Competitive Interactions Between Striped Bass and Other Freshwater Predators

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The goal of this study was to assess if predation by striped bass on game fishes, forage fishes, or both are limiting populations of game fishes in Norris and Watts Bar reservoirs. Specific objectives were (1) to identify the extent and effect of predation by striped bass on gamefish populations, (2) evaluate the potential for competition for prey resources among gamefish populations in the reservoirs, and (3) compare extent of competitive interactions between these two reservoirs that have different productivity levels. The study lasted from 1 October, 1996, through 30 September, 1998. Early in the study (February 1997) we identified complications that invalidated comparison of competitive interactions between the reservoirs. Thus, after consultation with TWRA, Watts Bar Reservoir was excluded from study, sampling escalated at Norris Reservoir, and objective 3 was voided. Consequently, most of the information reported herein pertains to Norris Reservoir, although summaries of data collected during the five-month sampling period at Watts Bar Reservoir are provided.

At Norris Reservoir during 1 October, 1996, and 30 September, 1997, we collected 1,136 striped bass (279-1,105 mm TL), 92 smallmouth bass (109-515 mm), 168 spotted bass (114-348 mm), 592 largemouth bass (95-592 mm), 237 black crappie (146-356 mm), 1,573 walleye (255-681 mm), 109 sauger (266-522 mm), 106 channel catfish (159-763 mm), and 34 flathead catfish (405- 875 mm). At Watts Bar Reservoir during 1 October, 1996 and 28 February, 1997 we collected 93 striped bass (194-960 mm), 80 hybrid striped bass (417-790 mm), 52 smallmouth bass (115- 549 mm TL), 76 largemouth bass (127-572 mm), 60 white crappie (220-390 mm), 367 sauger (247-508 mm), and 6 walleye (313 to 654 mm).

Striped Bass Predation of Game Fishes:

The first objective was to estimate the total consumption of game fishes by striped bass over a 1-year period using a bioenergetics model, and to determine whether this level of consumption resulted in gamefish biomass reductions greater than those acceptable to resource users. The net influence of predation on a population is equal to the amount consumed less what would have been lost to other sources of mortality (i.e., compensatory mortality responses). Therefore, to properly evaluate the significance of predation, estimates of gamefish removal by stripped bass were coupled with analyses of compensatory mortalities of the game fishes. The potential for the population to display a compensatory response is a function of their mortality-density relationship. If natural mortality is density-dependent and increases with density for a gamefish species, then their consumption by striped bass may have been mitigated. In other words, because of striped bass predation, other sources of mortality (e.g., cannibalism, consumption by other predators, starvation, disease), may be reduced resulting in no net change or even an increase in population size. Because predation on game fishes may vary annually, and our 1-year sampling period could not capture is variability, we simulated various levels of predation by striped bass and their effect on game fish density by modeling increases in the percentage of game fishes in striped bass diet.

The only game fishes consumed by striped bass were lepomids, ranging in total length from 53 to 203 mm. Overall, consumption of lepomids was relatively low, accounting for 4% (34.334 kg) of the 899,274 kg consumed, and 6% of the total biomass of lepomids in the reservoir. Although lepomids were eaten by striped bass and several other predators, black basses were eaten only by other black basses. By weight, black basses represented 9% of the diet of largemouth bass, 3% for smallmouth bass, and 14% for spotted bass.

Mortality-density relationships for the species considered were compensatory, indicating that decreased population abundance leads to increased survival. Given this relation, observed predation by striped bass on lepomids was not found to be harmful to the lepomid populations. Correspondingly, modeling predicted that if striped bass consumption of game fishes were to increase, black basses would have to make up 4-9% of the striped bass diet, and black crappie nearly 25%, before harmful effects would occur.

Potential for Competition:

Our second objective was to evaluate the potential for competition for prey among selected predators in Norris Reservoir. Competition is difficult to measure, and likely varies seasonally and annually depending on availability of food resources and changes in habitat utilization. Thus, our approach aimed at evaluating whether the conditions for intense competition existed, rather than actually measuring the extent of competition.

