Feature Article

Post-Stocking Mortality and Diet Composition of Hatchery Produced Advanced-Fingerling Largemouth Bass Stocked into Lake Seminole, Pinellas County, Florida

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Introduction

Supplemental stocking of largemouth bass *Micropterus salmoides* fingerlings with the intention of augmenting natural recruitment is a popular management tool (Boxrucker 1986). The size of fish at the time of stocking can affect the success of a supplemental stocking program (Olsen et al. 2000; Porak et al. 2002; Calvin et al. 2008; Mesing et al. 2008). Stocking advanced size largemouth bass (> 80 mm TL) may increase percent contribution (Mesing et al. 2008) and survival (Buynak and Mitchell 1999), and it is suggested that larger fish have greater prey availability and are less vulnerable to predation than smaller fish (Loska 1982; Wahl et al. 1995). Thus, the Florida Fish and Wildlife Conservation Commission (FWC) recently retooled their freshwater fisheries hatchery at Richloam, Florida to focus on the production of advanced-fingerling Florida largemouth bass *Micropterus salmoides floridanus*. Results from previous stockings in Florida using advanced size largemouth bass have been inconsistent yielding varying degrees of success (Porak et al. 2002; Mesing et al. 2008). Factors potentially affecting mortality of stocked largemouth bass included handling and stocking stressors, elevated water temperatures (> 25 ^{0}C) at time of stocking, vitamin C deficiencies and liver disease from being pellet reared, difficulty transitioning to natural prey, and angling mortality (Porak and Bonvechio 2007). FWC fisheries biologists have been challenged with developing an effective stocking program utilizing advanced-fingerling largemouth bass.

Hatchery-reared fish stocked in the wild must go through a critical period where the highest rate of mortality occurs (Diana 1995), which is generally directly following release (Brown and Laland 2001). These fish must develop feeding and anti-predator behaviors that are often not learned in the hatchery (Heggberget et al. 1992). Additional challenges occur when piscivorous fish species reared on pellet feed have to transition to natural prey (Larscheid et al. 1999; Olson et al. 2000; Porak et al. 2002). Reduced feeding may result in stress, which can lead to mortality via starvation or predation.

We investigated the success of supplemental stocking of pellet reared advanced-fingerling largemouth bass in a hypereutrophic system, which has historically displayed poor largemouth bass recruitment. The objective of the study was to compare survival and diet composition of stocked and wild age-0 largemouth bass within the first 90 days post-stocking (critical period). Results of this study may be used by hatchery managers to potentially increase the survival of pellet-reared hatchery fish in the wild.

Methods

Study Site and Stocking

Lake Seminole is a 289 ha hypereutrophic reservoir located in Pinellas County, Florida. The lake has had historic largemouth bass recruitment problems with low densities (11 largemouth bass/ha; Champeau et al. 2008). However, the lake supports an adequate forage base to support a much higher density of juvenile largemouth bass (Champeau et al. 2008).

Advanced-fingerling largemouth bass for this study were raised at the FWC Largemouth Bass Conservation Center at Richloam Hatchery. Brood fish were spawned in February 2008. The fry were placed in fertilized earthen ponds for 30 days and then returned to raceways where they were fed pellet

feed. One week prior to stocking fish were transitioned from pellet feed to live prey (eastern mosquito fish *Gambusia Holbrooki*).

The lake was stocked on 28 May 2008 with 18,263 coded wire tagged (CWT) advanced-fingerling largemouth bass (50-96 mm TL; mean = 80 mm TL). All stocked fish were dispersed randomly along 3,000 meters of vegetated shoreline. A random sample of 60 stocked largemouth bass were placed into two cylindrical 1.83 m diameter by 1.22 m deep cages within the stocking zone to estimate stocking mortality. Cages were checked for moribund fish and water quality variables (temperature and dissolved oxygen) were measured at 24, 48, and 72 h post-stocking.

Mortality and Diets

To evaluate mortality and diets of stocked and wild age-0 largemouth bass the lake was divided into 12-750m transects and electrofishing was conducted at 7, 14, 30, 60, and 90 days post-stocking. For each sampling event, nine transects were sampled (6 fixed sites and three randomly selected sites) for 15 min of electrofishing pedal time. All largemouth bass collected were measured (mm TL), weighed (g) and checked for coded wire tags. A representative sample of stocked largemouth bass (N=35) were sacrificed for diet analysis, and if 35 fish were not collected the total number collected were sacrificed. We also sacrificed five wild largemouth bass per cm group $\leq$ 20 cm TL; otoliths were removed to differentiate age-0 and age-1 wild fish and stomachs were removed to determine diet composition.

