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# INVENTORY OF FISHES OF EVERGLADES NATIONAL PARK

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ABSTRACT: *This inventory of the fishes of Everglades National Park summarizes the ichthyological and fisheries investigations that have provided information on the composition and distribution of the park's marine, brackish and freshwater fish faunas. Descriptions of the major aquatic habitats of the park provide a context for the subsequent complete inventory for the area. South Florida is a region in which members of the Antillean and Carolinian fish faunas meet and mix, giving rise to a diverse assemblage of fishes. Two hundred and ninety species of fishes have been recorded from the park, the majority of which occur both in North American and tropical West Atlantic waters. All of the native freshwater fishes in the park are derived from temperate North America; conversely, the seven established non-indigenous fish species originated in tropical waters. The table of species inellides abundance and habitat use information. Species that are of hypothetical or questionable occurrence are also noted.*

EVERGLADES National Park is a 0.9 million-hectare wilderness established at the southern tip of the Florida peninsula in 1947. On the north, the park is bordered by the Water Conservation Areas, by Big Cypress National Preserve on the west, by the developed coastal ridge to the east, and it extends to the mangrove-lined coasts of southern Florida (Fig. 1). Much of Florida Bay is within the southern park boundaries, which follow the inside alignment of the upper and middle Florida Keys. The congressionally authorized expansion area brings the park boundary to include northeast Shark Slough. Upland and wetland habitats comprise the freshwater and saline glades of the park. The park also includes one of the most extensive mangrove swamps on earth.

The scientific literature describing the composition and distribution of the southern Florida fish fauna began with the works of Henshall (1891), Lönnberg (1894), and Evermann and Kendall (1900). Until the middle of this century, relatively little was known about the fishes of the area included within Everglades National Park, although Schroder (1924) discussed the fishing industry that operated around Cape Sable early in this century. Gilby and Caldwell (1955) and Carr and Goin (1955) presented distributional data on Everglades freshwater and euryhaline fishes, and Briggs (1958) summarized the distribution of all Florida fishes.

Following those general faunal surveys, a number of important marine studies were completed within the park. Tabb and Manning (1961), Tabb

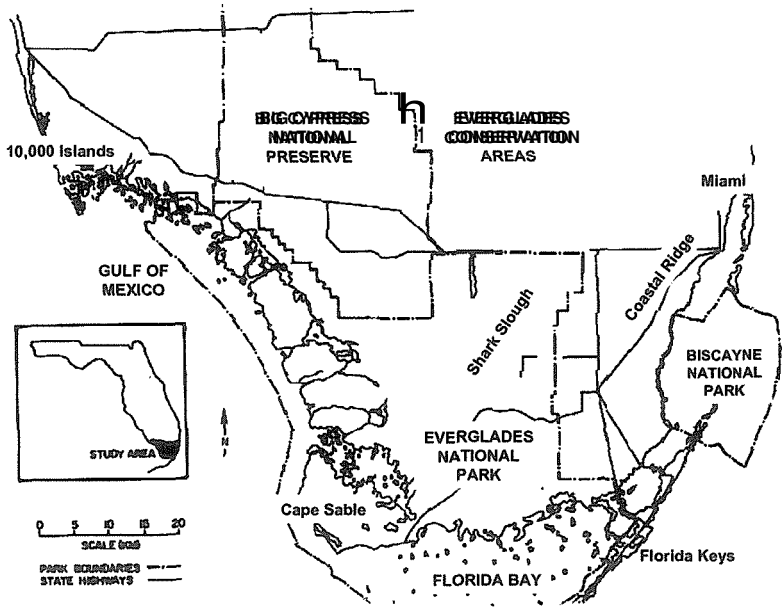


FIG. 1. Extreme southern Florida showing the boundaries of Everglades National Park and important landscape features.

and Roessler (1989), and Tabb and co-workers (1962; 1974) discussed the ecology and distribution of estuarine and marine fishes in Everglades National Park. Odum (1971) described the occurrence and food habits of fishes in North River, and McPherson (1970) listed the fishes taken in the Shark River estuary. Dahlberg (1970) and Daly (1970) discussed the menhaden and anchovies, respectively, of the park waters. Other works on marine and estuarine species included: Hudson and co-workers (1970) and Schmidt (1979) on the Florida Bay fauna, Roessler (1970) on Buttonwood Canal fishes, Clark (1971), Davis and Hilsenbeck (1974), and Schmidt (1993) on Whitewater Bay/Shark River species, and Jannke (1971) on sciaenid fishes in Everglades National Park. The decade of the 1980s produced numerous data on marine fishes from Florida Bay and the Gulf of Mexico by Colby and co-workers (1985), Powell and co-workers (1987), Robblee and Nutinet (1987), Rutherford and co-workers (1986), Sogard and co-workers (1989a; 1989b), and Thayer and co-workers (1987). The marine ichthyoplankton of the park was described by Collins and Finucane (1984), and A. Powell and co-workers (1987). Papers presented at the 1987 Florida Bay Symposium and published in Volume 50(1) of the Bulletin of Marine Science (1989) comprised the most complete body of data on the biology and fishery harvest of game species in the park. In recent years several papers have presented information about fishes inhabiting mangrove creeks and flats along the

northern shores of Florida Bay (Ley, 1992; McIvor et al., 1994; and Lorenz, 1997).

Research in areas adjacent to the park included the survey by Lindall and co-workers (1973) of the inshore and offshore fishes of the Gulf of Mexico, the study by Carter and co-workers (1973) of the fishes of the Ten Thousand Islands, and recent unpublished collections by John Briggs and students from the Ten Thousand Islands (Tolley, 1983), and by a National Marine Fisheries Service cruise in the Gulf of Mexico (Burgess, 1983).

