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Utilization of the red mangrove prop root habitat by fishes in south Florida

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ABSTRACT: The inherent difficulty of sampling the red mangrove prop root habitat has impeded our understanding of the utilization of this habitat by fishes. A block net and rotenone method was developed and used to sample 2 sites in each of 4 regions in Everglades National Park, Florida (USA). At each site a 3 mm mesh net was used to enclose 3 sides of a mangrove stand while an onshore berm formed the fourth side. Samples collected from the mangrove prop root environment were compared with samples collected using a 2-boat otter trawl in the immediately (8 to 10 m) adjacent, fringing seagrass habitat. The density and biomass of fish collected by the 2 gear were greater in the prop root habitat than in the adjacent fringing seagrass areas. There also were consistent differences in species composition between the 2 habitat types across all 4 geographic regions. Analysis of the stomach contents of gray snapper *Lutjanus griseus* suggested that smaller snapper tend to feed in the prop root habitat while larger snapper may forage out into adjacent areas to feed. The red mangrove prop root habitat is utilized by a wide variety of fish, and greater attention should be given to evaluating its contribution to fish production in south Florida and elsewhere.

INTRODUCTION

Mangroves dominate the shorelines of south Florida (USA), constituting an estimated 174 000 to 202 400 ha (430 000 to 500 000 acres) of estuarine and coastal habitat (Odum et al. 1982). Fringing forests of red mangroves *Rhizophora mangle* dominate the outer perimeter of protected shorelines and islands (Lugo & Snedaker 1974). The red mangroves that predominate in this fringe habitat have a well-developed prop root system that is flooded semidiurnally by tides and may provide habitat to fishes.

In recent years there has been an increasing recognition of the general importance of the fringing red mangrove habitat to estuarine-dependent fishes (e.g. Heald 1969, Odum 1970, Carter et al. 1973, Lugo & Snedaker 1974, Odum & Heald 1975, Yokel 1975, Weinstein et al. 1977, Odum et al. 1982). By and large, the emphasis has been on the detrital contribution of the mangroves to estuaries and to fishes. Mangrove leaves are a primary source of plant detritus in subtropical-tropical systems, and in certain systems many consumers appear to depend primarily on mangrove-derived detrital carbon as an energy source (Zieman et al. 1984). The presence of decaying plant matter and invertebrate detritivores probably provide rich food sources for foraging fishes, but quantitative data on energy transfer are lacking. Since dense aquatic vegetation can interfere with predators (e.g. Boesch & Turner 1984, Orth et al. 1984), the mangrove prop root habitat also may serve as a refuge for fish and invertebrates.

The use of fringing mangrove habitats by commercial and recreational fishery organisms has not been well documented. In a recent review of the ecology of mangrove systems in south Florida, Odum et al. (1982) pointed out that while fish communities of estuarine bays fringed by red mangroves have been sampled and described, fish utilizing the mangrove prop root habitat have not been sampled quantitatively. Visual observations abound, but quantitative data are lacking. Undoubtedly, the paucity of information on the mangrove habitat has been partly due to the inherent difficulty in quantitatively sampling this habitat type.

The objectives of this study were to measure quantitatively the fish communities utilizing the fringing red mangrove habitat over a relatively broad area; compare these fish communities with those in the immediately adjacent habitat characterized by rooted aquatic plants; and compare food consumed by gray snapper *Lutjanus griseus* collected from both habitats.

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AREA AND METHODS

Our study was conducted within Everglades National Park in south Florida (USA). Eight permanent stations were established, 2 each in Whitewater Bay, Coot Bay, northwestern Florida Bay and southeastern Florida Bay (Fig. 1). Whitewater Bay stations were located ca 1000 m apart in a northeastern embayment near East River. Coot Bay stations were located ca 1800 m apart between Tarpon Creek and Buttonwood Canal on the southwestern shore. In northwestern Florida Bay, sites were selected about 1500 m apart on the shores of Murray Key and Oyster Keys, while in southeastern Florida Bay stations were chosen on the shores of Captain Key and Crane Key, about 3000 m apart.

We used several criteria to select the mangrove stations. All stations were intertidal to subtidal with about 1 m water depth at the leading edge of mangrove prop roots at high tide. A berm was present 5 to 10 m shoreward of this leading edge, and the prop root habitat continued up to the shoreline. The sites were all dominated by *Rhizophora mangle*, and adjacent to each area were seagrass habitats.

In March 1984, areas were selected and sample sites prepared. Pipes (2.5 cm diameter, 2.8 m long) were driven into the sediment 4 to 8 m apart at the leading edge of each mangrove area. The width of this separation was dictated by the expanse of prop roots issuing from a single mangrove clump. Next, a 0.5 m path was cleared to the berm from each stake perpendicular to the shoreline. This activity entailed cutting prop roots to the sediment surface as well as removing some overhanging limbs so that a net could be positioned to prevent ingress and egress of fish. The data reported are for 8 sample periods between May 1984 and May 1985.

All sampling was carried out during daylight at high tide ±2 h using the following procedure. In each instance, a 32 × 2 m net with 3 mm mesh was used. The bottom of the net was fitted with 6 mm galvanized chain and the top of the net with a cork line; wooden staffs were fixed to each end of the net. Boats were brought to within 5 m of the site, and 2 individuals initiated deployment of the net. The net was carried rolled up to the center of the front stakes, unfurled, and spread out by passing around the outside of the stakes. Each individual then moved the net up the cut path

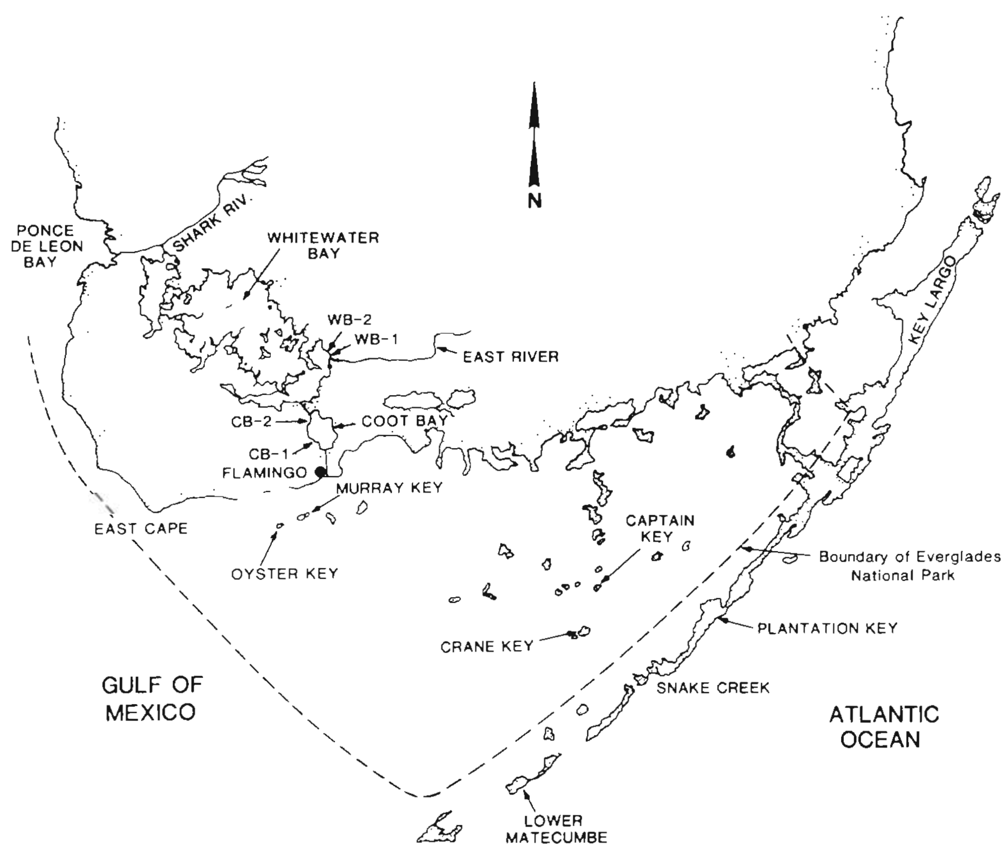

Fig. 1. Florida Bay and adjacent area showing location of mangrove sample sites in Whitewater Bay, Coot Bay, northwestern Florida Bay and southeastern Florida Bay

between mangroves onto the shore, pulling the net tight as they moved. The chain line was checked immediately and pushed into the sediment to prevent escape. Thus, the net blocked the front and sides of each area with the shore forming the interior border. A second net then was set at the nearby second mangrove site.

