Flathead Catfish Abundance and Growth in the Flint River, Georgia

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Abstract: Abundance and growth rates of flathead catfish (*Pylodictis olivaris*) from the Flint River, Georgia, were investigated during 1985 to gain basic information for future implementation of management strategies. Pectoral fins were disarticulated, sectioned at the articulating process, photographed, and enlarged for aging. The Schnabel and Schumacher-Eschmeyer multiple census population estimators produced similar results: there were 7,647 and 8,013 flathead catfish ≥ 305 mm in the 50-km section of river, respectively. Biomass estimates were 23.2 and 24.3 kg/ha. Growth was very fast for the earlier year classes (1976–1980), but had declined in recent years. Flathead catfish had become very abundant, and the reduced growth rate may be due to increased numbers, if growth is density dependent.

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Flathead catfish were reportedly introduced to the Flint River, Georgia, by individual fisherman around 1950 (Quinn 1987). Rapid species expansion in the Flint River suggested a need to study the abundance and growth rate of this transplanted species so that management strategies could be developed in the future.

Few studies of flathead catfish abundance have been conducted, due in part to the difficulty in collecting large numbers of fish. Multiple census population estimates have been described in Oklahoma reservoirs (Summerfelt et al. 1972, Weeks and Combs 1981), a Kentucky reservoir (Carter 1956), sections of the Missouri River (Morris et al. 1971), and the Coosa River, Alabama (Scott 1951). In other flathead catfish tagging studies, few fish have been recaptured, precluding estimates of population size.

Early investigations of flathead catfish growth rates (Jenkins 1952, Carroll and Hall 1964, Mayhew 1969, among others) adopted the methods described by Sneed (1951) for aging channel catfish. Sections were made at the distal end of the basal recess of the pectoral fin with an electric saw. However, the pectoral fin of flathead catfish contains a hollow lumen that expands as the fish grows and progressively

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erodes annuli, creating problems with age determination. Holz (1969) found that 88% of the age-III fish collected from the Missouri River had lost the first annulus, and 100% of age-IX fish had lost the second annulus in basal recess sections. Similar results were reported by Langemeier (1965), Edmundson (1974), and Guier et al. (1981). Turner (1977) found that as many as 5 annuli were missing in basal recess sections in old fish from Oklahoma. Layher (1981) reported that dorsal fin sections had significantly more annuli than pectoral fin basal recess sections. Due to the inadequacies of basal recess sections, Langemeier (1965) and Holz (1969) used articulating process sections, which do not include the hollow lumen, to determine true age and then back-calculated growth from basal recess sections. They reported difficulty in determining a central reference point in the articulating process sections from which to measure distances to annuli and preferred using the estimated center of the hollow lumen as the focus. However, standard computer back-calculation programs will not accomodate missing annuli. Moreover, early growth history of older fish is completely lost with that method. Turner (1977, 1980) used the midpoint of the innermost annulus on articulating process sections as the focus for measurement of succeeding annuli and validated annulus formation on these sections by flathead catfish of known age.

The purpose of this study was to determine abundance and growth rates of the flathead catfish in the Flint River, Georgia. Doerzbacher and Schramm (1984) described the use of an enlarger for aging with otoliths. In this study, I used an enlarger to produce prints for aging and measuring annuli on pectoral fin articulating process sections.

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Methods

The study area was the 50-km stretch of the Flint River between the Albany Dam and the city of Newton. River width is 60–90 m. Substrate is primarily Ocala limestone outcroppings and rubble with silt and sand deposits. The river is characterized by shoals alternating with longer reaches of deeper (5–10 m), slower moving water. Mean conductivity was 104 μmhos/cm. Mean monthly discharge during the study period was $74 m^3$/second.

Flathead catfish were collected with a boat-mounted, pulsed DC electrofishing unit as described by Quinn (1986). Peak efficiency with these battery-powered units was at 20 Hz frequency, pulse width of 0.4–0.5 milliseconds, 250–350 volts, and 3 amps. Fish were collected between 0900 and 1700 from 21 May through 20 November 1985. Flathead catfish $\geq$ 305 mm were tagged with numbered plastic anchor tags (Floy FD68B) inserted through the operculum as described by Summerfelt and Turner (1972). Population size was estimated with the Schnabel and Schumacher-Eschmeyer formulas (Ricker 1975). The entire stretch of river was sampled 4 times.