Analysis

We constructed catch curves to estimate instantaneous mortality (Z) and total mortality ($A=1-e^{-(Z*90d)}$) of stocked and wild age-0 largemouth bass (Timmons et al. 1980). We used the percent occurrence of common prey categories (empty, fish, and invertebrates) to compare the diet composition of stocked and wild age-0 largemouth bass. Percent similarity index (PSI) was used to compare percent occurrence of diet items between stocked and wild age-0 largemouth bass at each sampling event (Krebs 1999). A z-test was used to compare the proportion of diets by prey category between stocked and wild age-0 bass. Significance was set at $P < 0.05$.

Results and Discussion

Mean stocking mortality (72 hour evaluation) was 20% ± 11%. At the time of stocking water temperature was 31.6º C which may have led to the high rate of stocking mortality during the initial 72 hours. Porak and Bonvechio (2007) suggest that stocking should be done when water temperatures are < 25º C to reduce stocking stress which can lead to mortality.

Mortality 90 days post-stocking for stocked fish was 88.5% compared to 45.4% for wild age-0 largemouth bass (Figure 1). When evaluating the slopes of the catch curve the highest rate of mortality for stock largemouth bass occurred in the first 30 days post-stocking and reaches a plateau at 60 to 90 days post-stocking. The cause for the high rates of initial mortality is difficult to determine but can likely be attributed to lack of habitat, predation, competition and foraging efficiency. Schlechte et al. (2005) suggested that the likely source of initial mortality for stocked fingerling (30-64 mm TL) largemouth bass was predation; however, other researchers have suggested that stocking larger fish should decrease mortality via predation (Loska 1982). The transition from pellet feed to natural prey items may have been difficult, which could have led to the high rate of initial mortality in stocked largemouth bass. Percent similarity index results indicated that at 7 days post-stocking diets were much more dissimilar between wild age-0 and stocked largemouth bass than at 14, 30, and 60 days post-stocking (Figure 2). At 7 days post-stocking stocked largemouth bass had 86% empty diets compared to 37% for age-0 wild fish. Additionally z-test results indicated that the proportion of wild age-0 largemouth bass diets that contained fish was significantly more ($P = 0.03$) than stocked largemouth bass and the proportion of empty diets in stocked largemouth bass was significantly higher ($P = 0.03$) than wild age-0 fish throughout the study period. These results suggest that stocked fish had a difficult time making the transition to natural prey. Similarly, Olsen et al. (2000) found reduced feeding behavior of pellet reared advanced-fingerling walleye *Stizostedion vitreum* within the first 4 weeks post-stocking and suggested introducing natural prey prior to stocking.

In this study stocked largemouth bass were fed mosquito fish five days prior to stocking. It was observed that stocked fish transitioned to natural prey quickly in the hatchery (Rick Stout FWC hatchery manager, personnel communication). However, these fish were fed prey in an enclosed system (i.e. raceways) with no habitat complexity. McKeown et al. (1999) found reduced survival of stocked muskellunge *Esox masquinongy* raised in troughs on natural prey and attributed the reduced survival to the rearing environment. These results suggest that a learned foraging behavior may not be developed in the hatchery. Fish weakened by hunger are more likely to fall victim to predation, and unlearned foraging behavior may indirectly contribute to the higher predator related mortality observed in hatchery-reared fish (Brown and Laland 2001).

Results from this study as well as others suggest that changes in fish rearing procedures prior to stocking may increase the survival of stocked fish. These would include increasing the time stocked fish are introduced to natural prey and the introduction of habitat complexity to raceways to mimic a natural environment. Additionally, the introduction of predators to raceways may help develop hatchery-reared advanced-fingerling largemouth bass anti-predator skills. Ongoing research at the Richloam hatchery is aimed at addressing these issues in order to develop an effective stocking program using hatchery produced largemouth bass advanced-fingerlings.