Once the 2 nets were set, rotenone was applied within the blocked area, with only 1 site being treated at a time. Liquid emulsifiable Noxfish (Penic Corp)* containing 5.0 % rotenone (w/w) was diluted ca 1:4 with water from the area and usually dispensed below the water surface by sprayer, although on occasion it was applied by bucket and stirred. Four people positioned themselves adjacent to the net and/or within the blocked area, and fish surfacing were dipped over the next 30 min and preserved in 10 % formalin. Very few fish surfaced after 20 min, and after 30 min, the chain line of the net was gently lifted and additional fish were collected from the wall of the net. It was our experience that this latter collecting process provided numerous fish that had not been taken by dipping.

We carried out mark and recapture studies to estimate our efficiency of recovery using the block net procedure. Silver jenny *Eucinostomus gula* were collected by trawl, fin clipped, and held in water for a minimum of 15 min to ensure no immediate handling mortality. Ca 30 live fish then were released into each blocked area prior to rotenone application. Other species such as gray snapper *Lutjanus griseus,* sheepshead *Archosargus probatocephalus,* pigfish *Orthopristis chrysoptera,* barracuda *Sphyraena barracuda,* pinfish *Lagodon rhomboides* and goldspotted killifish *Floridichthys carpio* also were used, but silver jenny was the primary species. Mean recovery in January was 58 % (range = 33 to 82 %), while on other occasions it was 75 % (range = 66 to 88 %).

After each mangrove site was sampled, a trawl was deployed to sample the fishes of the adjacent seagrass habitat. A 1 min otter trawl towed between 2 boats at a speed of ca 2.0 ± 0.2 m s^{-1} (3.5 to 4.5 knots) was taken at each station. This trawl was taken as close to the mangroves as was feasible, and normally took place 8 to 10 m from the shoreline in an area not disturbed by earlier boat movement to the mangrove site; these samples were taken ca 1 to 1.5 h after the start of mangrove samplings. The trawl measured 3.4 m at the head rope and 3.8 m at the foot rope; it was made of 6 mm bar mesh with a 3 mm mesh tail bag. The net was fitted with 3 mm galvanized tickler chain strung between the trawl boards. One tethered float was deployed at the beginning, another at the end of the trawl, and the distance between the floats measured with an optical range finder.

* Use of trade names does not imply endorsement by the National Marine Fisheries Service, NOAA

Ancillary data were collected at both mangrove and adjacent trawl stations to characterize the habitat. A sample was taken of the surface sediments for analysis of organic content (loss of weight upon ignition at 500 °C for 24 h) and for silt-clay content. The sediment was dried (70 °C), weighed, rewetted with saturated sodium hexametaphosphate, and wet sieved. Material retained on 4.00 mm (shell) and 0.063 mm (sand) sieves was redried and the difference between initial total dry weight and the sum of these 2 size fractions taken as a measure of silt-clay content; this is a modification of ASTM (1963). Water temperature and salinity, and sediment depth (by penetration with a marked pole) also were measured. Adjacent to the mid-point of the trawl path a diver took three 100 cm^2 quadrat samples of bottom vegetation for species identification, shoot enumeration, and determination of decalcified (5 % phosphoric acid) dry weight biomass.

In January 1985, additional measurements of root systems were made at each mangrove site. All mangrove roots at the level of the water surface (at mid-tide) were counted; prop roots exposed in the upper intertidal zone of each area also were enumerated. In addition, the diameter of 50 prop roots issuing from 1 or 2 randomly selected main roots off the trunk were measured using vernier calipers. Average diameter of prop roots at the mid-tide water surface and number of prop roots were used to estimate prop root surface area of the site occupied by prop roots. The circumference of each measured root also was calculated as an indication of potential surface available for epibiotic growth and for grazing by fishes. All measurements were made at a water depth of ca 0.5 m at the leading edge of the mangrove prop roots. Thus, in some instances, measurements were made at or near the sediment-water interface close to shore.

Collected fish were identified to species and counted. Maximum, minimum and standard length of a 'typical' individual species were measured and total wet weight of each species was determined. In the case of gray snapper *Lutjansu griseus* standard lengths of all individuals were recorded. Stomach contents of gray snapper collected in the mangroves were identified to major taxonomic groups: copepods, amphipods, isopods, shrimp, crabs, and fish; only crustaceans and fish were observed in snapper stomachs. Number and length of each food item were recorded. Gravimetric analysis was not appropriate because of a wide range in digestive decomposition and/or regurgitation caused by preservation time. These analyses were compared to similar analyses made on gray snapper collected from seagrass meadows and channels in Coot Bay, Whitewater Bay and Florida Bay collected within the same time frame in a separate phase of our study (US NMFS Beaufort Laboratory 1985). These latter samples were taken by 2-boat otter trawl.

RESULTS AND DISCUSSION

Habitat characteristics

The areas sampled ranged from generally low salinity and turbid to high salinity and clear. Coot Bay and Whitewater Bay sampling areas were characterized by low to intermediate salinities with a range of 5.5 ‰ in November 1984 to 20.0 ‰ in May 1985, and averages of 13.5 ‰ and 16.3 ‰, respectively (Tables 1 & 2). Both areas also are characterized by 'brown water' presumably resulting from dissolved organic matter leaching from mangroves. The Flamingo and upper Florida Keys sides of Florida Bay were characterized by high salinity water averaging 33 ‰ during our sampling period (range 27 to 42 ‰). The area in the vicinity of Murray Key and Oyster Keys in the northwestern part of Florida Bay is highly turbid as a result of suspension of fine carbonates (Tabb & Dubrow 1962). In contrast, water clarity was always high at Crane Key and Captain Key in the southeastern region of the Florida Bay. Additional characteristics of Whitewater, Coot and Florida Bays have been described by numerous individuals (e.g. Ginsburg 1956, Tabb & Manning 1961, Tabb & Dubrow 1962, Schomer & Drew 1982, Zieman 1982).

