Estimating Annual Game Fish Bycatch in Commercial Fishing Devices from Harvest Data

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Abstract: A major concern in managing commercial fisheries is the potential effect on game fish populations. The objective of this study was to design a model to determine annual game fish bycatch in hoop nets, wire traps, and pound nets utilized in the St. Johns River, Florida, commercial catfish fishery. Annual bycatch was estimated with a model based on previous estimates of annual catfish harvest, catfish-to-game fish ratios, mean weight of catfish harvested and percentage composition of catfish harvested by each gear type. Hoop nets captured an estimated 435,635 game fish annually with 46,697 and 7,589 game fish captured annually by wire traps and pound nets, respectively. When catches of all 3 gear types were combined, black crappie *Pomoxis nigromaculatus* comprised 54.5% by number of all game fish caught, followed by *Lepomis* spp. (44.4%), *Morone* spp. (0.7%), largemouth bass *Micropterus salmoides* (0.4%), and chain pickerel *Esox niger* (0.01%). Comparison of these bycatch estimates with game fish population estimates, harvest data, and natural mortality estimates will permit assessment of the potential for commercial devices to negatively impact game fish populations.

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Commercial fishing on the St. Johns River, Florida, has resulted in controversy between sport and commercial fishing groups for many years (Dequine 1952, Hale et al. 1981*a*). The Florida Game and Fresh Water Fish Commission founded the commercial Fisheries Project in 1980 to monitor commercial fisheries, particularly to determine if these fisheries had detrimental effects on game fish populations. Most studies determining commercial impact rely on estimation of the amount of gear and effort involved in the fishery, although accurate data on gear and effort are difficult to obtain (Parrack et al. 1969, Seidensticker 1976, Heitman and Van Den Avyle 1978). The objective of this study was to create a model to assess annual game fish

bycatch in commercial gear fished in the St. Johns River without utilizing data on amount of gear used and effort expended.

Previous studies yielded bycatch data for 3 of the main commercial fishing devices: 981 hoop net observations (Hale et al. 1981*a*, 1982, 1983*b*, 1984), 187 wire trap observations (Hale et al. 1982), and 71 pound net observations (Hale et al. 1983*a*). By incorporating the ratio of catfish to game fish observed by each gear type, average weight of catfish harvested (Hale et al. 1981*b*, 1982, 1983*b*, 1984, 1985), annual reported catfish harvest (Hale et al. 1986*a*), and a 3-year tagging study to estimate catch composition per gear type (Hale et al., 1986*b*), a model was developed to estimate the total number of game fish caught annually in each of these 3 gear types.

Methods

The following formula was derived to estimate the annual game fish bycatch in the 3 commercial fishing devices evaluated:

$$AB = AH \times \%Comp. \div \overline{Wt}\,C \div (C{:}GF)$$

where

AB = estimated amount of annual game fish bycatch
AH = annual catfish harvest (kg)
%Comp. = percentage composition of catfish harvested by gear type
$\overline{Wt}\,C$ = mean weight (kg) of catfish harvested
C:GF = ratio of catfish to game fish by gear type.

Annual commercial catfish harvest weight (AH) was obtained from commercial fish house reports. AH for each gear type was obtained by multiplying the percentage of catfish harvested form each gear type, as determined from catfish tag returns, by total AH. Because AH was reported as weight, the number of catfish harvested annually was determined by dividing by the average weight of catfish ($\overline{Wt}\,C$). $\overline{Wt}\,C$ was determined from weighing >30,000 catfish from the St. Johns River from 1981 to 1985. The catfish-to-game fish ratio (C:GF) was estimated by recording catch composition of commercially fished hoop nets, wire traps, and pound nets.

Game fish bycatch composition per gear type was estimated for each species using the percentage composition of each species observed in hoop nets, wire traps, and pound nets. Game fish species observed in commercial gear were black crappie *Pomoxis nigromaculatus*, *Lepomis* sp. (bluegill *L. macrohirus*, redbreast sunfish *L. auritus*, redear sunfish *L. microlophus*, spotted sunfish *L. punctatus*, warmouth *L. gulosus*), largemouth bass *Micropterus salmoides*, striped bass *Morone saxatilis*, hybrid striped bass *M. chrysops* x *M. saxatilis* and chain pickerel *Esox niger*. Bluegill was the main *Lepomis* species analyzed. All other *Lepomis* species combined comprised <36% by number.

