Catfish Movement and Distribution in the St. Johns River, Florida

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Abstract: A 3-year tagging study was conducted to determine movement and distribution of catfish in the St. Johns River, Florida. A total of 8,800 white catfish (*Ictalurus catus*), channel catfish (*I. punctatus*), brown bullhead (*I. nebulosus*) and yellow bullhead (*I. natalis*) were tagged with Floy FD-68B anchor tags from May 1983 through December 1985. Of these tagged fish, 1,227 (13.9%) were recaptured. The highest return was from lake habitat (22.8%) followed by riverine (17.1%) and tributary (7.0%) habitats. The longest distance travelled was 178.2 km upstream. Approximately 52.0% of the recaptured catfish travelled upstream while 24.4% moved downstream and 23.6% remained stationary. Once a catfish reached the Lake George area, the likelihood that it would be available to the commercial fishery downstream appeared remote. Because no discrete catfish populations were observed, management decisions may be based on a holistic approach which assumes there is a single population of catfish in the St. Johns River.

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Knowledge of fish movement gained through a tagging study is important because it can help fisheries scientists better manage the resource (Funk 1955). Determining whether discrete populations exist within a river system is also one benefit of a tagging study (Ricker 1956). If discrete populations exist, measures should be taken to guard against overexploitation of these populations. Another benefit of a tagging study to record movment is the determination of basic movement patterns and distribution of fish within a river system. To know whether a fish is available to the fishery seasonally, annually, during part of its life cycle or its entire life cycle is important when managing a fishery.

Past studies of catfish in lotic habitats have shown a wide variation in direction and amount of movement. Channel catfish have exhibited little movement (Harrison

1953, McCammon and LaFaunce 1961), approximately the same amount of upstream and downstream movement (Funk 1955, Muncey 1958) or a marked downstream movement (Hubley 1963, Behmer 1964, Welker 1967). Seasonal movements of catfish have also been reported. McCammon (1956) observed that channel catfish moved upstream in spring and early summer and downstream in fall and winter in the lower Colorado River. A similar pattern was observed by Van Eeckhout (1974) in the Little Missouri River. Some catfish were sedentary (Mayhew 1971), while others travelled more than 345 km (Hubley 1963).

Little is known of the movement and distribution of catfish in the St. Johns River, Florida. Thus, a 3-year tagging study was initiated in 1983 to learn more about this important commercial fishery. The objectives of this study were to determine: (1) basic movement patterns and distribution of catfish in the St. Johns River, and (2) whether discrete catfish populations existed within this river system or the population represented a single stock.

Methods

Study Area

The study area was divided into 3 sub-areas (Fig. 1). Area I was a broad estuarine type habitat 1.0 to 5.1 km wide with no lake habitat. This farthest downstream area was 85.3 km long. The riverine portion of Area II was narrower than Area I and had a defined river channel. Approximately 25,000 ha of lake habitat were located in Area II. Area II was 68.6 km long including Lake George. In Area III, the river was much narrower than Area II and usually had a well-defined river channel near one of the banks. Approximately 8,250 ha of lake habitat were in Area III. Area III was the longest of the 3 areas at 109.6 km. All lakes in Areas II and III were natural. The St. Johns River was connected to or flowed through these lakes.

Number of Fish Tagged

A hypergeometric distribution chart, when $1-\alpha = 0.95$ and $p = 0.25$, was used to determine an approximate number of fish to tag (Robson and Regier 1964). Using 20 million fish as the estimated upper limit of the population and 1 million fish to be observed at commercial fish houses for tags, we estimated that 1,500 fish should be tagged. Thus, a goal was set to tag a minimum of 1,500 catfish each spring and fall from 1983 to 1985. Because little was known about fish movement, population levels or commercial exploitation of catfish in all 3 selected areas, an attempt was made to tag an equal number (500/season) of catfish in each area.