Characteristics of mangrove and adjacent seagrass sites varied regionally (Tables 1 & 2). Blocked mangrove areas varied in size by 2.7-fold with the largest in Coot Bay and the smallest in Whitewater Bay. At all sites, red mangrove prop roots dominated the physical structure of the blocked habitat with a range of from 660 to 2293 prop roots, or from 13.7 to 45.0 prop roots per m^2 of blocked area (Table 1). With the exception of the more northerly Whitewater Bay mangrove site (WB-2; Fig. 1), the total number of mangrove prop roots was related to the size of the area blocked. At the 4 Florida Bay sites, the area of open water within each blocked area that was outside the mangrove prop roots was similar, 16.3 to 20.5 m^2. Thus, of the 2 smaller sites (Captain Key, Murray Key) water interdigitated with prop roots represented half the blocked area while at the 2 larger sites water interdigitated with mangrove prop roots occupied >60 % of the blocked area. Similar measurements were not taken in Coot Bay or Whitewater Bay. At the surface of the water at mid-tide (or sediment if the area was exposed at the time of measurement), prop root diameter ranged from 0.8 to 4.9 cm with the mean for individual stations ranging from 2.3 to 3.2 cm. These prop roots occupied a total of 0.3 to 1.6 m^2 of water surface area at the sites and had collective perimeters ranging from 0.48 to 2.16 m

Table 1. Characteristics of mangrove habitats sampled for fish communities. WB = Whitewater Bay, CB = Coot Bay

Characteristic	Mangrove station							
	WB–1	WB–2	CB–1	CB–2	Murray	Oyster	Crane	Captain
Sediment								
% organic matter	31	38	34	40	10	7	26	10
% silt-clay	25	34	28	32	60	31	44	47
Depth (m)	0.9	0.7	1.3	1.4	0.4	2.0	1.7	2.0
Water depth (m)	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Blocked area								
Total area (m^2)	21.7	53.8	58.2	30.7	35.4	51.0	47.6	35.3
Open water (m^2)*	NC	NC	NC	NC	16.3	20.5	16.5	16.5
Mangrove roots								
Total no.	660	735	1745	803	942	2293	1443	915
No. m^{-2}	30.4	13.7	30.0	26.1	26.6	45.0	30.3	25.9
$\bar{X}$ Dia (cm)	2.3	2.8	2.4	2.3	2.9	3.0	3.2	2.6
Surface area (m^2)	0.27	0.45	0.79	0.33	0.63	1.63	1.19	0.49
Perimeter (m)	0.48	0.65	1.32	0.58	0.86	2.16	1.45	0.75
Salinity (‰)	13.1	13.6	16.3	16.3	30.0	33.4	33.9	35.5

NC: not computed
* Calculation of area of each blocked habitat without mangrove prop roots; difference between total and this value represents the approximate area surrounded by prop roots

(Table 1); this latter measure may be indicative of the surface available for browsing fishes to graze.

At the trawl sites, located ca 8 to 10 m from the mangrove fringe, submerged aquatic plants were prevalent. *Ruppia maritima*, widgeon grass, occurred at both of the low salinity areas in Whitewater Bay and Coot Bay, but did not occur in Florida Bay (Table 2). This plant also was more abundant at the Whitewater Bay areas than at Coot Bay, and during most of the study was characterized by having shoots extending to the water surface at the southernmost Whitewater Bay site (WB-1). Occasionally, large quantities of the alga *Chara hornemanni* also were present in Whitewater Bay. *Halodule wrightii*, Cuban shoalgrass, was present at both Coot Bay sites, and at Murray Key and Oyster Key (Table 2). Density and biomass of shoalgrass were much greater at the latter 2 sites than at the lower salinity Coot Bay areas. A third species, the turtlegrass *Thalassia testudinum*, was present only in Florida Bay and was most abundant at the Crane Key and Captain Key sites (Table 2), where it grew into the outer edge of the mangrove prop root habitat. Adjacent to Crane Key, turtlegrass was dense but fairly short, resulting in only a slightly higher dry weight biomass than occurred at Captain Key, which displayed almost half the number of short shoots per m^2. Thus, there was a great deal of variability in plant species composition, shoot density and biomass at paired sample sites as well as among regions.

Sediments varied in organic content and silt-clay content both within and between habitat types. Both Coot Bay and Whitewater Bay mangrove sediments were similar and had high organic contents ranging from a mean of 31 to 40 % (Table 1), while adjacent seagrass areas had values markedly lower (Table 2). The high and similar organic contents in the mangrove imply a quiescent environment with a build up of peat. Murray Key, Oyster Keys and Captain Key, on the other hand, had comparatively low organic matter values. Greater tidal amplitude and current were measured at Murray Key and Oyster Keys than elsewhere and, thus, these areas may be flushed of detrital matter more than other stations. Sand and shell particle sizes dominated the sediments of all mangrove habitats except Murray Key. The sediment in the adjacent seagrass was dominated by silt-clay particle sizes except at Crane Key.

Relative abundance of fish

A total of 18 482 fish distributed among 87 species and 39 families were collected from the mangrove and adjacent trawl stations between June 1984 and May 1985. Table 3 provides a listing of species and total numbers collected between June and May 1985; May 1984 data have been omitted from this table and subsequent analyses to avoid confounding temporal and site differences since we were unable to sample Crane Key and Captain Key sites in May 1984. Substantially greater numbers and biomass of fish were collected from the mangrove sites than from the adjacent seagrass habitats, with ca 75 % of the numbers (Table 3) and 68 % of the wet weight biomass of fish (36.8 of the total 54.2 kg) being taken from the mangroves.

Data on numbers and biomass for each site and sample date were converted to density and standing crop per m^2 for further comparisons by dividing total

Table 2. Characteristics of fringing seagrass stations sampled adjacent to mangrove prop root habitat sampled. RM = *Ruppia maritima*; HW = *Halodule wrightii*; TT = *Thalassia testudinum*; CH = *Chara hornemanni*

Characteristic	Station							
	WB–1	WB–2	CB–1	CB–2	Murray	Oyster	Crane	Captain
Sediment								
% organic matter	19	20	11	15	14	13	7	11
% silt clay	57	53	48	51	70	67	30	51
Depth (m)	0.4	0.5	1.0	0.9	1.9	1.3	1.3	1.5
Water depth (m)	1.1	1.1	1.2	0.9	0.9	0.8	1.2	1.1
Plant components								
Species	RM	RM	HW	HW	HW	HW	TT	TT
shoots m^{-2}	3310	493	580	750	2110	1970	1340	750
g dry weight m^{-2}	52.1	26.0	2.1	3.2	31.8	34.9	102.0	83.7
Species (cont'd)	CH	CH	RM	RM	TT			
shoots m^{-2}	–	–	38	460	30			
g dry wt m^{-2}	26.3	10.9	0.3	1.1	8.9			
Salinity (‰)	13.2	13.5	16.3	16.3	31.0	33.4	34.4	35.5

Table 3. Numbers of families and species of fish collected in mangrove prop root and adjacent seagrass sites in Coot Bay, Whitewater Bay, and Florida Bay during Jun 1984 to May 1985 and total numbers of each species collected. Mangrove samples were collected by block net; seagrass samples by high-speed trawl

