Island Mangrove Habitats as Spawning and Nursery Areas for Commercially Important Fishes in the Caribbean

GEORGE D. DENNIS
Department of Marine Sciences
University of Puerto Rico
Mayaguez, PR 00709-5000

ABSTRACT

Red mangrove (*Rhizophora mangle*) habitats have been typically considered nursery areas for larval and juvenile fishes. Preliminary sampling of nearshore coral reef, seagrass bed, and mangrove habitats in southwestern Puerto Rico using a night light - lift net methodology for the collection of larval and juvenile fishes suggest that few fish spawn in or near mangroves. There were equal or greater numbers of fish larvae in nearby seagrass bed and coral reef habitats when compared with mangrove prop root and lagoon habitats. Visual census in mangroves and adjacent habitats indicate that some common species that occur as juveniles in mangroves are also abundant in other habitats.

Island red mangrove habitats may be significantly different from continental mangrove habitats that have substantially more "estuarine" species. Commercially important fishes at most island locations are predominantly coral reef species. Mangrove dependent species make up only a small portion of the commercial landings. The role of mangroves as nursery areas may be over-estimated for island habitats where seagrass beds and reefs may also be important nursery areas.

INTRODUCTION

There has been an increasing interest in mangrove fishes in recent years (Austin, 1971; Odum and Heald, 1972; Valdes-Munoz, 1981; Galzin *et al.*, 1982; Louis and Lasserre, 1982; Ross, 1982; Louis *et al.*, 1985; Thayer *et al.*, 1987). It is a widely held view that mangroves are primary nursery areas for commercially important fishes (Heald and Odum, 1970). In fact, Hamilton and Snedaker (1984) state "it has been estimated that 80% of all marine species of commercial or recreational value in Florida are dependent upon mangrove estuarine areas for at least some critical stage of their life history". The basis of the nursery area concept has been the collection of larval and juvenile fishes within the mangrove system, but this paradigm has come into question in recent years. The occurrence of larval and juvenile fishes in mangrove areas is not prima-facie evidence that they are critical nursery areas. Most fish species in the tropics are distributed over a range of habitat types as juveniles and adults with one or two types considered important based on abundance.

The distribution of fishes may be due to habitat selection, stochastic recruitment, differential mortality, or ontogenetic migration (Sale, 1980). Some fishes should be expected by chance to occur in mangrove areas even if they contribute little to maintenance of the population. If we assume that the abundance (standing stock) can be used as a first approximation of the significance of a habitat to a given life-history stage of a species then we can assess the importance of various habitats by comparing abundance among habitats. If mangroves have significantly fewer larvae or juveniles than other habitats then they should not be considered a critical nursery area for a given species.

In this paper I make a preliminary comparison of the abundance of larval and juvenile fishes among nearshore habitats in southwestern Puerto Rico and assess the importance of mangroves to the commercial fisheries. Also I review the literature for evidence of the importance of mangroves as nursery areas at other Caribbean locations.

What is the Mangrove Habitat?

Before any comparison is made we must know what are the habitats to be compared. If one examines the mangrove literature there is a broad spectrum of ideas on what is the mangrove habitat. In a broad sense this habitat might be considered as inshore areas near fringing mangroves or mangrove cays, encompassing a wide range of bottom types considered by many as separate habitats (*e.g.*, coral reefs and seagrass beds). A more restricted definition would be mangroves and adjacent areas. This latter definition still causes several distinctive habitats to be included within the mangrove habitat. Seagrass beds, macroalgae beds, and sandy bottom areas directly abut the mangroves in most areas with interaction among these habitats being an important ecological feature of nearshore tropical ecosystem (Ogden and Gladfelter, 1983). Finally, the most restrictive and possibly best definition of the mangrove habitat is the mangrove prop- root system and adjacent muddy bottom areas, such as lagoons, creeks, and passages, that are derived from mangrove-induced deposition processes, viz. that would not be there except for the presence of mangroves. Use of this definition should allow us to separate the effects of mangrove areas on fish from that of other habitats.

What is a Nursery Area?

Nursery areas have not been explicitly defined in the mangrove literature. Besides the presence of larval or juvenile fishes other criteria are important in determining a nursery area. For demersal fishes a nursery area should be an area of optimum habitat where larval fishes can settle and continue growth and development with a low mortality rate due to predation or starvation. The optimality of any habitat should be determined by a balance between predation and growth rate.

For rapid growth in larval and juvenile fishes there must be an adequate food supply. Mangroves are net exporters of nutrients (Odum, 1971) providing a high level of primary productivity (Odum *et al.*, 1959), which supplies food for swarms of copepods and possibly young larval fishes (Odum, 1971). Larger larval fishes feed directly on the zooplankton assemblage.

When larval demersal fishes settle (usually at the beginning of the juvenile stage) there is generally a switch to more benthic food sources. Due to the high detrital levels in the mangroves there is an array of benthic invertebrates available as food for these juvenile fishes (Austin and Austin, 1971).

