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EXTENDED ABSTRACT

A Bioenergetic Evaluation of the Chronic-Stress Hypothesis: Can Catch-and-Release Fishing Constrain Striped Bass Growth?

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Although many studies have examined the effect of stress (i.e., catch-and-release fishing or exhaustive swimming) on fish, most have addressed either physiological disturbances or posthooking mortality. To our knowledge, only three studies have tested for indirect or sub-lethal effects of catch-and-release fishing: Kieffer et al. (1995) demonstrated that smallmouth bass *Micropterus dolomieu* offspring suffered considerable predation when adult males were angled from their nest sites and subsequently released; Clapp and Clark (1989) found that hooked-and-released smallmouth bass grew less than unhooked fish; and Diodati and Richards (1996) found that hooked-and-released striped bass *Morone saxatilis* had decreased condition factor compared with unhooked fish. For catch-and-release management strategies to succeed, hooking mortality should be minimal, and sub-lethal effects should not become magnified at the population level. Sub-lethal effects can include slower growth rates, decreased fecundity, or any type of resultant behavior that decreases fitness.

Age-9 through age-12 striped bass caught in the Massachusetts' commercial fishery have decreased in both mass at age and length at age, since the early 1980s (Stockwell and Diodati, unpublished data). When compared with stock

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abundance estimates, these data appear to indicate density-dependent growth (Stockwell and Diodati, unpublished data). However, other factors may contribute to the observed decreases, including stress from catch-and-release fishing.

The Massachusetts' recreational fishery was estimated to have caught and released more than 7 million striped bass in 1998, out of more than 15 million striped bass caught and released coastwide (National Marine Fisheries Service, Fisheries Statistics and Economics Division, personal communication). Total stock abundance of age-1+ striped bass coastwide was estimated at 35.8 million fish in 1998 (ASMFC 2000). The proportion of the coastwide population that resides in Massachusetts waters during the fishing season (May–October) is not known, but seven million fish probably represent a large proportion of the locally-available striped bass. Coupled with the potential for hook-and-release fishing to reduce striped bass growth (Diodati and Richards 1996), these observations suggest that the chronic-stress hypothesis is plausible. If catch-and-release fishing does pose a serious health risk to striped bass stocks, then understanding the potential scope of its effect is necessary to better identify appropriate management strategies that account for this phenomenon.

We evaluated the potential effects of catch-and-release fishing on seasonal growth estimates of striped bass, using the bioenergetics model for striped bass developed by Hartman and Brandt (1995). All simulations were run using Fish Bioenergetics 3.0 (Hanson et al. 1997). We ran baseline simulations from 15 May to 15 October for a 1,600-g fish (about 550-mm total length), given a food-limited (growth = 12.5% of body mass) and a food-unlimited (growth = 50% of body mass) environment. We then ran simulations, where the fish was caught and released one to three times, with a one to three day period of lost feeding opportunities after each hooking event.

Our results indicate that under food-limited conditions, a striped bass can have a 13–30% decrease in seasonal growth when caught and released two or more times with at least two days of no feeding following each hooking event (Figure 1). When food-unlimited conditions existed, three catch-and-release events with three days of no feeding resulted in only a 14% decrease in growth. These results are likely conservative, as we did not include energetic costs of the actual fight or its duration, or mechanical injury to body parts (e.g., jaw and eyes). We did not find any substantial differences in decreased growth when timing of catch-and-release events was varied. However, seasonal changes in predator diet or energy densities of predator and prey, coupled with seasonal water temperature fluctuations, could drastically change this result. Timing of hook-and-release events may be a critical issue, if striped bass rely on a specific time period for a majority of their seasonal growth (e.g., late season abundance of juvenile prey fishes).

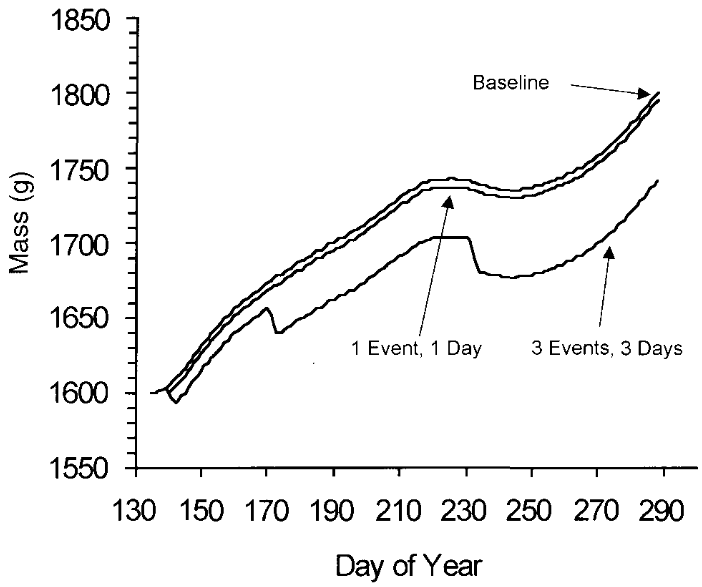

Figure 1. Growth trajectories of a 1,600-g striped bass growing 12.5% of its body weight, with no hook-and-release event (Baseline); one catch-and-release event with a one-day, no-feeding effect (1 event, 1 day); and three catch-and-release events with a three day, no-feeding effect (3 events, 3 days). Simulations were run from 15 May to 15 October.

Our simple modeling exercise indicates that catch-and-release fishing can have serious sub-lethal consequences on individual fish when food is limited. Combined with the magnitude of the catch-and-release fishery in Massachusetts and the observed declines in size at age, our modeling suggests catch-and-release fishing may be a significant contributor to declines in the overall health of striped bass stocks along the Atlantic Coast.

References

ASMFC (Atlantic States Marine Fisheries Commission). 2000. Status of the Atlantic striped bass. 1999. ASMFC, Striped Bass Technical Committee Report, Washington, D.C.

Clapp, D. F., and R. D. Clark, Jr. 1989. Hooking mortality of smallmouth bass caught on live minnows and artificial spinners. North American Journal of Fisheries Management 9:81–85.

Diodati, P. J., and R. A. Richards. 1996. Mortality of striped bass hooked and released in salt water. Transactions of the American Fisheries Society 125:300–307.

Hanson, P. C., T. B. Johnson, D. E. Schindler, and J. F. Kitchell. 1997. Fish Bioenergetics 3.0. University of Wisconsin, Sea Grant Institute, Madison, Wisconsin.

Hartman, K. J., and S. B. Brandt. 1995. Comparative energetics and the development of bioenergetics models for sympatric estuarine piscivores. Canadian Journal of Fisheries and Aquatic Sciences 52:1647–1666.

Kieffer, J. D., M. R. Kubacki, F. J. S. Phelan, D. P. Philipp, and B. L. Tufts. 1995. Effects of catch-and-release angling on nesting male smallmouth bass. Transactions of the American Fisheries Society 124:70–76.