Effects of Catch-and-Release Angling on Egg Densities in Largemouth Bass Nests

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Predation during early life stages of Centrarchidae offspring are a major cause of decreased reproductive success. For five-weeks Largemouth Bass *Micropterus salmoides* defend their broods from invaders such as Yellow Perch *Perca flavescens* and Bluegill *Lepomis macrochirus*. The focus of this study was to determine if predation upon Largemouth Bass broods increased as removal time from the nest via catch-and-release angling increased. Sampling was conducted on the Whitefish Chain, MN from 7 May - 7 June 2016, where a total of 29 nests were located and sampled. Three treatment groups were used; immediate catch-and-release, three-minute, and a seven-minute hold, along with a control group where no angling was performed. Median egg density and interquartile range (IQR) for each treatment are as follows: Control (8.20, IQR = 3.20 – 8.26), C&R (6.20, IQR = 4.32 – 7.44), 3-Min (1.88, IQR = 0.83 – 10.04), and 7-Min (2.40, IQR = 1.34 – 5.18). The best supported model including treatment group, predation, nest depth and total length, explained 55% of the variation in egg density. Egg densities decreased as total length of Largemouth Bass increased ($R^2 = 0.17$, $P = 0.03$). Predation appeared to occur heavily when Largemouth Bass nests were in neighboring areas to the nests of Bluegill, and less frequently when another Largemouth Bass was nearby.

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Introduction

Predation during early life stages is a major cause of decreased reproductive success for Centrarchids (Phillip et al. 1997; Suski et al. 2003; Suski et al. 2004). Centrarchids such as Largemouth Bass *Micropterus salmoides* begin to inhabit the shallow littoral zones at roughly 15 °C to form crater-like nests. Their nests are typically formed on hard substrates and even logs or dense weed beds where they mate with ready females (Kramer and Smith 1962). Once courtship is complete, the male stays and guards the brood for up to five weeks (Ridgway 1988). During these five weeks, males not only defend their broods from predators but also fan nests to oxygenate and keep them clean (Ridgway 1988; Hinch and Collins 1991; Suski et al. 2003). These crucial few weeks of brood development are rather strenuous on the males. In nest-guarding fishes such as Largemouth Bass, possible predators are forcefully chased from nests at an extensive metabolic cost to the nest guarder (Hinch and Collins 1991). They are in a constant battle with other Centrarchids as well as Cyprinids attempting to eat their brood.

Predation by Cyprinids or Centrarchids on nests of *Micropterus spp*. happens with or without catch-and-release angling of the male. This predation can be slow or rapid depending on the density of predators nearby (Ridgeway 1988; Swenson 2002). Swenson (2002) indicated 37% of 41 Largemouth Bass nests monitored fell victim to predation by large groups of Yellow Perch *Perca flavescens*. On the nests where predation occurred, the males would abandon as the copious quantities of Yellow Perch would approach. Hence, the male felt overwhelmed and assumed it was more cost effective to not fight off the Yellow Perch. Steinhart et al. (2004) studied the influence high densities of Round Gobies *Neogobius melanostomus* had on nesting Smallmouth Bass *Micropterus dolomieu* in Lake Erie. Male Smallmouth Bass were successful at guarding broods until angling occurred (Steinhart et al. 2004). An estimated 20-50% of the brood would be consumed during the catch-and-release process. Steinhart et al. (2004) also estimated an entire nest could be consumed in just over 15 minutes. This extensive predation is reduced by management techniques such as strict harvest limits, catch-and-release regulations or even closed fishing periods (Quinn 1993; Schramm et al. 1995; Gwinn and Allen 2010).

When a male is removed from its' nest, the developing brood is vulnerable to any predators looking for an easy meal (Neves 1975). Release of the male following angling can result in a few scenarios. First, the male could be unharmed and able to give full parental care. Secondly, the male might have developed a hook wound which could cause the fish to not give full parental care for his brood (Philipp et al. 1997; Cooke et al. 2000; Suski et al. 2003). Finally, there might be complete abandonment of the nest and brood survival could be non-existent (Philipp et al. 1997). This stress on fish due to catch-and-release angling may have negative effects on size of offspring, swim up date, and overall survival rate of that male's brood.