Right pectoral fins were disarticulated from a subsample of flathead catfish and stored in coin envelopes. Fins were sectioned at the articulating process as recommended by Turner (1980). Sections were made with either a dremel saw mounted on a platform as described by Witt (1961) or a fine-toothed jeweler's saw (2.5 teeth/mm). Sections were mounted on glass slides with clear epoxy and ground to a thickness of 0.5–1.0 mm with extra fine sandpaper on an electric disc sander. Mounted sections were then polished by hand with wet-dry carborundum paper (#400 and #600). Immersion oil was applied to the sections to improve differentiation of annuli, as recommended by H. L. Schramm (Texas Tech. Univ., Lubbock, pers. commun.). Sections were photographed with Kodak Plux-X, black and white print film (100 ASA). Overhead lighting for photography was by a 35-watt microscope light. The film was developed and the negatives were enlarged with a 75-watt Model B22 Omega Enlarger in a dark-room. Prints measuring 127 × 178 mm were produced. Total magnification was 8.2X. Annuli were counted on the photographs and measurements were made along the anterior quadrant from the center of the first annulus to succeeding annuli and to the most anterior edge of the section as described by Turner (1977). Annuli were recognized as narrow dark rings alternating with broad light zones on the prints. Back-calculation of length-at-age was done with the Fraser-Lee direct proportion method (Carlander 1982). The y-intercept was calculated from the linear regression of pectoral fin radius on total fish length for all fish. The mean growth increment between tagging and recapture was calculated for 3 groups of fish (305–450 mm, 451–600 mm, $\geq$ 601mm) for comparison with back-calculations.

Results

A total of 1,636 flathead catfish were tagged and 159 individuals were recaptured. The Schnabel estimator yielded a point estimate of 7,647 fish $\geq$ 305 mm ($6{,}154 < N < 10{,}111$, $P < 0.05$). The Schumacher-Eschmeyer estimator yielded a point estimate of 8,013 fish ($6{,}575 < N < 10{,}256$, $P < 0.05$). Applying the mean weight of all tagged fish (1,783 g) to the estimated number of fish yielded total biomass estimates of 13,634.6 kg and 14,287.2 kg with the Schnabel and Schumacher-Eschmeyer estimators. The Schnabel point estimate indicated 153 flathead catfish $\geq$ 305 mm per river kilometer, or 13 fish/ha and 23.2 kg/ha. The Schumacher-Eschmeyer estimate indicated 161 fish/rkm, or 14/ha and 24.3 kg/ha.

One hundred-eighty-two flathead catfish pectoral fins were successfully collected, sectioned, sanded, photographed, enlarged, and read. Some fins had been damaged when removed from the fish, and some were broken during the sectioning process.

Table 1 lists the growth histories of the 1976 through 1985 year classes. Mean length at age I was 203 mm and fish had reached 352 mm by age II. However, the

Table 1. Back-calculated length-at-age of flathead catfish collected from the Flint River by electrofishing in 1985.

Year class	N Fish	Length-at-age (mm) 1	2	3	4	5	6	7	8	9	Mean length at capture (mm)
1985	13										117
1984	26	152									203
1983	43	191	310								381
1982	24	176	302	421							501
1981	27	231	378	494	570						635
1980	19	229	385	517	620	697					763
1979	12	250	417	537	623	687	747				792
1978	13	232	375	529	633	711	765	807			855
1977	4	266	443	601	715	796	848	889	922		956
1976	1	313	563	735	828	891	922	953	985	1,000	1,016
Mean length at annulus, weighted (mm)		203	352	497	613	710	774	833	935	1,000	
Mean annual increment (mm)		203	149	145	116	97	64	59	102	65	

1984 year class averaged only 152 mm at age I, while back-calculated length-at-age for the 1977 year class was 266 mm (Table 1). A decline in growth rate for all ages was evident in recent years. The oldest fish collected was 9; it measured 1,016 mm and weighed 12.7 kg.

Flathead catfish recaptured during 1985 grew at an average rate of 0.32 mm/day (Table 2), or 9.6 mm/month. Growth of tagged fish was inversely related to size. Based on an 8-month growing season, mean annual growth for all sizes of fish was 77 mm (Table 2).

Discussion

The Flint River flathead catfish population is quite dense compared to abundance and biomass estimates from other areas. In a 33.8-km unchannelized section of the Missouri River, the Modified Schnabel estimate was 590 fish $\geq$ 200 mm ($321 < N < 3,599$; $P < 0.05$; Morris et al. 1971) which was equivalent to 17 fish/rkm or 0.13 kg/ha. The estimate for a 67.6-km channelized section was 627 ($544 < N < 741$; $P < 0.05$), or 9 fish/rkm and 0.15 kg/ha. Weeks and Combs (1981) estimated 8,900 flathead catfish from 201–400 mm and 7,539 $>$ 400 mm in a 4,050-ha Oklahoma reservoir with the Modified Schnabel formula, resulting in a total estimate of 4.1 fish/ha. The Schnabel and Schumacher-Eschmeyer estimators generated similar estimates in 850-ha Lake Carl Blackwell, Oklahoma, which ranged from 532–973 fish $>$ 550 mm, equivalent to 2.8–5.6 kg/ha (Summerfelt et al. 1972). In 445-ha Dewey Lake, Kentucky, population estimates ranged from 236–425 fish (Carter 1956).

