

# IMPORTANCE OF GROUNDWATER INFLOWS FOR MAINTENANCE OF STRIPED BASS HABITAT IN THE FLINT RIVER AND LAKE SEMINOLE

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**ABSTRACT:** Adult striped bass are heavily dependent on habitats influenced by the inflows of cool water from groundwater sources in the Flint River between Albany, Georgia, and Lake Seminole. Fish tracked with radio transmitters in 1984-85 moved into isolated spring-fed areas during May, when ambient river temperatures reached 24° C, and remained in these areas until October or early November, when the river cooled to 20° C. The duration of habitation of the spring-fed areas averaged 160 days per year (range 137-182), illustrating the vulnerability of the species to habitat changes that would occur if groundwater inflows were reduced or eliminated. Knowledge of the distribution of spring-fed areas that serve as important striped bass habitat provides a basis for linking fisheries concerns with other groundwater demands in this part of Georgia.

## INTRODUCTION

The striped bass (*Morone saxatilis*), which is best-known as an anadromous species that historically supported important commercial and recreational fisheries along the Atlantic coast of the U.S., also is native in Gulf of Mexico coastal rivers from the Florida panhandle to Louisiana. Gulf coastal stocks were primarily riverine, and habitat alterations have eliminated populations from most of the original range except the Apalachicola-Flint-Chattahoochee (AFC) River system, where a remnant population still persists.

Studies in reservoirs and Atlantic coastal river systems have shown that summer distribution and habitat use by adult striped bass are strongly influenced by water temperature (Coutant, 1985). During summer, individual striped bass larger than about 5 kg in weight typically select habitats having temperatures of 18-22°C and dissolved oxygen concentrations greater than 3 mg/l when surrounding waters are either warmer or have less oxygen. Preference for these cool-water areas, termed thermal refuges, can lead to overcrowding of fish when the volume of water having suitable conditions is limited, leading to impaired growth and increased vulnerability to diseases or overfishing (e.g., Coutant, 1978; Lewis, *et al.*, 1979).

Thermal refuges in river-reservoir systems are sometimes created by inflows from cold tributary streams, releases from upstream impoundments, groundwater sources, or oxygenated hypolimnetic areas of stratified waters (Cheek, *et al.*, 1985).

Wooley and Crateau (1983) concluded that native Gulf coast striped bass in the AFC system had better physical condition, greater longevity, and less weight loss in summer than did introduced Atlantic coast fish, presumably because Gulf fish were better adapted to warmer temperatures found in Gulf coastal rivers. To test this possibility, radio-telemetry techniques were used to evaluate temperature preferences of striped bass in the Flint River-Lake Seminole portion of the AFC system (Van Den Avyle and Evans, submitted). This work indicated that striped bass native to the AFC system had temperature preferences essentially identical to those reported elsewhere, revealing the significance of thermal refuges to the maintenance of the striped bass population in this system. In this paper, I will present an overview of seasonal distribution patterns observed for striped bass in the Flint River and Lake Seminole, demonstrate the importance of groundwater inflows as thermal refuges, and identify the need for considering fisheries habitat values in the allocation of groundwater resources in this area.

## METHODS

This study was conducted primarily on a 166-km reach of the Flint River extending from Jim Woodruff Lock and Dam, at Chattahoochee, Florida, upstream to a Georgia Power Company dam at Albany, Georgia (Figure 1). Locking operations at Jim Woodruff Dam allow passage of some adult striped bass (Wooley and Crateau, 1983), but the effects of the structure on spawning migrations and dispersal of juveniles in the system are poorly understood. Lake Seminole extends up the Flint River arm toward Albany about 46 km; the remaining unimpounded segment of the Flint River extends an additional 120 km upstream to Albany Dam, which blocks further movement by striped bass.

Temperature preferences and distribution patterns of striped bass were evaluated by surgically implanting temperature-indicating radio transmitters in adult fish and comparing the water temperatures where fish occurred with ambient conditions. Twenty-six fish were collected, tagged, and released primarily in March-May of 1984 and 1985 within a 13-km reach of the Flint River below Albany Dam. The size of the fish studied ranged from 63 to 113 cm total length (average, 92 cm) and 3.2 to 30.0 kg (average, 14.1 kg) in weight. Efforts to locate and obtain temperature data for tagged fish included tracking by boat, truck, and airplane from March 1984 through November 1985. When a telemetered fish was located, its temperature was estimated from the transmitter's signal, and temperature and dissolved oxygen concentrations were measured in an area near the fish's location. Further details regarding study methods were reported by Van Den Avyle and Evans (submitted).

#### RESULTS

Seventeen striped bass were relocated a sufficient number of times (4 to 98 days) to provide data useful for evaluating distribution and temperature selection. The remaining nine fish either died soon after release or shed their transmitters, providing no behavioral information.

During March and April, most telemetered fish were in the upper reaches of the Flint River near Albany dam, but some were found at the headwaters of Lake Seminole on the Flint River, and one was located below Andrews Lock and Dam on the Chattahoochee River (Figure 1). The upriver distribution of fish in the Flint River coincided with areas that Keefer (1986) reported as spawning sites for striped bass. When surface waters warmed in May, all fish moved to areas influenced by the discharge of 19-20°C water from five springs: three in the Flint River (at river km 138, 157, and 159), one in Lake Seminole (near Flint River km 8), and one where the Flint River entered Lake Seminole (river km 42). In the 13 cases for which movements into spring-fed areas could be adequately pinpointed, the ambient water temperature was  $24.2 \pm 0.3^\circ\text{C}$  ( $\bar{X} \pm \text{SD}$ ). Spring-fed areas served as thermal refuges and accounted for 96% of the locations determined for striped bass during summer. Temperatures selected by fish at this time averaged  $21.6 \pm 1.1^\circ\text{C}$  ( $N = 561$  locations) whereas ambient Flint River and Lake Seminole temperatures were 25-31°C. Striped bass were found almost exclusively in spring-fed habitats through October. The average ambient temperature when fish moved out of springs was  $20.1 \pm 2.4^\circ\text{C}$  ( $N=18$  fish). From November through February, the fish once again were widely distributed along the Flint River and in Lake Seminole (Figure 1).

