The Contribution of an Exotic Fish, the Oscar, to the Sport Fishery of the Everglades Water Conservation Areas[1]

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Abstract: An illegally introduced exotic fish species has now become a significant and extremely popular fishery in the Everglades Water Conservation Areas (WCA's). The oscar (*Astronotus ocellatus*) was accidentally introduced in the 1950s and became established in south Florida waterways. A gradual range expansion occurred; however, oscar populations remained low until the mid-1980s. For approximately 25 years, catches were infrequent and singular. Following an unexplained and accelerated population expansion, angler catches became more frequent and multiple. Recent peak season angler surveys in the Everglades have documented a substantial oscar fishery in terms of harvest and effort. The total number of oscar harvested in WCA-2A peaked at 11,583 in 1986–87, but dropped to 0 by the last year of the survey in that area (1989–90) for reasons which are unclear. During 3 consecutive surveys (1990–93) in WCA-3A, oscar was the number one species harvested. An estimated 99,590 oscar were harvested, which represented 63% of the total harvest. The mean total harvest rate from the 3 surveys was 2.73 per man-hour, compared to 2.36 per man-hour for all panfish, including black crappie (*Pomoxis nigromaculatus*), combined. Oscar ranked a close second behind largemouth bass (*Micropterus salmoides*) as the most sought after species. Many anglers who typically fished for black crappie on Lake Okeechobee relocated to the Everglades to fish specifically for oscar. Oscar sampled from the creels had a mean length of 252 mm and a mean weight of 410 g. Fifty percent of the oscar anglers interviewed used artificial lures, while other anglers used either crickets, minnows, shrimp, worms, or cut-bait. The largest documented oscar caught in the Everglades weighed 790 g.

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There are currently 18 species of exotic and 1 transplanted fish established in Florida. An exotic fish is defined as one introduced from a foreign country, while a transplanted fish is one that has been introduced outside its native range, but within a country where it naturally occurs (Shafland and Lewis 1984). In addition, 5 exotic fishes have reproducing but unstable populations and 43 other exotic fishes have been collected without evidence of reproduction (Shafland 1991). Most of these species are found in south Florida due to its sub-tropical climate and extensive aquarium trade industry. The butterfly peacock bass (*Cichla ocellaris*) is the only established exotic species that was legally introduced in Florida. It was introduced by the Florida Game and Fresh Water Fish Commission (FGFWFC) in 1984 and has become a popular sport fish (Shafland 1993). Most of the exotic species inhabiting Florida originated in either South America, Asia, or Africa.

The oscar is native to the Orinoco, Amazon, and La Plata River systems of South America. It is one of 13 members of the family Cichlidae currently established in Florida. This species was released from a fish farm in southeastern Dade County in the late 1950s (Courtenay et al. 1974). It is suspected that other releases aided in range expansion. Rivas (1965) reported the oscar to be well established in drainage canals between Miami and Homestead. Courtenay and Hensley (1978) described the oscar as one species of exotic fish that has shown a range expansion from 1972 to 1978. Populations of oscar had remained fairly low from their time of release up to the mid-1980s, although they were occasionally caught by sport anglers. Courtenay et al. (1974) reported that attempts to popularize this fish by local outdoor columnists in the late 1950s failed. He further stated that its status as a sport fish was unclear at that time. No oscar were reported from fish population surveys or angler use surveys in 1957 from the Water Conservation Area (WCA) sections of the Everglades ecosystem (Herke et al. 1959). The purpose of this paper is to document, for the first time, a significant contribution to a sport fishery in Florida by an illegally introduced exotic species (the oscar). An illegal introduction is defined as any introduction not sanctioned by the FGFWFC. Florida law prohibits the release of non-native aquatic species into the waters of the state.

Methods

The Everglades is the largest freshwater system in south Florida, extending south from Lake Okeechobee to Florida Bay. A large part of the southernmost portion is in the Everglades National Park, which encompasses 5,698 km^2. To the northwest of the park lies a 6,216 km^2 area known as Big Cypress Swamp, and to the north are the WCAs. Water Conservation Areas 1, 2, and 3, covering approximately 3,483 km^2, are easily accessible to east coast anglers and probably receive the majority of freshwater fishing pressure.

