The Anchored Gill Net Shad Fishery of the Altamaha River, Georgia

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Abstract: From 2007 to 2009, we quantified total effort and catch of the anchored gill net American shad (*Alosa sapidissima*) fishery in the Altamaha River, Georgia. We observed and recorded catch data of commercial fishermen interspersed throughout the river. These fishermen also recorded their daily catch and effort in log books. Total harvest of American shad was lowest in January and highest in February of each season. Total fishing effort was estimated monthly and was combined with catch-per-unit-effort data to estimate total harvest monthly. Most harvest and effort occurred in the lower half of the river. Each year, we conducted direct observations and collected log data for between 48% and 66% of the total fishery. The total value of the 2009 anchored gill net fishery was estimated to be US$18,104. We estimated that anchored gill net fishermen accounted for 53% of total shad landings in 2009.

Key words: American shad, harvest, gill net, CPUE, exploitation

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Commercial fisheries for American shad (*Alosa sapidissima*) have existed along the Atlantic seaboard since colonial times, but their economic importance increased during the 1800s (Facey and Van Den Avyle 1986). Before World War II, the species was the most valuable Atlantic coast food fish from Maine to Florida (Rulifson et al. 1982). Over the past century, however, commercial landings have declined sharply. Because American shad are an anadromous species, most commercial fisheries intercept adult spawners as they return to their natal rivers in early spring (Facey and Van Den Avyle 1986). Both females and males are harvested for meat, but gravid females are preferred because of the added value of their roe. While ecological changes and habitat degradation have contributed to coast wide declines, chronic overfishing has severely diminished many populations (Rulifson et al. 1982).

As in other southern Atlantic states, Georgia's commercial shad fishery peaked during the early 1900s (Michaels 1993). Although all five of Georgia's coastal rivers once supported commercial fisheries, the Altamaha and Savannah rivers have typically comprised most of the state's total landings. In 1967, for example, the Altamaha River alone accounted for 69% of the state's total harvest (Godwin and McBay 1967). Unfortunately, the shad run in the Altamaha River has declined steadily during the past century with annual landings averaging <24,000 kg during the last decade (Figure 1). Undoubtedly, a number of social, ecological, and environmental factors have played an important role in this decline; however, the most recent assessment states that the fishery has been overexploited (Michaels 1993).

Although little is known about current American shad populations in Georgia, the Altamaha River supports the largest remaining commercial fishery in the state based on both fishing effort and annual run size (Michaels 1993). Reported landings in the Altamaha River have continued the declining trend since 1987 (Figure 1), but comprehensive assessments are lacking. In a recent report, The Atlantic States Marine Fisheries Commission (ASMFC, 2007) noted that landings in the Altamaha River are currently an order of magnitude lower than those reported in the 1960s, but current data on fishing effort are needed to better evaluate trends in annual landings (ASMFC 2007). The goal of this study was to provide fisheries managers with quantified catch and effort data regarding the economic value of the Altamaha anchored gill net shad fishery.

Under current regulations, commercial shad fisheries are open in Georgia each year from 1 January to 31 March. Individual access to the fishery requires the annual purchase of a generic commercial fishing license (US$12). In the Altamaha River, state regulations have established two distinct harvest zones, separated by the Seaboard Coastline Railroad Bridge at river kilometer (rkm) 42 (Figure 2). Below this demarcation, fishing is open downstream to the Atlantic Ocean from Monday-Friday of each week. Upstream,