Two species may be able to share an abundant food resource without competing, but competition occurs only when the shared resource is in short supply. Therefore, in this second objective we estimated (1) diet overlap to assess if the prey supply was being shared, and (2) prey supply to assess if it was limiting. Substantial overlap would not confirm the presence of competition, but only the possibility for existence; however, finding no or limited overlap would indicate that substantial competition was unlikely. A supply-demand analysis was conducted to assess if forage deficiencies existed. By comparing supply versus demand, a ratio was developed to evaluate food resource sufficiency.

Collectively, the targeted predator populations in Norris Reservoir consumed an estimated 5.6 million kg of prey. On an annual basis, total consumption and clupeid consumption for all examined predator populations combined averaged 403 and 290 kg/ha, respectively. The majority of prey consumed (72%) consisted of clupeids. Of the clupeids identified to the genus level, 77% were Dorosoma spp. and 23% alewife.

The striped bass population consumed nearly 0.9 million kg of prey annually; 95% of the prey consumed were clupeids. Consumption by striped bass accounting for 16 and 21% of the total prey and total clupeids consumed by the targeted predator populations, respectively. Of the clupeids identified to the genus level, 67% were Dorosoma spp. and 33% alewife.

Diet overlap between striped bass and other species ranged from 0.04 to 0.99 (0 = no overlap, 1 = full overlap), and varied seasonally. Significant overlap occurred with all species, but not in all seasons. These results indicated that exploitative competition between stripped bass and coexisting game fishes is plausible if the prey-supply-to-predator-demand ratio is low.

Clupeid biomass available to predators averaged 558 kg/ha and annual production 687 kg/ha. For a total annual supply of 1,245 kg/ha. Most of the clupeid supply (86%) was centered on fish ages

0 and 1. Biomass of lepomids averaged 36 kg/ha and production 34 kg/ha, for a total annual supply of 70 kg/ha. Total prey supply (clupeids + lepomids) averaged 1,315 kg/ha.

Collectively, the targeted predator populations in Norris Reservoir consumed a total of 290 kg/ha of clupeids and 32 kg/ha of lepomids. Of the total demand for clupeids, black crappie accounted for 31%, striped bass 21%, walleye 18%, smallmouth bass 15%, largemouth bass 12%, spotted bass 3%, and sauger 1%. Age 0 clupeids represented 92% of the total demand for clupeids and 83% of the total prey demand. Of the total demand for lepomids, largemouth bass accounted for 39%, smallmouth bass 27%, walleye 15%, spotted bass 11%, striped bass 7%, and sauger 1%.

The supply-demand ratio averaged 3.5. Given simulated fluctuations in both supply and demand from 0.25 to 2 times that of the mean, supply-demand ratios ranged from 0.44 to 28.2. Supply-demand ratios less than 1, and probably less than 2, are unsustainable and perhaps uncommon, although not unlikely. It is difficult to associate a supply-demand ratio to competition without additional information on the minimum ratio necessary to sustain predator demand, but given the potential range of supply-demand ratios, it is likely that the level of competition for prey among game fishes in Norris Reservoirs varies annually and can become intense in some years.

We predicted that supply-demand ratios would increase by as much as 25% if striped bass were removed and stocking was discontinued. Such removal would increase prey supply by an estimated average 64 kg/ha. This surplus would increase biomass of native game fishes by as much as 13 kg/ha, or about 20%, if foraging efficiency of native predators is 1.0 (i.e., all prey eaten by striped bass can be captured by other game fishes). Nevertheless, foraging efficiency is likely to be less than 100%; thus, smaller increases should be expected. Our best guess, based on a 25% foraging efficiency in Norris Reservoir, is that biomass of other game fishes would increase by an average 5-10% if striped bass are removed.