Population estimates in large rivers have been hampered by difficulties in tag-

Table 2. Growth of flathead catfish tagged and recaptured during 1985 in the Flint River, Georgia.

Size class	*N* recaptured	Mean daily growth (mm/day)	Annual growth (based on 8-mo growth)
305–450 mm	68	0.41	98.4
451–600 mm	62	0.28	67.2
⩾601 mm	29	0.20	48.0
All	159	0.32	76.8

ging a significant portion of the population (Hesse and Newcomb 1982). Movement of fish into and out of the study area may also violate assumptions of the estimators (Ricker 1975). In this study, the effectiveness of the electrofishing system resulted in the tagging of > 20% of the estimated number of flathead catfish ≥ 305 mm in the study area. During the study period, 79% of recaptured flathead catfish showed no detectable movement (S. P. Quinn, unpubl. data). Limited movement has been described in other rivers (Funk 1955, Muncy 1957, Morris et al. 1971, Gholson 1975). Movement of tagged fish downstream, out of the study area, or movement of untagged fish upstream into the area would result in an overestimate of the population (Ricker 1975). However, upstream and downstream movement by tagged fish was approximately equal in the Flint River, and I feel such movement did not greatly bias the estimates.

Flathead catfish growth has been the most studied aspect of the biology of this species, and at least 30 publications have described growth in 36 or more bodies of water. The average growth rate in the Flint River generally exceeded all populations except Heyburn Reservoir, Oklahoma (Buck 1956), which had recently been impounded. Slightly greater lengths for some age classes have been described for other populations (Cross and Hastings 1956, Huntington and Hill 1956, Schoumacher 1968). In the Cape Fear River, where flathead catfish had recently been introduced (Guier et al. 1981), growth was almost as fast as in the Flint River. Pisano et al. (1983) described rather fast growth for a recently introduced population in California.

Length-at-age for Flint River flathead catfish has declined markedly since the 1970s (Table 1). Flathead catfish were first collected below the Albany Dam in 1974 (Pasch 1976). The earliest year classes grew at an extremely fast rate which gradually declined, possibly due to intraspecific competition. The growth rates of the 1982–1985 year classes are similar to many populations, although still somewhat above average. Jenkins (1952) and Jackson (1965) described reduction in flathead catfish growth rates in Oklahoma reservoirs, in the years following impoundment when fish populations were expanding. In the Missouri River, Holz (1969) attributed faster growth of flathead catfish in a channelized area to heavier commercial fishing pressure there than in an unchannelized area where fishing mortality was lower and population density higher.

This evidence suggest that flathead catfish growth is density dependent in some situations. The inverse relationship between population density and growth rate has been reviewed by Backiel and LeCren (1967). Flathead catfish appear well adapted to the Flint River which provides a diverse forage base (Quinn 1987). The reproductive behavior of flathead catfish has not been extensively studied, but observations in aquaria (Fontaine 1944), hatcheries (Sneed et al. 1961, Henderson 1963), and with wild populations (Davidson 1966, Turner and Summerfelt 1971) suggest that they are cavity spawners like channel catfish. The Ocala limestone which lines the banks of the Flint River provides excellent spawning habitat for this mode of reproduction. It is likely that the population will continue to increase. Growth rates may decline further if the density-dependent growth model is applicable. Increased fishing mortality could, however, counter that trend.

Doerzbacher and Schramm (1984) pointed out the advantages of using an enlarger for aging with otoliths (precision of measurements, ability to mark photographs, better resolution of annuli, reduction in observer fatigue, and ease of storage). These advantages apply to fin sections as well. In addition, prints would facilitate aging with a digitizing pad (Frie 1982). Pate (1980) reported that trunk vertebrae were quite accurate for aging flathead catfish, but that field extraction was difficult. Flathead catfish otoliths have apparently not been tried for age determination. Crumpton et al. (1984) reported that otoliths of 3 other species of catfish were not reliable due to incomplete formation of annuli which led to high rates of aging error. As a result, the use of articulating process sections with an enlarger is recommended for flathead catfish age-growth studies. Use of a specimen platform such as Doerzbacher and Schramm (1984) described might eliminate the need to photograph sections.

The growth rate of the smallest tagged fish (305–450 mm) was more than twice as fast as for fish ≥ 601 mm (Table 2), and it agreed quite well with back-calculated length-at-age data for the most recent year classes. Growth increments for larger recaptured catfish were somewhat less than for back-calculated length-at-age data. Recaptures of tagged flathead catfish from more northern populations indicated that most of the annual growth is accomplished during the summer months (Muncy 1957, Morris et al. 1971). Annual growth patterns of southern coastal plain populations are unknown, and fish may grow for more than the 8-month period which was used in this instance. Reduction in growth rate due to tagging stress is also possible.

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