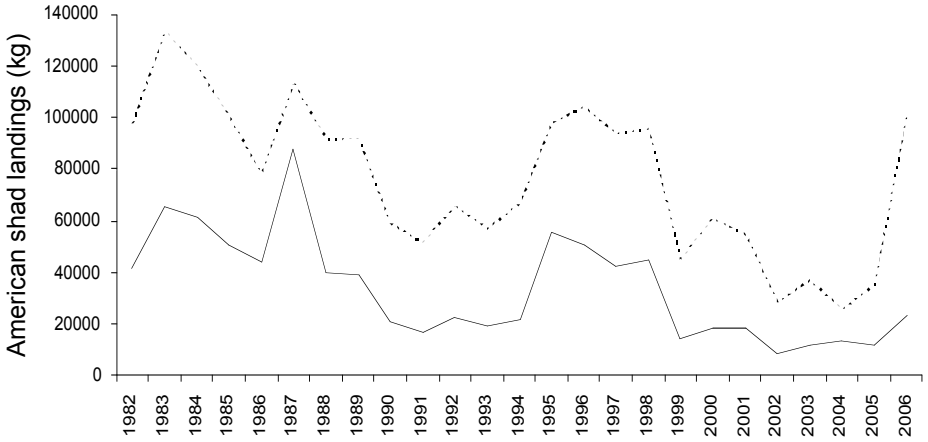

Figure 1. Annual landings (kg) of American shad in commercial gill net fishery from the Altamaha River, Georgia, 1982–2009. The solid and dashed lines depict reported and adjusted landings, respectively.

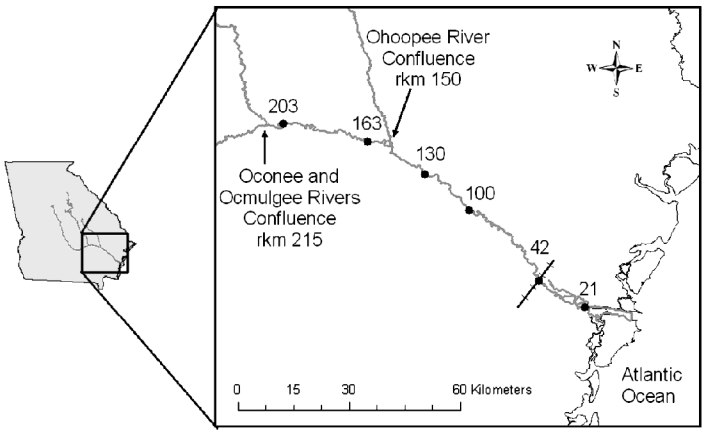

Figure 2. The Altamaha River with locations of commercial fishermen observed during the study. • = Six locations and river kilometer of fishermen surveyed in each year of the study. The Seaboard Coastline Railroad Bridge (rkm 42) divides the river into two strata under current Georgia Department of Natural Resources regulations.

the fishery is open from Tuesday–Saturday. During the open season, shad may be taken by anchored or drifted gill nets anywhere above rkm 21, but only drifted nets may be used below this point. All gill nets, regardless of how they are fished, must be constructed of webbing ≥11.4 cm (stretched measure) and a total net length of <30.5 m. Anchored nets must be spaced at least 182.9 m apart, with one end tied to the shore so that fish passage is unobstructed through at least half of the river channel.

Although drifted gill nets are permitted above the estuary, the vast majority of commercial nets deployed upstream of the estuary in the Altamaha River from 2004 to 2009 were anchored gill nets. As such, the primary focus of this study was to assess only the anchored gill net component of the fishery. Our specific objectives were to estimate annual effort, catch, and value of commercial landings in the anchored gill net fishery for American shad on the Altamaha River.

Methods

Study Site

The Altamaha River is formed on the coastal plain of Georgia by the confluence of the Ocmulgee and Oconee Rivers near Hazlehurst, Georgia (Figure 2). The river flows southeast 215 km to the Atlantic Ocean near Darien, Georgia. Because the stream drains over one-quarter of the state, channel depths and the location of the fresh-saltwater interface are variable depending on seasonal rainfall and hydropower operations of tributary impoundments. Under typical conditions, however, the channel is 50–70 m wide and 2–3 m deep (Heidt and Gilbert 1978). The head of tide is variable between rkm 45–55. Typically, the American shad spawning migration begins in late December, with the peak of the run occurring during February (Georgia Department of Natural Resources [GDNR], unpublished data).