Peak-season roving angler use surveys utilizing non-uniform probability were conducted in WCA-2A from 1985 to 1990 and in WCA-3A from 1990 to

1993 (Fig. 1). Surveys were conducted from December through May each year. The areas surveyed in WCA-2A were the L-38E and L-35B canals, which were approximately 19.4 and 16.1 km in length, respectively. These canals receive the majority of the fishing pressure in WCA-2A due to access availability and the proximity of Sawgrass Recreation Area. The L-67A Canal (42 km) in WCA-3A was surveyed. It is the most heavily fished canal in WCA-3A because of the access opportunities at Everglades Holiday Park Recreation Area and at the S-333 structure on Tamiami Trail.

The creel method was designed by Dr. Donald Hayne of the Institute of Statistics at North Carolina State University at Raleigh. The data were either sent to North Carolina State University for analysis, or analyzed using a version of their program modified by FGFWFC.

Results and Discussion

The first angler use surveys conducted in the WCAs occurred in the late 1950s (Herke et al. 1959). No recorded harvest of oscar was documented. The sport fishery consisted of largemouth bass, bream species and catfish. Dineen (1974) in "The Fishes of the Everglades" listed the black acara (*Cichlasoma bimaculatum*) as the only exotic species present in the WCAs. He reported other exotic species including oscar and walking catfish (*Clarias batrachus*) as being present in canals and rockpits adjacent to the Everglades. No oscar were col-

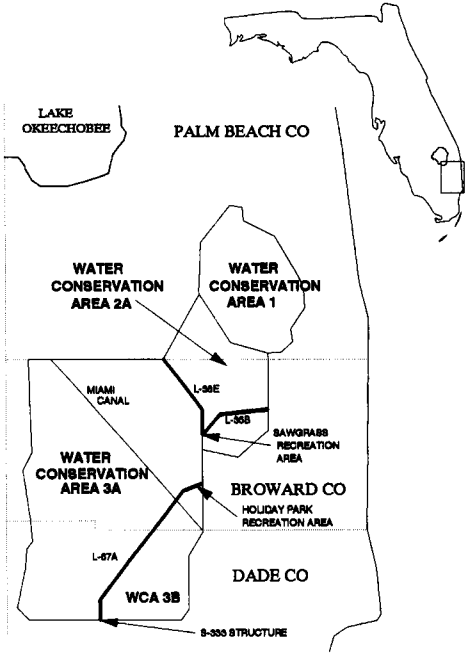

Figure 1. Map of areas studied by the Everglades Fisheries Investigations Project.

lected in fish population studies in marsh and canal habitats in WCA-2A and 3A from 1982 to 1985 (Morello et al. 1986).

The next angling survey in the Everglades was in 1985–86 in WCA-2A during the current study. There was no reason to expect oscar to contribute to the fishery; therefore, they were recorded in the miscellaneous category. Oscar were primarily caught incidentally by bass and bream fishermen. Over time, as more were caught, anglers began to target oscar. It soon became obvious that oscar were going to make a significant contribution to the fishery, and by January were added to the survey as a target species category. A total of 6,809 oscar were harvested during the 6-month survey period (Table 1). Oscar ranked second for target species, behind panfish, in total number harvested. While the majority of oscar harvested for the 1985–86 survey were incidental catches, by the end of the survey a total of 326 man-hours of fishing pressure was exerted specifically for oscar.

Oscar continued to gain in popularity with anglers during 1986–87 (Table 2). Man-hours of effort almost quadrupled for oscar, which made up 1% of the total effort for all species. A total of 1,298 man-hours were expended to harvest 11,583 oscar for a harvest success rate of 8.92 fish per hour. By 1987, oscar fishing had become very popular. During the 1987–88 survey, effort (2,458 man-hours) almost doubled the previous year's estimate; however, harvest success decreased to 3.12 fish per hour. Even though the man-hours of effort represented only 3% of the total effort for all species combined, it indicated that angler perception was changing. The oscar's image was beginning to shift from an undesirable exotic to an aggressive, good-fishing fish that is easy to catch and edible.

Oscar harvest and effort declined over the next 2 years. While this paralleled the trend for native species (Fig. 2), it was significant in that harvest values went from a high of 11,583 in 1986–87 to 0 in 1989–90. Reasons for the decline are unclear. Loftus and Kushlan (1987) reported that a common phenomenon

Table 1. Expanded harvest, effort, and success estimates obtained from the roving angler use survey in Everglades Water Conservation Area 2A (L-35B and L-38E canals) from December 1985 through May 1986.