Family/species	Mangrove	Seagrass	Total
Dasyatidae (Stingrays)			
Dasyatis sabina, Atlantic stingray	1	1	2
Elopidae (Tarpons)			
Elops saurus, ladyfish	–	1	1
Anguillidae (Freshwater eels)			
Anguilla rostrata, American eel	1	–	1
Ophichthidae (Snake eels)			
Myrophis punctatus, speckled worm eel	1	–	1
Clupeidae (Herrings)			
Brevoortia smithi, yellowfin menhaden	–	1	1
Harengula jacuana, scaled sardine	70	15	85
H. humeralis, redear sardine	119	–	119
Jenkinsia lamprotaenia, dwarf herring	56	16	72
Engraulidae (Anchovies)			
Anchoa hepsetus, striped anchovy	356	11	367
A. mitchilli, bay anchovy	808	968	1776
Synodontidae (Lizardfishes)			
Synodus foetens, inshore lizardfish	8	30	38
Ariidae (Sea catfishes)			
Arius felis, hardhead catfish	–	46	46
Batrachoididae (Toadfishes)			
Opsanus beta, gulf toadfish	79	25	104
Gobiesocidae (Clingfishes)			
Gobiesox strumosus, skilletfish	58	–	58
Exocoetidae (Flyingfishes)			
Chriodorus atherinoides, hardhead halfbeak	–	2	2
Hyporhamphus unifasciatus, halfbeak	1	–	1
Belonidae (Needlefishes)			
Strongylura marina, Atlantic needlefish	4	–	4
S. notata, redfin needlefish	82	–	82
S. timucu, timucu	46	4	50
Cyprinodontidae (Killifishes)			
Cyprinodon variegatus, sheepshead minnow	6	–	6
Floridichthys carpio, goldspotted killifish	1465	37	1502
Fundulus confluentus, marsh killifish	6	–	6
F. grandis, gulf killifish	181	–	181
F. similis, longnose killifish	42	–	42
F. seminolis, seminole killifish	1	–	1
Lucania parva, rainwater killifish	1222	280	1502
Poeciliidae (Livebearers)			
Gambusia affinis, mosquitofish	92	–	92
Poecilia latipinna, sailfin molly	226	–	226
Atherinidae (Silversides)			
Atherinomorus stipes, hardhead silverside	4608	–	4608
Hypoatherina herringtonensis, reef silverside	5	–	5
Membras martinica, rough silverside	409	–	409
Menidia peninsulae, tidewater silverside	179	44	223
Syngnathidae (Pipefishes)			
Hippocampus erectus, lined seahorse	–	9	9
H. zosterae, dwarf seahorse	2	18	20
Syngnathus dunckeri, pugnose pipefish	–	19	19
S. floridae, dusky pipefish	2	30	32
S. louisianae, chain pipefish	–	5	5
S. scovelli, gulf pipefish	219	145	364
Centropomidae (Snooks)			
Centropomus undecimalis, snook	3	1	4
Centrarchidae (Sunfishes)			
Lepomis macrochirus, bluegill	1	–	1
L. punctatus, spotted sunfish	1	–	1
Carangidae (Jacks)			
Caranx hippos, crevalle jack	1	–	1
Oligoplites saurus, leatherjacket	4	–	4
Selene vomer, lookdown	–	1	1
Lutjanidae (Snappers)			
Lutjanus griseus, gray snapper	27	5	32
L. synagris, lane snapper	1	11	12
L. apodas, schoolmaster	1	–	1
Gerreidae (Mojarras)			
Eucinostomus argenteus, spotfin mojarra	505	251	756
E. gula, silver jenny	1901	1961	3862
Haemulidae (Grunts)			
Haemulon aurolineatum, tomtate	–	8	8
H. parrai, sailors choice	8	1	9
H. plumieri, white grunt	–	5	5
H. sciurus, bluestriped grunt	2	–	2
Orthopristis chrysoptera, pigfish	–	22	22
Sparidae (Porgies)			
Archosargus probatocephalus, sheepshead	6	12	18
Calamus arctifrons, grass porgy	–	1	1
Lagodon rhomboides, pinfish	14	304	318
Sciaenidae (Drums)			
Bairdiella chrysoura, silver perch	–	86	86
Cynoscion nebulosus, spotted seatrout	2	32	34
Menticirrhus littoralis, gulf kingfish	–	1	1
Pogonias cromis, black drum	2	–	2
Sciaenops ocellatus, red drum	1	–	1
Scaridae (Parrotfishes)			
Sparisoma rubripinne, redfin parrotfish	–	1	1
Mugilidae (Mullets)			
Mugil cephalus, striped mullet	32	–	32
M. curema, white mullet	45	1	46
Sphyraenidae (Barracudas)			
Sphyraena barracuda, great barracuda	35	6	41
Clinidae (Clinids)			
Paraclinus fasciatus, banded blenny	4	–	4
Blenniidae (Combtooth blennies)			
Chasmodes saburrae, Florida blenny	2	–	2
Callionymidae (Dragonets)			
Callionymus pauciradiatus, spotted dragonet	10	4	14
Gobiidae (Gobies)			
Bathygobius soporator, frillfin goby	21	–	21
Gobiosoma bosci, naked goby	116	27	143
G. robustum, code goby	441	5	446
Lophogobius cyprinoides, crested goby	11	–	11
Microgobius gulosus, clown goby	326	72	398
Acanthuridae (Surgeonfishes)			
Acanthurus chirurgus, doctorfish	1	–	1
Triglidae (Searobins)			
Prionotus scitulus, leopard searobin	1	–	1
P. tribulus, bighead searobin	2	–	2
Bothidae (Lefteye flounders)			
Paralichthys lethostigma, southern flounder	–	1	1
P. albiqutta, gulf flounder	–	1	1
Soleidae (Soles)			
Achirus lineatus, lined sole	2	2	4
Trinectes maculatus, hogchoker	–	4	4
Cynoglossidae (Tonguefishes)			
Symphurus plagiusa, blackcheek tonguefish	1	–	1
Balistidae (Triggerfishes)			
Aluterus schoepfi, orange filefish	–	1	1
Monacanthus ciliatus, fringed filefish	–	5	5
M. hispidus, planehead filefish	–	8	8
Tetraodontidae (Puffers)			
Sphoeroides nephelus, southern puffer	–	9	9
Diodontidae (Porcupinefishes)			
Chilomycterus schoepfi, striped burrfish	–	2	2

values by respective areas sampled by the 2 gears. The areas of each mangrove site ranged from 21.7 to 58.2 m^2 (Table 1). The area covered by the otter trawl in 1 min ranged from 260 to 540 m^2 and averaged 351 m^2 (SE = 7.7; N = 62). The effective opening of the otter trawl of ca 3 m was used in calculating area sampled. Numbers and biomass of fish per unit area were summed over the survey periods and evaluated using ANOVAs. The model for the ANOVAs was that for a split plot design where the 'whole-plot' factor was regions in the Park sampled (e.g. Whitewater Bay, Coot Bay, northwestern Florida Bay, southeastern Florida Bay), and the subplot factor was sampled habitat (mangrove *vs* adjacent seagrass). Because of heterogeneity of variances, the data were transformed to logarithms prior to calculations.

There were significantly higher numbers and biomass of fish per m^2 in the mangrove habitats than in the immediately adjacent fringing seagrass habitats (Table 4a, b). The average (geometric mean) density of fish collected in the mangroves (8.0 m^{-2}) was about 35 times that collected in the immediately adjacent habitat (0.22 m^{-2}) on an areal basis. There was no evidence of interaction between region and habitat type or of differences among the 4 regions (Table 4a). Densities of fish collected in the red mangrove prop root habitat exceeded those from the adjacent habitat in all 62 collections (Table 5a). Analysis of biomass on an areal basis similarly detected significant differences among habitats and no evidence of interaction between region and habitat or of differences among regions (Table 4b). Average biomass of fish in the mangroves (15.0 g m^{-2}) was about 19 times greater in the mangroves than in the adjacent habitat (0.8 g m^{-2}). Biomass of fish taken from the mangroves exceeded values from adjacent seagrass meadows in 57 of the 62 samples, and the occasions when values for the adjacent habitat exceeded the mangroves were at Coot Bay (Table 5b). Here, catches of hardhead catfish *Arius felis* were responsible for the higher seagrass-trawl standing crops of fish. Fish taken from the mangroves were considerably smaller than those from the adjacent seagrass area, i.e. 1.9 g (wet weight) $fish^{-1}$ *vs* 3.5 g $fish^{-1}$. Inasmuch as we might expect some larger fish to be more adept at avoiding the trawl even at this high tow speed but not less susceptible to the rotenone, the actual difference in mean size may be greater than the data indicate.