Experimental Design

To quantify annual fishing effort and total landings, we conducted a standardized fishery assessment of the Altamaha mainstem from 1 January 2007 to 31 March 2009. Using a roving creel survey design (Malvestuto 1996), we conducted weekly counts of anchored gill nets by traversing the entire study area in a small boat. In 2007 and 2008, these counts were completed in two consecutive days, beginning with a random starting location and direction of travel. In 2009, counts were conducted continuously

from upstream to downstream, so that they could be completed in one day. In each year, a running count of shad nets was made by checking each floating net buoy encountered to confirm that an actively fishing shad net was present. Nets that did not comply with published fishing regulations were included in all net count totals, but were not reported to law enforcement until the end of the season to prevent any potential bias in fishing behavior.

Catch-per-unit-effort (CPUE) was obtained using a combination of direct observations of net retrievals and log books from six to seven commercial fishermen. The individual fishermen selected for the study were chosen based on river section where they fished and their willingness to participate in the study. The locations of their nets were independent of each other and interspersed throughout the study area. Each fisherman was compensated $500 annually in return for their cooperation in allowing us to observe randomly-selected net pulls and for keeping accurate log books of catch and effort. Observations of fishermen were randomized with some allowance for the individual schedules of each. Fishermen were not compensated until accuracy of log books had been verified at the conclusion of each fishing season. Accuracy of log books was verified using two independent methods: 1) comparison of log books to data recorded from days that fishermen were observed, and 2) using a matched-pair *t*-test.

Direct observations of catch were conducted at least three times for each participating fisherman during each shad season, but most fishermen were observed once or twice weekly. During each observation, we followed the fishermen to each net location in a small boat. As each net was retrieved, we recorded the number of each species captured along with various fishing metrics including: soak times, net dimensions, and mesh size. In the final year of the study, we also recorded sex and weight of the first three to five American shad captured in each net.

Data Analysis

To estimate total effort in the anchored gill net fishery, the mean number of nets fished was calculated for each month of the season. Total monthly net-hours was calculated based on the number of nets counted each week and the amount of time (total fishing hours) that the season was open. This included 12 hours for opening and closing days and 24 hours for all other days. Total monthly fishing effort was calculated using the formula:

total fishing effort (net hours) = Σ ((mean nets observed / mo) × (total fishing hours / mo))

Accuracy of log book data from each fisherman were evaluated using a one sample matched-pair *t*-test ($\alpha = 0.05$) to compare the mean of the differences between logged and observational data. To perform the test, the number of American shad recorded during net retrieval observations was standardized to the net hours recorded in log books for each particular observation. Once log book data were verified, estimates of total monthly catch and effort were calculated for each fisherman by supplementing the direct observational data with those from the log books recorded on days when observers were not present. Monthly CPUE for shad was estimated using the formula:

CPUE = (*n* shad observed + *n* shad logged) / total net hours

Total monthly harvest was then estimated using the formula:

total monthly catch = (total fishing hours / mo) × (mean monthly CPUE)

In 2009, the cash value of total landings from the anchored gill net fishery was calculated from total estimated catch, mean monthly market prices, and monthly sex ratios and weights of catches observed during that year of the study.

Results

Based on our roving counts of anchored gill nets, we estimated that between 13 and 20 fishermen participated in the fishery annually. Total estimated effort in the anchored gill net fishery varied from 22,689–27,310 hours annually (Table 1). Fishing effort was not consistent among months or years and appeared to be independent of CPUE (Figures 3, 4). Weekly effort varied from 6–35 nets per week during all three years of the study. Despite these inconsistencies in effort, several spatial and temporal trends in catch were observed. Most fishing effort (56.3%) occurred between rkm 35–100. Likewise, 68.9% of all shad harvest occurred in February and March between rkm 35–100. In all three years, CPUE was lowest in January, followed by an increase of at least 100% in February (Figure 4). In 2009, for example, CPUE increased from a low of 0.12 shad/h in January, to 0.36 shad/h in February. In 2008 and

Table 1. Estimated total fishing effort (h) and total catch (number of shad) of the anchored gill net shad fishery in the Altamaha River, Georgia, 2007–2009.