Historically, considerably less research has been focused upon freshwater fish communities in the park. The most comprehensive studies were those by Kushlan and Lodge (1974) and Loftus and Kushlan (1987), which thoroughly documented the status and distribution of fishes in the fresh waters of the park and its surroundings. Courtenay and co-workers (1974) and Shafland (1996) described the occurrence of non-native freshwater fishes in and near the park. Loftus and Kushlan (1987) clarified and revised those data, and Loftus (1987, 1988) and Courtenay (1997) added information on recently established non-native species. The fishes of the Everglades Water Conservation Areas immediately north of the park have been recorded by Dineen (1984) and Trexler and Jordan (1999). Several species that occur north of the park have never been collected within the park (Dineen, 1984; Loftus and Kushlan, 1987). Additional information on the relative species abundance and densities of fishes in and near the park may be found in Loftus and Eklund (1994), Howard and co-workers (1995), and Trexler and co-workers (1996).

Paulson (1959), Phillips (1971), and Schmidt (1975) have compiled previous fish lists for Everglades National Park. Extensive bibliographies for the marine fauna may be found in Schmidt (1991) and Schmidt and Kayer (1979), and for the freshwater ichthyofauna in Kushlan and Lodge (1974) and Loftus and Kushlan (1987).

This updated inventory of the ichthyofauna of the park contains an additional 70 species since the last list was compiled (Schmidt, 1975). This reflects the more complete knowledge of the fishes that has resulted from the increasing number of research studies in the aquatic habitats of the park because of Everglades restoration efforts and the seagrass dieoff phenomenon (Robblee et al., 1991).

METHODS.—This latest inventory of Everglades fishes has been compiled from several sources. Previous checklists for the park (Paulson, 1959, Phillips, 1971, and Schmidt, 1975) provided much of the background information for this inventory. In a few cases of incomplete documentation for a species listed in earlier checklists, I decided to keep the record if the regional literature supported its inclusion here. Records from the checklists were supplemented by the many published studies on the local freshwater and marine ichthyofaunas that included information on the habitat occurrence and abundance of various species. Examination of accession records at the three museums that housed the most extensive collections of park fishes, the University of Miami Rosenstiel School of Marine and Atmospheric Sciences (UMML—collection now at UF), the Florida Museum of Natural History (UF), Gainesville, and the

Everglades National Park museum (EVER) provided several unpublished records. Finally, the experiences of the author and, in particular, personal communications with colleagues were invaluable in preparing this latest inventory.

I have reported all fishes presently documented from park waters. The main inventory table includes information on the relative abundance and habitat occurrences of each species. Introduced (non-native) species are so designated in the table. The reference to the authority for the presence of a species in the park is also noted. Common and scientific names generally follow those in Robins and co-workers (1991). In a second table, fishes that have been taken from nearby waters outside the park, in habitats that also occur within the park, are listed as species of hypothetical occurrence. Those species may be found in the park with time or with further collecting. In a separate table, I have listed species of doubtful occurrence, the presence of which in park waters is uncertain due to the absence of voucher specimens, or to distributional anomalies.

The fishes are classified either as marine, estuarine, or freshwater, based upon the salinity in which they usually occur. Fishes (euryhaline species) that tolerate a range of salinities are so noted in the table. Aquatic habitats within the park are varied; descriptions of the major types follow:

*Freshwater everglades.*—A mosaic of aquatic plant communities combine to form the habitat that covers much of the park's interior. Natural habitats include sawgrass marshes, which cover the most area of the freshwater Everglades, and are dominated by *Cladium jamaicense*. Those habitats are interspersed with wet prairie and slough communities composed of various aquatic plant genera (e.g., *Nymphaea*, *Panicum*, *Eleocharis*, and *Rhynchospora*). The floating species of *Utricularia* support luxuriant surface mats of periphyton. Alligator ponds provide open, deep-water habitat for much of the year and provide refuge for fishes during the dry season when the surrounding shallow marshes dry. Along the edges of the main Everglades marshes, seasonally inundated prairies of *Muhlenbergia* grass, studded by numerous limestone solution holes, provide habitat for fishes. A limited area of cypress swamp (*Taxodium* spp.) also is present within the park.

Created freshwater habitats are present in and near the park. Canals and borrow pits are artificial deep-water habitats constructed for drainage, levee fill, or mining operations and are anthropogenic analogs, albeit larger and deeper, to alligator ponds. Canals have replaced all natural drainages of any significance along the extreme southeastern coast of Florida (Beck, 1965). Canals through the Everglades usually are bordered on one side by natural aquatic habitats and on the other side by a levee or road. The sloping canal edges are lined by marsh or swamp vegetation, particularly sawgrass, willow, or cattail (*Typha* spp.). Submerged vegetation is abundant along the margins of these canals. More detailed descriptions of freshwater habitats and their water quality characteristics may be found in Loftus and Kushlan (1987) and Gunderson and Loftus (1993).

*Estuarine habitats.*—These occur seaward of the interior freshwater marshes in an area referred to as the mangrove zone. These habitats include seasonally freshwater rivers, creeks, and ponds bordered by red mangrove (*Rhizophora mangle*). Sawgrass, black rush (*Juncus roemerianus*), and dwarf mangroves occur in marshes between the channels and ponds. Typical submerged plants in this region include *Najas guadalupensis* and *N. marina*, *Utricularia* spp., *Chara* spp., and *Ruppia maritima*. A series of large lakes and bays inland from the coast (e.g., Whitewater and Coot bays, Alligator Bay, West, Bear, Fox, and Cuthbert lakes) form extensive estuarine habitats.

During severe dry seasons, the watercourses become brackish or saline along their entirety. As salinity gradients change seasonally, fishes move up and down the rivers in response. The channels and deeper ponds offer dry season refuge for fishes from the surrounding areas. Fishes trapped in the drying marshes and shallow ponds become prey for many species of wading birds. The physical and biological characteristics of this region are more fully described by Odum and co-workers (1982) and Gilmore and Snedaker (1993).

*Marine habitats*—These are found in Florida Bay and the Gulf of Mexico and range from shallow carbonate banks and mudflats to deep channels. Large flats are covered by grassbeds of the genera *Thalassia*, *Halodule*, and *Syringodium*, with a variety of associated algae. The shorelines are edged by red and black mangroves, buttonwood (*Conocarpus erectus*), and by coastal prairies in some areas. A large number of islands (keys) in Florida Bay provide additional shallow shoreline habitat. Oyster bars composed of living and dead *Crassostrea virginica* provide hard-bottom habitat along some sections of coastline. Sandy beaches and sand substrates are generally uncommon. Reef-building corals are mostly absent, although areas of soft corals exist in southern Florida Bay. Tidal amplitude in much of Florida Bay is rather small; the effects of wind-driven water often overwhelm or enhance tidal influences. Detailed descriptions of marine environments in the park and their characteristic biota may be found in Tabb and Manning (1961), Tabb and co-workers (1962), Thayer and co-workers (1987), G. Powell and co-workers (1987), and Robblee and co-workers (1991).