Within the tropical reef system the species diversity declines from coral reefs to mangroves to seagrass beds (Able, 1974; Kimmel, 1985). One explanation for this decrease in diversity is the decrease in spatial heterogeneity (*i.e.*, shelter). Though direct evidence is lacking, the paucity of fishes on seagrass beds during the day when compared to night suggests strong selective pressures against inhabiting seagrass beds during the day (Robblee and Zieman, 1984). Diurnal predators, such as jacks, snappers, and sharks, feeding in seagrass beds can take advantage of the low relief to obtain prey fishes (Ogden and Zieman, 1977), which once detected have few means of escape other than to flee. The higher dimensionality of the mangrove prop-root system provides more opportunity for predator avoidance. Yet, there is less protection afforded by the mangrove prop roots than the coral reef habitat due to the relative open nature of the roots.

Many coral reef fishes exhibit a separation of habitats between the juvenile and adult stages. A benefit of habitat separation could be a reduced predation rate in juvenile habitats. The whereas settlement in nearby habitats, such as, seagrass beds and mangroves, could provide an opportunity to develop to a size that would improve survival on the coral reef. This suggest that there could be an advantage for larval and juvenile coral reef fishes to use seagrass beds and mangroves as nursery areas. Of the nearshore tropical habitats, mangroves potentially provide both a good food source and low predation, thus making them ideal nursery areas.

Island versus Continental Mangrove Habitats

Islands differ from continental areas primarily in freshwater and sediment discharge. Except for large islands, such as, Cuba and Hispaniola, most Caribbean islands have seasonal rainy periods resulting in limited, short-duration freshwater runoff. This allows for low turbidity, high salinity, and stable environmental conditions to dominate much of island coastal areas, with estuarine conditions restricted to river mouths during the rainy season. These conditions have an important effect on mangrove community development.

Island mangrove habitats differ from continental mangrove habitats in the types and proportion of mangrove communities. Of the five mangrove communities identified by Odum *et al.* (1982), two are of primary importance on islands: fringing forest with oceanic conditions and overwash island forests. Fringing forests with estuarine conditions are limited to river mouths. Thus the important mangrove habitat, in proportion of coasts covered, is fringing forests of red mangroves (*Rhizophora mangle*), which develop extensive prop-root systems.

METHODS

Larval Fish

Larval fishes were sampled in four nearshore habitats: mangrove prop roots, mangrove lagoon, seagrass bed, and coral reef in the La Parguera area of southwestern Puerto Rico (Figure 1). This portion of the coast supports a large undeveloped mangrove forest, best described as a fringing forest with oceanic conditions. The climate is dry and there are no rivers, thus salinity remains high (34 - 37 ppt) year-round and water clarity is relatively good.

The mangrove prop-root station was located on the leeward side of a nearshore mangrove island with a fringing forest of red mangroves. Soft mud bottom abuts the mangroves at this station and water depth is 1.2 m.

The mangrove lagoon station was located about 100 m east of the mangrove prop-root station, near the center of the east opening of the lagoon. The bottom at this end is soft mud with a water depth of 1.7 m. Trade wind driven water circulation is from east to west during the day, with a great reduction in wind speed during the night.

The seagrass bed station is located on a eastward extension of Isla Cueva. The bottom is composed of mixed seagrasses, predominantly *Thalassia testudinum*, with scattered small gorgonians and coral heads. Water depth is 1.5 m and water clarity high.

The coral reef station is located on the leeward end of a *Acropora palmata* dominated fringing reef of a mangrove cay, in the *Palmata* zone with a water depth of 1.7 m; adjacent bottom is seagrass covered.

Since a traditional towed-net ichthyoplankton system could not adequately sample the selected habitats, a night light - lift net sampling device was used (Figure 2). This device is composed of a floating styrofoam platform housing a 12 volt sealed beam automobile headlight bulb from which is hung, by four guide lines and steel ring, a standard 50 cm diameter, 500 μm mesh plankton net composed of 500 μm mesh. The light was powered by a battery on board a 6-m support boat.

Sampling consisted of lowering the plankton net to a depth of one meter then turning on the light. After 10 min, the net was rapidly hoisted to the surface by hand with the light still on. Three replicates were taken at each station. Coral reef and seagrass bed stations were sampled sequentially with a 10 min no-light period between replicates and mangrove and mangrove lagoon stations were alternately sampled. The order of station sampling was randomly selected with all samples taken within one day of the new moon from 2000 to 0100 hr. Monthly samples were taken at the mangrove prop-root station from September 1987 to August 1988 and in the mangrove lagoon from October 1987 to August

