 3	0.04	0.4 ± 0.3
Subarea III$^\lozenge$					
S-9	216	3.1 ± 3.7	31 ± 37	2.3	23 ± 39
S-10	180	5.7 ± 5.5	57 ± 55	6.1	61 ± 68
S-11	180	5.0 ± 4.0	50 ± 40	1.6	16 ± 10
S-12	180	14.0 ± 21.0	140 ±210	5.1	51 ± 61
S-13	180	3.7 ± 4.1	37 ± 41	1.5	15 ± 14
S-14	168	6.1 ± 8.4	61 ± 84	6.5	65 ± 102
S-15	110	9.3 ± 9.4	93 ± 94	4.4	44 ± 47
T-10	960	0.39 ± 0.31	3.9 ± 3.1	0.4	4 ± 3
T-11	960	0.80 ± 0.32	8 ± 3.2	0.1	1 ± 0
T-12	960	1.1 ± 0.33	11.0 ± 3.0	0.1	1 ± 1

* May 1973 - June 1974. $^\Delta$ Sept. 1974 - Sept 1975. $^\lozenge$ Oct. 1975 - Oct. 1976.

Table 27. "Wet Season" pattern of numbers and biomass of fishes in Western Florida Bay. June - November 1973.

	Biomass		Relative abundance	
	(g/m^2)	(Kg/h)	No. of fish/m^2	No. of fish /h
S-1	9.0 ± 3.5	90 ± 35	6.6 ± 5.1	66 ± 51
S-2	4.0 ± 3.3	40 ± 33	0.4 ± 0.2	4 ± 2
S-3	3.5 ± 1.8	35 ± 18	4.7 ± 2.8	47 ± 28
S-4	7.2 ± 7.4	72 ± 74	0.7 ± 0.3	7 ± 3
S-5	2.6 ± 0.7	26 ± 7	3.2 ± 1.2	32 ± 12
S-6	24.5 ± 9.1	245 ± 91	13.4 ± 9.8	134 ± 98
S-7	6.4 ± 4.7	64 ± 47	0.8 ± 0.7	8 ± 7
S-8	21.1±36.7	211 ± 367	2.3 ± 1.9	23 ± 19

Table 28. "Dry Season" pattern of numbers and biomass of fishes in western Florida Bay. December, 1973 - May, 1974.

	Biomass		Relative abundance	
	(g/m^2)	(Kg/h)	No. of fish/m^2	No. of fish /h
S-1	1.7 ± 1.7	17 ± 17	2.9 ± 5.1	29 ± 51
S-2	3.8 ± 4.8	38 ± 48	0.3 ± 0.3	3 ± 3
S-3	8.0 ± 5.8	80 ± 58	5.3 ± 3.4	53 ± 34
S-4	5.9 ± 6.1	59 ± 61	0.8 ± 0.4	8 ± 4
S-5	1.1 ± 0.2	11 ± 2	1.3 ± 1.0	13 ± 10
S-6	8.0 ± 7.2	80 ± 72	5.8 ± 6.3	58 ± 63
S-7	1.8 ± 1.4	18 ± 14	0.3 ± 0.3	3 ± 3
S-8	6.8 ± 5.1	68 ± 51	4.9 ± 8.5	49 ± 85
T-1	1.4 ± 1.2	14 ± 12	0.05 ± 0.08	0.5 ± 0.8
T-2	1.1 ± 1.0	11 ± 10	0.1 ± 0.1	1 ± 1
T-3	7.2 ± 4.2	72 ± 42	1.0 ± 0.7	10 ± 7
T-4	1.6 ± 1.3	16 ± 13	0.1 ± 0.1	1 ± 1

DISCUSSION

Salinity

The greatest variations and highest salinity values (2 - 67 ppt) were found along the mainland in central and eastern Florida Bay (Table 1). A similar range (0 - 67 ppt) was reported by Tabb (unpublished data) along the central Bay shoreline during a severe drought from April 1965 to July 1966. Although comparable values (55 - 60 ppt) recorded by McCallum and Stockman (1959) from Little Madeira Bay to Snipe Point during the sustained drought period of 1956 - 1957 tend to corroborate these salinities as drought-induced it is interesting to note that the highest known Bay salinity value (70 ppt) was reported by Finucane and Dragovitch (1959) along the western Florida Bay shoreline (Snake Bight).

In eastern Florida Bay, mainland stations receive surface freshwater runoff through Taylor River, Mud, and Trout Creeks. The Taylor River station consistently produced the lowest salinity readings as it lies near the center of the drainage basin, which receives the bulk of southerly drift of freshwater through the Taylor Slough. Salinity data from similarly distributed sampling stations (Tabb, unpublished data; McCallum and Stockman, 1959) in north central and northeastern Florida Bay are in close agreement with these findings. Large seasonal salinity variations of 40 - 50 ppt were also observed along the northeast Bay shoreline. Again, Tabb (unpublished data) and McCallum and Stockman found corespondent seasonal fluctuations along the mainland following sustained drought periods.

The earliest general knowledge of hydrographic conditions in the Bay ecosystem was provided by Ginsburg (1956). Following a wet year during the early 1950's he found, in eastern Florida Bay, normal to brackish salinities with a decreased gradient towards the mainland. Shortly thereafter, McCallum and Stockman who conducted the first detailed salinity-circulation study in the region, determined that salinity distribution is affected by important abiotic factors including topography, Gulf and Atlantic Ocean tidal exchanges, evaporation within the Bay, and climatic variations in the Bay and over the mainland. Of particular topographic importance in Bay salinity-circulation variations is the chain of mudbanks which extend in a southerly direction from the Black Betsy Keys. They strongly affected salinity distributional patterns observed in the current investigation and during the 1956 - 1957 study (McCallum and Stockman, 1959).

Seasonal and annual water mass movements characterized as salinity distributional patterns varied considerably between the subareas. In the current study, a north-south salinity gradient was found east of the Black Betsy Keys complex, with low salinities near the mainland during the wet season and an increased gradient southward to the Gulf of Mexico. During the drought period of 1974 - 1975, this gradient was reversed. Comparable findings in eastern Florida Bay were reported by McCallum and Stockman. West of the Black Betsies, the gradient was east-west. Higher salinity values were reported near the Black Betsy Keys, and lower values near the East Cape-Sandy Keys area. This gradient was not as pronounced during the hydroperiod when the gradient gradually shifted in a north-south direction.

At times, salinity varied significantly in association with rainfall and runoff. Periodic increases in salinity occurred when evaporation exceeded dilution by rainfall and runoff. In northeast Florida Bay, a significant negative relationship was found between 1-month lag rainfall recorded at Tavernier and salinity values in Little Blackwater Sound. The effects of heavy local rainfall rapidly reduced the nearshore northeast Bay salinities during the 1976 hydroperiod while offshore areas remained largely unaffected (Figures 6 and 7). However, local rainfall was not considered a significant factor in regulating the salinity regime in north central or northwestern portions of the Bay. During the study, Flamingo rainfall data (1, 2, or 3-month lag times) were not significantly related with salinities measured at the Florida Bay entrance to the Buttonwood Canal. Roessler (1970) also found local rainfall was not inversely related at a significant level with Buttonwood Canal salinity.

Freshwater runoff through the Taylor Slough drainage system was important in controlling hypersaline conditions in north central Florida Bay. During the drought period of 1974 - 1975, a highly significant inverse relation was determined between water level (1-month lag time) at the Taylor Slough bridge and hypersaline conditions near the north central Bay shoreline. It might then be expected that, following periods of low water levels in the Taylor Slough drainage region, the highest annual salinities would occur during May along the north central Florida Bay shoreline. Following the peak May salinities, there would be a three-to-five month period of reduced salinities thus resulting in estuarine conditions along the nearshore central Bay area. If, as in 1974, water levels remained low throughout the year, hypersaline conditions would gradually develop early in the following winter (1975) and increase quickly during the spring and summer months.

Ecologically, elevated salinities acted as a strong limiting factor in the distribution of certain Florida Bay fishes.

pH

There are large variations in the natural pH content of shallow marine waters. These fluctuations are related to buffer mechanism processes and to primary production. Although the pH at the surface of oceanic water normally varies from 8.0 to 8.3, a large diurnal uptake of carbon dioxide resulting in precipitation of calcium carbonate, particularly by the many green calcareous algae representative of the study area, produces high pH values (>8.3), while at night or early morning the reverse is true. In shallow, biologically active waters, particularly in warm tropical and subtropical areas, there is a large diurnal variation in pH with values ranging from a high of 9.5 in the daytime to a low of 7.3 at night or early morning (Water Quality Criteria, 1974).

During the 40-month investigation, pH varied diurnally from 5.8 to 9.8. Depressed values were found during morning periods of low oxygen saturation while higher readings were recorded at peak periods of photosynthetic activity during the late afternoon. In the present study, greatest variations were recorded over shallow seagrass beds in western Florida Bay. The mid-bay waters exhibited the highest pH values, but they showed little diurnal or total period variation when compared to the values recorded in western Florida Bay. This was due in part to the occurrence of several species of lime-secreting green algae, including *Batophora oesterdii*, *Acetabularia crenulata*, and *Penicillus* spp. Their density and their ability to increase the alkalinity of water through the precipitation of carbonates contributed to the high sustained pH values recorded in the central and eastern portions of the Bay.

In addition, other physicochemical processes are associated with pH variations. When the seasonal evaporation of seawater approaches 70 ppt, pH levels are increased as calcium carbonate precipitates. Copeland (1966) stated that high pH at salinities between 50 to 70 ppt may have, in addition to osmoregulatory problems, a toxic effect on organisms adapted to a lower and more constant pH regime. In general, pH did not appear to be a source of serious stress in the western and eastern portions of the Bay. However, the observed, consistently high pH of central Florida Bay suggests that pH in association with hypersaline conditions may act as a limiting factor.

Dissolved Oxygen

In the course of the study, daytime dissolved oxygen generally ranged from saturated to supersaturated conditions. Periods of supersaturation were associated with regions of low turbidity and high photosynthetic activity-primarily from the seagrasses, turtlegrass, and shoalgrass.

During the late afternoon, supersaturated values of 10 - 15 ppm were found over the tidally influenced, shallow seagrass flats in western Florida Bay while midbay "lakes" in central and east Bay reported lower saturation values, usually between 7.0 and 8.0 ppm. Presumably, the reduced oxygen concentrations were associated with elevated salinities, thus causing lower saturation values.

Lowest daytime oxygen concentrations (2 to 3 ppm) were reported in north central Florida Bay during the seasonal defoliation and decomposition of the dominant seagrasses and during the beginning of the wet season at the Taylor River and Mud Creek stations. This nearshore pattern of low daytime oxygen values in northeastern Florida Bay was associated with the flushing of partially decomposed organic debris from the mangrove regions. Tabb *et al.* (1962) and Davis and Hilsenbeck (1974) reported similar findings in the shallow waters of the Shark Slough-Whitewater Bay system. Low daytime oxygen concentrations observed near Buoy Key probably serve as a limiting factor for the distribution of aquatic organisms in the areas of restricted circulation in north central Florida Bay.

Turbidity

Florida Bay is noted for its highly turbid water (Tabb *et al.* 1962). In the present study, turbidities were generally higher near the mainland and decreased on a southerly transect towards the Gulf of Mexico. Highest turbidities, reported seasonally along the East Cape and Little Madeira shorelines, were associated with northly flows of wind which mixed calcium carbonate particles into suspension.

