Striped Bass in Trout Waters of the Upper Chattahoochee River, Georgia: Can These Two Fisheries Coexist?

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Abstract: We used mark-recapture methods, diet analysis, and bioenergetics modeling to assess the threat adult striped bass posed to trout stocked in the upper Chattahoochee River, Georgia. An estimated 311 (95% CI = 159–1,166) striped bass inhabited the trout waters during the summer of 1998. Their diet was dominated (numerically) by crayfish (60%) and trout (15%). Striped bass in the Chattahoochee River preyed on stocked trout and are capable of consuming 7–28% of the trout stocked annually. Further, estimates of predatory demand suggest that the current and possibly growing striped bass population pose a threat to the stocked-trout fishery.

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Resource managers often implement stocking programs in newly created systems to provide additional fishing opportunities for anglers. In reservoirs, pelagic prey species often reach densities sufficient to support populations of piscivorous sportfish (Zaret 1979, Kohler et al. 1986). Therefore, prey biomass can be transferred to sportfish biomass, which then becomes available to anglers. Specifically, striped bass *(Morone saxatilis)* introduction into reservoirs has been a long-standing management practice because of their value as a large sportfish and potential for exerting biological control of pelagic forage fishes (Bailey 1975, Coutant 1985, Matthews 1985). Additionally, cool oxygenated hypolimnetic discharge from some dams provide sufficient habitat to support trout fisheries in warmwater systems. Striped bass and trout are not stocked in the same locations; therefore, they rarely conflict with

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each other. However, because striped bass are capable of surviving downstream passage over dam retainer gates during periods of high water and are capable of upriver migration, they have immigrated into new locations that already support a trout fishery (Deppert and Mense 1980, Walters et al. 1996). Striped bass may affect the local trout fishery by competition and predation. Although tailwaters where striped bass and trout overlap are uncommon, the few instances where this overlaps occur present formidable challenges to fishery managers.

Introduced populations of striped bass often are targeted for food-habit studies because of their potential effects on forage and game species (Combs 1978, Morris and Follis 1978, Deppert and Mense 1980, Filipek and Tommey 1984, Moore et al. 1985, Matthews et al. 1988). In reservoirs, striped bass feed mostly on clupeids (Stevens 1957, Gomez 1970, Van Den Avyle et al. 1983, Matthews et al. 1992). In contrast, less research has been conducted on populations of riverine striped bass. Generally, striped bass are not significant predators on game-fish in warmwater reservoirs and their tailwaters (Combs 1978, Axon and Whitehurst 1985). However, several studies have found that striped bass feed on salmonids where the 2 species overlap (Shapovalov 1936, Filipek and Tommey 1984, Axon and Whitehurst 1985, Matthews et al. 1988). Recently, more studies have focused on tailwater fisheries (Deppert and Mense 1980, Walters et al. 1996, Blackwell and Juanes 1998, Tucker et al. 1998). Current data from landlocked riverine populations are needed to allow inference regarding patterns of prey use by striped bass co-existing with stocked trout. For example, high trout mortality because of striped bass predation would reduce the number of trout available to anglers. This situation would be undesirable from a management

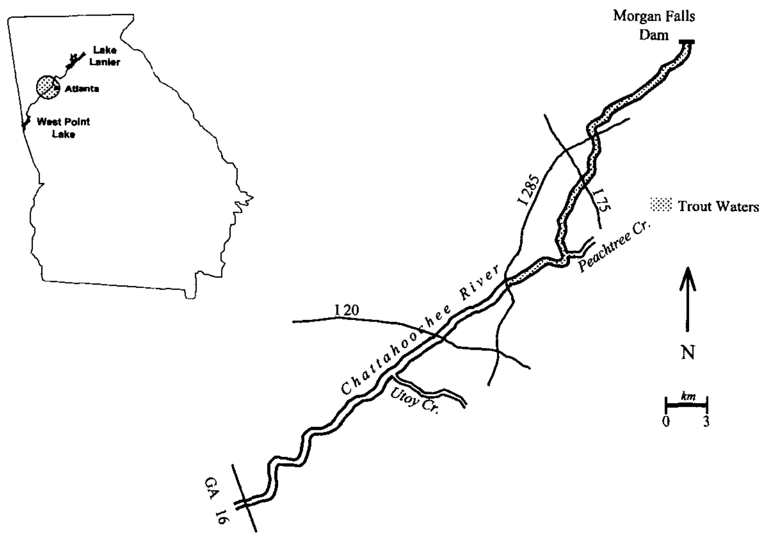

Figure 1. A map of the State of Georgia and the study reach of the upper Chattahoochee River below Morgan Falls Dam.

perspective because the goal of the trout stocking program would not be met. Furthermore, a low creel return of stocked trout may not be economically justifiable and may raise criticism about stocked trout becoming striped bass food.

