

Inventory of Freshwater Fish Species within Big Cypress National Preserve: The Basis for a Long-Term Sampling Program

Introduction

The Big Cypress ecosystem forms a largely undeveloped landscape in southwestern Florida. The ecosystem includes three major habitats: seasonally flooded marshes, forested wetlands and upland pine habitats, all of which are intersected by manmade canals. Much of the landscape lies within the Federally protected Big Cypress National Preserve (BCNP), which is managed by the National Park Service (fig. 1). To understand this ecosystem, knowledge about the ecology of its fishes is especially important, because they are the most numerous vertebrates within the Preserve, and provide food for predators such as wading birds and alligators. The hydrologic change resulting from surface-water drainage and impoundment within the system has probably decreased fish biomass and numbers, and altered the timing and the areas of fish availability to predators (Duever and others, 1986). In addition, non-native fish species have colonized natural and disturbed habitats of the Big Cypress ecosystem during the past three decades, because the local climate and habitats are favorable for their colonization and survival (Loftus and Kushlan, 1987).

Only recent baseline data exist for fish communities in the Big Cypress system, and these data are relatively scarce. The first collections were made in the 1960s and 1970s during studies of the prey populations for wading birds (Kahl, 1964; Browder, 1976; Kushlan, 1974). The composition and distribution of native and introduced fishes from the southern areas of the Preserve were reported on by Loftus and Kushlan (1987). Limited collections were made by W.F. Loftus (National Park Service, written commun., 1987), and by Dalrymple (1995). Small quantitative datasets on fish communities exist only for Corkscrew Swamp (Carlson and Duever, 1977), and coastal habitats in the southern Big Cypress Swamp (Carter and others, 1973). The present study, funded by the USGS Greater Everglades Priority Ecosystems Science Program, in cooperation with BCNP, was conducted to produce a complete inventory of fishes for the Preserve, and to test methods for quantitatively sampling those habitats.

Methods of Investigation

Big Cypress fishes were inventoried throughout the period from October 2002 through June 2004 (Ellis and others, 2003). We collected multiple samples in all major aquatic habitats in the Preserve. We also took samples during several seasons at many locations (table 1). Most data, however, were collected during the winter/spring dry season in canals and other deep-water habitats. The transition between the wet and dry seasons coincided with the time of highest species richness in many

habitats because fishes were concentrating, but had not yet experienced high mortality. We emphasized sampling during this period to record the maximum number of species living within each habitat. In addition, shallow wetlands were sampled during the summer and fall high-water period. Because much of BCNP is inaccessible by road, helicopter, swamp buggy, and all-terrain vehicles were used to reach interior sites within the Preserve.

The diversity of habitats in BCNP presented challenges to the development of a comprehensive sampling regime. The effectiveness of any method varies by habitat, and each has inherent biases. To compensate, we used several techniques when taking a sample. Traps and nets provided a means of

Habitat	Number of samples
Canals	155
Cypress forest	49
Freshwater marsh	42
Herbaceous prairie	33
Sloughs/ponds/rivers	25
Cypress prairie	15
Mixed swamp forest	14
Coastal marshes	10

Table 1. Number of samples per habitat type

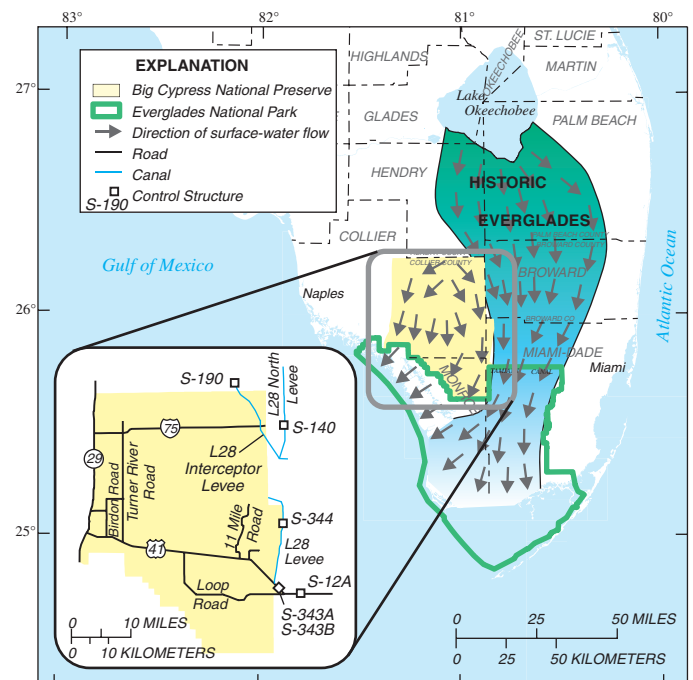


Figure 1. Map showing Big Cypress National Preserve.