Relative abundance categories used in this inventory are: *Common*, numerous and ubiquitous in appropriate habitats; *Locally Common*, numerous at specific locations or microhabitats but rare or absent in other parts of habitat; *Uncommon*, present in small numbers in suitable habitat or only locally or seasonally numerous; *Rare*, present only in very small numbers and of irregular occurrence, or occurs only in small, localized populations. These abundance categories apply only within park waters. Abundances of many species may differ greatly outside of the park, usually because of habitat and physico-chemical differences.

## RESULTS AND DISCUSSION

Southern Florida is an area in which members of the Antillean and Carolinian faunas meet. The fishes in the park belong to 22 orders and 85 families. Of the 290 native species of fishes reported from Everglades National Park (Table 1), 83 have strictly North American distributions. Florida is the northern limit for an additional 35 species of mainly neotropical fishes that occur in the park. The majority of fishes (173 species) found in Everglades National Park are found both in North American (not limited to Florida waters) and neotropical waters. Twenty-nine species listed as hypothetical have not been collected from park waters but occur in habitats shared by the park (Table 2). Some of those species may be found in the park with more extensive sampling or, in the case of the non-native species, may colonize by moving through the canal system where they presently reside to the east. Eleven species recorded from the area of the park are regarded as species of questionable occurrence, either because the record is far outside of the usual range for that species and/or because there are no voucher specimens with which to confirm the identification (Table 3).

All strictly freshwater fishes native to southern Florida are derived from North American temperate waters; most of these species range widely along the southeastern coastal plain (Loftus and Kushlan, 1987). Primary freshwater species (those groups completely restricted to fresh water) within the park number 20, while those that tolerate some salinity (secondary freshwater species) number eight. Of these freshwater species, most belong to two families of Perciformes: Centrarchidae and Cichlidae. All species of cichlids are introduced here. Both families have species that tolerate saline conditions and occasionally enter upper estuarine waters. In the densely vegetated marshes, members of the Cyprinodontidae, Fundulidae, and Poe-

TABLE 1. Fish relative abundance by habitat in Everglades National Park. Habitat descriptions are provided in the text. (I) ≡ Introduced species; (FW) indicates a species found also in the freshwater reaches of the estuary.

| Scientific name | Natural FW | Created FW | Estuarine | Marine | Citation* |
|---|---|---|---|---|---|
| Ginglymostomatidae | | | | | |
| *Ginglymostoma cirratum* | | | | R | 1, 2 |
| Rhincodontidae | | | | | |
| *Rhincodon typus* | | | | R | 21 |
| Lamnidae | | | | | |
| *Carcharodon carcharias* | | | | R | 7 |
| *Isurus oxyrinchus* | | | | R | 2, 10 |
| Carcharhinidae | | | | | |
| *Carcharhinus leucas* | | | U (FW) | U | 3, 11 |
| *Carcharhinus limbatus* | | | LC | LC | 1, 4, 7 |
| *Carcharhinus plumbeus* | | | | R | 7 |
| *Galeocerdo cuvier* | | | | R | 7 |
| *Negaprion brevirostris* | | | | LC | 2, 14 |
| *Rhizoprionodon terraenovae* | | | | C | 14 |
| Sphyrnidae | | | | | |
| *Sphyrna lewini* | | | | R | 2 |
| *Sphyrna mokarran* | | | | R | 2 |
| *Sphyrna tiburo* | | | LC | LC | 1, 2 |
| Pristidae | | | | | |
| *Pristis pectinata* | | | LC | LC | 1, 2 |
| Rhinobatidae | | | | | |
| *Rhizobatos lentiginosus* | | | | R | 5 |
| Torpedinidae | | | | | |
| *Narcine brasiliensis* | | | | R | 5 |
| Rajidae | | | | | |
| *Raja laevis* | | | | R | 7 |
| Dasyatidae | | | | | |
| *Dasyatis americana* | | | LC | LC | 1, 4 |
| *Dasyatis sabina* | | | U (FW) | | 3, 11 |
| *Gymnura micrura* | | | R | R | 22 |
| Myliobatidae | | | | | |
| *Aetobatus narinari* | | | | R | 2 |
| *Rhinoptera bonasus* | | | | U | 7, 14 |
| Mobulidae | | | | | |
| *Manta birostris* | | | | R | 7 |
| Lepisosteidae | | | | | |
| *Lepisosteus platyrhincus* | LC | C | LC | | 1, 3 |
| Amiidae | | | | | |
| *Amia calva* | U | C | LC (FW) | | 3 |

TABLE. Continued.