Collecting Methods and Tag Type

A low-voltage electrofishing device, selective for catfish, was used to collect most of the catfish. This device, commonly called a "monkey rig" in Florida, was tested in the St. Johns River and found to be very effective in water temperatures down to 24° C (Hale et al. 1984*a*). When water temperatures were below 24° C or

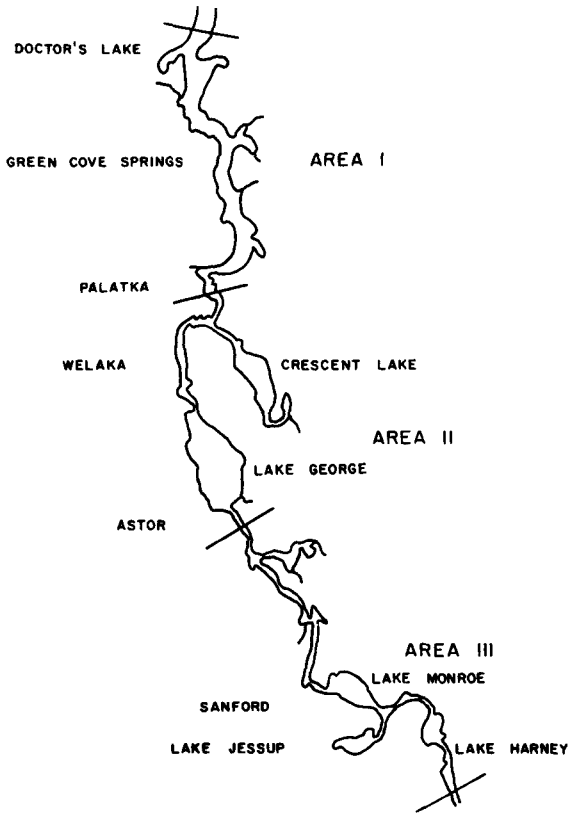

Figure 1. Map of study areas on the St. Johns River, Florida.

when adequate numbers of catfish could not be located, fish were donated by or purchased from commercial fishermen that fished hoop nets and pound nets.

The Floy FD-68B anchor tag was chosen for the tagging study. The tags were 80 mm long, 25 mm for the "T" anchor and 55 mm of bright yellow plastic tubing that contained our office phone number and identification number. Hale et al. (1983) reported a 97.1% tag retention of Floy FD-68B tags in a 6-month study on white and channel catfish. Because of this good retention rate, a single tag was used on all catfish.

Once collected, catfish were placed in a holding tank on board the electrofishing boat. The tank contained a concentration of approximately 0.6 cc Quinaldine/liter of water. All catfish were measured to the nearest millimeter total length (TL) and catfish $\geq$155 mm TL were tagged utilizing techniques described by Tranquilli and Childers (1982). The injection site was on the left side and slightly posterior to the dorsal spine. Fish $<$155 mm TL were considered too small to be readily caught by legal commercial methods and unable to withstand tagging stress. All tagged

fish were released within 0.4 km of the collection site. Tagged catfish recaptured no farther than 0.8 km from its point of release were regarded as stationary.

Prior to the tagging study, posters were distributed showing the location of the tag on the fish, information needed (date, location of capture, and grear type) and the address where information should be sent. Since most tagged fish would be caught by commercial fishermen, a mail box with a small slot cut in the top along with pencils and 20–30 manila envelopes were distributed to owners of all commercial fish houses on the river from Sanford to Paltaka, Florida. Owners were asked to put each returned tag into an envelope with the required information on the outside of the envelope and then place it into the mail box. All boxes were locked and were checked periodically by project personnel.

Results and Discussion

In 131 sampling trips from 9 May 1983 through 11 December 1985, 8,800 catfish were tagged and released in the St. Johns River and its tributaries. Approximately 63% of the catfish (5,535) were collected with "monkey rigs," 34% in hoop nets, and 3% in pound nets. Approximately 32.2% of the fish were donated by or purchased from commercial fishermen.

White catfish comprised 86.5% of the catfish tagged and released. Channel catfish and bullheads (brown and yellow) comprised the remaining 9.7% and 3.8%, respectively. White catfish was the dominant catfish species captured by commercial fishermen and comprised 69% to 88% of their catfish harvest (Hale et al. 1982, 1984*b*). White catfish averaged 78.7% of the total catch by number from 1980 to 1985. The higher percentage of white catfish tagged than harvested commercially was attributed to the habitat sampled and not gear selectivity. Although "monkey rigs" were selective for catfish, they were not selective for certain catfish species (Hale et al. 1984*a*).