Throughout central and eastern Florida Bay, zones of moderate turbidities, consisting of values between 3.0 and 9.0 FTU, were similar in terms of water condition descriptions developed by McCallum and Stockman (1959). They classified water clarity east of Whipray Basin to the Florida Keys as white, clear, or clear-yellow. During the study, a whitewater zone was located in the mid-bay region while a clear-yellow zone containing Little Madeira and Terrapin Bays existed towards the mainland. The distinctly clear water zones were found west of a line drawn from the Samphire Keys to Whipray Basin. The high degree of water clarity in this zone agrees closely with water conditions found in the elevated (38 - 42 ppt) salinity regions of Whitewater Bay by Tabb *et al.* (1962). They found a strong relationship between water clarity and the occurrence of marine algae, particularly *Udotea*, *Acetabularia*, *Batophora*, *Caulerpa*, and *Gracilaria*. In the present study, *Batophora*, with lesser amounts of *Acetabularia* and *Udotea*, dominated the bottom vegetation in the central Bay clear zone. In contrast, the moderate turbidities found in the whitewater zone east of the Russell Keys were associated primarily with the occurrence of another carbonate-secreting algae, *Penicillus*. During frequent periods of strong southeast or northerly winds fine aragonitic muds were stirred into suspension thereby producing a grayish-white color to the water. These turbid waters were often blown into normally clear sounds and coves along the northeast and north central Bay shoreline.

Benthic Mapping

The turtlegrass, marl banks and channels and their associated flora and fauna of northwestern Florida Bay, has been described previously by Tabb *et al.* (1962). However, the present study has provided important information about the relationships of these environments with the distribution and relative abundance, by number and weight, of fishes as they undergo predictable, seasonal, population fluctuations. In addition, observations made by Tabb *et al.* (1962) on the dominance of *Thalassia* on offshore marl banks and grassbeds of Sandy Key Basin and just east of Flamingo have provided the current study with sufficient information to document possible changes in the species composition of western Florida Bay seagrass beds.

Results taken from underwater observations, benthic sampling techniques, and otter trawl tows in Palm and Sandy Key Basins indicate a gradual replacement of *Thalassia* by another seagrass, *Syringodium*, which characteristically is found in waters of relatively stable marine salinities. These changes did not appear to be occurring in Rabbit Key Basin or offshore on the grassy banks southeast of Sandy Key which normally are waters of stable marine salinities but accompanied by very low turbidities (0.1 - 1.0 FTU). Conversely, Palm and Sandy Key Basins are constantly subjected to slightly higher turbidities (3 - 5 FTU) due to their proximity to East Cape and Flamingo.

Eastern Florida Bay bottom vegetative characteristics apparently remained unchanged. Although comparable community data are sparse, the dominant lime secreting algae *Penicillus* which has been credited by Stockman *et al.* (1967) for producing two-thirds of the lime mud in northeast Florida Bay, continues to flourish throughout the region. Central Florida Bay, like most of East Bay, suffers from a lack of comparative seagrass or algae information. Current data showed that *Penicillus* was continuous into Madeira Bay; however, previous studies (Stockman *et al.* 1967; Tabb *et al.* 1962) do not supply sufficient material to indicate if this is a significant distributional change. Salinity appeared to be the limiting factor in restricting the growth of *Thalassia* in Madeira Bay and in the intermediate belt of eastern Florida Bay. In northern Florida Bay, Tabb *et al.* (1962) reported thick seagrass beds occurring in salinities as high as 48 ppt. *Thalassia*, however, will not survive hypersaline conditions for long periods of time. Extensive *Thalassia* beds immediately south of Terrapin Bay were subjected to salinities over 60 ppt. for several months during the 1974 - 1975 drought period and appeared stunted and yellow in color. In addition, *Thalassia* beds immediately west of Dump Keys to Buoy Key and north to Rankin Bight experienced a "die-off" thus exposing bottom muds.

Fish Distribution

Similar species dominated the fish fauna collected in western Florida Bay and from the southwest coast of Florida. During the study, striped and bay anchovies were the predominant fishes by number, accounting for over 48% of the total catch (Table 14), followed by mojarra, killifish, and pinfish. Tabb and Manning (1961) stated that in northern Florida and Whitewater Bays, the most abundant fishes were also anchovies, mojarras, and pinfish. Comparable findings were reported by Roessler (1970) in the Buttonwood Canal.

A 1972 study of the fish fauna in the Ten Thousand Islands (Carter *et al.* 1973), approximately 80 km north of Florida Bay, reported that numerically the most abundant estuarine and marine shore fishes in decreasing order of abundance were bay anchovy, yellowfin menhaden *Brevoortia smithi*, scaled sardine, striped anchovy, pinfish, silver perch, and silver jenny. In that study, the bay anchovy accounted for over 70% of the total catch. In another investigation of the fish fauna of Charlotte Harbor on the west coast of Florida, Wang and Raney (1971) reported that the five most abundant species, other than the bay anchovy, were pinfish, silver perch, silver jenny, pigfish *Orthopristis chrysoptera*, and sand seatrout *Cynoscion arenarius*; some pelagic forms - needlefishes, herrings, and silversides - were not represented adequately since their collection gear consisted primarily of an otter trawl, which accounted for mostly benthic and epibenthic species.

Excluding the herrings, monthly and quarterly catch data at the regular stations indicate that the same four families of fishes (anchovies, mojarras, porgies, and drums) dominated both the western Florida Bay and the Ten Thousand Islands catch data as measured by biomass and numbers. The herrings, characteristically found in normal marine or low salinity zones, occurred infrequently in the Florida Bay catches. In western Florida Bay, the predominant species by biomass were pinfish, silver jenny, southern stingray, and silver perch. Studies in the Ten Thousand Islands (Carter *et al.* 1973) reported a similar assemblage of dominant species.

The lemon shark *Negaprion brevirostris* and barracuda *Sphyrna barracuda* were among the most abundant species by biomass taken in western Florida Bay and apparently represented recent faunal introductions into the area. Both species, known as large tropical nearshore marine predators, are commonly found only along the lower southeast coast of Florida. They were not reported by Tabb in his collections of northwest Florida Bay between 1957 and 1961; and only juvenile barracuda were taken, rarely, in the Buttonwood Canal study of 1963- 1964.

In the present study, an examination of barracuda and shark catch data suggests that a westward population shift is occurring from major areas of concentration along the Florida Keys to the westernmost regions of Florida Bay. These recent introductions were apparently associated with changing salinity conditions in western Florida Bay. Current water quality data (Appendix E) did not indicate a higher salinity range when compared to salinity regimes of previous studies (Tabb *et al.* 1962; Roessler, 1970) but suggested a temporal extension of the normal marine salinity regime (35 - 37 ppt), thus resulting in a reduction of low salinity periods.

In addition, dissimilarities were noted in the abundance of fishes reported from central and east Bay subareas and by abundance indices recorded from earlier investigations along the lower west and east coasts of Florida. In central Florida Bay, gray snapper, scrawled cowfish, *Lactophrys quadricornis*, and burrfish *Chilomycterus schoepfi*, were additional dominant species by weight while hardhead silverside, hardhead halfbeak, and spotfin mojarra numerically dominated the catch in the East Bay area. Comparative studies (Carter *et al.* t973; Wang and Raney, 1971; Yokel, 1975) conducted in southwest Florida estuaries did not record these species as dominant by number or by weight. However, Low (1973) and Brook (1976) noted the numerical abundance of the East Bay dominants in the lower Biscayne Bay - Upper Florida Keys region.

Diversity

Fourteen species of fish previously unreported in Everglades National Park were recorded during regular or supplemental collections: shortfin mako *Isurus oxyrinchus*, flat anchovy *Anchoa perfasciata*, hardhead silverside *Atherinomorus stipes,* peninsular silverside *Menidia peninsulae*, barred hamlet *Hypoplectrus puella*, bigeye *Priacanthus arenatus*, sea bream *Archeosargus probatocephalus*, queen angelfish *Holocanthus ciliaris*, redtail parrotfish *Sparisoma aurofrenatum*, princess parrotfish *Scarus taeniopterus*, naked goby *Gobiosoma bosci*, eyed flounder *Bothus ocellatus*, and scrawled filefish *Aluterus scriptus*.

In the western portion of the Bay, 142 species were recorded in the regular collections and supplemental surveys. Tabb and Manning (1961), during their previous survey, reported a total of 106 fish species collected or observed in the northwestern portion of Florida Bay from July 1957 to September 1960. The number of species in common between both studies are 91. However, 17 species were seen only in the Tabb and Manning endeavor while 35 were observed only during the present study. In the Buttonwood Canal study, Roessler (1970) reported a total of 103 species collected between January 1963 and December 1964. Seventy-two of these species were collected during the present study at the Florida Bay entrance to the canal.

The strong similarities between fish fauna taken in western Florida Bay with species taken during previous studies (Tabb and Manning, 1961; Roessler, 1970) indicate the continued existence of the region with faunal affinities closely allied to the temperate (Carolinean) fishes of the northern Gulf of Mexico and the west coast of Florida.

During the study, 115 species were reported from the central portion of the Bay. Hudson *et al.* (1970), during their "Porpoise Lake" survey, reported a total of 64 fish species collected or observed monthly in central Florida Bay from April 1965 to January 1968. The number of species in common between both studies is 32. Thirty-two species were seen only in the Porpoise Lake study while 32 were observed only during the present study. Seventy-five species were identified in eastern Florida Bay. Springer and McErlean (1962) reported a total of 106 grass flat associated species taken from a 12-month study during 1960 and 1961 on the Atlantic Ocean side of the middle Keys. However, only 36 species were shared between the two studies, probably as a result of a decreased sampling effort of the present study between March and September 1976. Obvious similarities between the species composition of eastern Florida Bay and the fish fauna collected by the "Porpoise Lake" study, (1964 - 1968) suggested a comparison between the areas. Species in common between the two areas were 45, a 20% overall increase when "Porpoise Lake" data were compared to Central Bay results.

Preliminary trawl tows in Porpoise Lake during August and September of 1974 indicated a very low concentration of biomass thereby suggesting that frequent periods of hypersalinity may have changed the species composition and abundance of the local "Porpoise Lake" fish fauna.

As a function of time, the S-I diversity values obtained from representative stations in western Florida Bay (1.27 - 3.32) are considerably higher than those reported from other studies of bay and inshore fish populations. Allen and Horn (1973) reported monthly values of 0.03 - 1.11 from fish seine collections taken in Colorado Lagoon, Alamitos Bay, California. McErlean *et al.* (1973) arrived at seasonal values of 0.4 to 1.5 from seine and trawl studies off the middle Patuxent Estuary in Maryland. These values are from inshore fish populations apparently subjected to environmental degradation resulting from power plant effluent. Trawl collection S-I values of about 1.3 - 2.2 from an undisturbed estuarine system along the coast of Georgia (Dahlberg and Odum, 1970) correspond more closely to the measurements obtained from western Florida Bay. Even though the fish populations of western Florida Bay are primarily Carolinean, the higher index numbers obtained are probably attributable to increased complexity associated with a greater variety of habitats found in tropical regions.