Year	Month	*n* of shad recorded	CPUE	95% Confidence interval	Estimated total fishing effort (h)	Mean estimated catch
2007	Jan	473	0.0947	±0.0220	10,794	1023
	Feb	1432	0.2044	±0.0388	7248	1482
	Mar	1050	0.2071	±0.0389	7675	1589
2008	Jan	465	0.0949	±0.0420	7569	718
	Feb	1374	0.2029	±0.0301	12,216	2478
	Mar	550	0.1210	±0.0333	7525	911
2009	Jan	459	0.1236	±0.0365	6846	846
	Feb	1369	0.3614	±0.0872	7776	2810
	Mar	610	0.1780	±0.0322	8067	1436

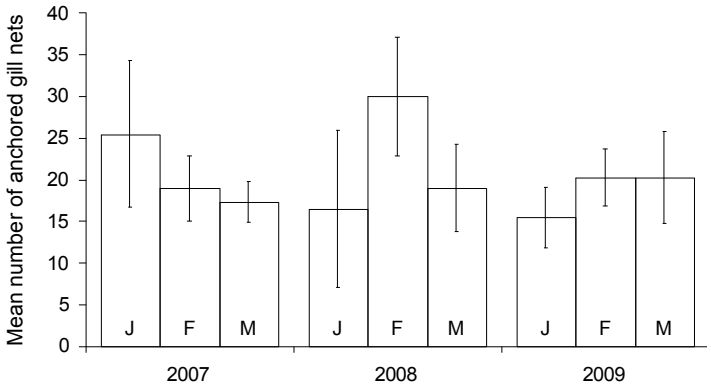

Figure 3. Mean number of anchored gill nets with associated 95% confidence intervals observed in the Altamaha River by month from 2007 to 2009. J = January, F = February, M = March

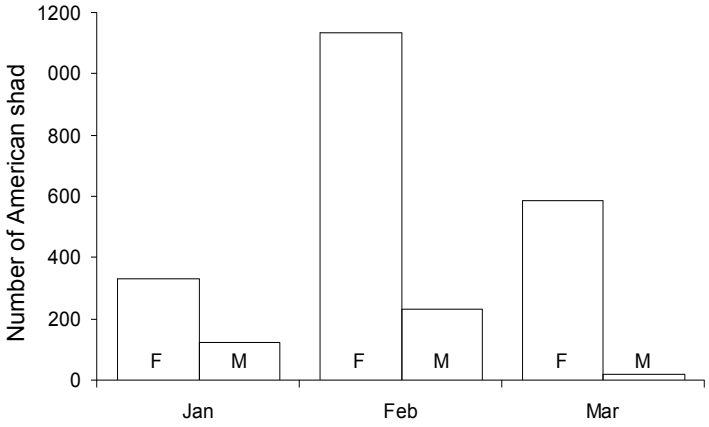

Figure 5. Raw number and sex of American shad observed during net retrievals in the Altamaha River in 2009. F = female, M = male

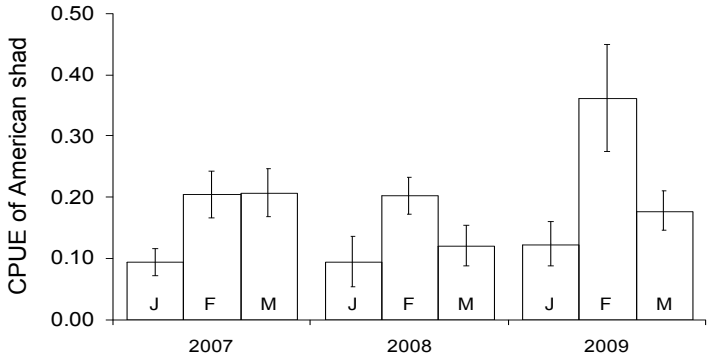

Figure 4. CPUE of American shad with associated 95% confidence intervals in the Altamaha River by month and year from 2007 to 2009. J = January, F = February, M = March

Table 2. Estimated landings value of the anchored gill net fishery for American shad in the Altamaha River, 2009. Market values were obtained from commercial fishermen monthly who sold their catch to fish wholesalers during the 2009 season.