Approximately the same number of catfish were tagged in each of the 3 areas, 30.1% in Area I, 35.2% in Area II, and 34.8% in Area III (Table 1). Approximately 51.6% of all fish were tagged and released in the main stream or riverine habitat. The remaining fish were tagged and released in tributary (37.6%) and lake (10.8%) habitats. More fish were tagged in tributaries in Areas I and II because fish were difficult to locate in the riverine portion of Area I and the presence of commercial gear in Area II (Hale et al. 1985).

Of the 8,800 catfish tagged, 1,227 (13.9%) were recaptured and reported (Table 1). Recaptures by area were 8.0% in Area I, 11.9% in Area II, and 21.0% in Area III. Return rates were low in Area I for many reasons. Less commercial fishing for catfish occurred in Area I than in the other 2 areas. The St. Johns River in Area I was very wide and concentrations of catfish were difficult to locate. Also, a large number of catfish in Area I were tagged and released in tributaries not open to commercial fishing. The percent return from fish released in the river was almost double the return of fish released in tributaries.

Table 1. Number of fish tagged and tag returns by area and habitat in the St. Johns River, Florida.

Area and habitat	Number of fish tagged	Percent of total tagged fish	Number of tag returns	Percent recaptured
Area I				
Riverine	1,214	13.8	131	10.8
Tributary	1,431	16.3	80	5.6
Lake	0	0.0	0	0.0
	Σ = 2,645	Σ = 30.1	Σ = 211	$\bar{x}$ = 8.0
Area II				
Riverine	840	9.6	88	10.5
Tributary	1,427	16.2	88	6.2
Lake	817	9.4	192	23.3
	Σ = 3,084	Σ = 35.2	Σ = 368	$\bar{x}$ = 11.9
Area III				
Riverine	2,486	28.2	559	22.5
Tributary	462	5.2	65	14.1
Lake	123	1.4	24	19.5
	Σ = 3,071	Σ = 34.8	Σ = 648	$\bar{x}$ = 21.0
Grand total				
Riverine	4,540	51.6	778	17.1
Tributary	3,312	37.6	233	7.0
Lake	948	10.8	216	22.8
	Σ = 8,800	Σ = 100.0	Σ = 1,227	$\bar{x}$ = 13.9

An even larger percentage of fish were released in tributaries in Area II. The bulk of fish tagged in Area II tributaries were released in Dunns Creek, a tributary that is open to commercial fishing. Although most fish released in Area II tributaries were readily available to the commercial industry, the percent return from Area II tributaries (6.2%) was not much higher than the return from Area I tributaries (5.8%). Commercial effort was much reduced in Dunns Creek during most of this study. The percent return of fish tagged in the river in Area II (10.5%) was virtually the same in Area I (10.8%), even though more commercial effort is expended in Area II and the riverine habitat is narrower and more conducive to commercial fishing in Area II. Poor tag return compliance of some commercial fishermen in Area II may have been responsible for this lower-than-expected riverine return. A very high return was observed from fish released in the lake habitat. Of 817 catfish tagged in Lake George, 23.3% were subsequently recaptured. This high return was attributed to the high level of commercial fishing effort in Lake George and in Area III, where many of the fish tagged in Lake George were recaptured.

The highest tag return by area was in Area III (21.0%). This higher level of return was attributed to the greatest amount of commercial fishing effort per area (Hale et al. 1982), very narrow riverine habitat, and excellent compliance by commercial fishermen. When all three areas were combined, the highest return was observed from lake habitat (22.8%) followed by riverine (17.1%) and tributary (7.0%) habitats.

Directional movement was determined for 949 catfish (Table 2). When evalu-

Table 2. Directional movement of 949 tagged catfish from the St. Johns River, Florida.