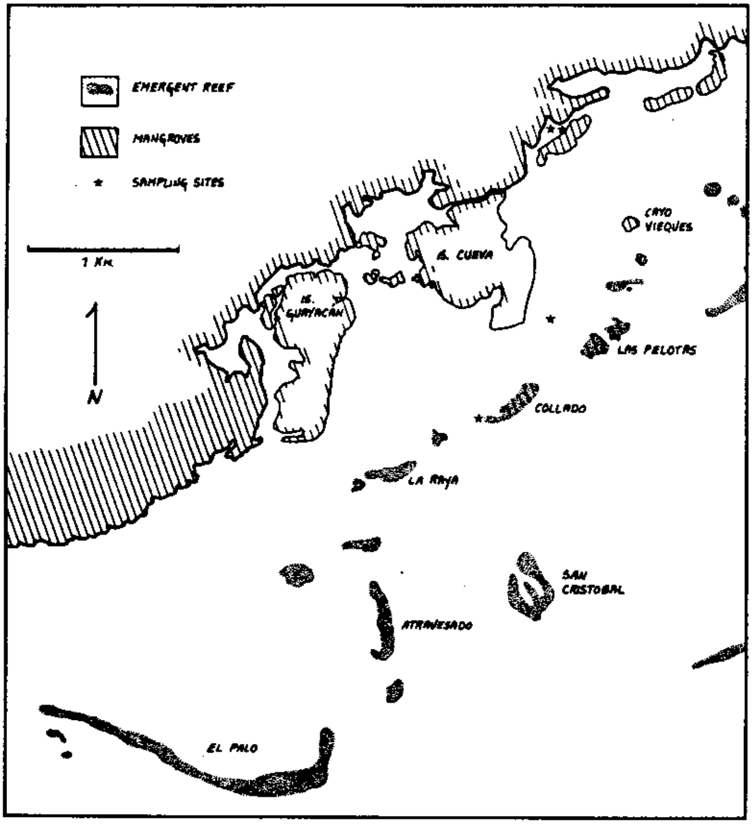

Figure 1. Sampling locations just west of La Parguera, southwestern Puerto Rico.

1988. Seagrass bed and coral reef samples were taken monthly from March to August 1988, but only March and July samples were analyzed for this paper. The sampling characteristics of this gear is discussed in detail by Goulet *et al.* (in manuscript) and a more detailed analysis of the data can be found in Dennis *et al.* (1991).

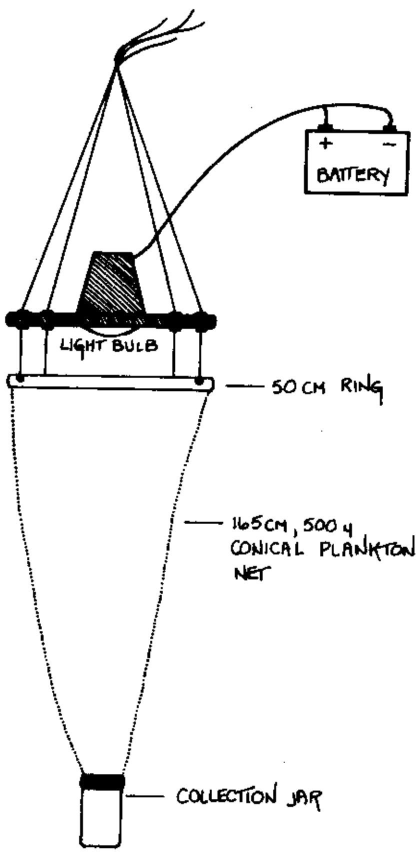

Figure 2. Night light -- lift net sampling device for larval fishes.

Juvenile Fish

Juvenile fish were sampled by visual census in the mangrove prop roots of the shoreline mangrove lagoon where larval fish sampling occurred (Figure 1). Twelve 15-m transects were layed out, six shoreline stations and six leeward island stations. Each transect was snorkelled on a monthly basis from September 1987 to September 1988. All fish observed from the furthest edge of the prop roots back to the emergent (at low tide) mud bank were identified to the lowest possible taxon, enumerated, and size or size of clams estimated. An indvidual

Table 1. Five most abundant larval fishes by habitat.

Mangrove Prop Roots		**Mangrove Lagoon**	
Rank Taxa	**Abun.**	**Taxa**	**Abun.**
1 *Harengula* sp.	132	*Harengula* sp.	111
2 *Albula vulpes*	71	*Anchoa sp.*	63
3 *Anchoa* sp.	53	*Albula vulpes*	13
4 GERREIDAE	23	*Jenkinsia* sp.	10
5 *Archosargus rhomboidalis*	15	ATHERINIDAE	8
No. of Taxa	17		15
Total No. of Larvae	327		232
No. of Samples	36		33
Mean No. per Sample	9.1		7.0
Seagrass Bed		**Coral Reef**	
Rank Taxa	**Abun.**	**Taxa**	**Abun.**
1. *Jenkinsia* sp	293	*Jenkinsia* sp.	108
2. GOBIIDAE	61	*Ar. rhomboidalis*	93
3. *Harengula* sp.	41	*Al. vulpes*	66
4 *Al. vulpes*	27	Unknown Preflexion	48
5 *A. rhomboidalis*	16	ATHERINIDAE	34
No. of Taxa	13		14
Total No. of Larvae	473		404
No. of Samples	6		6
Mean No. per Sample	79.2		67.3

was considered a juvenile if it had a juvenile color pattern and was not sexually mature (based on size at maturity from literature sources). Qualitative visual estimations of the relative abundance and size range of fishes inhabiting nearby seagrass beds and coral reefs were also made.

