THE CURRENT STATUS OF THE FISH FAUNA OF THE INDIAN RIVER LAGOON

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The estuarine fish fauna of east central Florida has been the subject of intensive qualitative and environmental research for the past seven years (Jones, et al. 1975; Gilmore, et al. 1976; Gilmore, 1977a; Snelson and Bradley, 1978), in contrast to the paucity of ichthyological data available prior to 1971. Previous fish studies were limited geographically, or in the number of fishes treated, and are not considered comprehensive (e.g. Evermann and Bean, 1897; Springer, 1960; Harrington and Harrington, 1961; Gunter and Hall, 1963; Christensen, 1965). Current quantitative and qualitative studies conducted by the author and his associates with the Harbor Branch Foundation captured over two million fish between Ponce de Leon Inlet, Volusia County, and Jupiter Inlet, Palm Beach County, providing abundant data on the species composition, relative numbers, biotope preferences, migratory habits and life histories. A regional description and ichthyofaunal check-list has been published (Gilmore, 1977a) describing basic fish habitats within the Indian River lagoon, its drainage, and the adjacent continental shelf. To date, 669 species have been recorded from this region of Florida of which 195 were previously unrecorded from the study area, including five undescribed species. Fifty-eight percent, or 385 of these fishes, occur in various biotopes within the

Indian River lagoon.

METHODS

Data presented are based on several thousand fish collections made from November 1971 to September 1978, at several hundred locations between Ponce de Leon Inlet, Volusia County, and Jupiter Inlet, Palm Beach County, during the 82 month period. Capture methods utilized traps, seines, trawls, gill nets, plankton nets, cast nets, drop nets (Gilmore, et al. 1978), dip nets, spears, dredges, hook and line, and fish toxicants. Many observations were made using SCUBA and photography.

Data have been reduced and analyzed with the aid of a Honeywell 2015 computer system.

REGIONAL SETTING AND FAUNA

The richness of the regional ichthyfauna can be attributed principally to the tropical-temperate transitional nature of the setting and fauna. The Indian River lagoon lies within a zone of faunal overlap between the northern, warm temperate, Carolinian marine faunal province and the southern, tropical and subtropical Caribbean marine faunal province. Because of this transition zone, and the proximity of the Florida Current, a unique combination of fishes is found along this coast of Florida. Many of the common and abundant species within our local fauna do not occur, or are not common, elsewhere in the state (Table 1, Fig. 1).

The Indian River lagoonal system extends 253 km (157 mi) from latitude 29°00'N at Ponce de Leon Inlet to 26°58'N at

Table 1. Sample of tropical fishes occurring in the Indian River lagoon estuary but not recorded from estuaries of the South and South Central Florida west coast.

SPECIES	HABITAT AND ABUNDANCE
Lutjanidae	
Lutjanus analis, Mutton snapper	Mangrove, seagrass, lagoon reefs: common
Gerreidae	
Eucinostomus lefroyi, Mottled mojarra	Sand bottom-inlets: common
Pomadasyidae	
Haemulon parrai, Sailors choice	Mangrove, seagrass, lagoon reefs: common
Pomadasyidae	
Pomacanthus paru, French angelfish	Lagoon reefs: occasional
Pomacentridae	
Eupomacentrus dorsopunicans, Dusky damselfish	Lagoon reefs: occasional
Scaridae	
Sparisoma chrysopterum, Redtail parrotfish	Seagrass, lagoon reefs: common
S. rubripinne, Yellowtail parrotfish	Seagrass, lagoon reefs: common
Clinidae	
Labrisomus nuchipinnus, Hairy blenny	Lagoon reefs: common
Eleotridae	
Gobiomorus dormitor, Bigmouth sleeper	Freshwater: occasional
Gobiidae	
Awaous tajasica, River goby	Freshwater: occasional
Gobionellus pseudofasciatus, Slashcheek goby	Fresh & brackish water: occasional
G. stigmaturus, Spottail goby	Seagrass: common
Lophogobius cyprinoides, Crested goby	Mangrove: common
Acanthuridae	
Acanthurus chirurgus, Doctorfish	Lagoon reefs: occasional
Bothidae	
Citharichthys spilopterus, Bay whiff	Sand bottom: common
Tetraodontidae	
Sphoeroides testudineus, Checkered puffer	Mangrove, seagrass: common