Table 4a. Analysis of variance of total numbers of fishes per m^2. Surveys conducted between Jun and May. Data transformed to logarithms of total number + 1.0 prior to calculations

Source	df	Mean square	F
Among regions	3	0.4002	2.57
Among blocks	1	0.0067	
Mainplot error	3	0.1554	
Mangrove *vs* seagrass	1	11.4274	94.73*
Region × mangrove-seagrass	3	0.6129	5.08
Subplot error	4	0.1206	

Table 4b. Analysis of variance of total biomass of fishes per m^2. Surveys conducted between Jun and May. Data transformed to logarithm of total biomass + 1.0 prior to calculations

Source	df	Mean square	F
Among regions	3	0.4398	3.54
Among blocks	1	0.4379	
Mainplot error	3	0.1244	
Mangrove *vs* seagrass	1	15.3934	93.94*
Region × mangrove-seagrass	3	0.5330	3.05
Subplot error	4	0.1745	

* $p = < 0.0007$

We recognize that some of the differences observed between densities and standing crops of fish collected in the 2 habitats may be the result of differences in efficiency of the 2 gears used. Our estimates of the efficiency of the block net-rotenone technique are based on tagged fish released into each blocked area prior to rotenone application. These estimates provided a mean recovery of ca 70 % with a mean of 58 % in January and 75 % thereafter. In January when water temperatures were about 17 to 20 °C, fish tended to sink rather than surface when rotenone was applied. We have no estimate for the efficiency of the 2-boat otter trawl. Trawl efficiencies vary among species and sizes of fish. Kjelson & Colby (1977) estimated gear efficiency of a 6.1 m otter trawl, towed by a single boat at about 0.8 m s^{-1} during the day, to range from 16 to 69 % for juvenile pinfish and spot. Increasing the tow speed as we did to 1.8 to 2.2 m s^{-1} should have reduced the ability of fish to avoid the trawl, but even if the trawl had an efficiency of only 20 %, our data would still imply much lower fish densities and standing crops in the adjacent seagrass meadows then in the mangrove habitats. The use of 2 boats greatly aids in attaining and maintaining this speed in trawling through grass beds as well as in maintaining the doors open to the maximum possible extent. Estimates of density obtained by this trawl method (1 min, 2 boats, 3.5 to 4.5 knots) over submerged grass beds are not dissimilar to those obtained throughout Florida Bay, Coot Bay and Whitewater Bay in over 250 trawls (2 min, 2 boats) over both vegetated and unvegetated bottoms (US NMFS Beaufort Laboratory 1985). We conducted some preliminary trials using a 4.0 m^2 Wegener ring and rotenone in the fringing seagrass habitat, but this approach normally yielded very low numbers of fish per ring and very low diversity. Estimates obtained for fringing seagrass areas, while low, are in the range collected from other meadows in Florida: 0.2 to 2.0 m^2 in Biscayne Bay seagrass beds (Sogard 1982); 0.3 to 1.5 m^2 in Apalachee Bay, and <0.6 m^2 in Indian River (computed by Sogard et al. unpubl.). Sogard et al., however, reported mean densities of 11 fish m^{-2} on several carbonate banks in Florida Bay using 1 m^2 throw traps.

We observed an overall seasonal trend in both mean numbers and biomass of fish at mangrove and adjacent seagrass sites. The overall density and standing crop of fish were maximum in fall in the mangrove habitat; this habitat type also displayed the greatest month-to-month variation in mean values (Fig. 2). There was an increase in abundance during autumn and again in spring; mean biomass also increased in autumn but decreased between March and May 1985. The precipitous decrease in the mean standing crop biomass of fishes collected among the mangrove prop roots in January 1985 coincided with a predominance of early stage juvenile (17 to 21 mm, standard length) silver jenny *Eucinostomus gula*, rainwater killifish *Lucania parva* and sailfin molly *Poecilia latipinna*, and a decrease in the average wet weight per individual (0.6 g). These data suggest spawning occurs during late autumn for these species in the Florida Bay area, and that the mangrove prop root habitat may provide refuge from predators. Although small individuals also were present 2 mo later in March, the average individual was larger and ranged in size from 27 to 47 mm for silver jenny, 19 to 27 mm for rainwater killifish and 22 to 35 mm for sailfin molly, further suggesting that this habitat may be important in growth and survival of these species. In the adjacent seagrass habitat there was a slight trend for density and standing crop values to be higher in summer and decrease during fall. Wet weight of an average individual was minimum in November (1.9 g). Small (<20 mm) silver jenny and rainwater killifish were present in the seagrass habitat during January and March, but larger individuals (>30 mm) were the rule. We believe that the abund-

Table 5a. Density of fish (numbers m^{-2}) collected from mangrove and adjacent seagrass sites in Everglades National Park, Florida

Site/habitat	Month, year							
	May 1984	Jun	Jul	Sep	Nov	Jan 1985	Mar	May
Murray Key								
Mangrove	1.2	1.8	2.8	5.9	5.5	3.0	2.3	3.7
Seagrass	0.07	0.05	1.4	0.57	0.19	0.14	0.21	0.73
Oyster Keys								
Mangrove	0.9	0.7	1.3	4.8	8.3	8.9	0.8	2.5
Seagrass	0.09	0.32	0.25	0.82	0.12	0.08	0.22	0.22
Crane Key								
Mangrove	NS	1.4	1.0	14.7	9.8	4.4	11.7	30.5
Seagrass	NS	0.01	0.09	0.30	0.26	0.03	0.00	0.03
Captain Key								
Mangrove	NS	1.5	0.3	3.2	86.6	27.7	2.5	0.9
Seagrass	NS	0.02	0.06	0.15	0.26	0.05	0.01	0.16
Whitewater Bay–1								
Mangrove	3.1	2.8	5.4	4.5	12.4	1.5	9.3	17.5
Seagrass	0.09	0.02	0.10	0.17	0.05	0.09	0.14	0.17
Whitewater Bay–2								
Mangrove	1.9	1.4	1.1	2.2	3.3	2.3	1.8	4.2
Seagrass	0.21	0.09	0.05	0.05	0.00	0 19	0.20	0.07
Coot Bay–1								
Mangrove	0.9	1.0	2.6	9.0	2.7	1.9	0.3	3.7
Seagrass	0.14	0.03	0.12	0.21	0.63	0.02	0.21	0.39
Coot Bay–2								
Mangrove	0.8	0.6	1.4	6.5	7.4	1.4	0.9	4.0
Seagrass	0.09	0.22	0.37	0.71	1.4	0.05	0.08	0.03

NS: no sample

ance of early stage juvenile silver jenny, rainwater killifish and sailfin molly among the red mangrove prop roots relative to the adjacent seagrass habitat implies a major refuge role for the prop root habitat.

Species composition and habitat comparisons

The 10 dominant species for the overall study period (Jun 1984 to May 1985) in decreasing order of abundance were: hardhead silverside *Atherinomores stipes*, silver jenny *Eucinostomus gula*, bay anchovy *Anchoa mitchilli*, goldspotted killifish *Floridichthys carpio*, rainwater killifish *Lucania parva*, spotfin mojarra *E. argentus*, code goby *Gobiosoma robustum*, striped anchovy *Anchoa hepsetus*, gulf pipefish *Syngnathus scovelli*, and clown goby *Microgobius gulosus*. Silver jenny, bay anchovy and gulf pipefish were more abundant in the adjacent seagrass meadows than in the mangrove sites. The other 7 dominants, however, were relatively more abundant among the mangrove prop roots (Table 3), and hardhead silverside were taken only among the mangrove prop roots. Only a few of these 10 species have been listed among the dominant species in previous collections in Florida Bay, Coot Bay and Whitewater Bay, although most occur frequently but not in abundance (Tabb & Manning 1961, 1962, Odum et al. 1982, Sogard et al. unpubl.). We believe that this general lack of information on prevalent species in south Florida is in part due to the paucity of information on mangrove and shore communities in south Florida. Carter et al. (1973), however, do report that mojarras (*Eucinostomus* spp.) were among the dominant species collected in areas of the Ten Thousand Islands, Florida.