RESULTS

Larval Fish

In 12 months of sampling 17 larval fish taxa were taken at the mangrove prop-root station and 15 taxa in ten months at the mangrove lagoon station. Table 1 list the five most abundant taxa by habitat. A monthly comparison of total number of larvae shows distinct seasonal patterns (Figure 3). The period of greatest abundance was July-August with a gradual decline in the fall and lowest larval abundance in the winter and spring in the mangroves.

Comparisons of total number of larvae and total number of taxa among

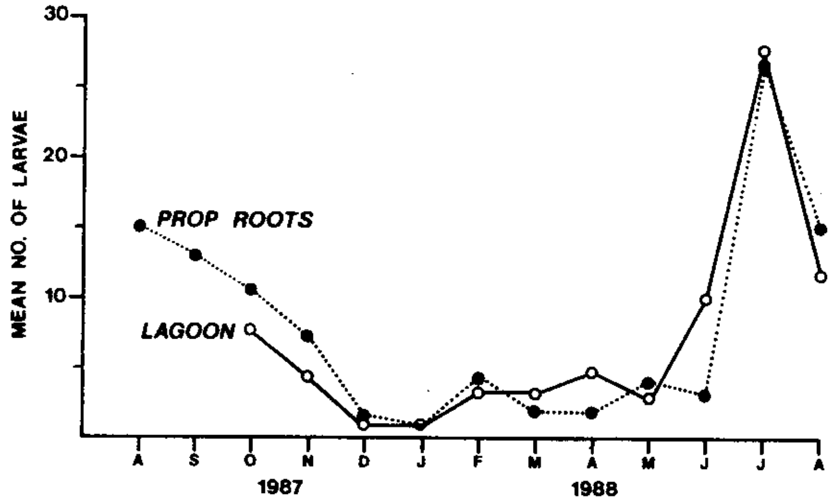

Figure 3. Total number of larvae captured by month for mangrove prop root and lagoon stations.

habitats showed that, in March, seagrass bed and coral reef stations had significantly more larvae and taxa (Table 2; Figure 4). In July, there was a significant increase in number of larvae at the mangrove stations and a decrease in abundance at the seagrass bed and coral reef stations resulting in no significant difference among habitats (Figure 5).

The high abundance of preflexion larvae (the larval stage just after hatching) at the seagrass and coral reef stations indicates recent spawning events, especially in the March sample. Throughout the year preflexion larvae were rare at the mangrove stations indicating that no spawning was occurring there.

Juvenile Fish

Thirty-six taxa were observed in the mangroves during one year of visual census. The most abundant species were the pelagic schooling species, *Anchoa* spp. (anchovies), *Jenkinsia* spp. (dwarf herring), and *Harengula* spp. (herring), which were typically at the edge of the mangrove prop roots entering only occasionally. Of the demersal species the ten most abundant are listed in Table 3. Of these, juveniles were observed in 16 taxa (44%) with only seven taxa (19%) apparently most abundant in the mangroves during the juvenile phase. New juvenile recruits showed seasonal trends in abundance similar to the larval

Table 2. Summary of mean abundance and standard deviation (SD) of larval fishes by habitat for March and July 1988. Sample size equals three for each habitat.

	Mangrove Prop Root		Mangrove Lagoon		Seagrass		Coral Reef	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
MARCH 1988								
Total Larvae	2.00	1.00	2.67	2.52	137.33	58.59	112.00	84.89
Preflexion	0.67	0.58	0.33	0.58	25.00	18.68	27.00	22.72
Post-flexion	1.33	1.53	2.33	2.52	112.22	53.41	85.00	62.55
Total Taxa	2.00	1.00	2.67	2.52	11.67	1.53	10.33	1.53
JULY 1988								
Total Larvae	25.33	0.58	24.33	11.06	21.33	7.09	19.33	4.73
Preflexion	-	-	-	-	1.33	1.53	3.00	3.61
Post-flexion	25.33	0.58	24.33	11.06	20.00	7.94	16.33	2.52
Total Taxa	3.67	1.57	3.67	2.08	4.33	1.15	4.67	1.53