The question of whether striped bass may be consuming the trout stocked into the upper Chattahoochee River has concerned state biologists and trout anglers. In 1990, about 25,000 fingerlings (0.4/ha) Gulf-race striped bass were stocked in West Point Lake, Georgia, by Georgia Department of Natural Resources (GDNR; Fig. 1); in 1992, an additional 176,400 fingerlings (2.8/ha) were stocked. Striped bass were assumed to fill the demand for a large sportfish and prey on the abundant forage fishes (e.g., shad). However, the absence of barriers above the lake enable striped bass to migrate upriver to the tailwaters of Morgan Falls Dam which has supported a state-sponsored trout fishery since 1960. Further, if striped bass establish a reproducing population, they eventually could reduce or eliminate the trout fishery through direct predation. Recently, there has been renewed interest in supplemental stocking of striped bass in West Point lake (L. Klein, pers. commun.). Therefore, information about the actual and potential tropic interactions between these species is essential for making effective management decisions about stocking striped bass. In this paper, we report the stomach contents of striped bass captured in the trout waters and assess their predation potential on the stocked trout fishery in the upper Chattahoochee River. Specific objectives were to estimate the abundance of striped bass in designated trout waters and to determine their summer food habits.

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Methods

Study Area

The upper Chattahoochee River refers to the reach of river from West Point Lake upriver to the headwaters. Most of the upper Chattahoochee River supports brown trout *(Salmo trutta),* rainbow trout (*Oncorhynchus mykiss),* and brook trout *(Salvelinus fontinalis).* The study site is influenced by 2 upriver impoundments. Buford dam, operated by the Army Corps of Engineers, forms lake Sidney Lanier. Morgan Falls Dam is located 57 river kilometers (rkm) downstream of Buford dam. Morgan Falls Dam has limited storage capacity and is a run-of-river hydropower facility operated by Georgia Power Company. Because of the hypolimnetic discharge from Buford Dam, both dam tailwaters have sufficient cool-water habitat to support a trout fishery.

The cool-water reach from Buford Dam downstream to the southernmost river crossing of U.S. Interstate 285 is designated by GDNR as trout waters (Fig. 1). Trout have been stocked in this reach of river by GDNR since 1960 (Biagi and Brown 1997).

The study reach of the river extended about 84 rkm from State Highway 16 (Alt. Hwy 27) bridge upstream to Morgan falls Dam (Fig. 1). Morgan Falls Dam represents the barrier at which point striped bass are incapable of further upriver movement. Sampling sites were located in areas where striped bass were found previously by state biologists and where the river was accessible. Also, these sites were near or within trout waters and represent the area where striped bass and stocked trout most likely would overlap (Fig. 1).

Fish Sampling

Adult striped bass were sampled bi-weekly from 16 June to 11 September 1998. Sampling was limited to daylight hours because access to several boat ramps was restricted, and low flows exposed shoal areas that made boat travel at night hazardous. Striped bass were collected with a boat-mounted electrofisher. Total length (mm) and weight (kg) were recorded at the time of capture for each striped bass. Water temperature was recorded during each sampling period.

Mark-and-recapture techniques were used to estimate the size of the striped bass population. Striped bass were marked with 2 serially-numbered Floy anchor tags inserted at the base of the second dorsal fin and released. A modified Schnabel model was used to estimate population size and 95% confidence intervals (Ricker 1975). One of 3 small (<600 mm TL) striped bass, not large enough to be from the early 1990s stockings, was aged by otolith ring count, and a tissue sample was collected for analysis of mitochondrial DNA to indicate genotype (Wirgin et al. 1991).