In contrast, richness values obtained from the central portion of the Bay (Figure 15) are similar or lower to S-I numbers reported from a disturbed estuarine system (McClearn *et al.* 1973). Similarly, correlation coefficients obtained in north central Florida Bay between biological variables and environmental factors indicated that associated periods of hypersalinity adversely affected fish distribution. Elevated salinities significantly reduced species diversity (S) and the numbers and biomass of the individuals, thus preventing north central, Florida Bay, unlike western Florida Bay, from servicing the resident and migrant fish populations with its probable primary function - to provide young fishes with a suitable nursery area where they can benefit from the availability of food and protection from their predators.

In eastern Florida Bay, there was little evidence of prominent seasonal trends in the species richness index. Species variation was apparently reduced due to the simultaneous exchange of the number of species and also to the apportionment of individuals within the species (Figure 16). The range of S-I (0.4 to 1.4) in eastern Florida Bay is again analogous to the values obtained from estuarine fish populations apparently subjected to environmental perturbations.

However, unlike most disturbed estuarine systems, there was no clear-cut, downward trend in the number of species. There were, however, noticeable shifts in the dominance of species. Seasonally, hardhead silversides and hardhead halfbeaks competitively replaced each other during periods of peak abundance; this is reflected graphically by the abrupt "crash" and "boom" effect.

<u>Population Fluctuations of the Dominant Species</u>

Although fish population variables in western Florida Bay, unlike those in central and eastern portions of the Bay, underwent regular temporal fluctuations as influenced by the cyclicity of the hydroperiod, there was a certain stability in the various fish communities when viewed on an annual or seasonal basis.

Abundance interrelationships of the dominant species in western Florida Bay compared favorably to the regularity of different, yet dominant, species reported by Livingston *et al.* (1976) in the Apalachicola Bay system along the northwest coast of Florida. Roessler (1970) also observed strong seasonal variations among dominant species in the Buttonwood Canal. For example. he found that pinfish and silver perch were negatively correlated to the seasonal variable thus suggesting low abundance during the winter months. Seasonally, pinfish and silver perch dominated the catches at Palm and Sandy Key Basins and probably caused the similarly observed negative relationship in the western Florida Bay catch data.

The local influx of estuarine-dependent fishes, primarily the euryhaline pinfish, accounted mostly for the increases in numbers of individuals during the winter season. Although this is normally the period of higher salinities, most aquatic organisms reach their maximum tolerance of higher salinities during the colder months of the year (Tabb *et al.* 1962). The preponderance of grunts, silver perch, and anchovies at the Buttonwood Canal, Murray Key, and East Cape stations contributed to large increases of individuals during the early summer months. Conversely, many fish reach their peak tolerance of low salinities during the warmer months of the year (Tabb *et al.* 1962).

One species, the ubiquitous pinfish, deserves special mention since it constitutes a major portion of the fish biomass of estuaries on the southeastern Atlantic coast, (Kjelson and Johnson 1976) and on Florida's southwest coast (Carter *et al.* 1973). Seasonally, juvenile pinfish dominated the western Florida Bay *Thalassia-Syringodium* habitats in the spring and summer months. Although Tabb and Manning (1961) indicated that sexually mature pinfish were never collected, several mature individuals were taken (up to 320 mm TL, not only in the regular collections but also from the sportfish survey at Flamingo (E. B. Thue, personal communication).

Growth rates from length frequency data taken in northern Florida Bay (Tabb and Manning, 1961) indicated that pinfish were late winter or early spring spawners as postlarval individuals were recruited during March. Comparative data on pinfish selected to represent the growth rates of a 0 age group dominant in western Florida Bay suggests that pinfish spawning times have changed to earlier in the winter as age 0 group fish were recruited during February (Figure 24).

<u>Seasonal Patterns of Abundance</u>

Seasonality in the abundance of the catches was evident. From May 1973 to October 1976, the annual total fish biomass in Florida Bay was 6 to 159 kg/h with a mean of 50 kg/h (Table 26); there was, however, considerable variation between the seasonal ranges of fish biomass, with 26 - 245 kg/h for the hydroperiod and 11 - 80 kg/h for the dry season (Tables 27 and 28).

Western Florida Bay estimates, in particular, are comparable with values reported from various other offshore and coastal areas. Oviatt and Nixon (1973), in a year-long study of the demersal fishes of Narragansett Bay in Rhode Island, found a range of 18.6 - 62.1 kg/h (16.5 - 56.5 lbs/acre) with a mean 31.1 kg/h (28.5 lbs/acre). Day *et al.* (cited in Oviatt and Nixon, 1973) found a similar range of 19.8 - 68.2 kg/h (18 - 62 lbs/acre) in a shallow Gulf coast estuary while McHugh (1967) reached a higher estimate of 55 - 310 kg/h (50 - 282 lbs/acre) from fishery catch data for the Gulf of Mexico. The biomass of these environments is small when compared to specialized marine ecosystems.

Bardach (1959) estimated the summer standing crop over a Bermuda coral reef to be 587 kg/h (529 lbs/acre). Quast (1968) determined that the range of fish biomass in a California kelp bed was between 328 - 371 kg/h (296 - 335 lbs/acre).

To conclude, the selectivity and limitation of fish sampling gear is well known (Carter *et al.* 1973; McHugh, 1967); however, these studies together, as discussed by Oviatt and Nixon (1973), represent many of the best estimates available on the standing crops of coastal marine fish populations.

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APPENDIX A. Distribution of fishes collected in western, central and eastern Florida Bay (Subareas I, II, and III), May 1973 to October 1976. Regular stations are indicated by the letter X. Parenthesis designate fishes only collected or observed in supplemental investigations.

Species	Common name	Subarea I	Subarea II	Subarea III
Ginglymostoma cirratum	Nurse shark	(X)	(X)	X
Isurus oxyrinchus	Shortfin mako	(X)		
Carcharhinus limbatus	Blacktip shark	X	(X)	
Negaprion brevirostris	Lemon shark	X	(X)	X
Sphyrna mokarran	Great hammerhead	(X)		
Sphyrna tiburo	Bonnethead	X		X
Pristis pectinata	Smalltooth sawfish	X		
Dasyatis americana	Southern stingray	X	(X)	(X)
Aetobatus narinari	Spotted eagle ray	(X)		(X)
Elops saurus	Ladyfish	X		(X)
Megalops atlantica	Tarpon	(X)		(X)
Albula vulpes	Bonefish	X		(X)
Myrophis punctatus	Speckled worm eel	X		
Ophichthus gomesi	Shrimp eel	X		
Brevoortia patronus	Gulf menhaden	X		
Brevoortia smithi	Yellowfish menhaden	X		
Harangula jaguana	Scaled sardine	X		X
Opisthonema oglinum	Atlantic threadherring	X	X	X
Sardinella Spp.	Herring			X
Anchoa cubana	Cuban anchovy	X		
Anchoa hepsetus	Striped anchovy	X	X	
Anchoa mitchelli	Bay anchovy	X	X	X
Anchoviella perfasciata	Flat anchovy	X		
Synodus foetens	Inshore lizardfish	X	X	X
Arius felis	Sea catfish	X	X	(X)
Bagre marinus	Gafftopsail catfish	X		
Opsanus beta	Gulf toadfish	X	X	X
Gobiesox strumosus	Skilletfish	X		
Ogcocephalus radiatus	Polka-dot batfish	X		
Chriodorus atherinoides	Hardhead half beak	X	X	X
Hemiramphus brasiliensis	Ballyhoo	X		
Hyporhamphus unifasciatus	Half beak	X		
Strongylura marina	Atlantic needlefish	X		
Strongylura notata	Redfin needlefish	X	X	X
Strongylura timucu	Timucu	X		
Tylosurus crocodilus	Houndfish	(X)		
Cyprinodont variegatus	Sheepshead minnow	X		X
Floridichthys carpio	Goldspotted topminnow	X	X	X
Fundulus chrysotus	Golden topminnow	X		
Fundulus confluentus	Marsh killifish	X		X
Fundulus grandis	Gulf killifish	X		X
Fundulus similis	Longnose killifish	X		X
Lucania parva	Rainwater killifish	X	X	X

Species	Common name	Subarea I	Subarea II	Subarea III
Poecilia latipinna	Sailfin molly	X		X
Atherinomorus stipes	Hardhead silversides			X
Membras martinica	Rough silversides	X		X
Menidia beryllina	Tidewater silversides	X		X
Menidia peninsulae	Peninsula silversides			X
Coryphoichthys albirostris	Whitenose pipefish	X		
Hippocampus erectus	Lined seahorse	X	X	
Hippocampus zosterae	Dwarf seahorse	X	X	X
Micrognathus criniger	Fringed pipefish	X		X
Syngnathus floridae	Dusky pipefish	X	X	X
Syngnathus louisianae	Chain pipefish	X	X	X
Syngnathus scovelli	Gulf pipefish	X	X	X
Centropomus undecimalis	Snook	X	(X)	(X)
Diplectrum formosum	Sand perch	X		
Epinephelus puella	Jewfish	(X)		
Epinephelus morio	Red grouper	(X)		
Epinephelus striatus	Nassau grouper	(X)		
Hypoplectrus puella	Barred hamlet	X		
Mycteroperca bonaci	Black grouper	(X)		
Mycteroperca microlepsis	Gag	X		
Priacanthus arenatus	Bigeye	X		
Pomatomus salatrix	Bluefish	X		
Rachycentron canadum	Cobia	X		
Echeneis naucrates	Sharksucker	X		
Echeneis neucratoides	Whitefin sharksucker	X	X	
Caranx crysos	Bluerunner	X		
Caranx hippos	Crevalle jack	X	(X)	X
Chloroscombus chrysurus	Atlantic bumper	X		
Oligoplites saurus	Leatherjacket	X		X
Selene vomer	Lookdown	X	X	
Trachinotus carolinus	Florida pompano	(X)	(X)	(X)
Trachinotus falcatus	Permit	X		X
Lutjanus analis	Mutton snapper	(X)		
Lutjanus apodus	Schoolmaster	X		X
Lutjanus griseus	Gray snapper	X	X	X
Lutjanus synagris	Lane snapper	X	X	X
Ocyurus chrysurus	Yellowtail snapper	(X)		
Lobotes surinamensis	Tripletail	(X)		
Diapterus plumieri	Striped mojarra	X		X
Eucinostomus argenteus	Spotfin mojarra	X	X	X
Eucinostomus gula	Silver jenny	X	X	X
Geres cinerus	Yellowfin mojarra	X		X
Anisotremus virginicus	Porkfish	(X)	(X)	
Haemulon aurolineatum	Torntate	X		X
Haemulon parri	Sailor's choice	X		
Haemulon plumieri	White grunt	X	X	X
Haemulon sciurus	Biuestriped grunt	X	X	X
Orthopristis chrysoptera	Pigfish	X	X	X

