

The St. Johns River, Florida Freshwater Striped Mullet Gill Net Fishery: Catch Composition, Status, and Recommendations

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Abstract: A 3-year study was initiated in 1992 to characterize the St. Johns River freshwater commercial striped mullet (*Mugil cephalus*) gill net fishery and estimate bycatch. Each year in fresh water, an estimated 137 fishers using 84 boats fished 1,554 days and harvested 233,109 kg of striped mullet. Approximately 86% of the fishers used the strike technique exclusively, while 14% used both strike and set-net techniques. Striped mullet comprised 99% of the total catch by number. The average annual freshwater game fish bycatch ranged from 86 to 274 fish (<1% by number). The extremely low bycatch would obviously have no negative impact on game fish populations in a system as large as the St. Johns River.

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Gill nets have historically been used to commercially harvest fish in fresh waters of several southeastern states such as Georgia (Quinn 1988), Kentucky (Bronte and Johnson 1983), Tennessee (Heitman and Van Den Avyle 1978), and Oklahoma (Johnston 1969). Although gill net fisheries are often heavily regulated through gear type, seasons, and specific areas (Quinn 1988, Timmons et al. 1989) and may benefit game fish by controlling rough fish biomass (Jester 1976, Stephen 1986), most sport anglers are opposed to the use of nets. Where commercial gill net fishing occurs, anglers have often blamed poor fishing success on net activities (Seidensticker 1976, Heitman and Van Den Avyle 1978). Anglers believe many game fish are removed from the system either through illegal harvest or bycatch mortality (Quinn 1988, Horns and Hammer

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1991). Game fish numbers may be reduced with gill nets whether or not they are the target species (Matlock et al. 1977) or are part of the incidental bycatch (Timmons et al. 1989).

Florida has not been an exception in this controversial issue, with gill nets being a primary factor in further polarizing commercial and recreational user groups. While most of the controversy and regulation changes have occurred in saltwater habitats, several changes have occurred recently in fresh water. Two regulations changes effective 1 January 1992 to protect St. Johns River *Morone* spp. populations were a closed fishing season on Lake George (1 Oct–30 Apr) and an increase in the minimum stretch mesh size from 12.7 to 15.2 cm between Green Cove Springs and Palatka. The latter rule virtually ended the 130-year old American shad (*Alosa sapidissima*) gill net fishery. Dissatisfied with the perceived slow pace with which state agencies were addressing public concern for Florida's marine resources, Florida citizens succeeded in placing a proposed constitutional amendment banning the use of entangling nets in most of Florida's waters on the November 1994 ballot.

Prior to this study, the St. Johns River was the only freshwater location in Florida where commercial gill net fishing was allowed. Target species there were striped mullet, gizzard shad (*Dorosoma cepedianum*), gar (*Lepisosteus* spp.), and American shad. To legally possess gill nets in fresh water, all fishers were required to have a permit from the Florida Game and Fresh Water Fish Commission (FGFWFC).

Permitted fishers were allowed 2 gill nets in their possession (not exceeding 550 m in length each and \geq 10.2 cm stretch mesh), and only 1 net was allowed in the water at a time. They were allowed to fish week days between Green Cove Springs and Jacksonville from 1 October to 31 December. Since GFC regulates freshwater fish only, gizzard shad and gar were the only 2 legally harvestable species of fish listed in the permit. However, the target species of all permitted fishers was striped mullet. All fishers that harvested striped mullet were also required to follow Florida Marine Fisheries Commission regulations regarding harvest of striped mullet.

Commercial gill net fishers harvested striped mullet in the St. Johns River utilizing 2 techniques. Using the strike method, fishers actively sought schools of mullet which they encircled or struck. The set net method involved setting a net in an area where striped mullet historically traveled and waiting for fish to swim into the net.

We initiated a study in 1992 to investigate the St. Johns River freshwater commercial striped mullet fishery because of its controversial nature and absence of data upon which to base management recommendations. Our objectives were to determine: 1) the amount of effort and harvest of the striped mullet fishery; 2) harvest techniques (whether fishers used set nets or struck their nets around a school of fish), and; 3) the amount and type of bycatch associated with the striped mullet fishery.