Tournament angling for black bass has grown in popularity in past years. Originally, Bass Anglers Sportsman Society (B.A.S.S.) tournaments were catch-and-keep until 1972 when the first catch-and-release tournament was held (Shupp 1978). B.A.S.S. is the forefront leader in practicing safe handling of *Micropterus spp.* A study done by Kwak and Henry (1995) concluded that annual Largemouth Bass mortality due to two separate catch-and-release tournaments on Lake Minnetonka, MN was extremely low at 1 – 3%. This suggests other stressors such as season of catch (spring, summer or fall), water temperature, and angler education have more of an effect on the survival rates of angled black bass (Cooke et al. 2002). These stressors should have a larger effect on angled nesting black bass, as hooking mortality can be detrimental to already weakened black bass. These stressors accompanied with the spawning season may cause nest abandonment which ultimately would lead to reduced year class strength.

For this study, we measured egg densities of Largemouth Bass following catch-and-release angling on nest guarding males. We examined if differences in live-well hold times resulted in variability in egg densities.

Methods

Study sites and dates

Nests were sampled between 7 May and 7 June 2016. Sampling was conducted between the hours of 800 to 1900. All sampling was performed on the waters of Cross Lake Reservoir, Loon Lake, Island Lake, Rush-Hen Lake, and Big Trout Lake, all bodies of water which are connected via channels on the 5665.6 ha Whitefish Chain of Lakes near Crosslake, MN. These systems have similar fish communities including abundant members from the Centrarchidae, Cyprinidae, Percidae, and Esocidae families. Percent littoral area for each lake is as follows: Big Trout 29%, Cross Lake Reservoir 48%, Loon and Island Lake 37%, Rush-Hen Lake 58%.

Equipment and Angling Gear

A standard nylon sock sectioned off to a five by five cm area was used for extraction of eggs. Sampling was conducted in the center of each nest to limit bias. The eggs were placed in small sample jars containing a 10% formalin concentration for preservation. Egg counts were performed later in the lab at Bemidji State University. Using a Humminbird Depth Finder/GPS, water temperature was recorded to the nearest 0.1 °C. Reel time (the length of time it took to get the fish in the boat) was measured with a standard stop watch. Before release, each fish was measured for total length (TL; mm). Water column depth at each nest was measured to the nearest centimeter. All fish were caught on a medium light spinning rod and reel rigged with a drop-shot size four hook and four-gram weight.

Catch and Release

There were three different treatment groups and one control group. The control group (Control) would be approached and eggs would be sampled before any attempt of angling was done. Angling was then performed on control group fish to get a measurement of TL for use in data analysis. The second group was immediate catch-and-release (C&R). This group was created to mimic the state law for black bass in Minnesota. The third treatment group was a 3-minute hold time (3-Min). Situations such as deep hooking or the angler wanting to take a picture are reasons behind the creation of this group. Finally, the fourth group was a 7-minute hold time (7-Min). This group was made to mimic a tournament situation where a bass is removed from its nest for up to eight hours. Seven minutes was deemed a sufficient time for any extensive predation to occur. For this experiment, release of each fish occurred after total length measurements were taken then nests would be sampled. Fish were released at an average distance of nine meters from their nest.

Data Analysis

A series of models were created using all possible combinations of the following variables: treatment group, if there was any witnessed predation upon replacement of the bass, water column depth at each nest (cm), male total length (mm), water temperature on nest (°C). Akaike's information criterion with correction (AIC_c; Sugiura 1978) was used to determine the best supported model. To demonstrate basic relationships between individual variables and nest egg densities, linear regression analysis was used to develop lines of best fit for individual scatter plots.