Immediately after capture, acrylic tubes were used to remove stomach contents (Van Den Avyle and Roussel 1980, Cailteux et al. 1990). Stomach contents were preserved in formalin and food items were counted, weighed, and identified to the lowest taxonomic level possible. Prey items were quantified 3 ways: frequency of occurrence, numerical abundance, and wet weight composition. Frequency of occurrence was the number of stomachs that contained a prey item. Numerical abundance was the total number of a prey type found in stomachs. Wet weight composition was the total wet weight (g) of a food item found in all stomachs. These categories also were expressed as percentages to indicate the proportional importance of each prey type in the striped bass's diet (Hyslop 1980).

An estimate of the potential threat that striped bass pose to the trout fishery was based on present wet weight of trout in the diet and maximum predatory demand of striped bass. The maximum daily consumption (C_{max}) model was chosen for this purpose. This bioenergetics model estimates the maximum amount that a fish can consume under ideal conditions (Adams and Breck 1990, Ney 1990). Hartmann and Brandt (1995*a*) incorporated adult striped bass in their determination of C_{max}, which best represented the age structure of the population in the Chattahoochee River. Therefore, their model was used to assess C_{max} of adult striped bass in the upper Chattahoochee River. Predatory demand was predicted by the laboratory-derived maximum daily consumption model:

$$C_{max} = CA \bullet W^{CB},$$

where CA (0.302) and CB (-0.252) are species-specific constants and W is wet weight (g) of striped bass. The C_{max} value predicts weight-specific maximum consumption rate by fish fed *ad libitum* at their optimum temperatures range (20–25 C; Hartman and Brandt 1995*a*). From this model, we calculated consumption rates based on several ration levels expressed as a percentage (25, 50, 75, 100) of C_{max} (Chipps et al. 2000). These ration levels should represent the Chattahoochee River population because wild striped bass generally feed at 40%–60% of C_{max} (Hartman and Brandt 1995*b*). Consumption rates were calculated per day and for the summer of 1998 (84 days). These estimates were multiplied by percent wet weight of prey comprising trout and by the population size (point estimate) to predict total weight and number of trout that an averaged-sized (mean weight) striped bass could potentially eat during a day or during the summer (Rieman et al. 1991, Fayram and Sibley 2000). The number of trout consumed was derived by dividing the total grams consumed by 9 g, which was the average weight of trout fingerlings stocked by GDNR. These estimates assess the potential threat striped bass pose on the stocked trout fishery when 2 species co-occur in the upper Chattahoochee River.

Results

Striped bass were sampled during the summer while they were in the Chattahoochee River. River water temperatures at sampling locations ranged from 13.7 to 24.3 C. Sixty-seven striped bass (534–1,066 mm TL) were examined during the summer. Their weights ranged from 1.7 to 11.6 kg with a mean of 8.2kg (SD =2.1; Fig. 2).

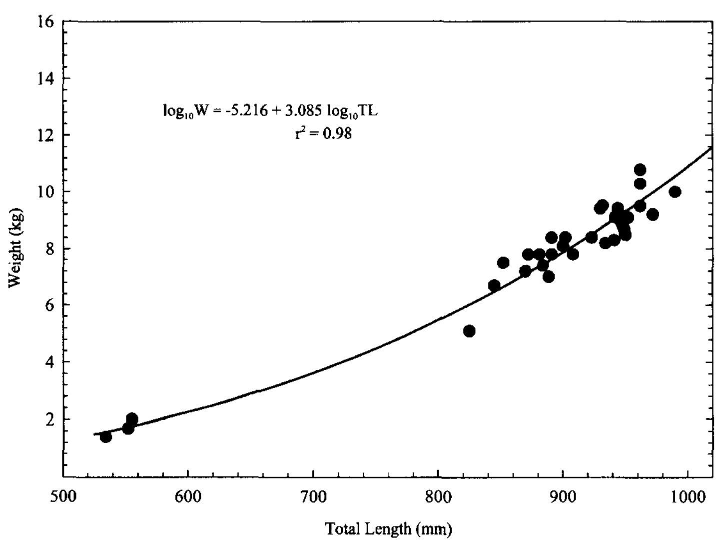

Figure 2. Length and weight of adult striped bass sampled from the upper Chattahoochee River between I-285 and Morgan Falls Dam, Georgia, during the summer (Jun–Sep) of 1998.

Table 1. Contents of non-empty stomachs of 27 adult striped bass sampled from the upper Chattahoochee River during summer (Jun–Sept) 1998.