Movement direction and measure	Area I	Area II	Area III	Σ	$\bar{x}$
Upstream					
Number of recaptures	76	181	236	493	
Percent travelled upstream	51.4	61.8	46.5		52.0
$\bar{x}$ distance travelled (km)	46.1	30.3	19.0		27.3
Downstream					
Number of recaptures	39	38	155	232	
Percent travelled downstream	26.4	13.0	30.5		24.4
$\bar{x}$ distance travelled (km)	14.2	25.3	18.7		19.0
Stationary					
Number of recaptures	33	74	117	224	
Percent remaining stationary	22.3	25.3	23.0		23.6
Total recaptures	148	293	508	949	

ating all 949 catfish, a definite upstream movement was observed. Approximately 52.0% of the fish travelled upstream while 24.4% moved downstream and 23.6% remained stationary. These results differ from those of many other studies. Harrison (1953) and McCammon and LaFaunce (1961) reported very little movement of channel catfish while Funk (1955) and Muncey (1958) reported about the same amount of upstream and downstream movement. In the Little Sioux River, Iowa, Welker (1967) reported a 44.5% downstream movement and 26.8% upstream movement. Hubley (1963) observed a 45.8% downstream movement and 18.8% upstream movement in the upper Mississippi River. A seasonal upstream movement (spring) was suggested by McCammon (1956).

The upstream movement observed in the St. Johns River, Florida, was not seasonal but occurred almost uniformly over the study with 1 exception. From 1,725 catfish tagged and released in fall 1983, a fast, definite upstream movement was observed. Approximately 68.4% of the recaptured fish released in fall 1983 moved upstream, 18.3% moved downstream and 13.3% remained stationary. This movement was attributed to falling water levels in the fall after heavy spring rains, preceded by very low water levels in 1981 and 1982.

Approximately 51.4% of the recaptured fish tagged in Area I moved upstream and travelled an average of 46.1 km. This upstream movement in the lower St. Johns River was expected. Funk (1955) theorized that fish nearer the mouth of a river tended to move upstream. However, a higher percentage of upstream movement (61.8%) was observed in Area II. This higher upstream movement was attributed to the mass upstream movement of catfish tagged in fall 1983.

The longest distance travelled upstream was 178.2 km by a white catfish. Welker (1967) reported that the maximum distance travelled was 191.4 km while Hubley (1963) reported an upstream movement of 345.2 km. In this study, a channel catfish travelled 108.1 km in 22 days and a white catfish moved 53.9 km in 8 days. About half of all tagged fish that moved upstream were caught within 16.1 km of their release site (Table 3). Approximately 93.6% of the tagged fish were

caught within 80.6 km of their release site. When fish moving upstream and downstream were combined, 94.6% were caught within 80.6 km of their release site. Funk (1955) reported that 64.1% of the tagged fish were recaptured within 16.1 km of the release point while 94.0% were recaptured within 80.6 km. These results closely coincide with results from our study.

Only 24.4% of the recaptured fish moved downstream in our study. No concentrated downstream movement similar to the fall 1983 upstream movement was observed. More catfish moved downstream in Area I than in Area II. This appeared unusual in light of Funk's (1955) theory. The greatest percentage of downstream movement occurred in Area III.

Downstream movement by area ranged from 14.2 to 25.3 km and averaged 19.0 km. This closely coincided with the 19.2 km average downstream movement reported by Funk (1955). The longest downstream movement recorded in our study was 116.4 km. It appeared that tagged catfish did not travel as far downstream before being recaptured as they did upstream. A total of 58.3% of the recaptured catfish that moved downstream were captured within 16.1 km of their release site as compared to 49.8% that moved upstream. Of the recaptured fish that moved downstream, 82.0% were captured within 32.2 km of their release site as compared to 70.4% that moved upstream.

The percentage of fish that remained stationary varied greatly in earlier studies. Hubley (1963) reported no movement in 23.9% of his catfish while Mayhew (1971) and Harrison (1953) observed no movement in 50% and 67.3% of their catfish, respectively. The percentages of catfish exhibiting no movement before being caught in our study ranged from 22.3% in Area I to 25.3% in Area II and averaged 23.6%. Funk (1955) concluded that there was a sedentary portion and a mobile portion of the catfish population. Our results appeared to confirm his conclusion. While some fish moved up to 17.7 km in 1 day, another fish was recaptured at its original site of release 903 days later.