The overall composition of the mangrove-fish community collected during the day was more diverse than that collected in the immediately adjacent seagrass habitat. Families Atherinidae, Cyprinodontidae, Gerreidae, Engraulidae and Gobiidae were represented most abundantly among the mangrove prop roots, while Gerreidae, Engraulidae, Cyprinodontidae and Sparidae were most prevalent in the seagrass (Table 3). Thirty-six species were collected exclusively in the fringing mangrove habitat while 24 species were taken exclusively in adjacent waters. Another 27

Table 5b. Wet weight standing crop fish (g m^{-2}) collected from mangrove and adjacent sites in Everglades National Park, Florida

Site/habitat	Month, year							
	May 1984	Jun	Jul	Sep	Nov	Jan 1985	Mar	May
Murray Key								
Mangrove	5.8	26.2	58.1	9.8	3.0	0.4	78.3	8.1
Seagrass	0.2	0.4	5.9	1.0	0.5	0.3	0.7	2.8
Oyster Keys								
Mangrove	4.8	38.6	52.1	22.6	5.0	1.9	1.3	8.7
Seagrass	0.1	0.3	0.7	0.7	0.3	0.1	0.6	0.8
Crane Key								
Mangrove	NS	2.3	0.9	26.4	9.3	3.4	11.9	50.0
Seagrass	NS	0.01	0.3	0.8	0.6	1.3	0.0	0.08
Captain Key								
Mangrove	NS	1.3	0.9	2.7	108.1	19.0	2.3	2.4
Seagrass	NS	0.01	0.2	1.0	0.4	0.7	0.01	0.1
Whitewater-Bay–1								
Mangrove	20.4	1.1	4.0	11.8	23.4	2.4	57.9	26.6
Seagrass	0.1	0.004	0.3	0.3	0.05	0.05	0.6	0.6
Whitewater Bay–2								
Mangrove	1.5	0.5	1.7	6.7	1.7	0.6	9.5	2.4
Seagrass	0.6	0.1	0.03	0.02	0.0	0.4	0.1	0.5
Coot Bay–1								
Mangrove	1.8	21.8	0.9	15.4	11.2	2.4	0.4	1.7
Seagrass	0.4	3.5	1.0	1.4	2.8	0.4	0.08	0.7
Coot Bay–2								
Mangrove	1.2	0.8	1.3	6.6	6.9	2.2	0.2	9.4
Seagrass	2.2	1.1	3.2	1.1	1.3	0.03	3.0	0.1

NS: no sample

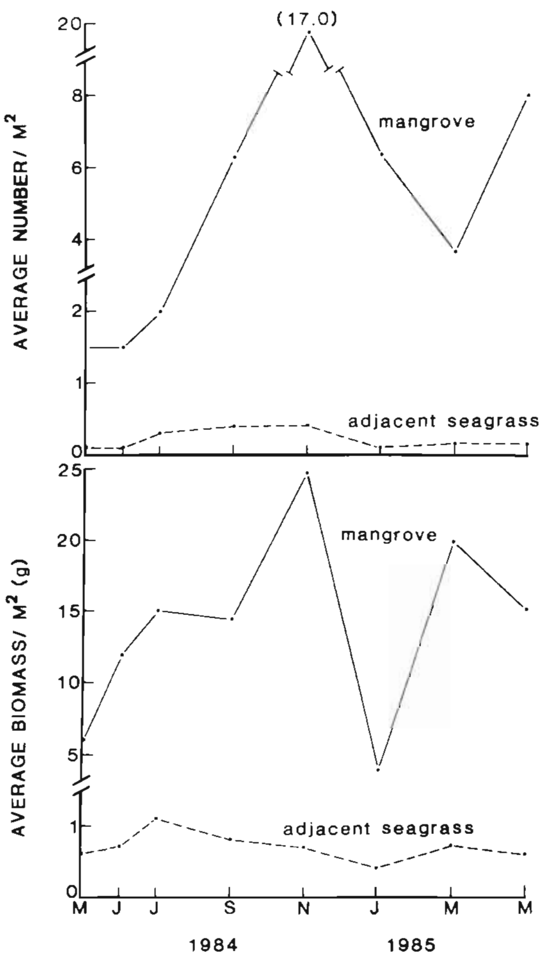

Fig. 2. Average abundance and biomass of fishes (per m^2) taken from 8 mangrove prop root habitats and 8 adjacent seagrass habitats in Everglades National Park

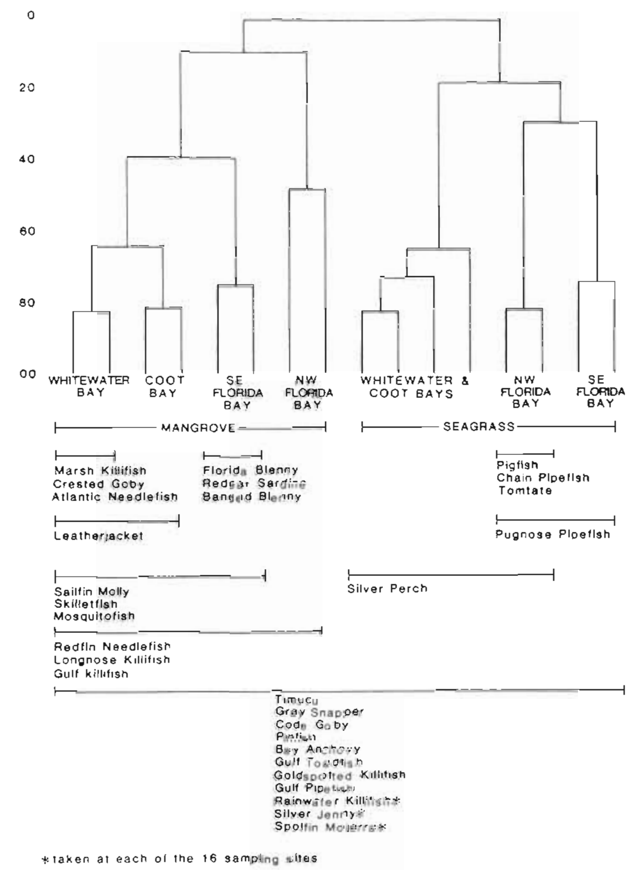

Fig. 3. Cluster analysis of 16 sample sites in Everglades National Park based on occurrence of 56 fish species. Species common to various regions and habitats listed in lower portion of figure

species were collected in both habitats (Table 3). Thirty-one species were collected only once and 17 of these were collected in the mangroves. Based on a few day-night comparisons (own unpubl. data), diversity and abundance in the mangrove habitat appear to increase at night.

Fish communities among geographic regions and between mangrove and adjacent seagrass habitats were compared using data on 56 species collected from at least 2 of the 8 sampling areas during this study. Our initial analysis was based on presence and absence of species. We used the absolute value of the correlation of a measure of similarity (BMDP 1983), and followed a complete or maximum distance linkage rule as recommended by Gauch (1982) in forming clusters. There was a clear separation of the mangrove and adjacent seagrass fish communities we collected during daylight (Fig. 3). With the exception of adjacent seagrass communities in Coot Bay and Whitewater Bay (Fig. 3), replicates within a given habitat and region resembled one another more closely than communities within that habitat in other geographical regions.