	Occurrence		Composition			
Food item	%	Frequency	%	Numerical	%	Wet Weight (g)
Crayfish	60	16	56	23	21	286.3
Salmonids	15	4	15	6	4	52.1
Catostomids	7	2	5	2	71	965.5
Lepomis sp.	4	1	2	1	1	13.6
Unidentified fishes	19	5	22	9	3	43.3

Sixty-two striped bass were marked; 5 of these were recaptured. Three striped bass were not large enough to be from the 1990 or 1992 stockings (Fig. 2). At the time of capture, these 3 striped bass probably were age 2. An estimated 311 individuals (95% CI = 159–1,166) were in the trout waters of the Chattahoochee River during summer 1998.

The stomachs of 67 striped bass were examined for prey items, 27 (40%) of which contained prey. Prey items included crayfish, salmonids (trout), catostomids (suckers), *Lepomis* sp., and unidentified fish remains. To be conservative, fish were classified as identifiable only if definite structures from undigested remains were available to confirm identification. The total wet weight of prey collected from the stomachs was 1,360.8 g. Crayfish were the most abundant prey type, and trout were the most abundant identifiable fish in the diet of striped bass by frequency of occurrence and numerical abundance. Two catostomids weighed a combined 965.5 g (71%) and were the most abundant prey type by wet weight (Table 1).

Maximum consumption for a mean weight striped bass (8,200 g) was 0.031 g/g/day, which yielded a maximum consumption rate for an average striped bass of 254.2 g/day. Based on 4% (wet weight composition) of trout in their diet, an average-sized Chattahoochee River striped bass could eat about 9.7 g/day of trout. Therefore,

Table 2. Diet summary of a striped bass in the upper Chattahoochee River, Georgia, predicted by bioenergetics modeling. The daily (g) and summer (84 days; kg) consumption rates are based on a population size of 311 (95% CI = 159–1,166) individuals at their mean weight (8,200 g) feeding at 25%, 50%, 75%, and 100% of their maximum consumption rate (C_{max}). Rate of trout consumed is based on 4% wet weight composition in their diet. Number of trout consumed is based on the mean weight of stocked trout (9 g).

	Day			Summer		
Maximum consumption (% C_{max})	Total prey (g)	Trout (g)	Number of trout	Total prey (kg)	Trout (kg)	Number of trout
25	19,764	754	84	1,660	63	7,039
50	39,528	1,508	168	3,320	127	14,078
75	59,292	2,263	251	4,981	190	21,117
100	79,056	3,017	335	6,641	253	28,156

the predicted number of fingerling-sized trout 311 striped bass could consume ranged from 84 to 335 a day or 7,039 to 28,156 during a summer depending on which ration level they are feeding (Table 2).

Discussion

Thermal stress is the most frequently cited management problem of adult striped bass (Axon and Whitehurst 1985). The relatively cool waters of the upper Chattahoochee River may be the primary reason striped bass migrate there, prey on the stocked trout, and cause a potential management conflict for GDNR. Distribution of adult striped bass (>5kg) during summer often is limited by suitable cool-water temperatures. They prefer water temperatures between 18–25 C (Coutant 1985). When this requirement is not met, striped bass feed less, are more vulnerable to disease, and have lower reproductive success (Coutant 1985, 1987; Matthews 1985). The presence of striped bass in the Chattahoochee River below Morgan Falls Dam during summer may indicate that West Point Lake does not have sufficient cool-water refuge for adult striped bass. Striped bass movement into the river for water temperatures similar to that occupied by trout makes habitat overlap likely in the tailwaters of Morgan Falls Dam.

Crayfish and stocked trout were the principal food items found in the stomachs of adult striped bass in the Chattahoochee River during the summer of 1998. Crayfish composed most of the striped bass diet (Table 1). Because crayfish have exoskeletons that are resistant to digestion, their slower digestion rates could have overemphasized the importance of crayfish in the striped bass diet (Hyslop 1980). Previous studies have reported crayfish to be of only minor importance in the food habits of adult striped bass (Combs 1978, Moore et al. 1985). For example, Filipek and Tommey (1984) found that only during the late summer did crayfish become of minor importance when striped bass were seeking thermal refuge in the Arkansas River. Striped bass in the Chattahoochee River seem to depend heavily on crayfish as a summertime food source.

