

Exotic Fishes of the Everglades: A Reconsideration of Proven Impact

The establishment and spread of exotic fishes in southern Florida has been repeatedly documented, especially by Walter R. Courtenay and his co-workers (Courtenay et al., 1974; Courtenay & Miley, 1975; Courtenay, 1978; Courtenay & Hensley, 1979). The potential environmental impacts of such introductions have captured popular attention and led to important discussions on how to control the release of non-native fishes (Courtenay & Robins, 1975; Shafland, 1979). Published accounts of exotic fishes in southern Florida have, to date, been based upon collections made from locations that were accessible by automobile or boat, especially along roadways and canals. No comprehensive surveys of exotic fish distribution in natural Everglades habitat have been conducted, and therefore the status of those species within the Everglades marsh has been extrapolated from nearby canals.

As part of a comprehensive survey of freshwater fish distribution in southern Florida, we sampled fishes throughout the Everglades marshes, using airboats* and helicopters, by electroshocking, rotenone, enclosure traps, and direct observation. A full description of the sampling sites, methods, and species accounts, can be found in Loftus & Kushlan (in press). In the present paper I briefly report the status of exotic fishes in the natural Everglades as of 1984, and contrast it with changes in an urban southern Florida canal occurring over an 18-years' period.

* Defined in Webster's Third New International Dictionary as 'a shallow-draft boat driven by an airplane propeller and steered by an airplane rudder.'—Ed.



FIG. 1. Distribution of exotic fishes in the Everglades marsh and in nearby southern Florida. A: *Clarias batrachus*. B: *Cichlasoma bimaculatum*. C: *Tilapia aurea*. D: *Hernichromis bimaculatus*. E: *Tilapia mariae*. F: *Tilapia mossambica*. G: *Astronotus ocellatus*. H: *Cichlasoma citrinellum*. I: *Cichlasoma meeki*. J: *Cichlasoma octofasciatum*. K: *Belonesox belizanus*.

Fig. 1 shows that the eleven species of exotic fishes, occurring primarily in the extensive canal systems of southeastern Florida, have followed these canals into the Everglades and adjacent Big Cypress Swamp. Few speci-

mens were taken in the Everglades marsh proper, however, despite extensive sampling throughout the area. Walking Catfish (*Clarias bairachus*) and Black Acara (*Cichlasoma bimaculatum*) have spread farthest, and are found in brackish rivers along the Gulf coast and in ponds within the Everglades marsh. However, even these collections indicate rather few fish to be present at any one site. Another currently spreading species is the Blue Tilapia (*Tilapia aurea*), which in the last four years has emigrated from a single introduction locus to many sites in the southern marshes and by all indications continues to spread (W.F. Loftus pers. comm.).

With the exception of the Blue Tilapia, we can conclude that, as of 1983, the several species of exotic fishes present in southern Florida have not penetrated the native fish communities of the southern Everglades proper. The occurrence of a few species in small numbers indicates that there has been no physical barrier to dispersal from canals into the Everglades marsh, but that some resistance has inhibited their increase in numbers, at least thus far. It is important to note that, as of the present study, exotic fishes were so infrequent in the marsh itself as to be ecological nonentities. They therefore could not have an important impact either quantitatively or qualitatively on the marsh's fish community.

This lack of ecological penetration is not the case in canals. I have monitored faunistic changes in a south Florida canal (Little River Canal, Dade County, Florida) from 1964 to 1982 (Table I). In 1964 the fish fauna in the Canal was dominated by centrarchids and poeciliids—all native

fishes. A single exotic cichlid, the Black Acara, was present. By the mid-1970s the Black Acara dominated the fish fauna, and by 1982, the number of exotic species had increased from one to five, while the native fish fauna had decreased from 23 to 16. By this date the fish community was dominated by the Spotted Tilapia (*Tilapia mariae*), which numerically had replaced the Black Acara as the dominant species.