Table 2. Distribution of fish species by habitat—Continued

Species	Habitats										
	Canals	Sloughs, ponds, rivers	Mixed swamp forest	Freshwater marsh	Cypress forest	Cypress prairie	Herbaceous prairie	Coastal marshes	All wetlands	Freshwater wetlands	Deep-water habitats
tadpole madtom	-	-	X	-	-	-	-	-	X	X	-
taillight shiner	X	-	-	-	-	-	-	-	-	-	X
tarpon	X	X	-	-	-	-	-	-	-	-	X
tidewater mojarra	X	-	-	-	-	-	-	-	-	-	X
timucu	X	-	-	-	-	-	-	-	-	-	X
walking catfish	X	X	X	-	-	-	X	X	X	X	-
warmouth	X	X	X	X	X	X	X	X	X	X	-
yellow bullhead	X	X	-	X	X	-	X	-	X	X	-

Two additional habitats hold water year-round:

- **Canals** — deep-water refuges for fishes during the dry season, from which they disperse in the wet season.
- **Sloughs/ponds/rivers** — natural, persistent water bodies. Ponds and rivers comprise a small geographic area of BCNP, but include important features as such as Deep Lake, Mud Lake, and Turner River.

Results and Discussion

From our sampling efforts, we identified 64 fish species (table 2). Fifty-five species are native to North America, and include species-rich groups such as sunfishes (Centrarchidae), killifishes (Cyprinodontidae and Fundulidae), livebearers (Poeciliidae), and catfishes (Ictaluridae). We also recorded nine nonindigenous species, most of which are in the cichlid family: Oscar (*Astronotus ocellatus*), black acara (*Cichlasoma bimaculatum*), Mayan Cichlid (*Cichlasoma urophthalmus*), blue tilapia (*Oreochromis aureus*), spotted tilapia (*Tilapia mariae*), and Jewel Cichlid (*Hemichromis letourneauxi*). Three non-cichlids were recorded: the poeciliid pike killifish (*Belonesox belizanus*), the callichthyid brown hoplo catfish (*Hoplosternum*

littorale), and the clariid walking catfish (*Clarias batrachus*). This study is the first to document *Hemichromis* and *Hoplosternum* from the Preserve, both of which are expanding their ranges southeastward (fig. 2). The number of non-indigenous species in BCNP has grown from three in the late 1970s (Loftus and Kushlan, 1987) to nine in 2004. Additional non-native species are present in the canal system near BCNP boundaries, which supports the hypothesis that this trend will continue. The Mayan cichlid is an example of a successful non-indigenous fish that has spread throughout much of the Preserve, where its population is especially large in canals. The potential ecological consequences of these invasions are uncertain.

The freshwater marshes and forested wetlands shared similar fish assemblages. Of the 33 species found in these habitats, 16 were common to all. Small fishes utilized shallow-water areas such as herbaceous prairies and cypress prairies when those habitats were inundated. As the shallow habitats dried, the relative abundance of those fishes in nearby swamp forests and cypress strands appeared to increase. This pattern was reported by Carlson and Duever (1977) for flagfish (*Jordanella floridae*) and least killifish (*Heterandria formosa*) populations during the annual dry-down of Corkscrew Swamp, and also occurs in the Everglades wetlands (Loftus and Kushlan, 1987). Small-bodied species, such as the eastern mosquitofish (*Gambusia holbrooki*), were often the most ubiquitous and numerous fishes in the samples (fig. 3).