Results

A total of 29 nests were surveyed; the control group had 5, C&R had 9, 3-Min had 8, and finally the 7-minute hold had 7. Overall egg density had a median of 4.32 eggs/cm^2 [interquartile range (IQR) = 1.96 – 8.20]. The median egg density per treatment group decreased from Control down to 3-Min and back up slightly in 7-min (Figure 1). Variability was large among all samples in each treatment group. Median egg density for each group is as follows: Median egg density and IQR for each treatment are as follows: Control (8.20, IQR = 3.20 – 8.26), C&R (6.20, IQR = 4.32 – 7.44), 3-Min (1.88, IQR = 0.83 – 10.04), and 7-Min (2.40, IQR = 1.34 – 5.18).

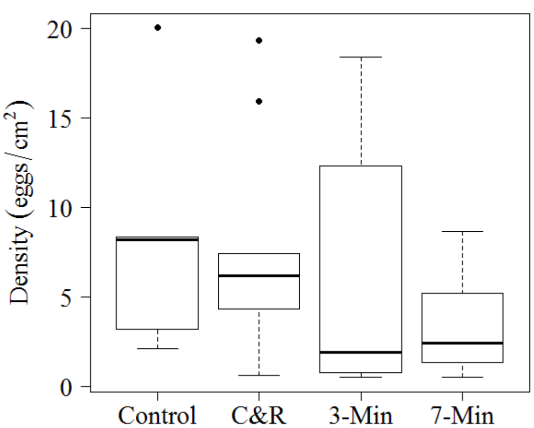

FIGURE 1. Egg density comparisons between each treatment group on the Whitefish Chain, Crosslake, Minnesota. Treatments were defined as follows: control (no angling until after egg collection), C&R (immediate release of the bass after TL was measured), 3-min (fish were held in the live-well for 3 minutes after TL was measured), and 7-min (fish were held in the live-well for 7 minutes after TL was measured).

The best supported model including treatment, predation, total length, and nest depth explained 55% of the variation in egg density (AIC_c = 186.25; Figure 2). The top ten analyzed models included the variable of total length, while five of them included the variable of nest depths or predation (Table 1).

Fish median length was 360 mm (IQR = 338 – 395). Egg densities decreased as total length of Largemouth Bass increased (R^2 = 0.17, P = 0.03; Figure 3). The median depth of each nest was 85 cm (IQR = 71 – 119). Egg densities decrease as water column depth of each nest increased but the relationship was not significant (R^2 = 0.05, P = 0.24; Figure 4).

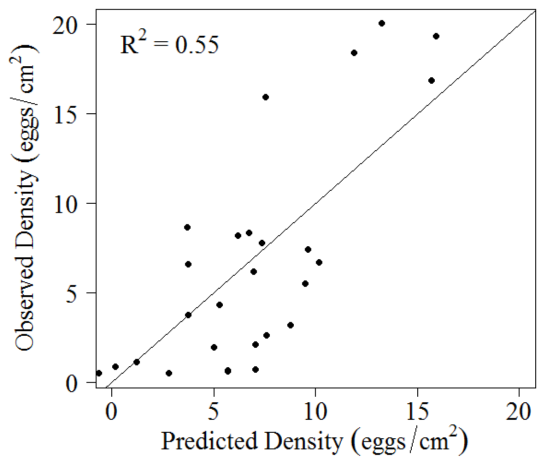

FIGURE 2. Plot of predicted and observed values of density (eggs/cm^2). Values were generated using results from the regression model containing variable; Egg Density vs. Treatment Group, Predation, Nest Depth and Total Length, (R^2 = 0.55).