| Scientific name | Natural FW | Created FW | Estuarine | Marine | Citation* |
|---|---|---|---|---|---|
| **Elopidae** | | | | | |
| *Elops saurus* | | | C (FW) | C | 1, 3 |
| *Megalops atlanticus* | | LC | LC (FW) | LC | 1, 3 |
| **Albulidae** | | | | | |
| *Albula vulpes* | | | U | U | 3 |
| **Anguillidae** | | | | | |
| *Anguilla rostrata* | C | C | C (FW) | | 3, 6 |
| **Muraenidae** | | | | | |
| *Gymnothorax moringa* | | | | R | 1 |
| *Gymnothorax nigromarginatus* | | | | U | 1 |
| **Ophichthidae** | | | | | |
| *Ahlia egmontis* | | | C | C | 1 |
| *Bascanichthys bascanium* | | | | C | 1, 5 |
| *Bascanichthys scuticaris* | | | | C | 1 |
| *Myrophis punctatus* | | | LC | LC | 1, 4 |
| *Ophichthus gomesi* | | | C | C | 1, 2 |
| **Clupeidae** | | | | | |
| *Brevoortia patronus* | | | | R | 2, 12 |
| *Brevoortia smithi* | | | LC | LC | 1 |
| *B. patronus* x *B. smithi* | | | | U | 4 |
| *Dorosoma petenense* | | LC | R | | 3 |
| *Harengula humeralis* | | | LC | R | 4, 6 |
| *Harengula jaguana* | | | | C | 1, 2, 4 |
| *Jenkinsia lamprotaenia* | | | | U | 6 |
| *Opisthonema oglinum* | | | C | C | 2, 4 |
| *Sardinella aurita* | | | | U | 4, 6 |
| *Sarinella brasiliensis* | | | | R | 8 |
| **Engraulidae** | | | | | |
| *Anchoa cubana* | | | | R | 1, 2 |
| *Anchoa hepsetus* | | | | C | 1, 4, 5 |
| *Anchoa lamprotaenia* | | | | R | 4 |
| *Anchoa mitchilli* | | | C (FW) | C | 1 |
| *Anchovia perfasciata* | | | | R | 2 |
| **Cyprinidae** | | | | | |
| *Notemigonus crysoleucas* | U | LC | | | 3 |
| *Notropis maculatus* | R | R | | | 3 |
| *Notropis petersoni* | C | C | LC (FW) | | 3 |
| **Catostomidae** | | | | | |
| *Erimyzon sucetta* | LC | C | | | 3 |
| **Ictaluridae** | | | | | |
| *Ameiurus natalis* | C | U | LC (FW) | | 3 |
| *Ameiurus nebulosus* | R | U | | | 3 |
| *Ictalurus punctatus* | | U | | | 3 |
| *Noturus gyrinus* | LC | LC | LC (FW) | | 1, 3 |

TABLE 1. Continued.

| Scientific name | Natural FW | Created FW | Estuarine | Marine | Citation* |
|---|---|---|---|---|---|
| **Clariidae** | | | | | |
| ***Clarias batrachus* (I)** | U | LC | LC (FW) | | 3 |
| **Ariidae** | | | | | |
| ***Arius felis*** | | | C (FW) | C | 1, 3 |
| ***Bagre marinus*** | | | LC (FW) | LC | 3, 4 |
| **Esocidae** | | | | | |
| ***Esox niger*** | | LC/R | | | 3 |
| **Synodontidae** | | | | | |
| ***Synodus foetens*** | | | C | C | 2, 4 |
| ***Trachinocephalus myops*** | | | | R | 7 |
| **Ophidiidae** | | | | | |
| ***Ophidion grayi*** | | | | U | 5 |
| ***Ophidion holbrooki*** | | | | R | 5 |
| ***Ophidion welshi*** | | | | R | 5 |
| **Bythitidae** | | | | | |
| ***Gunterichthys longipenis*** | | | | R | 6 |
| ***Ogilbia cayorum*** | | | | R | 22 |
| **Batrachoididae** | | | | | |
| ***Opsanus beta*** | | | C | C | 1, 4 |
| ***Porichthys plectrodon*** | | | U | U | 4 |
| **Antennariidae** | | | | | |
| ***Histrio histrio*** | | | | R | 4, 8 |
| **Ogcocephalidae** | | | | | |
| ***Ogcocephalus nastutus*** | | | R | R | 4 |
| ***Ogcocephalus radiatus*** | | | | U | 2, 5 |
| **Gobiesociade** | | | | | |
| ***Gobiesox strumosus*** | | | | U | 1, 2 |
| **Exocoetidae** | | | | | |
| ***Chriodorus atherinoides*** | | | | LC | 1, 2 |
| ***Hemiramphus balao*** | | | | R | 6 |
| ***Hemiramphus brasiliensis*** | | | LC | LC | 1 |
| ***Hyporhamphus unifasciatus*** | | | C | C | 1, 4 |
| ***Prognichthys gibbifrons*** | | | | R | 4 |
| **Belonidae** | | | | | |
| ***Strongylura marina*** | | | LC (FW) | LC | 4 |
| ***Strongylura notata*** | | | C (FW) | C | 1, 2, 4 |
| ***Strongylura timucu*** | | | C (FW) | C | 1, 3, 8 |
| ***Tylosurus crocodilus*** | | | | R | 2, 8 |
| **Aplocheilidae** | | | | | |
| ***Rivulus marmoratus*** | | | LC (FW) | | 1, 4, 10 |

TABLE II. Continued.

| Scientific name | Natural FW | Created FW | Estuarine | Marine | Citation* |
|---|---|---|---|---|---|
| Cyprinodontidae | | | | | |
| *Cyprinodon variegatus* | LC | | C (FW) | C | 1, 2, 3, 8 |
| *Floridichthys carpio* | | | C (FW) | C | 2, 3, 6, 8 |
| *Jordanella floridae* | LC | LC | C (FW) | | 3, 10 |
| Fundulidae | | | | | |
| *Adinia xenica* | U | | LC (FW) | | 1, 3 |
| *Fundulus chrysotus* | C | U | U (FW) | | 3 |
| *Fundulus confluentus* | C | | C (FW) | | 1, 3 |
| *Fundulus grandis* | | | C (FW) | C | 1, 2, 3, 5 |
| *Fundulus seminolis* | U | | | | 3, 6 |
| *Fundulus similis* | | LC | LC (FW) | LC | 1, 2, 3 |
| *Lucania goodei* | C | | U (FW) | | 3 |
| *Lucania parva* | | C | C (FW) | C | 2, 3 |
| Poeciliidae | | | | | |
| *Belonesox belizanus* (I) | C | C | C (FW) | | 3 |
| *Gambusia holbrooki* | C | C | LC (FW) | LC | 1, 3 |
| *Gambusia rhizophorae* | | | U (FW) | | 3 |
| *Heterandria formosa* | C | C | U (FW) | | 3 |
| *Poecilia latipinna* | LC | LC | LC (FW) | LC | 1, 2, 3 |
| Atherinidae | | | | | |
| *Atherinomorus stipes* | | | | | 2, 6 |
| *Hypoatherina harringtonensis* | | | | | 6 |
| *Labidesthes sicculus* | U | LC | | | 3 |
| *Membras martinica* | | | R | C | 4, 5, 6 |
| *Menidia beryllina* | | | C (FW) | | 3, 4 |
| *Menidia peninsulae* | | | | LC | 6 |
| Syngnathidae | | | | | |
| *Anarchopterus criniger* | | | | LC | 2 |
| *Bryx dunckeri* | | | | LC | 1, 2 |
| *Cosmocampus albirostris* | | | | R | 2 |
| *Hippocampus erectus* | | | LC | LC | 1, 4 |
| *Hippocampus zosterae* | | | | C | 1, 4 |
| *Micrognathus crinitus* | | | | U | 21 |
| *Syngnathus floridae* | | | | C | 4 |
| *Syngnathus louisianae* | | | | LC | 4, 5 |
| *Syngnathus scovelli* | | | LC | LC | 1, 4 |
| Scorpaenidae | | | | | |
| *Scorpaena albifimbria* | | | | R | 2 (U) |
| *Scorpaena brasiliensis* | | | | U | 1, 5 |
| Triglidae | | | | | |
| *Bellator egretta* | | | | R | 1 |
| *Prionutus ribo* | | | | R | 10 |
| *Prionotus scitulus* | | | | LC | 5, 13 |
| *Prionotus tribulus* | | | LC | LC | 1, 2, 4 |