Canals held the most diverse assemblage of fishes; 62 of the 64 species documented in the Preserve occurred within this habitat. Although this relatively high species richness reflects a greater sampling effort in this habitat compared to other habitats (table 1), it also is related to the presence of fish species that

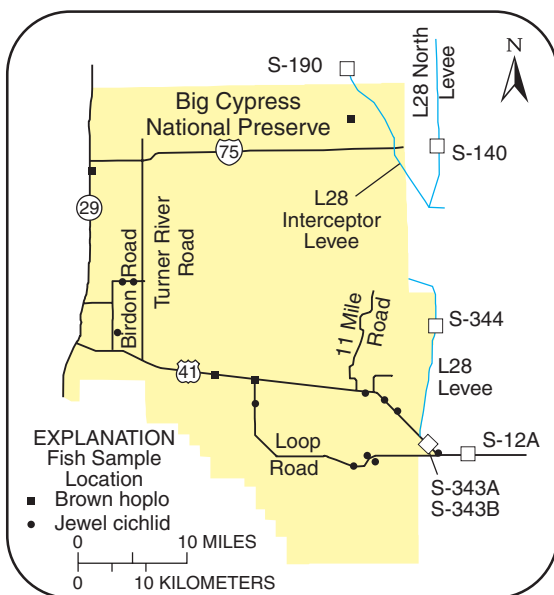


Figure 2. Newly established, introduced fishes in Big Cypress National Preserve include the Brown Hoplo catfish (*Hoplosternum littorale*) and Jewel Cichlid (*Hemichromis letourneauxi*). Copyrighted image used with permission.

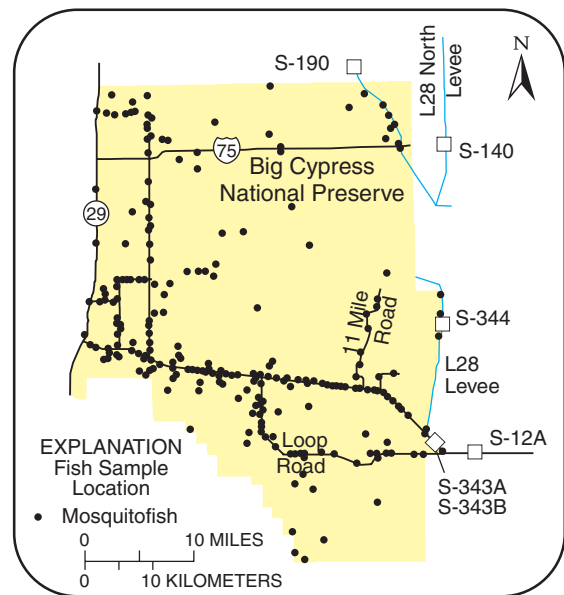


Figure 3. Distribution of the eastern mosquitofish, *Gambusia holbrooki*, was ubiquitous in Big Cypress National Preserve fish samples.

typically inhabit deep, open-water habitats, and to marine fishes that tolerate a wide range of salinities (“euryhaline” species). Open-water species included the brown bullhead (*Ameiurus nebulosus*), gizzard shad (*Dorosoma cepedianum*), redear (*Lepomis microlophus*), and black crappie (*Pomoxis nigromaculatus*), which are rarely found in BCNP wetlands. The marine invaders penetrate inland from the Gulf of Mexico through coastal canals. They do not seem to enter wetland habitats other than by way of channels in coastal marshes. Species in this category include the various needlefishes (*Strongylura* spp.), mojarras (*Eugerres* and *Eucinostomus*), and gobies (*Bathygobius*, *Lophogobius* and *Microgobius*), as well as snook (*Centropomus undecimalis*), gray snapper (*Lutjanus griseus*) and tarpon (*Megalops atlanticus*). The diversity and numbers of non-indigenous fishes are high in canals, especially during the dry season. Coastal marshes are also used by euryhaline species, and during the wet season, support most of the freshwater species found in the Preserve. Euryhaline species present in this habitat include clown goby (*Microgobius gulosus*), gulf killifish (*Fundulus grandis*), rainwater killifish (*Lucania parva*), and striped mullet (*Mugil cephalus*).

Sloughs, ponds, and rivers are the only natural habitats that retain water year-round. Few rivers exist within BCNP, although Turner River drains its southwestern portion. Lakes are also uncommon within BCNP; however, constructed borrow pits function as lakes. Both habitats, particularly those with hydrologic connections to the canal system, are home to large euryhaline and freshwater species. An example is the population of tarpon and Florida gar inhabiting Deep Lake—a flooded sinkhole adjacent to the Barron Collier Canal.