Species	Common name	Subarea I	Subarea II	Subarea III
Archeosargus probatocephalus	Sheepshead	X	X	(X)
Archeosargus rhomboidalis	Sea bream	X	X	
Calamus arctifrons	Grass porgy	X	(X)	X
Lagodon rhomboides	Pinfish	X	X	X
Bairdiella batabana	Blue croaker	X		
Bairdiella chrysura	Silver perch	X	X	X
Cynoscion nebulosus	Spotted seatrout	X	X	X
Equetus acuminatus	High-hat		(X)	
Menticirrhus americanus	Southern kingfish	X		
Menticirrhus littoralis	Gulf kingfish	X		
Micropogon undulatus	Atlantic croaker	X		
Pogonias cromis	Black drum	X		X
Scianops ocellatus	Red drum	X	(X)	(X)
Chaetodipterus faber	Atlantic spadefish	X	X	
Holocanthus ciliaris	Queen angelfish	(X)		
Lachnolaimus maximus	Hogfish	X		
Nicholsina usta	Emerald parrotfish	X	(X)	
Scarus taeniopterus	Princess parrotfish	(X)		
Sparisoma aurofrenatum	Redband parrotfish	(X)		
Sparisoma chrysopterum	Redtail parrotfish	X		
Sparisoma rubripinne	Redfin parrotfish	X		X
Sparisoma virdie	Stoplight parrotfish	(X)	(X)	
Mugil cephalus	Striped mullet	X	(X)	(X)
Mugil curema	White mullet	X		(X)
Mugil trichodon	Fantail mullet	X	(X)	X
Sphyraena barracuda	Great barracuda	X	X	X
Paraclinus marmoratus	Marbled blenny	X		
Chasmodes saburrae	Florida blenny	X	X	X
Callionymus pauciradiatus	Spotted dragonet	X	(X)	
Bathygobius soporator	Frillfin goby	X		
Gobiosoma bosci	Naked goby	X		
Gobiosoma robustum	Code goby	X		X
Gobionellus smaragdus	Emerald goby	X		
Microgobius gulosus	Clown goby	X		X
Microgobius microlepsis	Banner goby			X
Lophogobius cyprinodides	Crested goby			X
Scomberomorus cavalla	King mackerel	(X)		
Scomberomorus maculatus	Spanish mackerel	X		(X)
Prionotus scitulus	Leopard searobin	X		
Prionotus tribulus	Bighead searobin	X		
Bothus ocellatus	Eyed flounder	X		
Etropus crossotus	Fringed flounder	X		
Paralichthys albigutta	Gulf flounder	X		(X)
Paralichthys lethostigma	Southern flounder	X		
Achirus lineatus	Lined sole	X	X	
Trinectes maculatus	Hogchoker	X		
Symphurus plagiusa	Blackcheek tonguefish	X		
Aluterus schoepfi	Orange filefish	X		

Species	Common name	Subarea I	Subarea II	Subarea III
Aluterus scriptus	Scrawled filefish			X
Balistes vetula	Queen triggerfish	(X)		
Monocanthus ciliatus	Fringed filefish	X	X	X
Monocanthus hispidis	Planehead filefish	X	X	X
Lactophrys quadricornis	Scrawled cowfish	X	X	X
Lactophrys trigonus	Trunkfish	X		X
Spheorides nephelus	Southern puffer	X	X	X
Spheorides spengleri	Bandtail puffer	X		
Chilomycterus antillarm	Web burrfish	X		
Chilomycterus schoefi	Striped burrfish	X	X	X

APPENDIX B. Seasonal abundance by percent and the total number of fish collected at the regular stations in Florida Bay, 1973 - 76.

Species	Percentage taken in: Spring (March-May)	Summer (June-Aug.)	Fall (Sept.-Nov.)	Winter (Dec.-Feb.)	Total No. Caught
Ginglymostoma cirratum			100.0		1
Carcharhinus limbatus		100.0			1
Negaprion brevirostris	36.3	36.3	18.1	9.0	11
Sphyrna tiburo	50.0		50.0		4
Pristis pectinata		50.0	50.0		2
Dasyatis americana	72.7	27.3			11
Elops saurus	66.7			33.3	3
Albula vulpes	100.0				1
Myrophis punctatus	100.0				1
Ophichthus gomesi			100.0		1
Brevoortia patronus		100.0			2
Brevoortia smithi	83.4	1.4		15.2	151
Harangula jaguana	26.0	9.0	64.2	0.5	2635
Opisthonema oglinium	14.6	58.7	26.3	0.4	558
Sardinella spp.				100.0	11
Anchoa cubana	100.0				10
Anchoa hepsetus	78.0	3.7	1.0	16.8	34099
Anchoa mitchilli	44.1	24.9	22.0	9.0	31890
Anchoviella perfasciata	100.0				6
Synodus foetens	54.6	14.9	8.4	22.1	584
Arius felis	65.0	5.0	20.0	10.0	40
Bagre marinus	66.7	33.3			3
Opsanus beta	29.6	41.9	15.5	13.0	277
Gobiesox strumosus			100.0		1
Ogcocephalus radiatus	53.4	10.3	24.1	12.1	58
Chriodorus atherinoides	87.4	2.3	8.2	2.3	2451
Hemiramphus brasiliensis	100.0				4
Hyporhamphus unifasciatus	33.3	47.2	19.4		36
Strongylura marina	25.0	37.5	12.4	25.0	8
Strongylura notata	22.0	47.5	20.0	10.5	750
Strongylura timucu	14.8	66.7	18.5	7.4	27
Cyprinodont variegatus	12.5	5.1	62.2	20.2	688
Floridichthys carpio	16.6	16.0	46.3	21.2	25828
Fundulus chrysotus				100.0	1
Fundulus confluentus	22.2	1.0	35.0	41.7	103
Fundulus grandis	61.5	7.7		30.8	13
Fundulus similis	69.8	14.0	14.0	2.3	43
Lucania parva	18.0	26.3	37.6	17.6	7846
Poecilia latipinnia	11.3	19.4	14.5	54.8	391
Atherinomorus stipes	1.1	1.7	81.6	15.6	17882

	Percentage taken in:				
Species	Spring (March-May)	Summer (June-Aug.)	Fall (Sept.-Nov.)	Winter (Dec.-Feb.)	Total No. Caught
Membras martinica	3.2	11.0	54.6	31.0	2096
Menidia beryllina	0.3	12.1	19.4	68.2	315
Menidia peninsulae				100.0	3
Coryphoichthys albirostris	100.0				1
Hippocampus erectus	23.0	38.5	23.1	15.4	26
Hippocampus zosterae	19.1	38.2	31.8	10.8	160
Micrognathus crinigerus	38.8	38.9	5.6	16.7	18
Syngnathus floridae	35.8	17.8	14.7	31.6	753
Syngnathus louisianae	28.6	26.0	10.4	22.0	77
Syngnathus scovelli	23.6	36.9	17.6	21.8	959
Centropomus undecimalis		50.0	50.0		2
Diplectrum formosum	23.8	23.8	9.5	42.9	21
Hypoplectrus puella		31.6	68.4		19
Mycteroperca microlepsis	66.7		33.3		3
Priacanthus arenatus			100.0		1
Pomatomus salatrix	100.0				1
Rachycentron canadum			100.0		1
Echeneis naucrates			100.0		3
Echeneis neucratoides		42.9	42.9	14.2	7
Caranx crysos				100.0	1
Caranx hippos	18.2	45.4	18.2	18.2	11
Chloroscombus chrysurus		33.3	66.7		3
Oligoplites saurus		45.1	54.8		62
Selene vomer	22.2	44.4	33.3		9
Trachinotus falcatus	20.7	54.0	11.8	13.3	135
Lutjanus apodus		9.1	63.6	27.2	11
Lutjanus synagris	20.5	28.1	35.2	16.4	167
Lutjanus synagris	19.7	15.3	40.1	24.8	274
Diapterus plumieri		75.0	21.9	3.1	32
Eucinostomus argenteus	26.0	27.3	33.9	12.7	3727
Eucinostomus gula	18.5	23.2	37.1	21.0	31614
Geres cinerus	1.0	75.9	22.6	1.0	199
Haemulon aurolineatum				100.0	4
Haemulon parri	2.7	21.6	59.5	16.2	37
Haemulon plumieri	9.6	39.8	29.9	20.7	1193
Haemulon sciurus	8.9	8.9	24.4	57.8	45
Orthopristis chrysoptera	47.9	34.0	11.1	6.9	1803
Archeosargus probatocephalus	28.0	38.0	16.0	18.0	50
Archeosargus rhomboidalis	60.0	30.0	10.0		10
Calamus arctifrons	14.1	35.4	40.9	9.4	127
Lagodon rhomboides	31.5	42.9	19.3	6.3	6502
Bairdiella batabana		30.8	69.2		13
Bairdiella chrysura	26.8	32.8	24.1	16.5	1706
Cynoscion nebulosus	13.0	48.0	25.0	14.0	100
Menticirrhus americanus	20.0	10.0	5.0	65.0	20

Species	Spring (March-May)	Summer (June-Aug.)	Fall (Sept.-Nov.)	Winter (Dec.-Feb.)	Total No. Caught
	Percentage taken in:				
Menticirrhus littoralis	91.7	9.3			12
Micropogon undulatus		100.0			1
Pogonias cromis	33.3		33.3	33.3	3
Scianops ocellatus				100.0	2
Chaetodipterus faber	22.8	34.5	22.8	19.8	197
Lachnolaimus maximus		50.0	37.5	12.5	8
Nicholsina usta	31.1	31.1	24.6	13.1	61
Sparisoma chrysopterum		100.0			1
Sparisoma rubripinne			100.0		2
Mugil cephalus	20.3	23.4	14.1	42.2	64
Mugil curema	27.8			72.2	101
Mugil trichodon	2.6	89.2	5.5	1.6	806
Sphyraena barracuda	7.2	20.9	55.4	16.5	139
Paraclinus marmoratus	8.3		25.0	66.7	12
Chasmodes saburrae	10.5	36.9	26.3	26.3	19
Callionymus pauciradiatus	62.5	12.5		25.0	8
Bathygobius soporator	16.7	33.3	50.0		6
Gobiosoma bosci				100.0	1
Gobiosoma robustum	35.4	17.7	18.8	38.6	96
Gobionellus smaragdus	50.0	25.0		25.0	4
Microgobius gulosus	0.2	5.0	55.9	37.4	438
Microgobius microlepsis				100.0	1
Lophogobius cyprinodides			100.0		1
Scomberomorus maculatus	100.0				2
Prionotus scitulus	81.6	14.2	2.0	2.0	49
Prionotus tribulus	4.3	17.4	30.4	47.8	23
Bothus ocellatus		100.0			1
Etropus crossotus		100.0			1
Paralichthys albigutta	71.4	23.8	4.8		21
Paralichthys lethostigma		100.0			3
Achirus lineatus	38.4	38.4	11.5	11.5	52
Trinectes maculatus	71.4	14.2	14.2		7
Symphurus plagiusa	64.8	14.0	5.7	15.5	193
Aluterus schoepfi	10.5	42.1	36.8	10.5	19
Aluterus scriptus				100.0	1
Monocanthus ciliatus	2.1	40.3	50.4	7.2	456
Monocanthus hispidis	28.7	38.3	12.5	20.3	334
Lactophrys quadricornis	14.1	32.4	40.4	13.1	99
Lactophrys trigonus	28.6	21.4	28.6	21.4	14
Spheorides nephelus	32.7	12.9	9.4	45.0	318
Spheorides spengleri				100.0	1
Chilomycterus antillarm	25.0	50.0	25.0		4
Chilomycterus schoepfi	23.0	25.1	23.5	28.2	195
Total number	62247	32675	57886	29722	182530

APPENDIX C. Seasonal abundance by percent and the total biomass of fish collected at the regular stations in Florida Bay, 1973-1976.