TABLE. Continued.

| Scientific name | Natural FW | Created FW | Estuarine | Marine | Citation* |
|---|---|---|---|---|---|
| Centropomidae | | | | | |
| *Centropomus parallelus* | R | | R (FW) | | 9 |
| *Centropomus pectinatus* | R | | U (FW) | U | 8 |
| *Centropomus undecimalis* | | C | LC (FW) | LC | 3, 9 |
| Serranidae | | | | | |
| *Centropristis striata* | | | | R | 5 |
| *Diplectrum bivittatum* | | | | R | 8 |
| *Diplectrum formosum* | | | | LC | 2, 4 |
| *Epinephelus itajara* | | | | LC | 4, 11 |
| *Epinephelus morio* | | | LC (FW) | U | 1 |
| *Epinephelus striatus* | | | | R | 1, 2 |
| *Hypoplectus unicolor* | | | | U | 2, 5 |
| *Mycteroperca bonaci* | | | | R | 2 |
| *Mycteroperca microlepis* | | | | LC | 1 |
| *Rypticus maculatus* | | | | R | 22 |
| Centrarchidae | | | | | |
| *Elassoma evergladei* | LC | LC | LC (FW) | | 3 |
| *Enneacanthus gloriosus* | U | C | | | 3 |
| *Chaenobryttus gulosus* | C | C | U (FW) | | 3 |
| *Lepomis macrochirus* | U | C | U (FW) | | 3 |
| *Lepomis marginatus* | C | C | | | 3 |
| *Lepomis microlophus* | U | C | U (FW) | | 3 |
| *Lepomis punctatus* | C | C | U (FW) | | 3 |
| *Micropterus salmoides* | U | LC | LC (FW) | | 3 |
| *Pomoxis nigromaculatus* | | R | | | 3 |
| Percidae | | | | | |
| *Etheostoma fusiforme* | R | LC | R (FW) | | 3 |
| Priacanthidae | | | | | |
| *Priacanthus arenatus* | | | | R | 2 |
| Apogonidae | | | | | |
| *Astrapogon alutus* | | | | U | 5 |
| Pomatomidae | | | | | |
| *Pomatomus saltatrix* | | | | R | 2, 8 |
| Rachycentridae | | | | | |
| *Rachycentron canadum* | | | | U | 2, 4 |
| Echeneidae | | | | | |
| *Echeneis naucrates* | | | U | U | 1, 4 |
| *Echeneis neucratoides* | | | | U | 2 |
| Carangidae | | | | | |
| *Caranx bartholomaei* | | | R | R | 2 |
| *Caranx crysos* | | | | U | 1, 2 |
| *Caranx hippos* | | | C (FW) | C | 1, 2, 3 |
| *Caranx latus* | | | | R | 8 |
| *Caranx ruber* | | | | R | 7 |

TABLE 1. Continued.

| Scientific name | Natural FW | Created FW | Estuarine | Marine | Citation* |
|---|---|---|---|---|---|
| *Chloroscombrus chrysurus* | | | | U | 1, 2, 4 |
| *Hemicaranx amblyrhynchus* | | | | R | 4 |
| *Oligoplites saurus* | | | LC (FW) | LC | 1, 2, 4 |
| *Selene setapinnis* | | | LC | R | 2 |
| *Selene vomer* | | | | LC | 2, 4 |
| *Seriola dumerili* | | | | R | 7 |
| *Seriola zonata* | | | | R | 7 |
| *Trachinotus carolinus* | | | | U | 2, 8 |
| *Trachinotus falcatus* | | | | U | 2, 8 |
| Coryphaenidae | | | | | |
| *Coryphaena hippurus* | | | | R | 22 |
| Lutjanidae | | | | | |
| *Lutjanus analis* | | | | R | 2 |
| *Lutjanus apodus* | | | U | U | 2 |
| *Lutjanus griseus* | | | C (FW) | C | 1, 2, 3 |
| *Lutjanus jocu* | | | C | C | 1 |
| *Lutjanus synagris* | | | LC | LC | 1, 4 |
| *Ocyurus chrysurus* | | | | R | 2 |
| Lobotidae | | | | | |
| *Lobotes surinamensis* | | | | U | 2, 4 |
| Gerreidae | | | | | |
| *Diapterus plumieri* | | | C (FW) | C | 1, 2, 3, 4 |
| *Eucinostomus argenteus* | | | C (FW) | C | 4, 11 |
| *Eucinostomus gula* | | | C (FW) | C | 3, 4 |
| *Eucinostomus harengulus* | | | | R | 10 (PC) |
| *Eucinostomus lefroyi* | | | U | U | 21 |
| *Gerres cinereus* | | | LC | LC | 1, 2 |
| Haemulidae | | | | | |
| *Anisotremus virginicus* | | | | R | 1, 2 |
| *Haemulon aurolineatum* | | | U | U | 1, 2 |
| *Haemulon chrysargyreum* | | | | R | 8 |
| *Haemulon flavolineatum* | | | | R | 6 |
| *Haemulon parra* | | | | U | 2 |
| *Haemulon plumieri* | | | C | C | 1, 2, 6 |
| *Haemulon sciurus* | | | | U | 1, 7, 9 |
| *Orthopristis chrysoptera* | | | C | C | 1, 2, 5 |
| Sparidae | | | | | |
| *Archosargus probatocephalus* | | | LC (FW) | LC | 1, 2, 3 |
| *Archosargus rhomboidalis* | | | | U | 2 |
| *Calamus arctifrons* | | | | LC | 1 |
| *Calamus leucosteus* | | | | R | 6 |
| *Calamus penna* | | | | R | 22 |
| *Lagodon rhomboides* | | | C | C | 1, 2, 8 |
| Sciaenidae | | | | | |
| *Bairdiella batabana* | | | | U | 2, 4 |
| *Bairdiella chrysoura* | | | C (FW) | C | 1, 2, 6, 11 |