Jupiter Inlet (this includes Mosquito and Banana River lagoons). The lagoon is separated from the ocean by a barrier island system formed from the Pleistocene Anastasia formation. The lagoon opens to the Atlantic Ocean through five inlets and one lock, with four of the five inlets occurring south of 28°00'N. Thus, the southern portion of the lagoon (27°00'-28°00'N) receives more tidal influence and oceanic-estuarine water exchange than the extensive northern section north of Sebastian Inlet (28°00'-29°00'N). The lagoon fish fauna is exceptionally rich near these inlets, where nutrient loads, temperature and salinity are tempered by oceanic influence.

REGIONAL BIOTOPES AND ASSOCIATED FISHES

Eleven to sixteen kilometers west of the Indian River lagoon lies the St. Johns River and marsh. The freshwaters of the St. Johns River and associated marsh flow northward out of the Indian River region. Several man-made canals drain portions of the marsh utilized by agricultural interests. These canals, in turn empty into the Indian River lagoon with flow rates usually controlled by flood gates. Several natural freshwater drainages also occur in the area (e.g. St. Lucie and Loxahatchee rivers, and Taylor, Sebastian, Turkey, Crane, Turnbull creeks) but most of these have at least a portion of their drainage controlled by flood gates. The regional freshwater fauna contains 111 species, 60 (54%) of which are euryhaline, secondary freshwater, or marine intruders which also occur at higher salinities within the lagoon or Atlantic Ocean (e.g. Tarpon, Megalops atlantica; Snook, Centropomus undecimalis). The stenohaline primary freshwater fish fauna

is typically depauperate in south and south central Florida. For example, only three species of freshwater minnows (Cyprinidae) occur here. Primary freshwater fishes are usually the only species to occur west of the spillways. The flood gates and spillways therefore act as an effective barrier to the principle portion of this freshwater fauna, i.e. the euryhaline estuarine species. Because of this barrier, the fauna will be less speciose west of a spillway than in freshwater east of the spillway. It should be noted that a number of euryhaline fishes unique to this area of Florida and North America occur in fresh to brackish waters predominately east of the spillways as well as in natural freshwater drainage of the Indian River lagoon (e.g. Gobiomorus dormitor, Diapterus auratus, Pomadasys crocro, breeding Oostethus lineatus, Gilmore, 1977b; Gobionellus pseudofasciatus, Hastings, 1978).

The lagoon fish communities are diverse due principally to the nature of their habitat, which in most cases can be typified by a characteristic flora. Within the study area climatic conditions are moderate primarily due to the influence of the Florida Current. This allows for the growth of a diverse assemblage of tropical and subtropical semiaquatic and aquatic plants that subsequently produce food and habitat for the local fauna.

Throughout most of the lagoon the coastal marsh is dominated by mangroves (black mangrove, Avicennia germinans; white mangrove, Laguncularia racemosa; buttonwood, Conocarpus erectus; red mangrove, Rhizophora mangle) and the smooth cordgrass, Spartina alterniflora. The mangrove marsh produces

an abundance of detrital material which contributes directly to the productivity of the lagoon (Odum and Heald, 1972). The semiterrestrial, littoral nature of this habitat limits the number of fishes directly associated with the mangroves. Only 84 species have been recorded as having been captured in from the mangrove marsh (as compared to 210 from the seagrass biotope). However, detrital material produced by mangrove foliage is carried out into the estuary by tidal currents, and indirectly through primary consumption (e.g. by detritivorous crustaceans: caridean and paleomonid shrimp, ocypodid crabs) thereby greatly increasing both estuarine productivity and, subsequently, the fish fauna.