Species	Spring (March-May)	Summer June-Aug.)	Fall (Sept-Nov.)	Winter (Dec.-Feb.)	Total Biomass Caught
	Percentage taken in:				
Ginglymustoma cirratum			100.0		521.0
Carcharhinus limbatus		100.0			871.0
Negaprion brevirostris	29.8	26.9	33.7	9.6	16,714.0
Sphyrna tiburo	62.1		37.9		1,748.4
Pristis pectinata		5.8	94.2		55,178.0
Dasyatis americana	81.2	18.8			44,637.0
Elops saurus	58.3	12.1		29.6	1,153.6
Albula vulpes	100.0				0.1
Myrophis punctatus	85.5		14.5		5.5
Ophichthus gomesi			100.0		28.4
Brevoortia patronus		100.0			8.0
Brevoortia smithi	26.0	0.8		73.2	289.2
Harangula jaguana	4.7	10.2	84.8	0.3	3,030.1
Opisthonema oglinium	25.7	29.6	41.8	2.8	705.1
Sardinella spp.				100.0	12.3
Anchoa cubana	100.0				1.5
Anchoa hepsetus	78.5	3.3	0.7	17.5	19,727.9
Anchoa mitchilli	48.6	18.5	20.5	12.4	16,582.9
Anchoviella perfasciata	100.0				11.6
Synodus foetens	27.1	26.4	24.6	21.8	4,311.3
Arius felis	67.6	4.6	20.5	7.2	8,997.0
Bagre marinus	86.7	13.3			899.0
Opsanus beta	20.2	49.2	16.4	14.3	15,516.2
Gobiesox strumosus			100.0		1.0
Ogcocephalus radiatus	48.6	13.5	22.9	15.0	5,448.0
Chriodorus atherinoides	40.7	6.7	44.7	7.9	7,238.5
Hemirhamphus brasiliensis		100			80.4
Hyporhamphus unifasciatus	0.2	21.2	74.6		1,095.2
Strongylura marina	1.8	6.9	3.7	87.7	424.4
Strongylura notata	39.0	17.8	38.7	4.5	10,249.8
Strongylura timucu	10.4	46.3	12.0	31.3	531.0
Cyprinodont variegatus	14.4	3.6	24.1	57.9	419.2
Floridichthys carpio	25.4	12.9	39.4	22.3	25,847.9
Fundulus grandis				100.0	4.0
Fundulus confluentus	10.2	0.1	35.2	54.5	128.9
Fundulus grandis	5.3	5.7		89.0	175.5
Fundulus similis	1.9	0.8	1.3	96.0	441.7
Lucania parva	19.3	22.4	30.4	27.9	5,430.7
Poecilia latipinnia	11.8	15.1	2.7	70.4	555.0
Atherinomorus stipes	1.7	1.3	82.3	14.7	11,702.7

	Percentage taken in:				
Species	Spring (March-May)	Summer June-Aug.)	Fall (Sept-Nov.)	Winter (Dec.-Feb.)	Total Biomass Caught
Membras martinica	1.7	18.5	57.7	22.1	1,554.3
Menidia beryllina	1.1	26.9	61.9	10.0	183.1
Menidia peninsulae				100.0	2.0
Coryphoichthys albirostris	100.0				2.3
Hippocampus erectus	17.3	46.6	26.2	9.9	289.5
Hippocampus zosterae	19.5	47.5	25.0	3.0	40.0
Micrognathus crinigerus	36.4	31.8	2.3	29.5	4.4
Syngnathus floridae	24.4	22.1	18.5	34.7	2,030.0
Synganthus louisianae	14.3	35.1	36.1	13.8	64.3
Synganthus scovelli	27.3	35.9	13.4	23.4	544.8
Centropomus undecimalis		42.1	57.9		5,549.0
Diplectrum formosum	20.2	26.8	19.8	33.2	503.6
Hypoplectrus puella		39.1	60.9		278.9
Mycteroperca microlepsis	84.0		16.0		720.4
Priacanthus arenatus			100.0		133.8
Pomatomus salatrix	100.0				24.0
Rachycentron canadum			100.0		123.4
Echeneis naucrates			100.0		195.2
Echeneis neucratoides		1.2	61.4	37.4	437.2
Caranx crysos				100.0	86.5
Caranx hippos	2.0	7.3	74.4	16.3	552.0
Chloroscombus chrysurus		1.8	98.2		5.7
Oligoplites saurus		55.2	44.8		70.8
Selene vomer	41.1	58.7	0.2		698.7
Trachinotus falcatus	10.5	63.6	5.7	20.2	415.8
Lutjanus apodus		38.5	45.0	16.5	88.9
Lutjanus griseus	14.2	26.3	38.2	21.3	5,242.2
Lutjanus synagris	32.7	28.5	23.1	15.6	4,940.3
Diapterus plumieri		26.4	38.7	34.9	1,102.6
Eucinostomus argenteus	46.8	22.1	24.2	6.8	9,907.8
Eucinostomus gula	25.0	19.2	33.6	22.2	84,884.7
Geres cinerus	26.6	32.6	38.9	1.9	966.9
Haemulon aurolineatum			100.0		54.6
Haemulon parri	2.3	32.1	62.9	2.7	206.2
Haemulon plumieri	8.1	56.3	21.2	14.4	12,315.2
Haemulon sciurus	0.5	9.3	80.8	9.4	648.4
Orthopristis chrysoptera	15.8	49.4	33.6	1.1	17,368.5
Archeosargus probatocephalus	15.5	18.4	42.4	23.7	1,910.8
Archeosargus rhomboidalis	33.7	59.2	7.0		530.9
Calamus arctifrons	7.3	14.7	58.8	19.2	2,306.1
Lagodon rhomboides	20.4	43.2	29.8	6.7	111,317.1
Bairdiella batabana		42.9	57.1		685.8
Bairdiella chrysura	9.6	22.5	29.3	38.6	28,226.0
Cynoscion nebulosus	4.1	14.8	24.4	56.8	1,601.8

Species	Spring (March-May)	Summer June-Aug.)	Fall (Sept-Nov.)	Winter (Dec.-Feb.)	Total Biomass Caught
	Percentage taken in:				
Menticirrhus americanus	11.4	10.4	4.4	73.8	29.8
Menticirrhus littoralis	99.7	0.3			345.3
Micropogon undulatus		100.0			0.1
Pogonias cromis	28.3		42.4	29.3	3,464.0
Scianops ocellatus				100.0	3,480.0
Chaetodipterus faber	19.9	18.9	24.3	37.9	24,211.8
Lachnolaimus maximus		40.1	39.1	20.8	353.8
Nicholsina usta	19.8	34.5	25.3	20.4	2,471.6
Sparisoma chrysopterum		100.0			52.0
Sparisoma rubripinne			100.0		432.3
Mugil cephalus	16.3	8.9	26.5	48.4	15,990.1
Mugil curema	77.0			23.0	52.2
Mugil trichodon	13.1	31.5	53.3	2.0	10,191.0
Sphyraena barracuda	11.8	31.4	34.2	22.6	14,668.9
Paraclinus marmoratus	7.5		27.3	65.2	35.9
Chasmodes saburrae	13.1	40.7	23.8	22.4	74.7
Callionymus pauciradiatus	84.6	10.8		4.6	6.5
Bathygobius soporator	5.0	11.6	45.0	38.4	30.2
Gobiosoma bosci				100.0	0.2
Gobiosoma robustum	37.2	21.0	6.5	35.2	53.7
Gobionellus smaragdus	2.8	1.2		96.1	317.2
Microgobius gulosus	0.1	6.6	44.0	49.3	95.7
Microgobius microlepsis				100.0	1.5
Lophogobius cyprinodides				100.0	2.5
Scomberomorus maculatus	100.0				1.8
Prionotus scitulus	84.4	12.2	0.1	3.3	67.1
Prionotus tribulus	6.9	16.3	28.3	48.5	40.6
Bothus ocellatus		100.0			3.0
Etropus crossotus	100.0				2.0
Paralichthys albigutta	42.4	55.0	2.7		806.0
Paralichthys lethostigma		100.0			14.9
Achirus lineatus	53.3	21.8	9.8	15.1	48.2
Trinectes maculatus	86.9	11.5	1.6		6.1
Symphurus plagiusa	0.5	20.1	10.1	18.6	194.5
Aluterus schoepfi		99.4	0.6		397.6
Aluterus scriptus				100.0	6.0
Monocanthus ciliatus	3.4	26.0	29.8	10.9	2,866.5
Monocanthus hispidis	24.4	32.1	28.8	14.7	3,303.9
Lactophrys quadricornis	15.4	24.3	37.0	22.3	5,577.6
Lactophrys trigonus	51.5	23.4	16.6	8.5	465.4
Spheorides nephelus	19.0	29.4	17.0	34.6	2,119.0
Spheorides spengleri				100.0	2.0
Chilomycterus antiserum	47.1	44.7	8.2		8.5
Chilomycterus schoepfi	24.5	16.5	28.2	30.8	13,076.6
Grand Total					674,948.5

APPENDIX D. Developmental stages of fish identified in Florida Bay from May 1973 to October 1976.

Species	Larval	Juvenile	Adult
Ginglymostoma cirratum		X	X
Isurus oxyrinchus			X
Carcharhinus limbatus		X	X
Negaprion brevirostris		X	X
Sphyrna mokarran			X
Sphyrna tiburo		X	X
Pristis pectinata		X	X
Dasyatis americana		X	X
Aetobatus narinari			X
Albula vulpes	X		X
Elops saurus	X	X	
Megalops atlantica		X	X
Myrophis punctatus		X	
Ophichthus gomesi		X	
Brevoortia smithi		X	
Brevoortia patronus		X	
Harangula jaguana	X	X	
Opisthonema oglinium	X	X	
Sardinella spp.		X	
Anchoa cubana		X	
Anchoa hepsetus	X	X	X
Anchoa mitchilli	X	X	X
Anchoviella perfasciata		X	
Synodus foetens	X	X	X
Arius felis		X	X
Bagre marinus		X	X
Opsanus beta	X	X	X
Gobiesox strumosus		X	
Ogcocephalus radiatus		X	
Chriodorus atherinoides		X	X
Hemiramphus brasiliensis		X	
Hyporamphrus unifasciatus		X	
Strongylura marina		X	
Strongylura notata	X	X	X
Strongylura timucu		X	
Tylosaurus crocidilis		X	
Cyprinodont variegatus		X	X
Floridichthys carpio	X	X	X
Fundulus grandis		X	X
Fundulus similis		X	X
Fundulus chrysotus			X
Lucania parva		X	X
Fundulus confluentus		X	X
Poecilia latipinnia	X	X	X
Atherinomorus stipes		X	
Menidia peninsulae		X	