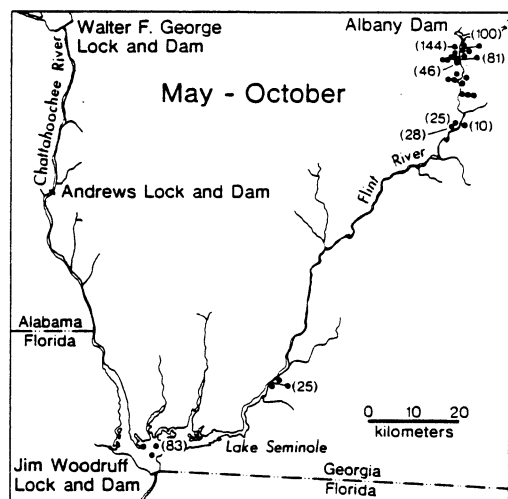
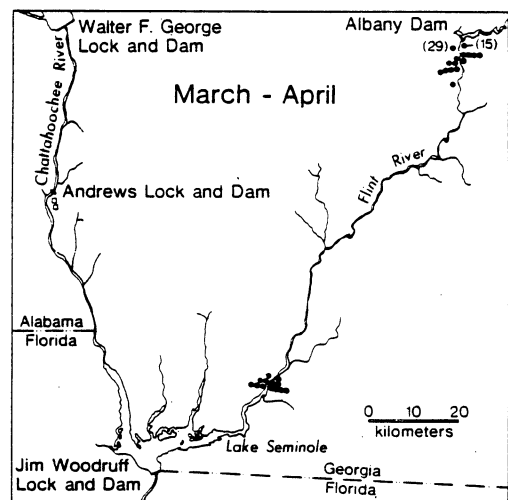
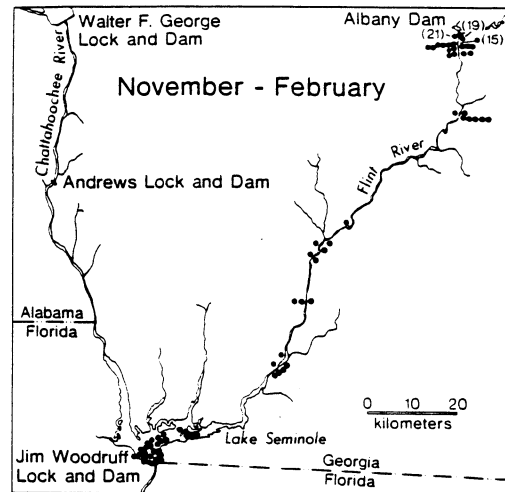


FIGURE 1. LOCATIONS OF DAILY INTERCEPTIONS OF STRIPED BASS IN THE AFC SYSTEM, 1984-85. NUMBERS IN PARENTHESES INDICATE MULTIPLE OBSERVATIONS.

## CONCLUSIONS AND RECOMMENDATIONS

Seasonal distribution patterns observed for striped bass in this river-reservoir system support the earlier conclusions of Wooley and Crateau (1983) regarding the riverine behavior of striped bass in the Apalachicola River downstream from Jim Woodruff Lock and Dam. Fish they tagged also tended to move into springs along the river and remain there through the summer. The year-round reliance on riverine habitats and seasonal movement patterns of striped bass in the Flint River-Lake Seminole system are also similar to those described for striped bass in rivers along the Atlantic coast of South Carolina (Scruggs, 1957), Georgia (Dudley, *et al.*, 1977), and Florida (McLane, 1958).

Other investigators have expressed the importance of conserving areas that provide cool, oxygenated waters preferred by striped bass during summer (Cheek, *et al.*, 1985; Coutant, 1985; Moss, 1985). Springs along the Flint River represent critical habitats that should be protected. Of 723 daily locations determined for striped bass in this study, 571 (79%) were made for fish in spring-fed areas. The importance of the springs is further illustrated by the length of time that fish were known to inhabit them during summer. In 1984, seven fish spent an average of 153 days (range, 137-182) in thermal refuges, and in 1985, the average for six fish was 167 days (range, 152-176).

Numerous springs in addition to those frequented by the striped bass we tracked exist along the Flint River between Albany Dam and Jim Woodruff Lock and Dam. Further research is needed to identify the relative importance of these sites as fish habitat. Groundwater in this part of Georgia is used extensively for agricultural, industrial, and municipal purposes (Hayes, *et al.*, 1983). The influences of water withdrawals on flows from springs that are critical habitats for striped bass should be considered by regional developers and planners. To properly regulate development, managers need further information on the numbers and locations of spring-fed areas, the potential value of each to striped bass, and the degree of vulnerability to groundwater withdrawals. This would include knowing which aquifers supply important springs, present and projected demands for water from these aquifers, and relationships among groundwater withdrawals, water levels, and spring flows.

Protection of striped bass habitat in the Flint River is important because this system supports the last remnant population of the once wide-spread native Gulf coast striped bass (Wiringin, *et al.*, in press). Furthermore, the river has the potential to provide a very significant recreational fishery for large striped bass (14 of 26 striped bass collected exceeded 15 kg in weight). The importance of groundwater inflows to other fish species and to the augmentation of

flows in the Flint River during periods of drought also needs to be determined.

## ACKNOWLEDGMENTS

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