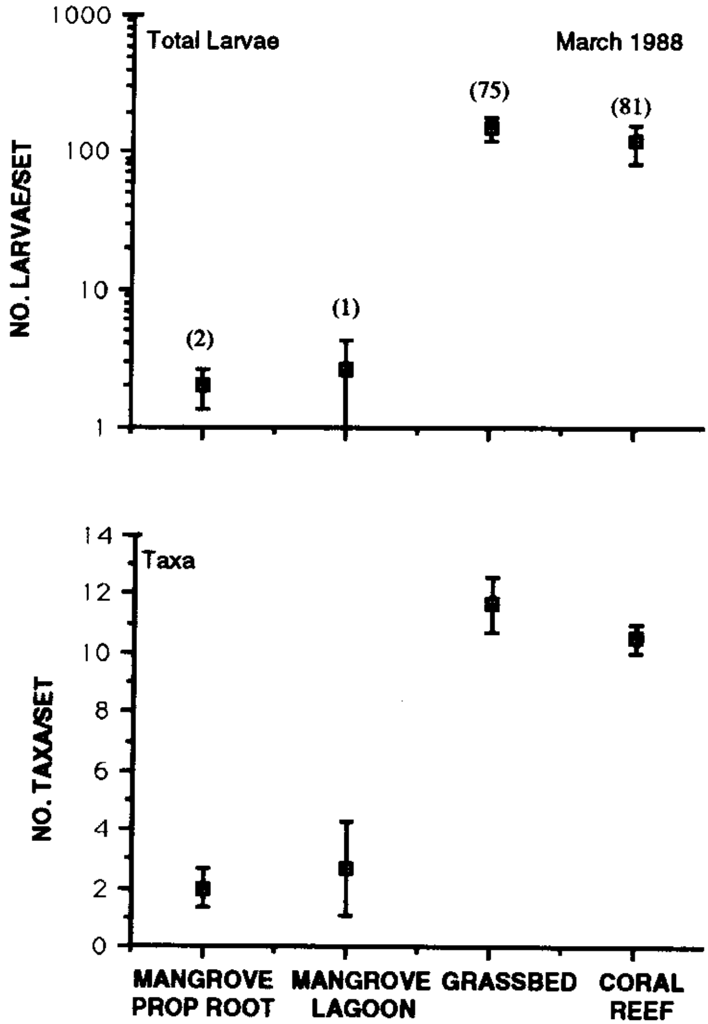

Figure 4. Mean number (± 1SD) of larvae and taxa by habitat for March 1988. Sample size of three for each habitat. Number in parenthese is total number of preflexion larvae.

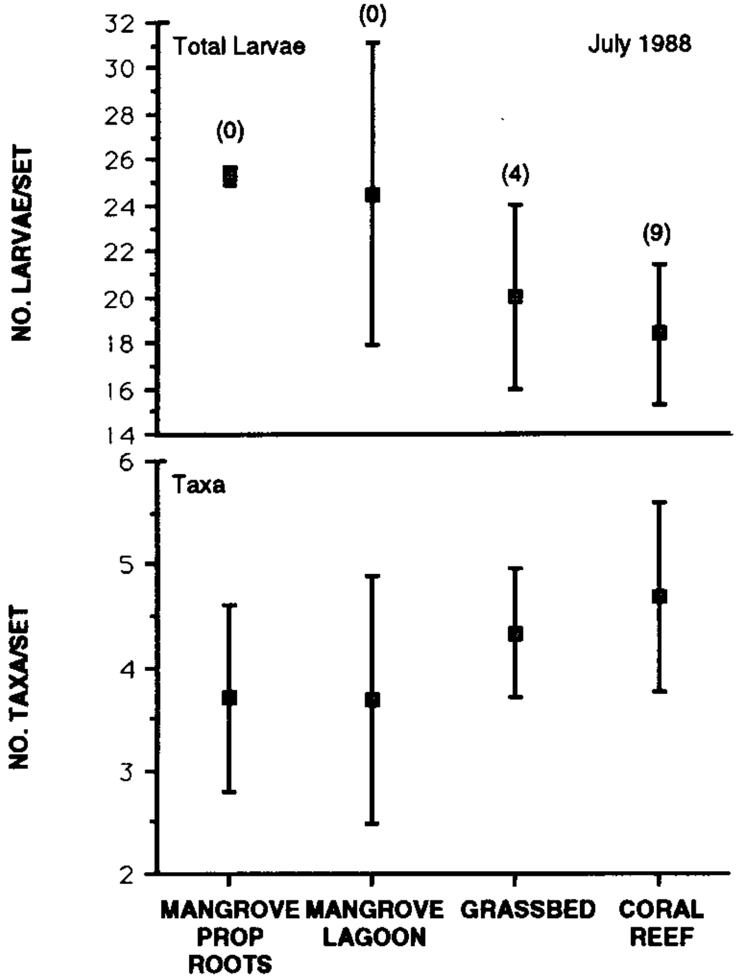

Figure 5. Mean number (±1SD) of larvae and taxa by habitat for July 1988. Sample size of three for each habitat. Number in parentheses is total number of preflexion larvae.

Table 3. Ten most abundant demersal species observed in the mangrove prop-root habitat.