Methods

The St. Johns River is Florida's longest river (500 km) and has a drainage area of over 10,000 km² (Hale 1993). The commercial freshwater striped mullet gill net

fishery occurred primarily in the 46-km section of river between Green Cove Springs and the designated saltwater line (FGFWFC 1995) in Jacksonville.

Three striped mullet seasons (1992, 1993, and 1994) were evaluated during this study. Strike data were collected from observed strikes, strikes reported verbally to biologists and strikes recorded by fishers in a GFC-issued log book. To observe strikes, biologists either accompanied fishers in their boats or stayed in close proximity in FGFWFC boats. We used VHF radios to aid in locating fishers and give them the opportunity to notify us as they were making a strike. Once a school of striped mullet was struck, a count of all captured fish was made. When large catches were made (3,000–6,000 fish), a subsample of striped mullet was weighed to determine average individual fish weight. The total number of mullet caught was then estimated by dividing the total weight of the catch (received from the fish house) by the average individual weight. Data from observed strikes from all 3 years were combined to estimate the average catch/strike.

Reported strikes were recent unobserved strikes made within the previous 24 hours that fishers verbally related to biologists. Fishers reported strike location, amount, and type of bycatch and striped mullet harvest. Data from reported strikes from all 3 years were combined to estimate the average catch/strike.

Log books with waterproof field sheets were used in 1993 and 1994 only. Essig and Holliday (1991) reported that log books were particularly useful in determining effort, participation, and socioeconomic information. They also found that surveys targeting easily identifiable, highly desirable species could use log books to collect catch data because bias in anglers' ability to recall numbers of fish would be minimized. Log books were issued to 9 fishers in 1993 and 5 in 1994. Fishers issued log books were selected on the basis of their cooperation and support of the study in 1992, current willingness to participate, and recommendation of their peers. Data from log book strikes from 1993 and 1994 were combined to estimate the average catch/strike. The standard error of the 3-year mean was calculated for observed and reported strikes and 2-year mean for log book strikes.

We attempted to survey all permitted striped mullet fishers after each season. Fishers were asked who their fishing partners were, number of days fished, and if all effort occurred in fresh water (saltwater effort and harvest were separated and not reported in this study). Fishers were also asked which fishing technique they used (strike or set net), approximate number of strikes and/or sets made daily, and weight of striped mullet harvested.

All permittees were mailed a self-addressed, stamped questionnaire after the 1992 season. The questionnaire return rate was very low and many returns were incomplete. We then attempted to contact all nonrespondents by telephone. Since Johnson and Timmons (1989) found that telephone surveys yield more accurate data than mail surveys and our questionnaire return rates were so low in 1992, we elected to use the telephone as the initial means of contact following the 1993 and 1994 seasons. Permittees not contacted by telephone during those years were mailed a self-addressed, stamped questionnaire. Reported survey results were expanded to reflect 100% of the permitted fishery.

Results

Post Season Surveys

Of the 556 fishers issued permits during the study, 421 (76%) responded to our surveys (Table 1). Approximately 26% stated that they did not fish at all; 19% fished <25% of the time and were classified as marginal part-time fishers. Thirty-five percent fished >75% of the time and were considered full-time St. Johns River striped mullet fishers.

A total of 253 boats were used (range 72–101) to fish 4,662 days (range 1,433–1,733) during the study. Approximately 86% of the fishers in these boats utilized the strike technique exclusively. Of the 35 fishers (14%) that fished set nets part of the time, 5 (2%) stated that 50% of their effort was spent fishing set nets. The remaining 30 fishers (12%) expended <50% of their effort fishing set nets. Only 1 fisher (<1%) fished set nets exclusively. Fishers made 4,826 strikes (range 1,382–1,803) that caught 699,328 kg of striped mullet (range 172,440–304,830) during the 3-year study.