A major change in the Indian River high marsh mangrove system has taken place during the past eight to twenty years with the impoundment of this marsh for mosquito control (Provost 1959, 1967). In many impoundments, particularly in St. Lucie and Indian River counties, the mangroves have been killed by inundation. As a result, fish populations associated with these marshes have changed, with some previously common species now considered infrequent or rare. Of all the regional biotopes considered in this study, the mosquito impoundment contains one of the most depauperate fish faunas with only 35 species recorded. Most of these species can withstand the extremes of salinity (0-50‰) and temperatures (6-36°C) characteristic of this shallow eutrophic marsh habitat (e.g. mosquitofish, Gambusia affinis; sheepshead minnow, Cyprinodon variegatus).

Spermatophyte seagrass beds form another major fish habitat, harboring the most diverse fish fauna in the lagoon

with 210 recorded species. These seagrasses, Thalassia testudinum, Halodule wrightii, Halophyla spp. and Syringodium filiforme, are found primarily in nearshore shallows where light penetration is best. Large beds may also be found toward the middle of the lagoon where the water is shallow and generally clear. The fishes occurring in this habitat are not only juveniles of estuarine and neritic species but also adults of estuarine predators. Many of these larger predators are valuable in the local sport, game and commercial fisheries (e.g. speckled seatrout, Cynoscion nebulosus). The complement of resident fishes of a particular seagrass bed is unique to the location of that bed. Some species may be found only in beds many kilometers away from the nearest inlet, while others are only found in beds adjacent to the inlets. Inlet seagrass beds are a preferred nursery ground for offshore fishes. As will be shown below these seagrass beds are not only rich in species but they are highly productive in fish numbers and biomass.

Associated with the seagrass beds is a diverse flora of macrophytic algae. This algae, consisting mostly of Gracilaria spp., Acanthophora spp. and Hypnea spp. occurs seasonally both as epiphytes and drifting aggregates ("drift algae"). This algae supports a large number of invertebrates, particularly micro-and macro-crustaceans (e.g. amphipods and decapods, respectively) which in turn attract predatory fish species (e.g. code goby, Gobiosoma robustum; pipefish, Syngnathus scovelli) seeking both food and cover. The total number of fish species occurring in this algal community has not yet been determined.

The most abundant fishes in the Indian River lagoon are

planktivores (e.g. bay anchovy, Anchoa mitchilli; scaled sardine, Harengula jaguana). Anchoa mitchilli is the most common species making up nearly 70% of the total numerical fish catch, but comprises less in biomass. Approximately 20 fishes, most of which are planktivores, consistently occur in the open surface waters of the estuary. Because of their dependence on planktonic organisms for food it is possible to correlate planktivore numbers with plankton levels. Plankton levels may vary with the concentration of nutrients which, in turn, are greatly effected by freshwater runoff. Manipulation of freshwater drainage by man almost certainly effects the plankton-planktivore populations. Data have been collected and further analysis should show the nature of these effects.

Second only to the seagrass biotope in faunal richness are the lagoon reefs, formed by pilings, rocks, and debris, that may form shelter and habitat for typical reef dwelling species. Ninety-two species have been recorded from this biotope, many of which are juveniles of reef dwelling forms found offshore in the Atlantic Ocean (e.g. Pomacanthids, angelfish; Serranids, groupers; Lutjanids, snappers). For this reason this fauna is particularly speciose in the proximity of inlets.

QUANTITATIVE SEAGRASS COLLECTIONS

Quantitative collections of fishes have been made primarily in seagrass beds, as many species can be caught in this biotope and principally as juveniles (Jones et al. 1975; Gilmore et al. 1976). Because the younger fish have had a much shorter life history (i.e. usually much less than a year) they have had less time to interact with their environment

(including other species, meteorological and hydrological parameters). Adults, however, have gone through several seasons of varying meterological and hydrological conditions and have had many complex social and predatory interactions. It is therefore somewhat easier to detect environmental cause and effect responses in juvenile fishes than in adult populations. For these reasons along with the assessability and richness of the seagrass biotope our collections have contained predominantly juvenile fishes. Using both seine and drop net methods, these collections have been made monthly during diurnal and nocturnal periods since 1974 (Gilmore et al. 1978). From these data environmental effects on specific fish populations can be studied. Migratory patterns, spawning periods, growth rates and habitat preference are being determined for forty common species, thirty of which are listed in Table 2. Diurnal and noctural collections have demonstrated extensive inshore-offshore movements of several species, as well as a distinct change in relative numbers and faunal composition between day and night. Drop net collections have also produced relatively high fish density and biomass estimates (e.g. maximum 150 fish/m^2; mean 12 fish/m^2) for specific seagrass bed locations. Day and night drop net samples taken over sand bottom contained few species and individuals relative to adjacent seagrass beds. This supports the hypothesis that the sand bottom biotope is not very productive. These quantitative collections have also revealed that some of the most ubiquitous grass bed fishes occurring seasonally in high densities are the dimunitive gobies.