Nursery Value	Seagrass Beds	Coral Reef	Rank	Species	No. Obs.	% Total
1	*Lutjanus apodus*	997	28.4	1	R	C1
2	*Haemulon flavolineatum*	627	17.9	2	A	A1
3	*Eucinostomus* spp.	327	9.3	1	R	R
4	*Stegastes leucostictus*	218	6.2		C	C
5	*Sphyraena barracuda*	169	4.8	1	R1	C1
6	*Haemulon* juveniles	168	4.8	2	A	R
7	*Sphoeroides testudineus*	153	4.4	2	C	R
8	*Lutjanus griseus*	130	3.7	1	R	R1
9	*Chaetodon capistratus*	121	3.4	1	C	C1
10	*Acanthurus chirurgus*	119	3.4		C	C1
			86.3			
	TOTAL	3509				

Nursery Value:
1 - High, critical habitat
2 - Medium, possibly critical

Abundance Category:
A - abundant
C - common
R - rare

Size Category:
1 - larger size than found in mangroves

fishes with greatest abundance in the late summer (unpubl. data).

DISCUSSION

There was no evidence of spawning fishes in the mangrove area as preflexion larvae were rare. Based on water circulation patterns in this area one would expect more preflexion larvae than observed in the mangroves, if they were passively dispersed by currents. The large difference in abundance of preflexion larvae between the seagrass bed/coral reef stations and mangrove stations over a relatively small distance suggest that the larvae may be able to control their position even at this earlier stage. In general, there were more larvae and larval taxa taken outside the mangroves, although there were six times more samples taken in the mangroves.

A traditional towed-net ichthyoplankton study was undertaken in south Florida to examine the distribution of fish larvae in the nearshore environment (Collins and Finucane, 1984). Shallow water nearshore habitats, as well as, mangrove channels were sampled, but the interpretation of these results is not straight forward due to confounded caused by nearshore samples being taken at night, while the mangrove samples were taken during the day. In general similar trends to this study were found in south Florida with fewer taxa and larvae taken in mangroves channels when compared to nearshore areas.

Of the larvae that were common, only *Harengula* and *Anchoa* were distinctively more abundant in the mangroves. Louis *et al.* (1985) found mangrove lagoon areas of Guadeloupe were recruitment areas for juvenile *Harengula humeralis*. Mangrove prop roots may also be a recruitment area for gerreids as larvae were common and young juveniles (ca. 20-30 mm TL) were observed in the prop roots.

Over 190 taxa of fishes are known from the La Parguera area of Puerto Rico (Kimmel, 1985), but only a small proportion (18%) were observed in mangroves. Of the common juvenile fishes observed in the mangroves, three species, *L. apodus*, *S. barracuda*, and *L. griseus* were distinctive of that habitat Young juveniles of these species were only rarely seen in other nearby habitats. Three other species, *E. argenteus*, *S. testudineus*, and *C. capistratus*, were typical of the mangroves, but are also abundant in other habitats (*e.g.*, sandy bottom or seagrass beds). The remaining common species are more abundant in other habitats. Other less common species which are typically observed in the mangroves as juveniles are *Gerres cinereus* and *Scarus guacamaia*.

The low abundance of pre-settlement larval in the mangrove prop roots may be explained by the preponderance of small piscivorous fishes in the mangroves. *Lutjanus apodus*, *L. griseus*, *S. barracuda*, and belonids make up a formidable gauntlet of predators in the prop roots. As shown by Shulman (1985) for coral reefs, larval fishes may settle in nearby seagrass beds, where their small size allows them to hide among the grass blades and the encounter rate with predators is lower. Once they outgrow their grass refuge and are less at risk to predation they may move into the mangroves. This is not apparently necessary for *H. flavolineatum* and *E. argenteus* which were observed as post-settlement juveniles in the prop roots. Whether some fishes preferably migrate to the mangroves or end up there by chance remains to be proven. Even if a fish is abundant in the mangroves it may still have a higher mortality rate than in other habitats resulting in no net benefit to utilizing the mangroves. In both larval and juvenile fish abundance there was marked seasonality suggesting that an important use of the mangroves may be on a relatively short term (1-2 months) seasonal basis. This is an important consideration in designing comparative studies and especially in "one shot" environmental impact assessments. It would be easy to miss the important annual events in the mangroves with only one or two sampling periods and come to erroneous conclusions.

At most Caribbean island locations the commercial fisheries are usually dominated by coral reef species. This is certainly true in Puerto Rico where about 93% of the demersal catch is attributable to coral reef species (Table 4). Only about 7% of the landings are based on fishes for which the mangrove habitat is important. The role of mangroves in the life history of some species (*e.g., O. chrysurus* and *Haemulom sciurus*) is still unclear and these may increase the proportion of the catch dependent on mangroves, but still the importance of mangroves in island fisheries has been overestimated.