TABLE. Continued.

| Scientific name | Natural FW | Created FW | Estuarine | Marine | Citation* |
|---|---|---|---|---|---|
| *Cynoscion arenarius* | | | U | U | 4 |
| *Cynoscion nebulosus* | | | LC | LC | 1 |
| *Equetus acuminatus* | | | | R | 2 |
| *Equetus lanceolatus* | | | | R | 1 |
| *Equetus umbrosus* | | | | U | 5 |
| *Larimus fasciatus* | | | | R | 7 |
| *Leiostomus xanthurus* | | | U | U | 1, 5 |
| *Menticirrhus americanus* | | | | LC | 2, 5 |
| *Menticirrhus littoralis* | | | | U | 2 |
| *Menticirrhus saxatilis* | | | | U | 17 |
| *Micropogonias undulatus* | | | | R | 1, 4 |
| *Pogonias cromis* | | | U | U | 1, 4, 8 |
| *Sciaenops ocellatus* | | | LC (FW) | LC | 1, 3 |
| *Stellifer lanceolatus* | | | | R | 17 |
| Ephippidae | | | | | |
| *Chaetodipterus faber* | | | | C | 1, 2, 4, 5 |
| Pomacanthidae | | | | | |
| *Holacanthus ciliaris* | | | | R | 16 |
| Cichlidae | | | | | |
| *Astronotus ocellatus* (I) | | C | | | 3, 15 |
| *Cichla ocellaris* (I) | | R | | | 21 |
| *Cichlasoma bimaculatum* (I) | LC | LC | | | 3 |
| *Cichlasoma urophthalmus* (I) | C | C | U (FW) | | 15 |
| *Oreochromis aureus* (I) | LC | C | LC (FW) | | 3, 15 |
| *Oreochromis mossambicus* (I) | | U | | | 18 |
| *Tilapia mariae* (I) | U | U | U (FW) | | 3 |
| Mugilidae | | | | | |
| *Agonostomus monticola* | | | R | | 11 |
| *Mugil cephalus* | | U | | C | 1, 2, 3, 8 |
| *Mugil curema* | | | R | C | 1, 2, 8 |
| *Mugil gyrans* | | | C (FW) | C | 2, 5 |
| Sphyraenidae | | | | | |
| *Sphyraena barracuda* | | | U (FW) | LC | 1, 2, 8, 13 |
| *Sphyraena guachancho* | | | | R | 6 |
| Polynemidae | | | | | |
| *Polydactylus octonemus* | | | | U | 7, 10 |
| Pomacentridae | | | | | |
| *Abudefduf saxatilis* | | | | R | 7 |
| *Pomacentrus leucostictus* | | | | R | 7 |
| Labridae | | | | | |
| *Bodianus rufus* | | | | R | 12 |
| *Halichoeres bivittatus* | | | | R | 7 |
| *Lachnolaimus maximum* | | | | U | 1, 4 |

TABLE H. Continued.

| Scientific name | Natural FW | Created FW | Estuarine | Marine | Citation* |
|---|---|---|---|---|---|
| **Scaridae** | | | | | |
| *Cryptotomus roseus* | | | | R | 6 |
| *Nicholsina usta* | | | | LC | 1, 5, 6 |
| *Scarus guacamaia* | | | | R | 7 |
| *Scarus taeniopterus* | | | | R | 2 |
| *Sparisoma aurofrenatum* | | | | R | 2 |
| *Sparisoma chrysopterum* | | | | R | 2 |
| *Sparisoma radians* | | | | R | 13 |
| *Sparisoma rubripinne* | | | | U | 1, 2, 4 |
| *Sparisoma viride* | | | | R | 2, 22 |
| **Clinidae** | | | | | |
| *Paraclinus fasciatus* | | | | U | 6, 8 |
| *Paraclinus marmoratus* | | | | U | 6, 8 |
| **Blenniidae** | | | | | |
| *Chasmodes saburrae* | | | | LC | 1, 2 |
| *Hypsoblennius hentz* | | | LC (FW) | R | 1 |
| *Parablennius marmoreus* | | | | R | 1, 5 |
| **Callionymidae** | | | | | |
| *Diplogrammus pauciradiatus* | | | | LC | 2, 6 |
| **Eleotridae** | | | | | |
| *Dormitator maculatus* | | | LC (FW) | | 1, 4 |
| *Eleotris pisonis* | | | R | | 4 |
| *Gobiomorus dormitor* | | | R (FW) | | 3 |
| **Gobiidae** | | | | | |
| *Barbulifer ceuthoecus* | | | | R | 8 |
| *Bathygobius soporator* | | | LC | U | 20 |
| *Coryphopterus glaucofraenum* | | | | R | 16 |
| *Gobionellus oceanicus* | | | U | U | 4 |
| *Gobiomellus saepepallens* | | | | R | 8 |
| *Gobiomellus skulfeldti* | | | | R | 9 |
| *Gobiomellus smaragdus* | | | LC (FW) | LC | 4 |
| *Gobiosoma bosc* | | | LC (FW) | U | 2, 3 |
| *Gobiosoma robustum* | | | C | C | 1 |
| *Lophogobius cyprinoides* | | | LC (FW) | LC | 1, 3 |
| *Microgobius gulosus* | | | C (FW) | U | 1, 2, 3 |
| *Microgobius microlepis* | | | | U | 2, 6 |
| *Microgobius thalassinus* | | | R | R | 9, 13 |
| **Microdesmidae** | | | | | |
| *Microdesmus sp.* | | | | R | 19 |
| **Acanthuridae** | | | | | |
| *Acanthurus chirurgus* | | | | R | 6 |
| **Scombridae** | | | | | |
| *Scomberomorus cavalla* | | | | R | 2, 4 |
| *Scomberomorus maculatus* | | | | LC | 1 |
| *Scomberomorus regalis* | | | | R | 7 |