Species	Harvest (*N*)	Effort (man-hours)	Success (*N*/hour)
Largemouth bass	3,056	34,809	0.09
Black crappie	3,760	4,783	0.77[a]
Panfish	31,942	15,223	1.90
Catfish	1,131	518	2.20[a]
Oscar	6,809	326	no est.
Misc.	22,969	7,616	3.02
Total	69,667	63,275	

[a]Calculated estimate.

Table 2. Expanded harvest, effort, and success estimates for oscar obtained from the roving angler use surveys in Everglades Water Conservation Area 2A (L-35B and L-38E canals) between 1985–86 and 1989–90.

Year	Harvest (*N*)	Effort (man-hours)	Success (*N*/hour)
1985–86	6,809	326	
1986–87	11,583	1,298	8.92
1987–88	7,657	2,458	3.12
1988–89	4,340	1,472	2.95
1989–90	0	43	0

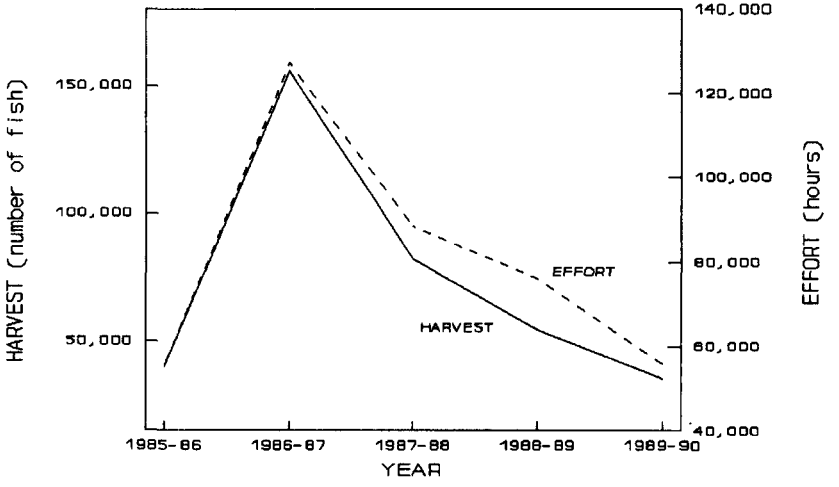

Figure 2. Total harvest and effort estimates for all fish species (excluding oscar) by year for the L-35B and L-38E canals, Water Conservation Area 2A, between 1985 and 1990.

among exotic species is an explosive population increase followed by a rapid decrease, eventually reaching equilibrium with their environment. The decline in effort in WCA-2A (Table 2) may have been influenced by the increase in popularity, over the same time period, of WCA-3A as a quality oscar fishery. The drop in harvest to 0 in 1989–90 might be partially explained by the effects of a cold front in December 1989. This resulted in a large die-off of cichlids in WCA-2A, the majority of which were oscar. The location of the angler use survey changed the following year to WCA-3A, and while it was known that oscar were being caught again in WCA-2A, actual numbers were not documented.

WCA-3A experienced an oscar population expansion similar to WCA-2A, but not a dramatic population decrease as yet. Three peak season angler use

surveys were completed in WCA-3A from 1990 to 1993. Oscar was the number one species harvested each year (Table 3). The greatest number of oscar harvested occurred in 1991–92, and was an estimated 53,286 fish. The mean total harvest rate for oscar from the 3 surveys was 2.73 per man-hour. This compares to 2.36 per man-hour for all panfish, including black crappie, combined. The catch estimates (harvest + release) during the 1990–91, 1991–92, and 1992–93 surveys were 45,287, 91,239, and 15,056, respectively, providing a mean total catch rate of 3.78 per man-hour. Oscar ranked a close second, behind largemouth bass, in man-hours of effort. In 1991–92, oscar received 34% of the total effort for all species, compared to 40% for largemouth bass.

The decrease in total harvest and effort in 1992–93 may have been caused by poor fishing conditions during that survey period. At that time, large releases of water by the South Florida Water Management District were being made from Lake Okeechobee, passed through the WCAs, and delivered to Florida Bay. The resulting high water levels and increased currents throughout most of the survey period kept many anglers away. The total number of anglers interviewed declined approximately 42% from the previous year.