Table 2. Top thirty fishes collected during seagrass quantitative seine survey from March 1974 to April 1977.

SPECIES	SPAWNING ACTIVITY J F M A M J J A S O N D	SPECIMENS COLLECTED
Anchoa mitchilli, Bay anchovy	x x x x x x x x x x x x	1,278,190
Harengula jaguana, Scaled sardine	x x x x x x	132,210
Lagodon rhomboides, Pinfish	x x x x x	60,800
Brevoortia smithi, Yellowfin menhaden	x x x x	54,298
Anchoa lyolepis, Dusky anchovy	x x x x	20,011
Anchoa hepsetus, Striped anchovy	x x x x x x	19,388
Diapterus auratus, Irish pompano	x x x x x x x x x	17,326
Anchoa cubana, Cuban anchovy	x x x	16,146
Mugil curema, White mullet	x x x x x x	16,054
Eucinostomus argenteus, Spotfin mojarra	x x x x x x x x x x x x	15,025
Mugil cephalus, Striped mullet	x x x x x	11,213
Opisthonema oglinum, Thread herring	x x x x	10,560
Eucinostomus gula, Silver jenny	x x x x x x x x x x x x	10,486
Menidia peninsulae, Tidewater silverside	x x x x x x	8,469
Bairdiella chrysura, Silver perch	x x x x x x x	5,971
Orthopristes chrysoptera, Pigfish	x x x x x x	4,689
Sardinella anchovia, Spanish sardine	x x x x x x x	2,917
Gobionellus boleosoma, Darter goby	u n k n o w n	2,571
Leiostomus xanthurus, Spot	x x x x x	2,449
Membras martinica, Rough silverside	x x x x x x x	1,475
Gobiosoma robustum, Code goby	u n k n o w n	1,316
Diplodus argenteus, Silver porgy	x x x x ?	1,137
Hippocampus zosterae, Dwarf seahorse	u n k n o w n	1,027
Syngnathus scovelli, Gulf pipefish	x x x x x x x x x x x x	1,008
Lutjanus synagris, Lane snapper	x x x x x x x	725
Anchoa lamprotaenia, Bigeye anchovy	u n k n o w n	702
Strongylura notata, Redfin needlefish	x x x x x x	638
Fundulus similis, Longnose killifish	x x x x x x x x x	613
Haemulon parrai, Sailors choice	x x x x x x x	610
Lucania parva, Rainwater killifish	u n k n o w n	479

SUMMARY

Currently the Indian River lagoon contains a rich ichthyofauna. Moderate temperatures, due to a proximate warm oceanic current, and a transitional flora and fauna combine with a diverse assemblage of habitats to produce this ichthyofaunal richness. In several of these biotopes (e.g. mangrove impoundments and freshwater canals) manipulation and changes by man have lowered fish species diversity and richness. The richest fish community is found in association with the seagrass bed biotope. The latter acts as both a nursery ground for estuarine and offshore neritic species and as a feeding ground for adults of various estuarine predators. A recently discerned fish community has been found in association with epiphytic and drifting macrophytic algae and further study may reveal a very productive microcosm based on the primary productivity of such algae.

Quantitative studies using seines and drop nets provide data on the life history of many of the more common estuarine fishes occurring in seagrass beds. Temporal and spatial changes have been monitored for four years showing spawning peaks, migratory habits, changes in densities and biomass.

The value of the various fish habitats and the seagrass biotope to the diversity and productivity of the lagoon fish fauna is obvious. For this rich ichthyofauna to continue to be diverse and productive there must be proper management of man's activities which, as shown, can greatly effect local fish populations via habitat destruction.

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