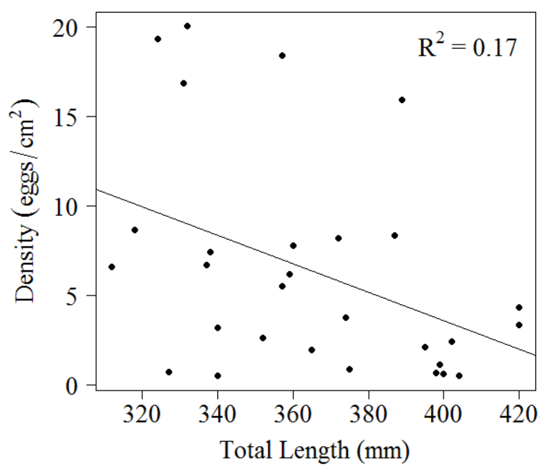

FIGURE 3. Relationship between egg density and Largemouth Bass total length of fish captured spring 2016 in the Whitefish Chain. Dark line represents line of best fit, fitted by regression analysis.

Among fish sampled eight of them had predation occurring on the nest when released (Figure 5), these fish had a median egg density of 4.98 eggs/cm^2 (IQR = 2.20 – 6.98). While the nests which did not have predation had a median egg density of 4.32 eggs/cm^2 (IQR = 1.96 – 8.36). The primary predator of Largemouth Bass broods was Bluegill *Lepomis macrochirus*. On one occasion, Pumpkinseed *Lepomis gibbosus* entered the unguarded nest; in another case, unidentified Cyprinids were observed on the unguarded nest.

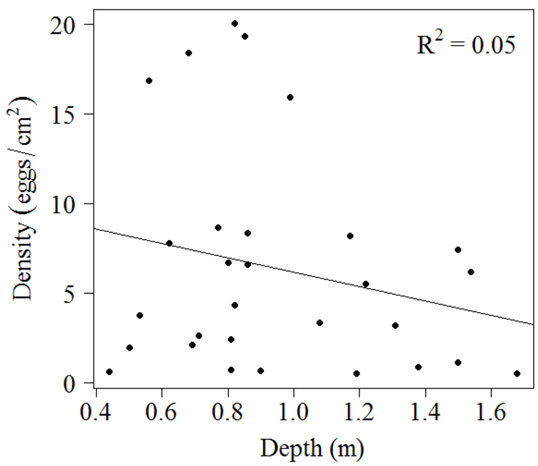

FIGURE 4. Relationship between egg density and water column depth of each Largemouth Bass nest for fish captured spring 2016 in the Whitefish Chain. Dark line represents line of best fit, fitted by regression analysis.

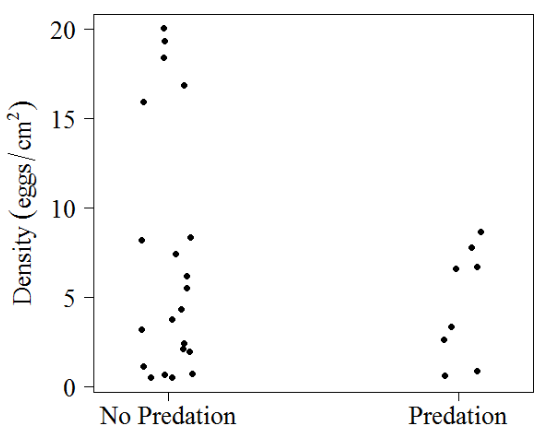

FIGURE 5. Observation of predation or no predation on the nests of angled largemouth bass compared to the calculated egg densities of those nests. Egg densities are to the nearest egg/cm^2.