TABLE. Continued.

| Scientific name | Natural FW | Created FW | Estuarine | Marine | Citation* |
|---|---|---|---|---|---|
| **Xiphiidae** | | | | | |
| *Xiphias gladius* | | | | U | 7 |
| **Stromateidae** | | | | | |
| *Nomeus gronovii* | | | | R | 8 |
| *Peprilus alepidotus* | | | | R | 12, 22 |
| **Bothidae** | | | | | |
| *Ancyllopsetta quadrocellata* | | | | U | 1, 5 |
| *Bothus ocellatus* | | | | R | 2 |
| *Citharichthys macrops* | | | | R | 5 |
| *Citharichthys spilopterus* | | | | LC | 4, 12 |
| *Etropus crossotus* | | | | U | 1, 4 |
| *Paralichthys albigutta* | | | LC | LC | 4, 5 |
| *Paralichthys lethostigma* | | | | U | 1, 2 |
| *Paralichthys squamilentus* | | | | R | 1 |
| *Syacium gunteri* | | | | LC | 12 |
| **Soleidae** | | | | | |
| *Achirus lineatus* | | | C (FW) | C | 1, 2, 3, 5 |
| *Symphurus diomedianus* | | | | U | 5 |
| *Symphurus plagiusa* | | | C | C | 1, 4, 13 |
| *Trinectes inscriptus* | | | | R | 6 |
| *Trinectes maculatus* | | | LC (FW) | C | 1, 3 |
| **Balistidae** | | | | | |
| *Aluterus schoepfi* | | | | U | 1, 4, 6 |
| *Aluterus scriptus* | | | | R | 2, 7 |
| *Balistes capriscus* | | | | R | 4 |
| *Balistes vetula* | | | | R | 7 |
| *Canthidermis maculata* | | | | R | 4 |
| *Monacanthus ciliatus* | | | | C | 1, 5, 10 |
| *Monacanthus hispidus* | | | | C | 1, 5 |
| **Ostraciidae** | | | | | |
| *Lactophrys quadricornis* | | | | C | 2, 4, 5 |
| *Lactophrys trigonus* | | | | U | 1, 2 |
| **Tetraodontidae** | | | | | |
| *Chilomycterus antillarum* | | | | R | 2 |
| *Chilomycterus schoepfi* | | | C | C | 1, 2, 4 |
| *Diodon hystrix* | | | | R | 1 |
| *Sphoeroides nephelus* | | | C | C | 1, 2, 4 |
| *Spoeroides spengleri* | | | U | U | 4, 5 |
| **Molidae** | | | | | |
| *Mola mola* | | | | R | 7 |

*The citation codes are as follows: 1 = Tabb and Manning, 1961; 2 = Schmidt, 1979; 3 = Loftus and Kushlan, 1987; 4 = Roessler, 1970; 5 = Lindall et al., 1973; 6 = Thayer et al., 1987; 7 = Schmidt, 1975; 8 = G. Powell et al., 1987; 9 = Carter et al., 1973; 10 = Robins et al., 1991; 11 = Tabb et al., 1962; 12 = Tabb and Roessler, 1989; 13 = Clark, 1971; 14 = Henshall, 1891; 15 = Loftus, 1988; 16 = Robblee and Hutinet, unpub.; 17 = Jaanke, 1971; 18 = Trewavas, 1984; 19 = Collins and Finucane, 1984; 20 = Paulson, 1959; 21 = Loftus, personal obs.; 22 = UMML/FEVER collections. PC = personal communication with the author, U = an unpublished work by the author.

TABLE 2. Fishes that may occur in Everglades National Park, but have not yet been collected there (Species of Hypothetical Occurrence). (I) = Introduced species.

| Scientific name | Freshwater | Estuarine | Marine | Citation |
|---|---|---|---|---|
| *Dorosoma cepedianum* | X | | | Loftus and Kushlan, 1987 |
| *Echiophis intertinctus* | | | X | Lindall et al., 1973 |
| *Menidia conchorum* | | | X | Schmidt 1975 |
| *Syngnathus springeri* | | | X | Carter et al., 1973 |
| *Hippocampus reidi* | | | X | Carter et al., 1973 |
| *Centropomus ensiferus* | | | X | Rivas, 1962 |
| *Serraniculus pumilio* | | | X | Lindall et al., 1973 |
| *Serranus subligarius* | | | X | Lindall et al., 1973 |
| *Astrapogon stellatus* | | | X | Lindall et al., 1973 |
| *Diapterus auratus* | | | X | Carter et al., 1973 |
| *Cynoscion nothus* | | | X | UF collection |
| *Cluetodon ocellatus* | | | X | UF collection |
| *Mugil gaimardianus* | | | X | — |
| *Lupinoblennius nicholsi* | | | X | Carter et al., 1973 |
| *Hypleurochilus geminatus* | | X | | Lindall et al., 1973 |
| *Chaetopsis ocellata* | | | X | — |
| *Gobionellus boleosoma* | | | X | G. Tolley, 1983 |
| *Trichiurus lepturus* | | | X | Carter et al., 1973 |
| *Sarda sarda* | | | X | Carter et al., 1973 |
| *Bothus robinsi* | | | X | Lindall et al., 1973 |
| *Syacium papillosum* | | | X | Lindall et al., 1973 |
| *Esox ainericanus* | X | | | Dineen, 1984; Trexler and Jordan, 1999 |
| *Pterygoplichthys multiradiatus* (I) | X | | | Courtenay, 1997 |
| *Cichlasoina citrinellum* (I) | X | | | Courtenay, 1997 |
| *Cichlasoma managuense* (I) | X | | | Gesthing and Shafland, 1997 |
| *Cichlasoma meeki* (I) | X | | | Courtenay, 1997 |
| *Cichlasoma octofasciatum* (I) | X | | | Courtenay, 1997 |
| *Geophagus surinamensis* (I) | X | | | Courtenay, 1997 |
| *Hemichromis letourneuxi* (I) | X | | | Courtenay, 1997 |