Month	Weight (kg)	Price ($/kg)	Mean Weight (kg)	Value ($)
		Females		
Jan	905	3.31	1.475	2996
Feb	3596	2.43	1.542	8738
Mar	1387	2.20	1.583	4831
		Males		
Jan	247	2.43	1.064	600
Feb	563	1.54	1.177	867
Mar	54	1.32	1.092	71

2009, CPUE was highest in February (0.20 and 0.36, respectively) and then declined to 0.12 and 0.18, respectively, in March (Figure 4). In 2007, harvest was highest in March because of an increase in both effort and CPUE, indicating that the peak spawning run occurred later in that year.

Over the three fishing seasons, data collected from direct observations and log books accounted for 48%–66% of all fishing effort expended in the anchored gill net fishery. Estimated total catch varied from a low of 4,094 shad in 2007, to 5,092 shad in 2009 (Table 1). Total catch data recorded during direct observations of fishermen was not significantly different than data provided in fishermen log books ($P > .059$ for all three years).

Biological analysis of the 2009 harvest revealed that the percentage of females in the catch increased during each month of the season until reaching 96.6% percent of the total harvested in March (Figure 5). Males comprised only 3.4%–27.4% of monthly landings. As the percentage of females in the catch increased, their mean weight also increased from a low of 1.47 kg to 1.58 kg per fish (Table 2). Using mean monthly weights and sex-ratios obtained from samples of the catch, we estimated the wholesale value of total landings in the 2009 anchored gill net fishery at $18,104 (Table 2).

Discussion

The results of this study provide the first published quantitative assessment of the anchored gill net shad fishery on the Altamaha River since 1993 (Michaels 1993). Unfortunately, the trend of American shad commercial landings from the Altamaha River has continued to decline. Although 194 river kilometers of the Altamaha are open to anchored gill net fishing, most catch and effort came from the reach between rkm 35–100. The spatial differential could be because of several reasons. The fishermen who

operated in the lower river were "true" commercial fishermen who sold their catch at market at least once a week, whereas the upper river fishermen often only fished for their own food. Also, because of consecutive drought years in Georgia, conditions in the lower river were often more suitable for anchored gill nets. No more than 35 anchored gill nets were observed in the river at any one time during any of the three seasons evaluated (Figure 3). Based on the spatial and temporal grouping of these nets, we estimated that <25 individual fishermen participated in the fishery in any given year. Commercial wholesalers who reported landings to GDNR typically do not indicate the type of gear they use, but in 2009 we calculated that 53% of total landings were from anchored gill nets.

Based on local traditions and knowledge regarding the timing of the shad run, many fishermen did not begin setting nets until after the first full moon in February. In all three years of the study, CPUE and total harvest were lowest in January, but increased two- to three-fold in February. Catch rates in March declined in two of the three years; however, the percentage of females in the catch steadily increased throughout the season in all years. Not surprisingly, market prices paid to commercial fishermen declined as catches increased (Table 2).

Widespread overfishing of American shad populations along the Atlantic coast has, at least in part, led to steady declines in commercial landings over the last century (Facey and Van Den Avyle 1986). Landings in the Altamaha River have been steadily decreasing since the 1960s and are currently at all-time lows (ASMFC 2007). Although the Altamaha River once supported one of the largest and most economically important fisheries in Georgia, our results show that the total landings from the anchored gill net portion of the fishery were valued at only $18,000 in 2009. In comparison to Georgia's shrimp fishery, which is worth millions of dollars annually, the Altamaha anchored gill net fishery is quite small. From a management perspective, the economic and social values of the fishery must be balanced by ecological concerns over the apparent coastwide declines in American shad populations. Further studies are needed, however, to better assess population dynamics and abundance trends in relation to total harvest, as well as the social and economic values of shad fisheries.

Acknowledgments

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