Species	Larval	Juvenile	Adult
Membras martinica			
Menidia beryllina		X	
Hippocampus zosterae		X	X
Hippocampus erectus		X	X
Micrognathus crinigerus		X	X
Syngnathus floridae		X	X
Syngnathus scovelli	X	X	X
Syngnathus louisianae		X	
Coryphoichthys albirostris			X
Centropomus undecimalis		X	X
Diplectrum formosum		X	X
Mycteroperca bonaci		X	
Mycteroperca microlepsis.		X	
Epinephelus morio		X	
Epinephelus itajara		X	X
Epinephelus striatus		X	
Hypoplectrus puella		X	X
Priacanthus arenatus			X
Pomatomus salatrix		X	
Rachycentron canadum		X	X
Echeneis neucratoides		X	
Echeneis naucrates		X	
Oligoplites saurus		X	
Caranx crysos		X	X
Caranx hippos		X	X
Trachinotus falcatus		X	
Trachinotus carolinus			X
Selene vomer		X	
Chloroscombus chrysurus		X	
Ocyurus chrysurus		X	
Lutjanus griseus		X	
Lutjanus apodus		X	
Lutjanus synagris		X	
Lutjanus analis		X	
Diapterus plumieri		X	X
Eucinostomus argenteus		X	X
Eucinostomus gula	X	X	X
Geres cinerus		X	X
Lobotes surinamensis			X
Haemulon parri		X	X
Haemulon sciurus		X	
Haemulon plumieri		X	
Haemulon aurolineatum		X	
Orthopristis chrysoptera		X	X
Anisotremus virginicus		X	
Archeosargus probatocephalus		X	X
Archeosargus rhomboidalis		X	
Calamus arctifrons		X	

Species	Larval	Juvenile	Adult
Lagodon rhomboides	X	X	X
Pogonias corms		X	X
Bairdiella chrysura	X	X	X
Bairdiella batabana		X	
Cynoscion nebulosus		X	X
Equetus acuminatus		X	
Menticirrhus littoralis		X	X
Menticirrhus americanus		X	
Micropogon undulatus		X	
Scianops ocellatus		X	X
Chaetodipterus faber		X	X
Holocanthus ciliaris			X
Lachnolaimus maximus		X	
Nicholsina usta		X	X
Sparisoma virdie			X
Sparisoma chrysopterum		X	
Sparisoma rubripinne		X	X
Sparisoma aurofrenatum		X	
Sparisoma taeniopterus			X
Mugil cephalus		X	X
Mugil curema		X	
Mugil trichodon		X	X
Sphyraena barracuda		X	X
Paraclinus marmoratus		X	X
Chasmodes saburrae		X	X
Callionymus pauciradiatus		X	
Bathygobius soporator			X
Gobionellus smaragdus		X	X
Gobiosoma robustum		X	X
Gobiosoma bosci		X	
Microgobius gulosus	X	X	X
Microgobius microlepsis		X	
Lophogobius cyprinodides			X
Scomberomorus maculatus		X	X
Scomberomorus cavalla			X
Prionotus scitulus		X	
Prionotus tribulus		X	
Bothus ocellatus		X	
Paralichthys albigutta		X	X
Paralichthys lethostigma		X	X
Etropus crossotus		X	
Achirus lineatus		X	
Trinectes maculatus		X	
Smyphrus plagiusa		X	X
Monocanthus hispidis		X	X
Monocanthus ciliatus		X	
Aleutra schoepfi		X	X
Aleutra scriptus		X	

Species	Larval	Juvenile	Adult
Lactophrys quadricornis		X	
Lactophrys trigonus		X	
Spheorides nephelus		X	
Spheorides spengleri		X	
Chilomycterus schoepfi		X	X
Chilomycterus antillarum	X	X	

APPENDIX E. Hydrobiologicai parameters

Station S-1 Florida Bay entrance to the Buttonwood Canal
May 1973 - June 1976

Statistic	Salinity (ppt)	Temp. (°C)	Dissolved Oxygen (ppm)	pH	Depth (m)	Number of Fish Species	Number of Fish Individuals	Fish Biomass (gms)	Biomass (gm/m^2)
Sample mean	33.07	26.04	7.07	7.97	0.83	17.8	775	1,312	4.2
Variance	61.62	14.60	23.55	16.11	0.06	35.2	80,821	4,454	40.4
Standard deviation	7.85	3.82	4.85	4.01	0.24	5.9	762	1,156	6.4
Standard error	1.71	0.83	1.25	0.97	0.051	1.3	166	253	1.4
Kurtosis	-0.86	-0.37	-0.91	1.12	-0.73	-0.59	0.8	0.3	0.3
Skewness	-0.10	0.15	-1.36	-2.02	0.39	0.12	1.3	1.0	1.0
Minimum	20.1	18.00	0.00	0.00	0.50	6.0	125	87.2	0.5
Maximum	44.0	33.20	9.80	8.60	1.30	29.0	2,732	4,265	23.4
Range	24.1	15.20	9.80	8.60	0.80	23.0	2,607	4,177	22.9

Station S-2 Joe Kemp Key
May 1973 - June 1974

Statistic	Salinity (ppt)	Temp. (°C)	Dissolved Oxygen (ppm)	pH	Depth (m)	Number of Fish Species	Number of Fish Individuals	Fish Biomass (gms)	Biomass (gm/m^2)
Sample mean	36.17	26.53	7.60	8.27	0.76	11.8	156	983	3.5
Variance	39.08	11.07	2.70	0.12	0.06	26.6	10,391	-	14.7
Standard deviation	6.25	3.32	1.64	0.36	0.26	5.2	102	1,100	3.8
Standard error	1.67	0.88	0.67	0.12	0.07	1.4	27.2	294	1.0
Kurtosis	-0.81	-0.33	-0.31	-1.16	-1.32	-1.00	-0.44	-0.5	-0.55
Skewness	0.32	-0.45	-0.58	-0.03	0.16	0.47	0.78	1.1	0.94
Minimum	25.80	19.40	4.80	7.70	0.40	5.0	33	80.6	0.2
Maximum	47.00	30.90	9.70	8.70	1.20	21.0	373	3,204	11.7
Range	21.20	11.50	4.90	1.00	0.80	16.0	340	3,124	11.5

Station S-3 Palm Key
May 1973 - June 1974

Statistic	Salinity (ppt)	Temp. (°C)	Dissolved Oxygen (ppm)	pH	Depth (m)	Number of Fish Species	Number of Fish Individuals	Fish Biomass (gms)	Biomass (gm/m^2)
Sample mean	37.83	27.06	11.51	8.68	0.56	9.2	815	989	5.5
Variance	28.97	11.82	3.47	0.20	0.02	3.6	308,996	699,570	21.6
Standard deviation	5.38	3.43	1.86	0.44	0.15	1.9	556	836	4.6
Standard error	1.49	0.95	0.70	0.15	0.04	0.5	154	232	1.3
Kurtosis	-1.00	0.22	-0.73	-1.55	0.30	-0.87	-0.92	1.19	1.20
Skewness	0.03	-0.46	0.07	0.29	0.81	-0.45	0.59	1.55	1.55
Minimum	28.50	19.50	8.90	8.20	0.30	6.0	241	291	1.6
Maximum	46.00	33.10	14.50	9.30	0.90	12.0	1,875	3,041	16.9
Range	17.50	13.60	5.60	1.10	0.60	6.0	1,634	2,750	15.3

Statistic	Salinity (ppt)	Temp. (°C)	Dissolved Oxygen (ppm)	pH	Depth (m)	Number of Fish Species	Number of Fish Individuals	Fish Biomass (gms)	Biomass (gm/m^2)
					Station S-4 Murray Key May 1973 - June 1974				
Sample mean	36.31	26.06	7.98	8.04	0.72	15.7	284	1,507	5.5
Variance	18.32	15.86	6.60	0.18	0.07	11.7	27,003	78,259	23.6
Standard deviation	4.28	3.98	2.65	0.43	0.27	3.4	164	1,334	4.9
Standard error	0.93	0.87	-	-	0.06	0.8	35.9	291	1.1
Kurtosis	1.96	-0.43	-	-	-0.17	-0.51	2.32	1.57	1.55
Skewness	1.01	-0.35	-	-	0.60	0.30	1.60	1.63	1.62
Minimum	23.50	17.10	4.4	6.9	0.30	10.0	101	237	0.9
Maximum	43.20	32.10	12.50	8.60	1.30	23.0	758	4,934	18.0
Range	19.70	15.00	8.1	1.7	1.00	13.0	657	4,697	17.1
					Station S-5 Clive Key May 1973 - June 1974				
Sample mean	37.51	25.36	6.93	8.25	0.68	12.2	930	829	1.8
Variance	29.11	17.16	3.31	0.08	0.04	8.1	18,159	169,135	0.8
Standard deviation	5.39	4.14	1.82	0.29	0.19	2.9	647	411	0.9
Standard error	1.49	1.14	0.64	0.09	0.05	0.8	179	114	0.3
Kurtosis	-0.50	-0.78	-1.17	-0.86	-0.95	0.87	-0.10	-1.25	-1.23
Skewness	0.84	-0.41	-0.37	0.38	0.08	0.66	0.87	0.47	0.47
Minimum	31.10	17.60	4.20	7.80	0.40	8.0	283	315	0.7
Maximum	48.60	31.00	9.20	8.70	1.00	19.0	2,401	1,574	3.5
Range	17.50	13.40	5.00	0.90	0.60	11.0	2,118	1,258	2.8
					Station S-6 Man-O-War Key May 1973 - June 1974				
Sample mean	38.23	26.23	7.13	8.37	0.93	10.9	586	1,146	14.7
Variance	22.09	13.29	1.22	0.05	0.07	8.7	256,436	704,590	116
Standard deviation	4.70	3.64	1.10	0.23	0.26	3.0	506	839	10.8
Standard error	1.30	1.01	0.36	0.07	0.07	0.8	140	233	3.0
Kurtosis	-0.56	-0.53	-1.42	-1.21	-0.20	-0.98	-1.46	-0.33	-0.32
Skewness	0.53	-0.55	-0.38	-0.24	0.39	0.09	0.41	0.69	0.70
Minimum	31.90	18.70	5.40	8.00	0.50	7.0	70.0	146	1.9
Maximum	47.80	30.50	8.40	8.70	1.50	16.0	1,435	2,907	37.3
Range	15.90	11.80	3.00	0.70	1.00	9.0	1,365	2,761	35.4