Observed Strikes

During the 3-year study, 71 strikes were observed (range 7–47 strikes/year) during 921 hours of observation time (Table 2). Of 35,744 fish captured, 99% were striped mullet, while freshwater and saltwater game fish combined for <1% of the catch. On average, about 498 striped mullet were caught/observed strike (median = 11.5), along with 0.17 freshwater game fish and 0.03 saltwater game fish/strike. Six species of freshwater nongame fish ($N = 142$) and 14 species of saltwater nongame fish ($N = 228$) were captured.

Reported Strikes

Thirty-two strikes were reported to biologists (range 4–17 strikes/year) during the study (Table 3). Of 16,712 fish captured, 99% were striped mullet. On average, about 515 striped mullet were caught/reported strike (median = 115) along with 0.12 freshwater game fish and 0.09 saltwater game fish/strike. Four species of freshwater

Table 1. Survey results of fishers issued gill net permits to fish for striped mullet in the St. Johns River, Florida, October–December 1992–1994.

Category	1992	1993	1994	Annual mean
N permits issued	183	208	165	185
N survey respondents	169	133	119	138
N days fished	1,433	1,733	1,496	1,554
N boats	80	101	72	84
N strike-only fishers	66	84	67	72
N set net-only fishers	0	1	0	<1
N part-time set netters	14	16	5	12
N strikes	1,382	1,803	1,641	1,609
N kg harvested	172,440	304,830	222,058	233,109

Table 2. Catch from observed commercial striped mullet strike gill nets fished in the St. Johns River, Florida, October–December 1992–1994

Category	N caught in observed nets			Mean N/strike (71 strikes)	SE for 3-year mean
	1992 (7 strikes)	1993 (47 strikes)	1994 (17 strikes)		
Target species					
Striped mullet	13,160	7,320	14,880	498.03	148.05
Freshwater game fish					
Bluegill	0	1	9	0.14	
Largemouth bass	0	1	0	0.01	
Striped bass	0	0	1	0.01	
Total	0	2	10	0.17	0.08
Freshwater nongame fish^a	1	118	23	2.00	0.65
Saltwater game fish					
Common snook	0	2	0	0.03	0.02
Saltwater nongame fish^b	8	211	9	3.21	0.90

^aNumber and species of freshwater nongame fish: 93 gizzard shad, 26 longnose gar, 20 white catfish, 1 bowfin, 1 brown bullhead, 1 channel catfish.

^bNumber and species of saltwater nongame fish: 67 Atlantic menhaden, 50 ladyfish, 19 gafftopsail catfish, 18 crevalle jack, 18 sheepshead, 11 southern flounder, 10 spotted seatrout, 9 black drum, 9 red drum, 6 weakfish, 3 Atlantic croaker, 3 Atlantic stingray, 3 spot, 2 hardhead catfish.

Table 3. Catch from reported commercial striped mullet strike gill nets fished in the St. Johns River, Florida, October–December 1992–1994.

Category	N caught in observed nets			Mean N/strike (71 strikes)	SE for 3-year mean
	1992 (7 strikes)	1993 (47 strikes)	1994 (17 strikes)		
Target species					
Striped mullet	10,435	3,970	2,072	514.91	148.28
Freshwater game fish					
Bluegill	0	1	0	0.03	
Striped bass	0	2	0	0.06	
Black crappie	1	0	0	0.03	
Total	1	3	0	0.12	0.07
Freshwater nongame fish^a	88	29	5	3.81	1.28
Saltwater game fish					
Common snook	0	2	0	0.06	
Tarpon	1	0	0	0.03	
Total	1	2		0.09	0.05
Saltwater nongame fish^b	38	62	6	3.31	0.81

^aNumber and species of freshwater nongame fish: 42 white catfish, 39 longnose gar, 36 gizzard shad, 3 channel catfish.

^bNumber and species of saltwater nongame fish: 49 ladyfish, 19 Atlantic menhaden, 15 spotted seatrout, 11 red drum, 4 Atlantic croaker, 2 sheepshead, 2 spot, 2 weakfish, 1 Atlantic stingray, 1 sailors choice.

nongame fish ($N = 122$) and 10 species of saltwater nongame fish species ($N = 106$) were captured.