Table 1. Estimates of game fish bycatch in commercial gear on the St. Johns River, Florida. Annual catfish harvest[a] 1,221,904.4 kg (AH)

Gear Type	Hoop Net	Wire Trap	Pound Net
Percentage composition of catfish captured by gear type[b]	65.6	13.8	1.9
Average annual catfish harvest by gear type (kg)	801,569	168,623	23,216
N catfish/year[c] (# AH)	3,485,083	733,145	100,939
Ratio catfish-to-game fish[d] (C:GF)	8.0/1	15.7/1	13.3/1
Estimated *N* game fish bycatch/ year (AB)	435,635	46,697	7,589
Percentage of game fish bycatch/gear type	88.9	9.5	1.6

[a]Based on average weights reported in 6-year summary (1980–86) of commercial harvest.
[b]Results from 3-year catfish tagging study.
[c]Average weight of catfish in the 1980–85 fish house samples (0.23 kg).
[d]Based on gear observations with commercial fishermen: 981 hoop net observations from 1981–84, 187 wire trap observatons from 1980–81, and 71 pound net observations from 1981–83.

Results and Discussion

Data from previous studies were used in the model to estimate annual game fish bycatch (Table 1). AH averaged 1,221,904.4 kg during our 6-year study of commercial harvest (Hale et al. 1986*a*). An average weight of 0.23 kg per catfish was used in all calculations. Utilizing hoop nets as an example, the formula would read as follows:

$$AB = AH\,(1{,}221{,}904.4\text{ kg}) \times \%\text{Comp.}\,(0.656) \div \overline{\text{Wt}}\,C\,(0.23\text{ kg}) \div C{:}GF\,(8.0{:}1)$$

$$AB = 435{,}635\text{ game fish.}$$

Hoop nets exhibited the smallest ratio (8.0:1) of catfish-to-game fish captured, while wire traps and pound nets captured higher proportions of catfish (15.7:1 and 13.3:1, respectively). Of the estimated 489,921 game fish caught annually by these 3 gear types, hoop nets captured 88.9% by number; wire traps, 9.5%; and pound nets, 1.6%. These numbers reflect game fish captured, not necessarily game fish removed permanently from the river. Florida law requires that all game fish captured in commercial devices be immediately returned to the water. Initial mortality rates of game fish caught in hoop nets (0.2%) (Hale et al. 1981*a*, 1982, 1983*b*, 1984), wire traps (3.8%) (Hale et al. 1982), and pound nets (3.3%) (Hale et al. 1983*a*), were low. However, secondary mortality was not determined.

Annual game fish bycatch by species was also determined (Table 2). Hoop nets captured the largest number of black crappie (233,149; 98.6%), *Lepomis* sp. (150,680; 78.4%), and largemouth bass (1,156; 68.9%) annually. Pound nets captured the largest number of *Morone* sp. (2,672; 87.4%). When all 3 gear types were combined, black crappie comprised 54.5% by number; *Lepomis* sp., 44.4%; *Morone* sp., 0.7%; largemouth bass, 0.4%; and chain pickerel, 0.01%. An estimated 1,897 largemouth bass were captured annually (5.2 daily) by the 3 gear types. The St. Johns River has 9 lakes covering 38,759 ha and at least as much area in riverine

Table 2. Estimates of annual game fish bycatch by species in commercial gear on the St. Johns River, Florida.

Game fish	Hoop net	Wire trap	Pound net
Black crappie	263,559	747	2,876
Morone sp.	436	0	3,020
Largemouth bass	1,307	514	76
Lepomis sp.	170,333	45,436	1,579
Chain pickerel	0	0	38
Total	435,635	46,697	7,589

habitat available for sport and commercial fishing. Using only the lake area, the estimated annual game fish bycatch (489,921) would equate to 12.6 game fish captured per ha of water.

In summary, we feel that annual game fish bycatch was accurately estimated with the model although data on number of fishermen, amount of gear used and commercial fishing effort were not available. These bycatch estimates can be compared to game fish population estimates, harvest data, and natural mortality estimates when available to assess potential negative impacts. These data indicated that commercial fishing devices in the St. Johns River had a minimal impact on game fish populations. This study showed that different studies can be used to provide a data base to form a model allowing an evaluation of potential impact of commercial fishing devices on game fish populations.

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