Statistic	Variable								
	Salinity (ppt)	Temp. (°C)	Dissolved Oxygen (ppm)	pH	Depth (m)	Number of Fish Species	Number of Fish Individuals	Fish Biomass (gms)	Biomass (gm/m^2)
Station S-7 Sandy Key May 1973 - June 1974									
Sample mean	36.51	26.48	8.23	8.40	0.71	9.4	265	2,419	5.4
Variance	8.35	16.92	1.22	0.07	0.09	3.8	72,213	-	33.4
Standard deviation	2.89	4.11	1.10	0.27	0.30	2.0	269	2,611	5.8
Standard error	0.77	1.09	0.39	0.09	0.08	0.5	71.8	698	1.5
Kurtosis	-1.08	-0.25	-0.67	-1.42	-1.53	0.26	-0.86	1.60	1.60
Skewness	0.12	-0.78	-0.66	0.11	0.15	0.85	0.80	1.60	1.60
Minimum	31.70	17.40	6.20	8.00	0.30	7.0	9.0	26.0	0.1
Maximum	40.80	31.40	9.40	8.80	1.20	14.0	772	9,210	20.4
Range	9.10	14.00	3.20	0.80	0.90	7.0	763	9,184	20.3
Station S-8 East Cape May 1973 - June 1976									
Sample mean	36.06	26.21	6.70	7.80	0.89	12.7	3,871	6,847	20.6
Variance	6.68	14.02	0.75	0.35	0.09	30.1	53,216	26,688	916.3
Standard deviation	2.58	3.74	0.89	0.11	0.30	5.5	6,615	12,387	30.3
Standard error	0.564	0.82	-	-	0.07	1.2	1,444	2,703	6.6
Kurtosis	-1.17	-0.84			0.16	3.95	3.53	7.01	1.22
Skewness	-0.35	-0.44	-	-	0.27	1.68	2.13	2.70	1.66
Minimum	3.16	18.10	4.5	7.2	0.30	6.0	17.0	12.3	0.1
Maximum	39.40	31.20	8.00	8.40	1.50	17	24,069	52,543	99.9
Range	7.80	13.10	3.5	1.2	1.20	11	24,052	52,541	99.8
Station S-9 Madeira Beach October 1975 - September 1976									
Sample mean	34.38	25.16	6.98	7.77	0.93	7.4	497	663	3.3
Variance	101.04	28.99	0.27	0.23	0.01	3.1	42,304	52,543	12.7
Standard deviation	10.05	5.38	0.52	0.48	0.13	1.8	862	807.8	3.6
Standard error	3.55	1.90	1.09	0.17	0.04	0.6	305	286	1.3
Kurtosis	-1.25	-1.14	3.58	0.95	-0.56	-1.02	2.73	-0.57	-0.54
Skewness	-0.25	-0.39	-2.53	-1.55	-0.74	-0.11	2.11	1.10	1.09
Minimum	18.80	17.40	6.2	6.70	0.70	5.0	39.0	53.1	0.3
Maximum	47.10	31.60	7.60	8.10	1.10	10.0	2,590	2,119	9.8
Range	28.30	14.20	1.4	1.40	0.40	5.0	2,551	2,066	9.5

Statistic	Salinity (ppt)	Temp. (°C)	Dissolved Oxygen (ppm)	pH	Depth (m)	Number of Fish Species	Number of Fish Individuals	Fish Biomass (gms)	Biomass (gm/m^2)
	Variable								
Station S-10 Trout Creek, October 1975 - September 1976									
Sample mean	29.86	25.24	7.40	7.70	1.03	9.75	1,094	1,022	5.7
Variance	116.32	30.02	0.65	0.06	0.05	5.64	6,876	93,542	30.7
Standard deviation	10.78	5.48	0.87	0.264	0.22	2.37	1,228	997	5.5
Standard error	3.81	1.93	-	-	0.08	0.84	434	353	2.0
Kurtosis	-0.18	-1.17	-	-	-1.25	-0.98	-0.87	1.83	1.82
Skewness	-0.25	-0.51	-	-	0.21	-0.30	0.86	1.74	1.73
Minimum	10.60	17.0	6.0	7.3	0.80	6.0	113	241	1.3
Maximum	47.10	30.80	8.70	8.1	1.40	13.0	3,294	3,333	18.5
Range	36.50	13.80	2.7	0.8	0.60	7.0	3,181	3,092	17.2
Station S-11 - Little Blackwater Sound, October 1975 - September 1976									
Sample mean	29.45	24.90	6.4	7.6	1.31,	9.42	292	618	3.4
Variance	120.94	32.13	0.33	0.16	0.01	15.61	34,285	27,941	7.0
Standard deviation	10.99	5.66	0.58	0.40	0.07	3.95	185	477	2.6
Standard error	4.15	2.14	-	-	0.02	1.49	70	181	1.0
Kurtosis	-0.86	-1.45			-0.61	-1.31	-0.79	-1.06	-1.05
Skewness	-0.69	-0.35	-	-	-0.13	0.12	0.49	0.87	0.88
Minimum	10.60	17.40	5.5	7.1	1.20	4.0	80	220	1.2
Maximum	40.10	30.80	7.0	8.1	1.40	15.0	610	1,372	7.6
Range	29.50	13.40	1.5	1.0	0.20	11.0	530	1,153	6.4
Station S-12 - Nest Key, October 1975 - September 1976									
Sample mean	44.95	25.33	7.76	7.71	1.27	7.5	925	2,529	13.4
Variance	28.87	21.47	0.19	0.19	0.02	2.9	84,184	47,163	466.1
Standard deviation	5.37	4.63	0.44	0.43	0.14	1.7	1,133	3,814	21.6
Standard error	1.90	1.64	0.16	0.15	0.05	0.6	401	1,349	7.6
Kurtosis	1.02	-0.61	0.88	1.86	-0.93	-1.13	-0.60	0.78	0.77
Skewness	-1.11	-0.72	-1.43	-1.77	0.13	0.09	0.99	1.51	1.52
Minimum	33.40	16.90	6.80	6.70	1.10	5.0	42.0	111	0.6
Maximum	52.10	30.60	8.10	8.00	1.50	10.0	3,015	10,805	60.2
Range	18.70	13.70	1.30	1.30	0.40	5.0	2,973	10,694	59.6

Statistic	Salinity (ppt)	Temp. (°C)	Dissolved Oxygen (ppm)	pH	Depth (m)	Number of Fish Species	Number of Fish Individuals	Fish Biomass (gms)	Biomass (gm/m^2)
	Variable								
Station S-13 Manatee Key, October 1975 - September 1976									
Sample mean	45.36	25.80	7.98	8.16	1.24	5.9	270.3	664	3.7
Variance	11.39	18.45	0.65	0.02	0.02	3.3	71,391	51,352	16.9
Standard deviation	3.37	4.30	0.81	0.14	0.14	1.8	267	743	4.1
Standard error	1.19	1.52	0.28	0.05	0.05	0.6	94.5	263	1.5
Kurtosis	-1.53	-1.03	-0.15	-0.93	-0.93	-1.66	-1.04	0.36	0.38
Skewness	0.27	-0.54	-0-95	0.38	-0.39	0.35	0.72	1.30	1.30
Minimum	41.70	18.70	6.40	8.00	1.00	4.0	19	112	0.6
Maximum	50.10	30.30	8.90	8.40	1.40	8.0	738	2,221	12.3
Range	8.40	11.60	2.50	0.40	0.40	4.0	719	2,109	11.7
Station S-14 Bottle Key, October 1975 - September 1976									
Sample mean	45.53	25.95	8.21	8.12	1.06	5.6	1,105	1,030	6.1
Variance	1.14	16.31	0.46	0.02	0.02	1.7	54,843	84,443	70.2
Standard deviation	1.07	4.03	0.67	0.15	0.14	1.3	1,719	1,409	8.38
Standard error	0.'37	1.42	-	0.05	0.05	0.5	608	498	2.96
Kurtosis	-0.70	-0.88	-	-1.47	-0.56	-0.56	-0.51	-0.37	-0.37
Skewness	0.39	-0.52	-	0.03	-0.60	0.74	1.16	1.18	1.17
Minimum	44.10	19.00	7.4	7.90	0.80	4.0	28.0	66.6	0.4
Maximum	47.40	30.40	9.30	8.30	1.20	8.0	4,237	3,698	22.0
Range	3.30	11.40	1. 9	0.40	0.40	4.0	4,209	3,632	21.6
Station S-15 West Key, October 1975 - September 1976									
Sample mean	39.30	26.57	9.39	8.23	1.24	9.6	487	1,023	9.9
Variance	5.30	23.45	1.21	0.01	0.03	5.3	76,272	84,410	79.3
Standard deviation	2.31	4.84	1.10	0.10	0.17	2.3	526	1,041	8.9
Standard error	0.87	1.83	0.42	0.04	0.06	0.87	199	394	3.4
Kurtosis	-0.23	-1.43	-0.94	-1.45	-1.02	0.20	0.53	1.04	1.41
Skewness	-0.80	-0.44	0.71	-0.59	0.13	-1.30	1.27	1.48	1.69
Minimum	35.00	19.70	8.2	8.10	1.00	5.0	32.0	50.6	3.8
Maximum	42.00	31.70	11.20	8.30	1.50	11.0	1,555	3,220	29.2
Range	7.00	12.00	3.00	0.20	0.50	6.0	1,523	3,170	25.4

Statistic	Salinity (ppt)	Temp. (°C)	Dissolved Oxygen (ppm)	pH	Depth (m)	Number of Fish Species	Number of Fish Individuals	Fish Biomass (gms)	Biomass (gm/m^2)
	Variable								
Station T-1 Joe Kemp Channel October 1973 - December 1975									
Sample mean	38.28	25.36	7.33	7.93	1.91	4.7	68.0	1,025	2.1
Variance	11.71	25.50	1.91	0.40	0.02	24.8	32,193	-	4.6
Standard deviation	3.42	5.05	1.38	0.63	0.15	5.0	179.4	1,027.8	2.2
Standard error	0.48	0.71	0.21	0.09	0.02	0.7	25.4	145.4	0.3
Kurtosis	-0.32	0.40	0.33	0.79	0.16	2.08	10.7	1.84	1.80
Skewness	-0.09	-1.14	-0.39	-1.15	-0.64	1.70	3.40	1.46	1.50
Minimum	30.70	11.90	3.90	6.20	1.50	0.0	0.0	0.0	0.0
Maxinum	44.40	30.60	9.80	8.80	2.20	20.0	843	4,551	9.5
Range	13.70	18.70	5.90	2.60	0.70	20.0	843	4,551	9.5
Station T-2 Chonchie Channel October 1973 - February 1975									
Sample mean	36.72	24.10	7.51	7.88	2.45	4.8	29.6	459	1.0
Variance	6.30	25.10	0.66	0.35	0.16	12.9	2,898	291,511	1.3
Standard deviation	2.51	5.01	0.81	0.59	0.40	3.6	54	540	1.1
Standard error	0.44	0.88	0.51	0.11	0.07	0.6	9.5	95.4	0.2
Kurtosis	-1.01	-0.94	-0.59	-0.71	-0.27	-0.72	8.35	2.76	2.68
Skewness	-0.15	-0.43	0.26	-0.58	-0.81	0.66	2.83	1.90	1.88
Minimum	32.20	14.40	6.30	6.70	1.60	0.0	0.0	0.0	0.0
Maximum	40.80	30.50	9.10	8.80	3.00	13.0	257	2,036	4.2
Range	8.60	16.10	2.80	2.10	1.40	13.0	257	2,036	4.2
Station T-3 Palm Key Basin October 1973 - September 1976									
Sample mean	38.75	26.42	8.59	7.98	1.28	13.57	390	2,266	4.7
Variance	10.42	20.92	8.94	1.48	0.05	16.95	87,539	87,144	17.8
Standard deviation	3.23	4.57	2.99	1.21	0.22	4.12	296	2,022	4.2
Standard error	0.42	0.60	-	-	0.03	0.54	38.9	266	0.6
Kurtosis	0.03	0.23	-	-	-0.110	-0.70	1.82	6.01	5.99
Skewness	0.41	-0.98	-	-	0.015	-0.20	1.19	2.36	2.36
Minimum	32.90	14.30	6.2	6.7	0.80	5.0	20.0	48.3	0.1
Maximum	47.20	31.70	10.60	8.90	1.80	22.0	1,424	10,326	21.5
Range	14.30	17.40	4.4	2.2	1.00	17.0	1,404	10,278	21.4