The causes of the changes in the faunistic composition of the canal are not determinable, in that the increase in exotic species corresponded to an apparent lowering of water quality. Nonetheless, it seems certain that canals in developed areas, such as on the southeastern coast of Florida, are now dominated by exotic species. Canals that cross the Everglades support exotic species, but these fishes are not as numerous as in developed areas. The situation is somewhat different in the nearby Big Cypress Swamp, where Black Acara and Walking Catfish are abundantly present in canals and ponds. In the ecosystem involved, which differ from those of the Everglades marshes discussed above, it is likely that the exotic fishes are having a substantial effect on the native fish community, although the character of any effect remains to be documented.

That the southern Everglades marsh continues to support a vigorous native fish community despite the nearby presence of several exotic fish species, should be encouraging to preservationists. This finding would suggest that the community has resisted invasion, though whether such resistance will continue indefinitely is not known. It may take a single period of extensive flooding to permit the establishment and dramatic increase in numbers of one or more species of non-native fish; or perhaps the arrival on the scene of a particularly successful invader will permit the subsequent invasion of other species. Certainly the adverse effects of exotic species of the native fish community may take a considerable time to develop.

Of concern in that last respect is the rapid spread of the Blue Tilapia, a large vegetarian fish representing an adaptive type such as is not present in the native fauna. Its spread also illustrates the lack of vigilance on the part of authorities, despite all the previous discussions of potential deleterious effects of such invasions. The Blue Tilapia entered the Everglades from an aquaculture facility located on the boundary of Everglades National Park. It was known that individual fish often escaped from this facility, yet no action was taken by federal (National Park) or state authorities regarding the placement of the facility or its operation.

As it is likely that, over time, additional penetration of the marsh by exotic species will occur, a need remains for concern about such an eventuality. However, as of the beginning of 1984, the long-expected adverse impact of exotic fishes on the natural fish community of the Everglades marsh itself had not occurred, despite their abundance in adjacent canals and in the Big Cypress Swamp.

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TABLE I

Comparison of the Fish Fauna of a Southern Florida Canal over an 18-years' Period.

Species	1964*	1982*
Florida Gar (<i>Lepisosteus platyrhincus</i>) . . .	P	P
Bowfin (<i>Amia calva</i>)	P	—
Tarpon (<i>Megalops atlanticus</i>)	P	P
American Eel (<i>Anguilla rostrata</i>)	P	P
Golden Shiner (<i>Notemigonus crysoleucas</i>) . .	A	—
Yellow Bullhead (<i>Ictalurus natalis</i>)	A	P
Brown Bullhead (<i>Ictalurus nebulosus</i>) . . .	P	P
Armored Catfish (<i>Pterygoplichthys</i> sp.)* . .	—	P
Golden Topminnow (<i>Fundulus crysotus</i>) . . .	P	—
Bluefin Killifish (<i>Lucania goodei</i>)	A	P
Mosquitofish (<i>Gambusia affinis</i>)	A	A
Least Killifish (<i>Heterandria formosa</i>)	A	P
Sailfin Molly (<i>Poecilia latipinna</i>)	P	P
Brook Silverside (<i>Labidesthes sicculus</i>) . . .	A	—
Snook (<i>Centropomus undecimalis</i>)	P	P
Blue-spotted Sunfish (<i>Enneacanthus gloriosus</i>)	P	—
Warmouth (<i>Lepomis gulosus</i>)	A	P
Bluegill (<i>Lepomis macrochirus</i>)	A	P
Redear Sunfish (<i>Lepomis microlophus</i>) . . .	A	P
Spotted Sunfish (<i>Lepomis punctatus</i>)	A	—
Largemouth Bass (<i>Micropterus salmoides</i>) . .	P	P
Oscar (<i>Astronotus ocellatus</i>)*	—	P
Black Acara (<i>Cichlasoma bimaculatum</i>)* . .	P	P
Jewel fish (<i>Hemichromis bimaculatus</i>)* . . .	—	P
Spotted Tilapia (<i>Tilapia mariae</i>)*	—	A
Striped Mullet (<i>Mugil cephalus</i>)	P	P
Bigmouth Sleeper (<i>Gobiomorus dormitor</i>) . .	P	P
Fat Sleeper (<i>Dormitator maculatus</i>)	P	—

* = non-native species.

*A = abundant, P = present but not abundant, — = not collected.

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