Strikes From Fisher Log Books

Of the 9 fishers given log books in 1993, 8 fished during the striped mullet season and 6 later returned their log books. Of the 5 fishers issued log books in 1994, 3 fished during the striped mullet season and all returned their log books. In 90 strikes made in both seasons, fishers recorded catching 38,436 fish (99% striped mullet). On average, about 421 striped mullet were caught/fisher-recorded strike (median = 148) along with 0.06 freshwater nongame fish and 0.01 saltwater game fish/recorded strike (Table 4). Three species of freshwater nongame fish ($N = 265$) and 15 species of saltwater nongame fish ($N = 249$) were captured.

Discussion

Post-Season Surveys

Approximately 92% of the striped mullet fishers were contacted after the 1992 fishery, compared to 64% in 1993 and 72% in 1994. The higher response rates in 1992 was attributed to the increased time and effort expended in contacting fishers.

One of our objectives was to determine the type of gill net fishery that occurred (strike vs. set net). Approximately 86% of the fishers reported themselves to be strike fishers exclusively. Only 1 of the 253 fishers was a set net fisher only. Of the 35 fishers that fished both strike and set nets, 5 utilized both techniques equally. Most fishers indicated they fished set nets <5 times a year.

Table 4. Catch from commercial striped mullet strike gill nets fished in the St. Johns River, Florida, October–December 1993–1994 recorded in fisher log books.

Category	<i>N</i> caught in observed nets		Mean <i>N/strike</i> (71 strikes)	SE for 2-year mean
	1993 (63 strikes)	1994 (17 strikes)		
Target species				
Striped mullet	18,248	19,669	421.30	95.78
Freshwater game fish				
Bluegill	0	3	0.03	
Striped bass	2	0	0.02	
Total	2	3	0.06	0.03
Freshwater nongame fish ^a	218	47	2.94	0.95
Saltwater game fish				
Common snook	1	0	0.01	0.01
Saltwater nongame fish ^b	221	27	2.76	0.48

^aNumber and species of freshwater nongame fish: 207 gizzard shad, 32 longnose gar, 26 white catfish.

^bNumber and species of saltwater nongame fish: 67 Atlantic menhaden, 56 spotted seatrout, 39 ladyfish, 30 red drum, 19 sheepshead, 9 black drum, 9 crevalle jack, 5 weakfish, 4 Spanish mackerel, 3 gafftopsail catfish, 2 Atlantic croaker, 2 southern flounder, 1 bluefish, 1 sailors choice, 1 spot.

In 1992, fishers averaged 2,156 kg of striped mullet/boat. Many fishers stated that more fish were present in 1992 than in previous years, but extremely high water levels forced a large percentage of striped mullet out of the river just before the season began.

The average striped mullet catch increased from 2,156 kg/boat in 1992 to 3,018 kg/boat in 1993. Many fishers stated that mullet were plentiful in 1993, but were difficult to catch because of weather fronts that occurred on weekends (when fishing not allowed), causing fish to move then and not during the week.

The average striped mullet catch increased slightly to 3,084 kg/boat in 1994. Inclement weather conditions in 1992 and 1993 made fishing very difficult for most fishers and as a result, a small number of fishers did very well, but most had poor seasons. Weather conditions were much better in 1994 which made fishing easier for most fishers. This resulted in more fishers having a better season.

Observed Strikes

An average of 23.6 hours of observation time was necessary to observe 1 strike in 1992 while the average in 1993 and 1994 dropped to 11.4 and 12.1 hours/strike, respectively, due to improved observation efficiency. As we spent more time with fishers, we were able to determine the best fishing times and areas. After learning how important VHF radios were for fishers to relay information to each other, we purchased 2 radios for our use. When fishers learned the goals of this study and became more confident in our objective approach, they became more inclined to notify us by radio before making a strike.