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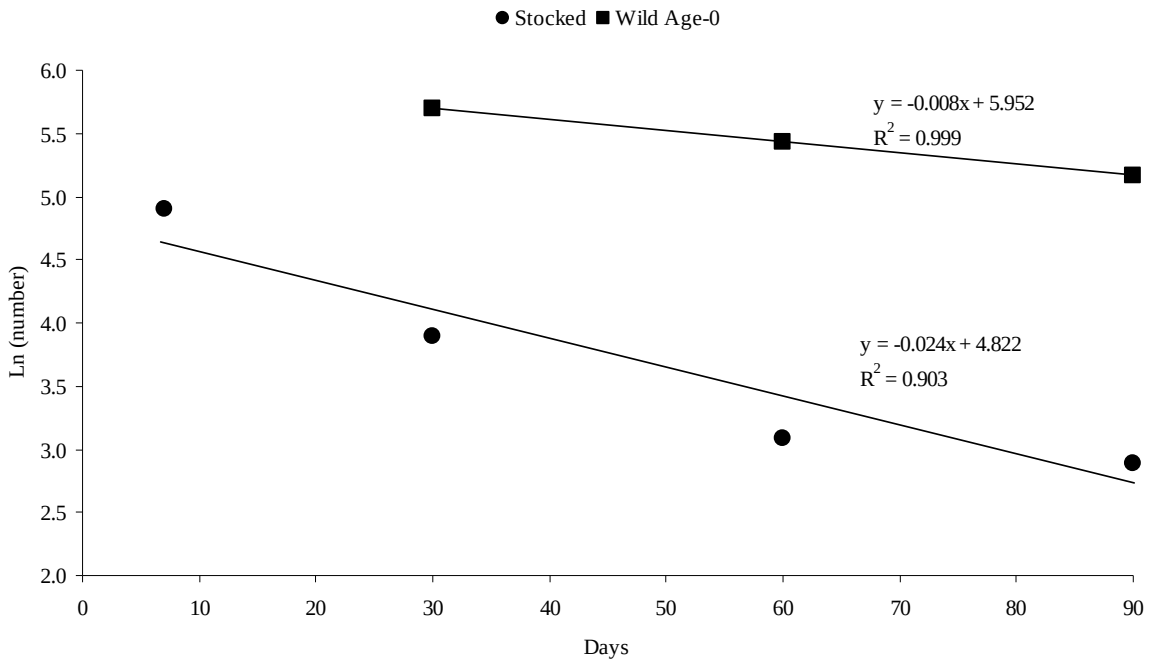

Figure 1. Catch curve for stocked and wild age-0 largemouth bass collected at 7, 14, 30, 60, and 90 days post-stocking from Lake Seminole, Florida. The descending limb of the catch curve was used to estimate mortality for wild age-0 largemouth bass (30, 60, and 90 days post-stocking) and stocked advanced-fingerling largemouth bass (7, 30, 60, and 90 days post-stocking). The sampling events at 7 and 14 days were excluded for wild age-0 bass because they had not fully recruited to electrofishing gear and the sampling event at 14 days was excluded for stocked bass because a different electrofishing boat was used, which changed the catchability coefficient.