As I am only presenting a preliminary assessment of the role of one small area of mangroves in Puerto Rico as a nursery area, it is important to inquire into its representativeness. In other mangrove surveys in La Parguera juvenile *H. sciurus, O. chrysurus,* and *Archosargus rhomboidalis* were common on occasion (Kimmel, 1985; Rooker and Dennis, 1992), but were only rarely seen in this study. Austin (1971) reported 31 species collected in Puerto Rico mangroves; abundant species were similar to those found in this study. Table 5 shows the most common species taken in a low salinity mangrove lagoon (Laguna Joyuda) on the west coast of Puerto Rico and in a mangrove river estuary on the north coast of Puerto Rico. Certainly a different suite of species use low salinity mangrove areas, but there is no indication of more commercially important species utilizing them. Important commercial species in turbid-water low-salinity mangroves are larger gerreids (*Eugerres* spp. and *Diapterus* spp.) and snooks (*Centropomus* spp), which compose only a small portion (3.0%) of the commercial catch (Table 4). Similar species composition and dominance to Puerto Rico is evident in mangrove areas in Guadeloupe (Table 6). Still, there is no evidence of a dependence of commercially important species using these mangroves. Even in south Florida the common mangrove fishes are only marginally of commercial importance (Table 7). Similar conclusions have been reached for mangrove areas in Australia (Robertson and Duke, 1987).

Few of the studies cited have made comparisons among habitats. Yet they

Table 4. Commercial landings of classified demersal fishes for 1986 in Puerto Rico ranked by landing weight (Y. Sadovy, pers. comm., CODREMAR).

Rank	Category	Scientific Name	Lbs. Landed	% Total
1	silk snapper	*Lutjanus vivanus*	376,941	24.9
2	grunts	HAEMULIDAE	223,432	14.8
3	grouper	SERRANIDAE	209,496	13.9
4	parrotfishes	SCARIDAE	109,824	7.3
5	yellowtail snapper	*Ocyurus chrysurus*	108,309[1]	7.2
6	lane snapper	*Lutjanus synagris*	91,729	6.1
7	jack	*Caranx* spp.	54,414	3.6
8	trunkfish	OSTRACIIDAE	35,640	2.4
9	mullet	*Mugil* spp.	35,260[1]	2.3
10	hogfish	*Lachnolaimus maximus*	34,116	2.3
11	other snapper	*Lutjanus* spp.	32,760*	2.2
12	snook	*Centropomus* spp.	32,291*	2.1
13	mutton snapper	*Lutjanus analis*	31,326	2.1
14	queen triggerfish	*Balistes vetula*	30,492	2.0
15	barracuda	*Sphyraena* spp.	22,763*	1.5
16	goatfish	MULLIDAE	20,275	1.3
17	porgy	*Calamus* spp.	18,434	1.2
18	sardina	CLUPEIDAE	18,275*	1.2
19	squirrelfish	HOLOCENTRIDAE	13,329	0.9
20	mojarra	GERREIDAE	12,481*	0.8
			TOTAL	1,511,587
		* Mangrove dependent fishes	118,570	7.8
		[1] Possibly mangrove dependent	143,569	9.5
		Maximum mangrove dependent	262,139	17.3

Table 5. Common fishes reported from other mangrove habitats in Puerto Rico ranked by number.

Laguna Joyuda
Mangrove Lagoon
West coast Puerto Rico

Trawl Stoner (1986)		Gill net, etc. Perez Ramirez *et al.* (1981)	
Rank	Species	Rank	Species
1	*Achirus lineatus*	1	*Mugil curema*
2	*Eucinostonus gula*	2	*Achirus rhombeus*
3	*Diapterus rhombeus*	3	*Diapterus rhombeus*
4	*Eucinostomus argenteus*	4	*Bairdiella ronchus*
5	*Gerres cinereus*	5	*Eugerres plumieri*
6	*Anchoa cubana*	6	*Centropomus unidecimalis*
7	*Eugerres plumieri*	7	*Caranx latus*
8	*Diapterus auratus*	8	*Gerres cinereus*
9	*Gobionellus boleosoma*	9	*Lutjanus griseus*
10	*Bairdiella ronchus*	10	*Megalops atlanticus*

Rio Espiritu Santo Estuary
North coast Puerto Rico
Gill net
Corujo Flores (1980)

Rank	Species
1	*Opisthonema oglinum*
2	*Mugil curema*
3	*Gobiosoma spes*
4	*Bathygobius soporator*
5	*Eleotris pisonis*
6	*Lupinoblennius dispar*
7	*Diapterus rhombeus*
8	*Micropogonias furnieri*
9	*Cetengraulis edentulus*
10	*Bairdiella ronchus*

Table 6. Common fishes associated with mangroves in Guadeloupe.