Using the 3-year average freshwater game fish catch rate (0.169 fish/strike), an estimated 272 freshwater game fish were captured annually. No freshwater game fish initial mortality was observed and delayed mortality was also probably low. In a delayed mortality study of game fish caught in gill nets fished in Lake Apopka, Hale et al. (1995) reported 82% survival after 48 hours (primarily using black crappie, *Pomoxis nigromaculatus*). Since the Lake Apopka fishery is a set-net fishery (which allows for potentially longer entanglement time) and a spring/summer fishery (with warmer water temperatures than the striped mullet fishery), game fish bycatch survival in the St. Johns River striped mullet fishery is likely higher.

Reported Strikes

Using the 3-year average freshwater game fish catch rate (0.125 fish/Strike), an estimated 201 freshwater game fish were captured annually. The 3-year average freshwater game fish catch rate in reported strikes (0.125 fish/strike) was close to the 0.169 fish/strike catch rate in observed strikes. The striped mullet catch rate in reported strikes was only 3% higher than in observed strikes. These similarities increased the credibility of reported strike data.

Strikes From Fisher Log Books

Anderson and Thompson (1991) stated that the most important factors in the success of an angler diary monitoring program are (1) a well-designed diary, (2) a high

level of cooperation, and (3) concern among anglers about conservation. Our log book field sheets were designed to make reporting as easy as possible. All data were recorded by having the fisher fill in a blank or circle the appropriate response. Also, only fishers that expressed the desire to cooperate in our study were asked to participate. Cooperation also may have been enhanced by the fact that fishers were dependent upon the FGFWFC annually for their permit to fish. Regarding conservation, most fishers appeared more concerned about earning an income than about conservation.

Although utilized only 2 years, fisher log books accounted for more strikes (90) than observed (71) or reported strikes (32). An estimated 96 freshwater game fish were captured annually as determined by the 2-year freshwater game fish catch rate. The 2-year average freshwater game fish catch rate recorded in log books (0.056 fish/strike) reflected a lower catch rate than observed or reported strikes. Unless fishers were more reluctant to record freshwater game fish bycatch than to report it, no satisfactory explanation for the lower game fish catch rate is readily apparent.

The striped mullet catch rate from fisher log books (421 fish/strike) was 16% lower than in observed strikes and 18% lower than in reported strikes. Fishers may have been more willing to make a strike that might result in a poor striped mullet catch while we were not observing them. Fishers also may have been less willing to make a strike that could result in a higher game fish bycatch while being observed.

Essig and Holliday (1991) rated prestige bias as high for log book data, implying that anglers may overemphasize good fishing trips and underemphasize poor fishing trips. Fishers in our study may have underemphasized poor strikes. No striped mullet were reported caught in 3% of the reported strikes and 3% of the log book strikes while 13% of the observed strikes caught no striped mullet. However, with a lower reported striped mullet catch rate in log books (421 fish/strike) than in reported or observed strikes, it appears that fishers did not overemphasize the good strikes.

Another potential source of bias could have come from intentional misreporting as found by Essig and Holliday (1991). Since we made it clear to fishers that landings data would be combined and anonymous, underreported striped mullet catches for income purposes should not have been a problem. In fact, reported strikes exhibited the highest striped mullet catch rate (515 fish/strike). Some fishers may have underreported freshwater game fish catch rates. Reported (0.125 fish/strike) and log book game fish catch rates (0.056 fish/strike) were both lower than freshwater game fish catch rates in observed strikes (0.169 fish/strike). The fact that FGFWFC issued fishers' permits annually and was very concerned about the potential freshwater game fish bycatch could have influenced some of their reporting rates.

Recommendations

An amendment banning the use of entangling nets in most of Florida's waters to harvest saltwater fish including striped mullet became effective 1 July 1995. Although gill nets could be used in fresh water to harvest freshwater fish, the FGFWFC ruled that marine bycatch in gill nets would violate the new amendment and voted to ban all gill net fishing on the St. Johns River.

Should the political climate change and gill net use in Florida be reinstated, the St. Johns River freshwater striped mullet fishery should merit strong consideration. This fishery exhibited a very low freshwater game fish bycatch (96-272 fish annually) and an extremely high success in catching the target species (99% of the total catch by number).

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