TABLE 3. The following species have been reported from the Everglades region, but there is no evidence to support their presence there. (Species of Doubtful Occurrence)

| Scientific name | Freshwater | Marine | Citation |
|---|---|---|---|
| *Lepisosteus osseus* | X | | Stevenson, 1976 |
| *Brevoortia tyrannus* | | X | Kushlan and Lodge, 1974 |
| *Notropis chalybaeus* | X | | Stevenson, 1976 |
| *Opsopoeodus emiliae* | X | | Stevenson, 1976 |
| *Anchoa cayorum* | | X | Schmidt, 1993 |
| *Aphrododerus sayanus* | X | | Briggs, 1958 |
| *Ophidion marginatum* | | X | Tabb and Roessler, 1989 |
| *Menidia menidia* | | X | Schmidt, 1975 |
| *Chaenopsis limbaughi* | | X | Thayer et al., 1987 |
| *Chasmodes bosquianus* | | X | G. Tolley, 1983 |
| *Sphoeroides pawus* | | X | Schmidt, 1993 |

ciliidae are numerically dominant (Loftus and Eklund, 1994; Trexler et al., 1996). The families Percidae, Cyprinidae and Catostomidae are represented in the park by only a few species. In the rest of North America, these families are predominant in most communities. The reasons for these differences probably include the absence of freshwater stream habitats and unfavorable abiotic conditions of heat, drought, and low dissolved-oxygen events.

Many fishes in the park inhabit more than one habitat. Peripheral freshwater species, which may survive in both fresh and salt waters, are numerous in park habitats (Loftus and Kushlan, 1987). Members of the speciose order Cyprinodontiformes may be found across the salinity gradient and are often very common where they occur. Other euryhaline fishes inhabit primarily marine and estuarine habitats, and occasionally move into fresh water. These number 83 species in the park, the majority belonging to three families of Perciformes: Haemulidae, Sciaenidae, and Gobiidae. Notably, Sciaenidae is the most diverse family in all park waters with 16 species.

There are 164 strictly marine fishes in the park. Of the Elasmobranchs, the requiem sharks (Carcharhinidae) are the most speciose. Seven families of Rajiformes are also present; however, no family is represented by more than three species. In the class Osteichthyes, the order Clupeiformes has two speciose families occurring within the park, Clupeidae and Engraulidae. The family Syngnathidae (order Gasterosteiformes) has numerous members in marine Park waters, as does the family Serranidae (order Perciformes). The jacks (Carangidae) are represented by 14 species, of which the crevalle jack (*Caranx hippos*) is especially common.

Although the body of research on freshwater fishes in Everglades National Park is small compared to work in marine and estuarine waters, the composition, abundance, and distribution of the freshwater fauna are better known. Marine and estuarine habitats are extensive and difficult to sample, so that the abundance and distribution of many species are poorly under-

stood. However, some general characteristics of the saltwater fauna are obvious. The records show that most offshore pelagic species occur infrequently in the shallow park waters. The inshore marine fauna of southern Florida and the Florida Keys is very diverse, but many characteristic species are rare or absent in the park. Members of the inshore fauna are often associated with hard coral or worm reef habitats, which are mostly absent from park waters. Also, winter water temperatures are warmer on the ocean side of the Florida Keys than in park waters because of the moderating influence of the Florida Current. As a result, tropical reef species are uncommon in Everglades National Park and normally occur there only as strays.

Other habitat characteristics of Florida Bay and inshore areas of the Gulf of Mexico influence the composition of the fish community. Because estuarine habitats receive seasonally fluctuating amounts of freshwater runoff from the Everglades, salinities vary greatly during the year. The network of mudbanks restricts water circulation in Florida Bay, affecting biotic communities and resulting in ecological conditions different from those in contiguous marine habitats on either coast of the peninsula (Holmquist et al., 1989). Florida Bay may act as a barrier to gene flow for some fishes that have presumably disjunct ranges on the Atlantic and Gulf coasts.

Marine fishes exhibit seasonal movements related to spawning, immigrations to and from nursery grounds, and changes in temperature and salinity (Moe, 1972). Seasonal migrations include coastwise movements by species that spend either the summer or winter along the Florida coast, e.g., bluefish (*Pomatomus saltatrix*), mackerel (*Scomberomorus* spp.), and dolphin (*Coryphaena hippurus*), or may reflect localized movements by south Florida populations, e.g., spotted seatrout (*Cynoscion nebulosus*), and gray snapper (*Lutjanus griseus*). Many species as larvae or juveniles show ontogenetic movements into estuarine nursery habitats, then move offshore as they mature. Freshwater species in the Everglades exhibit limited movements among habitats related to changes in seasonal environmental conditions, especially the flooding or drying of the marshes (Loftus and Kushlan, 1987). Diadromous and euryhaline species, such as tarpon (*Megalops atlanticus*), American eel (*Anguilla rostrata*), and common snook (*Centropomus undecimalis*), commonly move between salt and freshwater habitats, spending time in both.

Nine introduced freshwater species have colonized the park during the past two decades, with seven species establishing breeding populations. The butterfly peacock bass (*Cichla ocellaris*), and the Mozambique tilapia (*Oreochromis mossambicus*) have not yet become established there. Several other introduced species are found in the canal system outside the park and may make their way into park waters in the future (Table 2). All non-native freshwater fishes in the park have their origins in the tropics or subtropics, and most were the result of aquarium or aquaculture introductions (Courtenay et al., 1974; Loftus, 1988; and Loftus and Kushlan, 1987). Most introduced species tolerate low to moderate salinities, so have colonized the

mangrove region of the park. There are no exotic marine fishes known from the park.

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