Eleven species were collected in every region and in both habitats. Three of these species – silver jenny, rainwater killifish, and spotfin mojarra – were collected at every one of the 16 sites and were among the dominants we collected during the study (Table 3). Mojarras (*Eucinostomus* spp.) are reported to be dominant species in mangrove-lined bays in the Ten Thousand Islands (Carter et al. 1973, Colby et al. 1985), and Tabb & Manning (1961) – sampling in Whitewater Bay, Coot Bay, and Florida Bay – reported the 2 mojarra present but not abundant in the brackish waters of Coot Bay and Whitewater Bay. In our collections, however, both were among the dominants in the mangrove and adjacent seagrass fish communities, with densities in Coot Bay and Whitewater Bay frequently exceeding those at the high salinity sites in Florida Bay. Rainwater killifish, reportedly abundant in low salinities (Tabb & Manning 1961, Carter et al.

1973), was most abundant in our study among mangrove prop roots and was collected in greater abundance in higher salinity in southeastern Florida Bay sites at Crane Key than at either of the lower salinity Coot Bay or Whitewater Bay sites. Other species, normally associated with grass flats or bay bottoms (e.g. pinfish, code goby, gulf pipefish) and open water conditions (e.g. bay anchovy, timucu) were taken in both habitats. Juvenile gray snapper, an important recreational species in Everglades National Park, was taken in both mangrove and seagrass habitat types but most frequently in the mangrove prop root area. The only site where we did not collect gray snapper among the mangroves was Murray Key, and our only samples of gray snapper in the adjacent seagrass meadows were at Captain Key and Crane Key. Although densities of gray snapper were low, when one considers the linear extent of mangrove fringe present in south Florida, the prop root habitat must be considered important to the production of this sportfish.

There were 14 species of fish collected on more than one occasion (Fig. 3). Hardhead silverside was the most abundant fish collected, and was taken almost exclusively from mangrove habitats in Florida Bay at Crane Key and Captain Key during autumn and spring; this species did appear once in Whitewater Bay collections, and therefore does not show up on this figure. Two killifish and 1 needlefish were collected in all 4 geographic regions. Both species of killifish were reported as rare in the area by Tabb & Manning (1961) and were not collected in the bay system of the Ten Thousand Island region by Carter et al. (1973) or Colby et al. (1985); it must be remembered that none of these investigations sampled the mangrove habitat *per se.* Among these mangrove sites, the sailfin molly *Poecilia latipinna,* mosquitofish *Gambusia affinis* and skilletfish *Gobiesox strumosus* did not appear to be restricted by salinity, being collected at the high salinity southeastern Florida Bay mangrove sites as well as at the much lower salinity mangrove sites (see Table 1a, b for salinity) in Coot Bay and Whitewater Bay. Odum et al. (1982), however, do not report the sailfin molly from low salinity mangrove-lined habitats in south Florida. Marsh killifish *Fundulus confluentus,* crested goby *Lophogobias cyprinoides* and Atlantic needlefish *Strongylura marina,* all collected only in low numbers among mangrove prop roots, were restricted to the low salinity sample sites, while redear sardine *Harengula humeralis* (119 individuals) as well as 2 blennies were present only in mangrove habitats near the Florida Keys (high salinity). Mullet (*Mugil* spp.), commercial fish in Florida Bay, were collected only at Oyster Keys and Murray Key. Of the 78 mullet collected (Table 3), 77 were taken among mangrove prop roots, but, in this instance we know that trawling would under-sample juvenile and adult mullet. These fish presumably feed on sediments and detritus. Thus, our data show that several of the species using the fringing prop root habitat are of commercial or recreational value, while many are important forage organisms for predatory fish.

Unlike the prop root community, no species collected from the adjacent seagrass habitat was present in all 4 sampling regions. Silver perch *Bairdiella chrysoura* was the most ubiquitous, being collected in all seagrass areas except at Captain Key and Crane Key. This species is reported as the most abundant sciaenid in the Florida Bay area (Tabb & Manning 1961). Although not one of the dominant fish collected in our study, it was among the most abundant organisms in the mangrove-lined bay system of the Ten Thousand Islands on the west coast of Florida (Carter et al. 1973, Colby et al. 1985). Several species (pigfish, chain pipefish, tomtate) were restricted to the high salinity seagrass sites adjacent to the mangroves in Florida Bay or just to those fringing seagrass meadows sampled in northwestern Florida Bay (Fig. 3). Their distribution was consistent with the observation of Tabb & Manning (1961) that these species generally are most prevalent on vegetated bottoms in high salinity areas of Florida Bay rather than in Coot Bay or Whitewater Bay.

A second analysis, based on logarithms of species abundances, resulted in a somewhat different grouping of the 16 sampling sites (Fig. 4). The major difference from our first approach (analysis of presence) was that mangrove fish communities in northwestern Florida Bay more closely resembled seagrass communities than other mangrove communities when data on total abundance were employed. Interestingly, these 2 stations were more similar to the seagrass communities of Whitewater Bay and Coot Bay than to

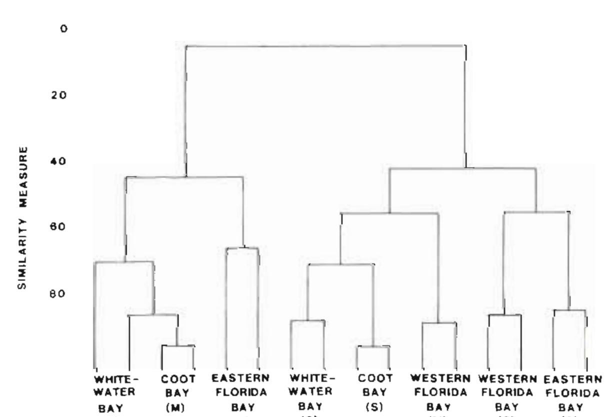

Fig. 4. Cluster analysis of 16 sample sites in Everglades National Park based on logarithm of abundance of 56 fish species. Mangrove and seagrass sites denoted by (M) and (S) respectively

the seagrass communities immediately adjacent to them in western Florida Bay. With several exceptions, there was again a tendency for replicates to more closely resemble one another than samples from other habitats or other regions.

Examination of species abundance data suggested that the main reason the 2 mangrove communities of northwestern Florida Bay more closely resemble the adjacent fringing seagrass communities than mangrove communities in other regions was that these 2 sites contained few species that were markedly abundant in the other mangrove sites sampled, i.e. striped anchovy, mosquitofish, skilletfish, naked goby *Gobiosoma bosci*, code goby, gulf toadfish *Opsanus beta*, clown goby, and sailfin molly. These 2 sites also contained certain species, such as the inshore lizardfish *Synodus foetens*, otherwise found only in fringing seagrass sites.

Comparison of food habits of gray snapper collected from mangroves and adjacent seagrasses

An important sportfish in Everglades National Park is the gray snapper *Lutjanus griseus*; its abundance is perceived to be declining in the Park (J. Tilmant, ENP, pers. comm.). Although its abundance was never high in the mangrove prop root habitats (0 to 4 site^{-1} on any one sample date), this species was collected at all but the Murray Key site during the study. Gray snapper also were collected in channels and open water trawl samples over seagrass meadows (in lower areal densities) in a separate phase of our overall study (US NMFS Beaufort Laboratory 1985); only 4 snapper were collected from the fringing seagrass sites immediately adjacent to the mangroves, however (Table 3). These collections provided an opportunity to compare food habits of fish from the 2 habitat types.