Approximately 20% of the total number of anglers interviewed were non-residents, and 69% of those were targeting oscar. Many non-resident anglers who regularly fish Lake Okeechobee for black crappie during the winter months diverted to WCA-3A to fish specifically for oscar. Oscar (N = 1,158) measured during creel surveys ranged from 117 to 351 mm ($\bar{x}$ = 252 mm) in length and from 109 to 790 g ($\bar{x}$ = 410 g) in weight. Oscar anglers mainly fished from boats and fished along canal banks until locating a concentration of oscar. Courtenay and Hensley (1978) reported that oscar are usually seen in deeper areas under ledges or near logs or weedy areas. Oscar were considered carnivores with important diet items consisting of fish, insects, and amphibians (Hogg 1976), but Hilton (FGFWFC, unpubl. data) classified oscar as omnivorous after finding vegetation as the second most frequently occurring food item. Oscar in WCA-

Table 3. Expanded harvest, effort, and success estimates for all fish categories obtained from the roving angler use survey in Everglades Water Conservation Area 3A (L-67A Canal) between 1990–91 and 1992–93.

	Harvest (N)			Effort (man-hours)			Success (N/hour)		
Species	90–91	91–92	92–93	90–91	91–92	92–93	90–91	91–92	92–93
Largemouth bass	2,598	4,496	234	24,707	20,833	9,495	0.07	0.16	0.02
Black crappie	67	143	210	205	88	211	0.16	0.38	1.08
Panfish	8,132	17,364	8,312	3,301	7,117	3,072	1.79	2.64	2.89
Catfish	184	82	49	426	204	592	0.45	0.38	0.10
Oscar	34,016	53,286	12,288	11,915	17,666	6,745	3.01	3.22	1.95
Misc.	6,315	6,805	3,378	9,105	6,506	5,734	0.65	0.97	0.62
Totals	51,312	82,176	24,471	49,536	52,414	25,848			

2A and 3A were caught on a wide variety of baits including crickets, minnows, shrimp, worms, and cut-bait. Fifty percent of the oscar anglers interviewed were using artificial baits.

The high harvest rates for oscar in WCA-3A were somewhat surprising, considering the mercury contamination problem in the Everglades. Based on mercury concentrations in body tissue, fish species can either fall under a no consumption advisory (>1.5 ppm) or a limited consumption advisory (0.5− 1.5 ppm). Twenty-four oscar from the WCAs were tested for mercury. Levels ranged from 0.15 to 1.01 ppm with a mean value of 0.56 ppm. Health advisories concerning consumption of contaminated fish were issued for several species in the Everglades. People who want to eat oscar are advised by the Florida Department of Health and Rehabilitative Services to limit consumption to no more than once a week (227-g portion) for a healthy adult male. Children under 15, pregnant or lactating women, and women who intend to become pregnant should limit consumption to once per month. Other species under the limited consumption advisory include warmouth (*Lepomis gulosus*), yellow bullhead (*Ameiurus natalis*), spotted sunfish (*Lepomis punctatus*), and Mayan cichlid (*Cichlasoma urophthalmus*). Species that should not be eaten at all include largemouth bass, bowfin (*Amia calva*), and Florida gar (*Lepisosteus platyrhincus*).

Conclusion

Oscar have contributed significantly to the Everglades fishery for several years. While angler attitude toward the oscar is divided, many are spending time and money to fish for them. During the 3 angler use surveys in WCA-3A, over one-third of the total effort of anglers who were targeting a specific species was exerted towards catching oscar (36,326 man-hours). This contributed an estimated $123,342 to the overall angler expenditure[2]. Only largemouth bass received more man-hours of effort (55,035). The decline in overall fishing pressure in WCA-3A was attributed to undesirable fishing conditions caused by water conveyance practices. This decline was offset, however, by the popularity of oscar fishing. The future of the oscar fishery is unclear, but we predict it to expand in a northerly direction based on observations and reports of increased catches in canals near Lake Okeechobee. One main factor affecting expansion is water temperature. The lower lethal temperature for oscar is 12.9 C (Shafland and Pestrak 1982).

The status of native fish displacement by the oscar is unknown, but no evidence of displacement has evolved from preliminary population data. Future studies are needed to address this more thoroughly. Even though the oscar is being increasingly sought after by anglers, transport and release of these fish in other water bodies is both discouraged and illegal.

[2] Value derived by expanding individual fishing trip expenditure for oscar anglers.

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