Discussion

Egg densities were effected by catch and release angling, with a combination of other measured variables (total length, nest depth and if predation was occurring). Largemouth Bass build highly visible nests in predictable spots on rather shallow shorelines (Kramer and Smith 1962). These basses are aggressive during their parental care period (Ridgeway 1988), yet this aggression can lead to them being vulnerable to angling methods (Kieffer et al. 1995). When guarding, males are removed from the nest by anglers, predators such it small Centrarchids or Percids can quickly consume the offspring (Neves 1975), with the level of predation proportional to the length of time the fish is absent from the nest (Kieffer et al. 1995; Philipp et al. 1997)**.** The Largemouth Bass in this study that had predation on their nest typically neighbored nesting areas of Bluegills who recently spawned. Bluegills spawn in clusters sometimes up 100 fish, where they all work together to fight off an invader (Breder 1936; Gross and MacMillan 1981). As catch-and-release angling is found to cause large physiological effects, it may result in decreased brood survival of males that choose to nest near Bluegills (Cooke et al 2002). On the nests where no predation was observed in this study, Bluegills were not witnessed to be in the area and other Largemouth Bass were visibly nesting in that area. Although cannibalism may occur between Largemouth Bass, it was never witnessed in this study. This suggests that Largemouth Bass do not expend needed energy to leave their nest to go violate a nest of its counterpart.

Although not well documented, nest predation may be influenced by the size of nesting males and has been considered a limiting factor to Largemouth Bass reproductive success (Hinch and Collins 1991; Suski et al. 2003). Of the sampled fish, the males who had their nests fall victim to predation upon removal had a median length of 356 mm. The nests where no predation was witnessed had males with a median total length of 365 mm. Larger male size has been linked to increased mating success and parental care (Phillip et al 1997). Yet our results indicated the nests with the lowest egg densities were those of the larger size Largemouth Bass. These contradictory results may be explained on a location based study. The larger males tend to nest by themselves, away from all other males. This relates to the defensive meaner of all black bass suggesting that if these males chose to instead nest near other Largemouth Bass there might be a possibility that invaders would avoid the area due to the presence of another Largemouth Bass.

Currently Minnesota has a new catch-and-release season for *Micropterus spp.* Created in 2016 this season allows anglers of the state to fish for Largemouth or Smallmouth Bass two weeks before the regular season opener. Yet, there is research that has shown not all people oblige to these regulations and will fish for them as soon ice comes off the lake (Kubacki et al. 2002). Illegal angling reduces the reproductive success of the bass population as well as the angled individual (Suski et al. 2002; Ostrand et al. 2004), which leads to a potential gap in year class for that species. In areas with high densities of Largemouth Bass this effect may not be as noticeable. Whereas, areas with small densities of black bass species the effect may seem more severe.

TABLE 1. Measured variables included in the ten best supported models explaining variation in Largemouth Bass egg densities. Models are organized from smallest AIC_c to largest AIC_c score.

Model Variables	R-squared	AICc
Treatment, Total Length, Depth, Predation	0.55	186.25
Total Length	0.17	187.64
Treatment, Total Length, Depth	0.45	188.19
Total Length, Predation	0.22	188.49
Total Length, Depth	0.21	189.16
Treatment, Total Length	0.36	189.21
Total Length, Depth, Predation	0.28	189.31
Treatment, Total Length, Depth, Predation, Temperature	0.56	190.07
Treatment, Total Length, Predation	0.41	190.25
Total Length, Temperature	0.17	190.26

One potential management option is to have conservation areas. These are sectioned off zones, that restrict fishing for all species of fishes. Removal of human disturbance should increase egg densities and result in less nest abandonment (Gwinn and Allen 2010). These zones should be set in optimal spawning areas of Largemouth Bass.

Catch-and-release angling of male black bass has resulted in nest abandonment (Phillip et al. 1997). This abandonment results from increased physiological stress (Kieffer et al. 1995). The physiological stress can affect egg densities if the nest guarding males are angled off their nest (Steinhart et al. 2004). Results from our study show that egg densities in nests of Largemouth Bass are effected by a combination of catch-and-release angling during the spawning season, male total length, nest depth, and observed predation.

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References

Breder, C. M. 1936. The reproductive habits of the North American sunfishes (family Centrarchidae). New York Zoological Society, the Zoological Park.

Cooke, S. J., D. P. Philipp, J. F. Schreer, and R. S. McKinley. 2000. Locomotory impairment of nesting male Largemouth Bass following catch-and-release angling. North American Journal of Fisheries Management 20:968-977.