Grand Cul de Sac Marin Mangrove Prop Roots Rank by number Rotenone Galzin et al. (1982)		Manche-a-Eau Mangrove Lagoon Rank by weight Fyke net Louis *et al.* (1985)	
Rank	Species	Rank	Species
1	*Eucinostomus* sp.	1	*Harengula humeralis*
2	*Harengula humeralis*	2	*Diapterus rhombeus*
3	*Diodon holocanthus*	3	*Eugerres brasilianus*
4	*Haemulon flavolineatum*	4	*Caranx latus*
5	*Ocyurus chrysurus*	5	*Sphyraena barracuda*
6	*Lutjanus apodus*	6	*Gerres cinereus*
7	*Atherinomorus stipes*	7	*Hyporhamphus unifasciatus*
8	*Phaeoptyx conklini*	8	*Centropomus ensiferus*
9	*Sphoeroides testudineus*	9	*Oligoplites saurus*
10	*Sphyraena barracuda*	10	*Eucinostomus argenteus*

have reiterated the fact that mangroves are nursery areas based on the abundance of juvenile fishes. This may be due to the fact that it is difficult to find a sampling method which is equally as effective in mangrove, seagrass bed, coral reef, and sandy bottom areas. A comparative study was made between mangrove prop roots and adjacent seagrass beds in south Florida, where the density of fishes was about 35 times greater and biomass about 19 times greater in the mangroves (Thayer *et al.*, 1987). Does this indicate that the populations of fishes are greater in the mangroves than seagrass beds? I suggest not, as the mangrove prop-root habitat is restricted to a narrow fringe, concentrating the fishes into a small area, whereas there is a tremendous area of seagrass bottom in Florida Bay with a diffuse fish assemblage. If density is compared on a per area basis then the total area of each habitat needs to be considered. There is a considerable area of mangroves in south Florida and the population of fishes might still be greatest in the mangroves even after correction for area, but I doubt this would be the case for most Caribbean islands mangrove stands. Thayer *et al.*'s study does indicate that the loss of a square meter of mangrove fringe will results in a greater loss of fish biomass than a square meter of seagrass bed. Destruction of mangrove areas could possibly lead to direct decreases in fishery yields (Lindall and Saloman, 1977), but may be more detrimental, indirectly, by degrading nearshore grass beds and reefs through increasing the effects of freshwater runoff and turbidity.

It is evident from my limited results and other studies that mangrove areas

Table 7. Common fishes associated with mangroves in south Florida.

Mangrove Prop Roots, Rotenone, Thayer *et al.* (1987) Rank	Species	Seagrass Beds, Trawl, Thayer *et al.* (1987) Rank	Species
1	*Atherinomorus stipes*	1	*Eucinostomus gula*
2	*Eucinostomus gula*	2	*Anchoa mitchilli*
3	*Floridichthys carpio*	3	*Lagodon rhomboides*
4	*Lucania parva*	4	*Lucania parva*
5	*Anchoa mitchilli*	5	*Eucinostomus argenteus*
6	*Eucinostomus argenteus*	6	*Syngnathus scovelli*
7	*Gobiosoma robustum*	7	*Bairdiella chrysoura*
8	*Membras martinica*	8	*Microgobius gulosus*
9	*Anchoa hepsetus*	9	*Ariopsis felis*
10	*Microgobius gulosus*	10	*Menidia peninsulae*

Mangroved Lined Bays, Trawl, Browder *et al.* (1986) Rank	Species	Mangroved Lined Bays, Trawl, Colby *et al.* (1985) Rank	Species
1	*Anchoa mitchilli*	1	*Anchoa mitchilli*
2	*Brevoortia smithi*	2	*Anchoa hepsetus*
3	*Lagodon rhomboides*	3	*Brevoortia smithi*
4	*Bairdiella chrysoura*	4	*Membras martinica*
5	*Membras martinica*	5	*Bairdiella chysoura*
6	*Syngnathus scovelli*	6	*Lagodon rhomboides*
7	*Gobiosoma robustum*	7	*Eucinostomus gula*
8	*Cynoscion arenatus*	8	*Orthopristis chrysoptera*
9	*Lucania parva*	9	*Eucinostomus argenteus*
10	*Symphurus plaguisa*	10	*Cynoscion arenatus*

are important for juvenile fishes which are either directly used for human consumption or an integral part of the food web, but that other habitats may be just as or more important as nursery areas. Once further research has been accomplished it would not be surprising to find that the small area I studied was unusually poor as a nursery area and that other areas in La Parguera may be more important in terms of nursery potential. This points up the fact that all mangrove areas may not have the same nursery area potential and areas which are being considered for alteration should be surveyed in a systematic fashion to determine if that particular area is exceptionally important as a nursery area. The synergetic effect of mangroves and grass beds (or other habitats) in close proximity can not discounted as an important additional feature of the nursery area concept.

Mangroves have many important functions and it is not necessary to overemphasize the fishery importance of these areas to the contrary of facts. Further among-habitat comparative research is necessary to fully evaluate the nursery area importance of mangroves.

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