Table 3. Distance travelled of 633 catfish moving upstream or downstream in the St. Johns River, Florida.

Distance travelled (km)	Upstream percent recaptures	Downstream percent recaptures	All fish percent recaptures
0.8–16.1	49.8	58.3	52.6
16.2–32.2	20.6	23.7	21.6
32.3–48.4	12.3	9.9	11.5
48.5–64.5	7.8	3.8	6.5
64.6–80.6	3.1	1.0	2 4
80.7–96.8	1.4	1.9	1.6
96.9–112.9	2.6	1.0	2.0
113.0–129.0	1.0	0.5	0.8
129.1–145.2	0.7	0.0	0.5
145.3–161.3	0.2	0.0	0.2
161.4–177.4	0.2	0.0	0.2
177.5–193.5	0.2	0.0	0.2

The percentage of upstream recaptures by area varied (46.5% to 61.8%) as did downstream recaptures (13.0% to 30.5%). The percent of stationary recaptures by area did not fluctuate very much (22.3% to 25.3%). Because there was little variation in percentages of recaptured fish that remained stationary in each area, the average percent that remained stationary was used to estimate the percentage of the sedentary population of catfish in the St. Johns River. Also, it was unknown how many catfish classified as stationary were recaptured before they had an opportunity to move upstream or downstream. For this reason, the average percent that remained stationary (23.6%) must be considered to be the maximum percentage for the sedentary population.

The number of days tagged catfish remained at large before being recaptured ranged from 0 to 903 days and averaged about 82 days. Catfish that moved upstream remained at large an average of 88 days and downstream an average of 84 days. Catfish from the St. Johns River remained at large for a much shorter time period than in Missouri streams (Funk 1955). Catfish in Missouri that moved upstream averaged 223 days at large and 309 days at large for fish that moved downstream. These differences were attributed to the low catfish exploitation from sport fishing in Missouri streams as compared to higher catfish exploitation by commercial fishermen on the St. Johns River. The shortest average number of days at large for the 3 areas was in Area III (73.3 days) which was the area where more commercial fishing occurred.

Upstream movement of tagged catfish was reflected in the distribution of recaptured tagged fish by area. Although 30.1% of all fish tagged were released in Area I, only 13.5% of the recaptured fish were reported in Area I (Table 4). In Area II, 35.2% of all tagged fish were released there, while 25.7% of the recaptured catfish were caught in Area II. However, in Area III, 60.8% of all recaptured catfish were caught there while only 34.8% of the tagged fish were released there. This higher percentage was due to the upstream movement and greater amount of commercial fishing effort in Area III.

Approximately 75.1% of the recaptured fish originally released in Area I were recaptured in Area I (Table 4). Only 66.1% of the recaptured fish originally released in Area II were subsequently recaptured in Area II. The majority of the remaining fish originally tagged in Area II (31.9%) moved upstream into Area III. In Area III,

Table 4. Distribution of 1,180 recaptured catfish by area in the St. Johns River, Florida.

Area	Number of recaptures from fish tagged in respective areas	Percent of fish recaptured from Area I	Percent of fish recaptured from Area II	Percent of fish recaptured from Area III
I	201	75.1	17.4	7.5
II	360	1.9	66.1	31.9
III	619	0.2	4.8	95.0
Σ	1,180			
$\bar{x}$		13.5	25.7	60.8

95.0% of the recaptured fish originally released in Area III were subsequently recaptured there. Only 4.8% of the fish originally released in Area III moved downstream into Area II, while only 1 out of 619 catfish travelled from Area III into Area I. It appeared that once a catfish reached the Lake George area of the St. Johns River, the likelihood that it would be available to the commercial fishery downstream was remote.

Results showing movement between areas indicated that there were no discrete populations of catfish in the St. Johns River. Although fewer catfish tagged in tributaries were recaptured, some fish from all tributaries were recaptured upstream and downstream from their tributary. This does not mean that catfish in tributaries represent discrete populations, just that those catfish have a smaller chance of being recaptured than catfish released in the St. Johns River. When management decisions are made on catfish in the St. Johns River, they should be based on a holistic approach which assumes there is a single catfish population, not on a lake or regional basis.

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