Cooke, S. J., J. F. Schreer, D. H. Wahl, and D. P. Philipp. 2002. Physiological impacts of catch-and-release angling practices on Largemouth Bass and Smallmouth Bass. American Fisheries Society Symposium 489-512.

Gwinn, D. C. and M. S. Allen. 2010. Exploring population-level effects of fishery closures during spawning: An example using Largemouth Bass. Transactions of the American Fisheries Society 139:626-634.

Gross, M. R. and A. M. MacMillan. 1981. Predation and the evolution of colonial nesting in Bluegill sunfish (*Lepomis macrochirus*). Behavioral Ecology and Sociobiology 8:163-174.

Hinch, S. G. and N. C. Collins. 1991. Importance of diurnal and nocturnal nest defense in the energy budget of male Smallmouth Bass: insights from direct video observation. Transactions of the American Fisheries Society 120:657-663.

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.

Kramer, R. H. and L. L. Smith. 1962. Formation of year classes in Largemouth Bass. Transactions of the American Fisheries Society 91:29-41.

Kubacki, M. R., F. J. Phelan, J. E. Claussen, and D. P. Philipp. 2002. How well does a closed season protect spawning bass in Ontario? American Fisheries Society Symposium 31:379-386.

Kwak, T. J. and M. G. Henry. 1995. Largemouth Bass mortality and related causal factors during live-release fishing tournaments on a large Minnesota lake. North American Journal of Fisheries Management 15:621-630.

Neves, R. J. 1975. Factors affecting fry production of Smallmouth Bass (*Micropterus dolomieu*) in South Branch Lake, Maine. Transactions of American Fisheries Society 104:83-87.

Ostrand, K. G., S. J. Cooke, and D. H. Wahl. 2004. Effects of stress on Largemouth Bass reproduction. North American Journal of Fisheries Management 24:1038-1045.

Philipp, D. P., C. A. Toline, M. F. Kubacki, D. B. F. Phillipp, and F. J. S. Phelan. 1997. The impact of catch-and-release angling on the reproductive success of Smallmouth Bass and Largemouth Bass. North American Journal of Fisheries Management 17:557-567.

Quinn, S. 1993. Bass seasons, conservation measure or needless regulation? In-Fisherman 18:30-38.

Ridgway, M. S. 1988. Developmental stage of offspring and brood defense in Smallmouth Bass (*Micropterus dolomieu*). Canadian Journal of Zoology 66:1722-1728.

Schramm, H. L., P. E. McKeown, and D. M. Green. 1995. Managing black bass in northern waters: summary of the workshop. North American Journal of Fisheries Management 15:671-679.

Shupp, B. D. 1978. Status of bass fishing tournaments in the United States. Fisheries 4:11-19.

Steinhart, G. B., E. A. Marschall, and R. A. Stein. 2004. Round Goby predation of Smallmouth Bass offspring in nests during simulated catch-and-release angling. Transactions of the American Fisheries Society 133:121-131.

Sugiura, N. 1978. Further analysts of the data by Akaike's information criterion and the finite corrections. Communications in Statistics - Theory and Methods 7:13-26.

Suski, C. D., J. H. Svec, J. B. Ludden, F. J. S. Phelan, and D. P. Philipp. 2003. The effect of catch-and-release angling on the parental care behavior of male Smallmouth Bass. Transactions of the American Fisheries Society 132:210-218.

Suski, C. D. and D. P. Philipp. 2004. Factors affecting the vulnerability to angling of nesting male Largemouth and Smallmouth Bass. Transactions of the American Fisheries Society 133:1100-1106.

Swenson, W. A. 2002. Demographic changes in a Largemouth Bass population following closure of the fishery. Pages 627-638 in D. P. Philipp, and M. S. Ridgway, editors. Black bass: ecology, conservation, and management. American Fisheries Society, Symposium 31, Bethesda, Maryland.