Variable

Station T-4 Rabbit Key Basin
October 1973 - December 1975

Statistic	Salinity (ppt)	Temp. (°C)	Dissolved Oxygen (ppm)	pH	Depth (m)	Number of Fish Species	Number of Fish Individuals	Fish Biomass (gms)	Biomass (gm/m^2)
Sample mean	40.75	25.15	7.34	7.94	1.74	7.4	42.3	677.0	1.5
Variance	14.89	26.64	1.78	0.58	0.07	16.8	1,743	368,375	1.6
Standard deviation	3.86	5.16	1.33	0.76	0.28	4.1	41.7	607	1.3
Standard error	0.53	0.71	0.20	0.11	0.03	0.6	5.8	84.2	0.2
Kurtosis	-0.98	-0.15	-1.43	0.16	-0.63	-0.92	0.92	2.36	2.35
Skewness	0.29	-0.89	0.11	-1.07	-0.69	0.39	1.30	1.49	1.47
Minimum	33.90	12.80	5.40	6.10	1.20	1.0	1.0	3.2	0.0
Maximum	43.10	31.20	9.60	9.00	2.10	15.0	172	2,919	6.1
Range	14.20	18.40	4.20	2.90	0.90	14.0	171	2,915	6.1

Station T-5 East Snake Bight
September 1974 - September 1976

Statistic	Salinity (ppt)	Temp. (°C)	Dissolved Oxygen (ppm)	pH	Depth (m)	Number of Fish Species	Number of Fish Individuals	Fish Biomass (gms)	Biomass (gm/m^2)
Sample mean	41.80	27.54	8.53	7.6	1.07	6.2	81	830	1.8
Variance	54.12	18.39	5.01	2.31	0.02	11.4	4,792	72,139	2.6
Standard deviation	7.356	4.29	2.23	1.52	0.14	3.4	69.2	756	1.6
Standard error	1.30	0.76	-	-	0.03	0.6	12.2	134	0.3
Kurtosis	-0.17	-0.24			4.18	1.10	0.63	-0.31	-0.54
Skewness	0.21	-0.94	-	-	1.95	0.96	1.16	0.90	0.78
Minimum	27.50	18.80	4.8	6.6	0.90	1.0	2.0	5.9	0.0
Maximum	57.30	32.30	11.0	8.60	1.60	16.0	268	2,472	5.1
Range	29.80	13.50	6.3	2.0	0.70	15.0	266	2,467	5.1

Station T-6 Crocodile Point
September 1974 - September 1976

Statistic	Salinity (ppt)	Temp. (°C)	Dissolved Oxygen (ppm)	pH	Depth (m)	Number of Fish Species	Number of Fish Individuals	Fish Biomass (gms)	Biomass (gm/m^2)
Sample mean	48.55	27.49	7.80	7.68	1.05	2.8	51.0	239	1.0
Variance	18.58	18.54	1.57	1.27	0.03	3.2	5,118	64,023	2.0
Standard deviation	4.31	4.31	1.25	1.62	0.17	1.8	71.5	253	1.4
Standard error	0.79	0.79	-	-	0.03	0.3	13.8	48.7	0.3
Kurtosis	0.43	-0.76	-	-	0.26	-0.50	3.5	-0.64	2.0
Skewness	0.52	-0.72	-	-	1.33	0.04	2.0	0.67	1.5
Minimum	41.00	19.30	5.8	6.8	0.90	0.0	0.0	0.0	0.0
Maximum	60.00	32.00	10.20	8.90	1.40	7.0	272	826	5.2
Range	19.00	12.70	4.4	2.1	0.50	7.0	272	826	5.2

Statistic	Variable Salinity (ppt)	Temp. (°C)	Dissolved Oxygen (ppm)	pH	Depth (m)	Number of Fish Species	Number of Fish Individuals	Fish Biomass (gms)	Biomass (gm/m^2)
Station T-7 Madeira Bay September 1974 - September 1975									
Sample mean	50.95	26.6	7.78	7.94	1.08	2.5	28	192	0.4
Variance	48.51	23.6	0.51	0.25	0.00	3.3	1,538	66,536	0.3
Standard deviation	6.96	4.86	0.72	0.50	0.08	1.8	39.2	258	0.6
Standard error	1.68	1.18	0.18	0.13	0.02	0.4	9.5	63	0.1
Kurtosis	-0.81	-0.64	-0.28	2.43	-1.55	-0.50	-0.72	-0.72	-0.48
Skewness	0.29	-0.90	-0.11	-1.63	0.34	0.73	0.73	0.96	1.07
Minimum	42.0	17.8	6.70	6.5	1.0	0.0	0.0	0.0	0.0
Maximum	64.8	31.2	8.80	8.4	1.20	6.0	108	692	1.6
Range	22.8	13.4	2.10	1.9	0.2	6.0	108	692	1.6
Station T-8 Barnes Key Basin September 1974 - September 1975									
Sample mean	42.7	26.45	7.48	8.09	1.9	3.5	20.0	288	0.6
Variance	3.66	22.78	0.62	0.10	0.00	2.4	279	33,816	0.1
Standard deviation	1.91	4.77	0.79	0.321	0.09	1.6	16.7	184	0.4
Standard error	0.39	0.97	0.17	0.07	0.01	0.31	3.4	38	0.07
Kurtosis	-0.52	-0.79	-1.22	-0.08	3.23	-0.93	-0.41	-0.97	-0.90
Skewness	0.74	-0.75	0.49	-1.12	-1.84	0.03	0.76	0.25	0.27
Minimum	40.50	17.70	6.60	7.40	1.70	1.0	1.0	7.2	0.0
Maximum	46.80	31.30	8.80	8.40	2.10	6.0	60	631	1.3
Range	6.30	13.60	2.20	1.0	0.40	5.0	59	624	1.3
Station T-9 Sandy Key Basin January 1975 - June 1976									
Sample mean	37.72	26.82	7.45	7.93	1.99	13.4	108	1,640	3.2
Variance	5.02	13.22	0.72	0.49	0.05	24.2	10,970	64,681	10.6
Standard deviation	2.24	3.636	0.85	0.70	0.2	5.0	105	1,570	3.3
Standard error	0.439	0.71	-	-	0.04	1.0	20.5	308	0.6
Kurtosis	-1.07	-0.61			-0.32	0.34	0.16	3.60	4.19
Skewness	-0.30	-0.74	-	-	-0.90	0.90	1.27	1.85	2.0
Minimum	33.40	19.00	5.8	6.0	1.5	7.0	10	266	0.5
Maximum	40.50	30.40	8.90	8.50	2.2	26.0	351	7,090	14.8
Range	7.10	11.40	3.1	2.5	0.7	19.0	341	6,824	14.3

Statistic	Salinity (ppt)	Temp. (°C)	Dissolved Oxygen (ppm)	pH	Depth (m)	Number of Fish Species	Number of Fish Individuals	Fish Biomass (gms)	Biomass (gm/m^2)
	Variable								
Station T-10 Little Madeira Bay October 1975 - September 1976									
Sample mean	27.05	26.30	6.00	7.72	1.73	3.9	18.1	208	0.4
Variance	142.02	6.24	1.80	0.05	0.00	3.9	237	34,555	0.2
Standard deviation	11.91	2.49	1.34	0.23	0.05	12.0	15.4	186	0.4
Standard error	3.59	0.75	-	-	0.01	0.59	4.6	56.0	0.1
Kurtosis	-0.19	-1.52	-	-	-1.67	-0.89	0.38	-0.94	-0.88
Skewness	-0.11	-0.08	-	-	0.56	0.45	0.92	0.68	0.70
Minimum	8.00	22.90	4.4	7.5	1.70	1.0	3.0	22.3	0.1
Maximum	49.20	29.30	7.60	8.10	1.80	7.0	50	557	1.2
Range	41.20	6.40	3.2	0.6	0.10	6.0	47	535	1.1
Station T-11 Buttonwood Sound October 1975 - September 1976									
Sample mean	43.68	25.67	7.50	7.91	2.67	4.5	56.5	385	0.8
Variance	4.56	9.74	1.41	0.03	0.03	2.3	894	46,192	0.19
Standard deviation	2.13	3.12	1.19	0.18	0.18	1.5	29.9	215	0.4
Standard error	0.57	0.83	0.31	0.05	0.05	0.4	8.0	57.4	0.1
Kurtosis	-0.53	-1.43	-0.82	-1.07	-1.32	-0.78	1.67	-1.24	-1.23
Skewness	0.78	0.10	-0.49	-0.64	-0.38	0.35	1.63	0.30	0.26
Minimum	41.30	21.50	5.40	7.60	2.40	2.0	30	109	0.2
Maximum	47.70	29.80	8.90	8.10	2.90	7.0	135	715	1.5
Range	6.40	8.30	3.50	0.50	0.50	5.0	105	606	1.3
Station T-12 Tavern Creek October 1975 - September 1976									
Sample mean	42.74	24.96	7.66	8.04	2.42	5.8	55.4	541	1.1
Variance	1.98	12.46	0.35	0.01	0.09	8.0	953	34,069	0.2
Standard deviation	1.40	3.53	0.59	0.10	0.30	2.8	30.9	185	0.4
Standard error	0.44	1.11	0.18	0.03	0.09	0.89	9.76	59	0.1
Kurtosis	-0.53	-0.97	-1.26	-1.04	-1.16	0.35	-0.76	-0.74	-0.81
Skewness	-0.94	0.59	-0.21	0.27	0.56	1.15	-0.24	0.02	-0.02
Minimum	40.30	21.10	6.80	7.90	2.10	3.0	7	255	0.5
Maximum	44.10	30.60	8.40	8.20	2.90	12.0	100	826	1.7
Range	3.80	9.50	1.60	0.30	2.90	9.0	93	571	1.2

APPENDIX F. Hectares of macrobiotical communities and representative stations in Florida Bay.[Δ] Sampling stations represent habitat areas.

Communities	Stations	Hectares	Percent
Western Florida Bay			
Diplanthera	S-8	615	2.3
Diplanthera - Thalassia	S-1	210	
	S-2	1,200	
	S-4	1,230	
	S-5	4,047	
	S-6	1,408	
		8,095	30.6
Diplanthera - Gracilaria	S-3	114	0.4
Thalassia	S-7	4,710	
	T-4	5891	
		10,601	40.0
Thalassia - Syringodium	T-3	1,327	
	T-9	1,537	
		2,854	10.8
Caulerpa	T-1	356	
	T-2	3,852	15.9
		4,208	100.0
Subtotal		26,497	
Central Florida Bay			
Diplanthera - Thalassia	T-5	6,880	16.4
Thalassia - Batophora	T-6	6,637	15.9
Diplanthera - Penicillus	T-7	9,405	22.5
Thalassia - Porites	T-8	18,972	45.3
Subtotal		41,894	100.0
Eastern Florida Bay			
Diplanthera - Thalassia	S-9	1214	
	S-10	664	
	S-11	307	
	S-13,14	3999	
	T-10	663	
		6846	21.4
Diplanthera - Penicillus	S-12	20186	63.3
Thalassia - Porites	T-12	2072	6.4
Thalassia - Syringodium	T-11	2395	7.5
Thalassia	S-15	388	1.2
Subtotal		31,887	100.0
Total sampled area		100,278	
Total unsampled area*		5,303	
Grand Total Florida Bay		105,581	

[Δ] Hectares based on dot grid estimates from 1973 IR aerial photography.
* Western Florida Bay (Central Snake Bight and Nine Mile Bank).