Loftus and Kushlan (1987) reported 34 native and 3 non-indigenous species from their collection efforts, compared to 56 native and 9 non-native species in the present study. However, a similar number of species were collected from the freshwater wetlands in both studies (29 in the earlier study and 33 in this study). The increase in species in the present study is the result of much greater sampling effort, particularly in coastal canals and rivers, and a larger sampling area. Loftus and Kushlan (1987) sampled only the southern area of BCNP, which lies south of U.S. Highway 41. Loftus and Kushlan (1987) found that species composition within the Big Cypress Everglades ecosystems were nearly identical; our data support this finding.

Several previously reported species within the Preserve were not collected in the present study. W.F. Loftus (National Park Service, written commun., 1987) found diamond killifish (*Adinia xenica*) and naked goby (*Gobiosoma bosc*). The survey by Dalrymple (1995) of the northern BCNP area included reports of chain pickerel (*Esox niger*) and channel catfish (*Ictalurus punctatus*) in the L-28 Canal. None of these species appear to be widespread in BCNP.

Continuing Research

This inventory is the initial step in a fish research program for BCNP. Although we identified effective methods for sampling various habitats during the inventory, the sampling did not include quantitative measurements of population densities. Quantitative data describing fish-community dynamics in the Big Cypress Swamp are lacking, except for short-term studies in the Corkscrew Swamp (Carlson and Duever, 1977) and southern Big Cypress region (Carter and others, 1973). We have begun a long-term program to study community composition and dynamics before and after restoration actions change hydrologic patterns in the region. Our current work includes repetitive sampling five times per year to compare baseline community data at sites within areas likely to be affected by hydrologic changes with those that will experience little effect. We are using equipment that provides density estimates for fishes in forested wetlands, especially quadrat drop traps. Sites are also sampled with drift-fence/minnow-trap arrays, with electrofishing, or other nets. Results from these quantitative collection efforts will help us better understand the functioning of the fish community in this large, complex ecosystem.

References Cited

- Browder, J.A., 1976, Water, wetlands, and wood storks in southwest Florida: Gainesville, University of Florida, Ph.D. dissertation, 406 p.
- Carlson, J.E., and Duever, M.J., 1977, Seasonal fish population fluctuations in a South Florida swamp, in Proceedings of the Southeastern Association of Fish and Wildlife Agencies, v. 31, p. 603-611.
- Carter, M.R., Burns, L.A., Cavender, T.E., and others, 1973, Ecosystems analysis of the Big Cypress Swamp and estuaries: U.S. Environmental Protection Agency, Region IV: Atlanta, Georgia, U.S. Environmental Protection Agency Report 904/9-74-002.
- Dalrymple, G.H., 1995, Wildlife Inventory for Baseline Studies of the Addition Lands of the Big Cypress National Preserve: Miami, Report prepared for Florida International University.
- Duever, M.R., Carlson, J.E., Meeder, J.F., and others, 1986, The Big Cypress National Preserve: New York, National Audubon Society, 455 p.
- Ellis, G., Zokan, M., Lorenz, J., and Loftus, W.F., 2003, Inventory of the freshwater fishes of the Big Cypress National Preserve, with a proposed plan for a long-term aquatic sampling program: Annual Project Report to the USGS Priority Ecosystems Science Program, Davie, Florida, 104 p.
- Kahl, M.P., 1964, Food ecology of the wood stork (*Mycteria americana*) in Florida: Ecological Monographs, v. 34, p. 97-117.
- Kushlan, J.A., 1974, Effects of a natural fish kill on the water quality, plankton, and fish population of a pond in the Big Cypress Swamp, Florida: Transactions of the American Fisheries Society, v. 103, p. 348-352.
- Loftus, W.F., and Kushlan, J.A., 1987, Freshwater fishes of southern Florida: Bulletin of the Florida State Museum, Biological Sciences, v. 31, p. 147-344.
- National Park Service, 1991, Big Cypress National Preserve General Management Plan and Final Environmental Impact Statement: Ochopee, Florida.

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