Starck (1971) carried out a detailed study of food habits and feeding of gray snapper collected from grass meadows, coral reefs and areas adjacent to mangroves. He reported that small juveniles collected from seagrass areas consumed crustaceans (93 %), primarily amphipods and caridean shrimp; larger juveniles collected near mangroves and in seagrass beds also consumed crustaceans (69 %), primarily pink shrimp *Penaeus duorarum* and xanthid crabs. Starck further reported a high incidence (52 %) of empty stomachs, and stated that juvenile snappers in grass beds fed during the day while larger snappers fed at night; stomachs of fish collected in late afternoon were generally empty.

There were only a few qualitative differences in gut contents of snapper taken from the 2 habitats (Fig. 5 & 6). The primary food items for fish from both habitat types were isopods, amphipods, xanthid crabs, caridean shrimp and demersal fish, observations similar to those of Starck (1971). Penaeid shrimp were absent in the diet of snapper collected from the mangrove prop root habitat. The frequency of occurrence of penaeid shrimp in fish collected from seagrass meadows was 34 %, similar to the overall frequency reported by Starck (1971), while it was zero for fish collected from mangroves. We rarely collected or observed penaeid shrimp in the mangrove habitat; they were more common in adjacent habitat trawl samples, and reported to be the dominant large invertebrate in the Florida Bay seagrass meadow/carbonate mud bank habitat (Tabb & Dubrow 1962). Identifiable fish in stomach contents of snapper collected in mangroves were rainwater killifish and pipefish (Syngnathidae), while gulf toadfish, goby (Gobidae), seahorse (*Hippocampus* spp.), and silver jenny were consumed in the seagrass beds.

Our limited stomach-content analyses and observations suggest both a feeding and refuge strategy by gray snappers utilizing the mangrove prop root habitat. We sampled during mid-day, the period Starck (1971) indicated that juvenile but not larger snapper should be feeding. With the exception of the 151 to 250 mm snapper collected from the mangroves, there was a trend for a higher frequency of empty stomachs in larger fish (Fig. 5). We do not know if rotenone may have caused regurgitation in larger fish, but the fact that a similar trend was observed in the seagrass meadow samples (Fig. 6), where rotenone was not employed, suggests that this was not the case. The presence of rainwater killifish and absence of shrimp in the guts of snappers from the mangrove prop root areas also suggests that smaller snapper feed within the prop root habitat. By their presence, prop roots should slow water currents allowing settlement of fine

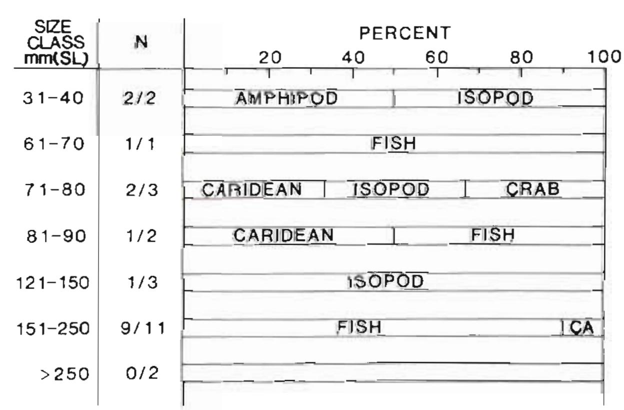

Fig. 5. *Lutjanes griseus*. Frequency of occurrence of food items in stomachs of 24 gray snapper collected in mangrove prop root habitats of Everglades National Park. N = number of fish with food relative to number of stomachs examined. CA = caridean shrimp. Three fish (May 1985) not processed

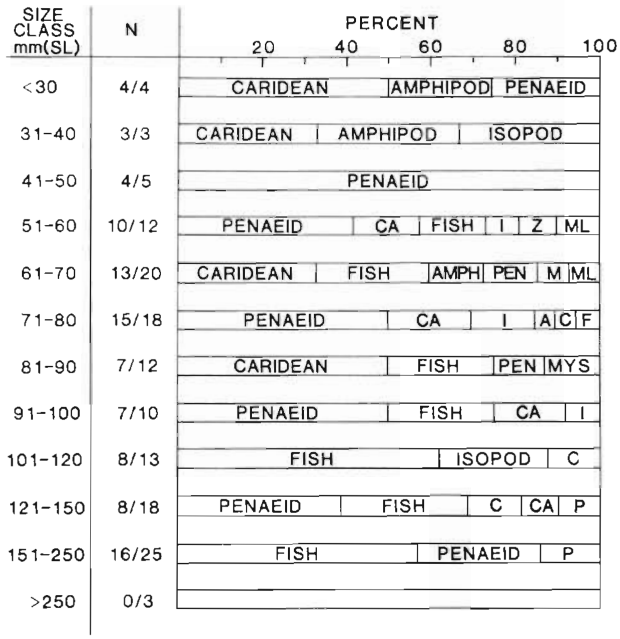

Fig. 6. *Lutjanes griseus.* Frequency of occurrence of food items in stomachs of 143 gray snapper collected in channels and seagrass meadows in Everglades National Park. N = number of stomachs with food relative to number examined. I = isopod; Z = zoea; ML = megalopa; M or MYS = mysid shrimp; A or AMPH = amphipod; C = crab; CA = caridean shrimp; F = fish; PEN = penaeid shrimp; P = plant debris

material, both living and dead, onto epiphyte-covered prop roots as well as onto the sediment, thereby providing a rich and varied food resource for other fish and invertebrates. It is likely that the prop roots themselves also provide a degree of protection from predators in a manner similar to seagrass blades (Orth et al. 1984, Thayer et al. 1984), and it is not unusual to see fish and spiny lobsters dart into the mangrove habitat when an object or shadow passes by.

CONCLUSIONS

Within the geographical area encompassed by our study, the intertidal fringing red mangrove prop root habitat and immediately adjacent seagrass meadows support different fish communities during daylight. Despite the fact that both sampling techniques employed were less than 100 % efficient, our data show the fringing red mangrove prop root habitat to be of major importance for a wide variety of fishes. This habitat appears to support an overall greater density and standing crop biomass of fishes than the adjacent fringing seagrass habitat. Several species utilizing mangroves are of commercial and recreational importance; many are forage foods for predatory fishes. It seems likely that increasing the sample size either by sampling additional examples of each habitat within each region, or by extending the sampling period in time, might, to some extent, blur some of the boundaries of the fish communities that have emerged from this analysis. It is nevertheless clear that these 2 major habitats fulfill different functions for different species of fishes during the day and that both are essential to the viability of fish production in this region.

Our sampling and analyses presented here do not address the day-night utilization of mangrove prop root and adjacent fringing seagrass habitats. It is entirely possible that a fraction of the fish community utilizing mangrove prop root habitat leaves that habitat at night to forage in nearby seagrass communities similar to some patch-reef coral fishes (Zieman 1982). We did carry out several preliminary day-night comparisons (unpubl.). These suggested that, in general, there is a more diverse and larger fish community among prop roots at night than during the day. Several species, however, were more abundant during daylight than at night, data that lend some support to the above hypothesis.

Overall losses of mangroves in south Florida have not been great but there have been substantial losses in specific locations (Odum et al. 1982). Because degradation of these habitats is continuing to occur both through natural and man-induced events, it is important that we recognize the values of fringing mangroves as nursery areas for commercial and recreational fishes and their food resources in order to predict impacts of alterations before they occur. Efforts need to be expended to evaluate this and more extensively flooded mangrove habitats for their relative value to fish and crustaceans.

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