In the present study, similar results for frequency of occurrence and numerical abundance of crayfish suggests that many striped bass, not just a few individuals, were preying on crayfish (Table 1). Several studies have determined that striped bass will switch to invertebrates when forage fishes are lacking (Stevens 1957, Matthews et al. 1988, Walters et al. 1996). Additionally, Timmons et al. (1981) found that Chattahoochee River largemouth bass *(Micropterus salmoides)* fed primarily on crayfish before the impoundment of West Point Lake. Therefore, the abundance of crayfish in both largemouth bass and striped bass diets may reflect a relatively high abundance of crayfish in the Chattahoochee River or a relatively low abundance of forage fishes.

Although trout were not the most important prey, stocked trout were the most important identifiable fish in the diet of striped bass by frequency of occurrence (15%) and numerical abundance (15%). However, weight composition (Table 1) indicated trout (4%) were less important than catostomids (71%). This result could be biased because one catostomid weighed 883 g, which was 65% of the total biomass, and probably overemphasized the importance of suckers as food. Also, because few stomachs contained trout, further quantification of stomach content is needed to determine how accurate 4% represents trout consumed by the population.

Forty percent of the adult striped bass sampled from the upper Chattahoochee River contained prey. Some of the empty stomachs may be attributed to regurgitation during sampling. However, this was not observed during the study. Also, capture of striped bass was conducted during daylight hours. Therefore, food that was consumed during the previous night may have already passed through the stomach before sampling occurred.

Striped bass are capable of reducing the number of stocked-trout in the Chattahoochee River. About 50,000 trout fingerlings for the put-grow-take fishery are stocked twice annually (usually in July and December). The estimated striped bass population of 311 individuals could, assuming trout are 4% of their diet and they are feeding at 50% of C_{max}, potentially consume 14,078 (14%) fingerlings stocked annually in the river (Table 2). Striped bass in other areas have preyed on stocked trout in sufficient numbers to reduce the population (Deppert and Mense 1980, Walters et al. 1996). For example, large striped bass depleted the trout population after seasonal stocking ceased below Hoover Dam, on the Colorado River (Walters et al. 1996). However, during the present study, striped bass had not eliminated stocked trout because trout were observed in the river on most sampling occasions.

If striped bass are capable of natural reproduction in the Chattahoochee River, a self-sustaining population would increase greatly their threat on the trout population in the Chattahoochee River. Three of the striped bass sampled during our study were younger that the fish originally stocked in the early 1990s (Fig. 2). These younger fish probably represent successful recruitment of striped bass that were spawned in 1996. An analysis of mitochondrial DNA from one of these striped bass indicated that the genotype was the same as the previously stocked fish (I. Wirgin, pers. commun.). Successful recruitment of striped bass probably would increase their predation pressure on the trout fishery. In that case, an increase in trout stocking rates or removal of striped bass might be necessary for both fisheries to co-exist in the Chattahoochee River.

The current trout stocking program should be evaluated to address the potential and possible growing threat posed by striped bass. The evaluation should consider the feasibility of some of the following stocking alternatives (Axon 1975, Walters et al. 1996). Stocking trout more frequently may help reduce the predation threat posed by striped bass. More frequent stockings may provide more trout available to anglers, but may also concentrate predators. Also, stocking larger trout may reduce predation because the larger trout may be more successful at avoiding striped bass. However, these alternatives may not be economically feasible (Walters et al. 1996). Similarly, because large striped bass usually are confined in the river predominately during the summer, stocking trout in winter and early spring may limit predation. Trout stocked in the winter may have a better chance of evading predation than trout stocked when striped bass have already migrated into the river. Implementation of a combination of these recommendations may be necessary to balance the trout fishery and a self-sustaining striped bass fishery. However, if a balance is not feasible, stocking trout above Morgan Falls Dam and leaving the tailwater habitat to the striped bass fishery may be an option.

In conclusion, adult striped bass in the upper Chattahoochee River during the summer fed predominantly on crayfish, but also preyed on stocked trout. The current striped bass population threatens the availability of trout for anglers. Furthermore, this threat will increase greatly if striped bass are capable of reproducing in the river, as was indicated by this research. Finally, the striped bass reproductive status should be investigated to assess the threat a growing populations would pose to the upper Chattahoochee River trout fishery below Morgan Falls Dam.

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