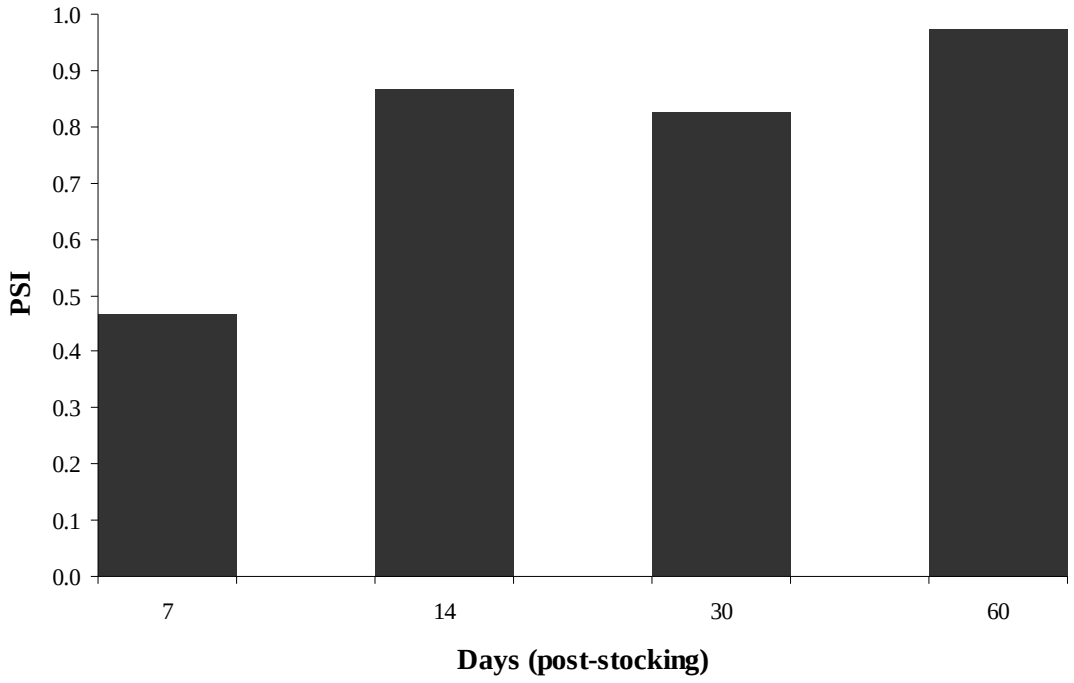

Figure 2. Percent similarity index (PSI) comparing percent occurrence of diet items (fish, invertebrates, and empty) found in the stomachs of stocked and wild age-0 largemouth bass at 7, 14, 30, and 60 days post-stocking. The similarity between wild age-0 largemouth bass and stocked largemouth bass diet composition is presented on a scale of 0 to 1 (y-axis), where 1.0 is identical and 0 is no similarity. The 90 day post-stocking PSI value was not used due to a small sample size of stocked bass.

References

Boxrucker, J. 1986. Evaluation of supplemental stocking of largemouth bass as a management tool in small im poundments. North American Journal of Fisheries Management 6:391-396.

Brown, C., and K. Laland. 2001. Review Paper: Social learning and life skills training for hatchery reared fish. Journal of Fish Biology 59:471-493.

Buynak, G.L., and B. Mitchell. 1999. Contribution of stocked advanced-fingerling largemouth bass to the population and fishery at Taylorsville Lake, Kentucky. North American Journal of Fisheries Management 19:494-503.

Champeau, T., and 6 coauthors. 2008. Southwest Florida Regional Fisheries Management: Annual Report. Florida Fish and Wildlife Conservation Commission, Division of Freshwater Fisheries Management, Tallahassee, Florida.

Colvin, N.E., C.L. Racey, and S.E. Lochmann. 2008. Stocking contribution and growth of largemouth bass stocked at 50 and 100 mm into backwaters of the Arkansas River. North American Journal of Fisheries Management 28:434-441.

Diana, J.S. 1995. Biology and ecology of fish. Cooper Publishing, Indiana.

Heggberget, T.G., M. Staurnes, R. Strand, and J. Husby. 1992. Smoltification in salmonids. NINA-Norsk-Institutt-for-Naturforskning-Forskningsrapport 31:3-42.

Krebs, C.J. 1999. Ecological Methodology, 2nd Ed.. Menlo Park, California: Addison-Welsey Educational Publishers, Inc. 620 pp.

Larscheid, J., J. Christianson, T. Gengerke, and W. Jorgensen. 1999. Survival, growth, and abundance of pellet-reared and minnow-reared muskellunge stocked in Northwestern Iowa. North American Journal of Fisheries Management 19:230-237.

Loska, P.M. 1982. A literature review on the stocking of black basses (*Micropterus* spp.) in reservoirs and streams. Georgia Department of Natural Resources, Game and Fish Division, Atlanta, Georgia.

Mesing, C.L., R.L. Cailteux, P.A. Strickland, E.A. Long, and M.W. Rodgers. 2008. Stocking advanced-fingerling largemouth bass to supplement year-classes in Lake Talquin, Florida. North American Journal of Fisheries Management 28:1762-1774.

McKeown, P.E., J.L. Forney, and S.R. Mooradian. 1999. Effects of stocking size and rearing method on muskellunge survival in Chautauqua Lake, New York. North American Journal of Fisheries Management 19:249-257.

Olson, M.H., T.E. Brooking, D.M. Green, A.J. VanDeValk, and L.G. Rudstam. 2000. Survival and growth of intensively reared large walleye fingerlings and extensively reared small fingerlings stocked concurrently in small lakes. North American Journal of Fisheries Management 20:337-348.

Porak, W.F., and 7 coauthors. 2002. Factors affecting survival of largemouth bass raised on artificial diets and stocked in Florida lakes. American Fisheries Society Symposium 31:649-665.

Porak, W.F., and K.T. Bonvechio 2007. Largemouth bass stocking workshop: Florida Bass Conservation Center (September 27-28, 2005), Florida Fish and Wildlife Conservation Commission, Eustis, Florida. 22pp.

Schlechte, J.W., R.K. Betsill, and D.L. Buckmeier. 2005. A laboratory evaluation of post stocking predatory losses for cultured largemouth bass. Transactions of the American Fisheries Society 134:141-148.

Timmons, L.T., W.L. Shelton, and W.D. Shelton. 1980. Sampling of reservoir sport fish populations with rotenone in littoral areas. Proceedings of the Southeastern Association of Fish and Wildlife Agencies 32:474-484.

Wahl, D.H., R.A. Stein, and D.R. DeVries. 1995. An ecological framework for evaluating the success and effect of stocking fishes. American Fisheries Society Symposium 15:176-189.