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Year-Class Production of Black Bass Before and After Opening of a Spring Catch-and-Release Season in New York: Case Studies from Three Lakes

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Abstract.—Impacts of angling for black bass *Micropterus* spp. during the nesting stage have received much recent attention, with particular focus on individual nest and genetic implications. However, few empirical studies of population-level impacts have been conducted. New York State historically protected nesting bass with a closed season. In 1994, a special spring bass season was opened in the New York waters of Lake Erie, and in 2007, a spring catch-and-immediate-release season was opened in most of New York's remaining waters. Long-term monitoring programs were in place on two inland lakes and New York's portion of Lake Erie prior to the regulation changes, facilitating assessment of impacts of liberalizing regulations on year-class production. In Canadarago Lake (surface area 770 ha), fall electrofishing surveys sampled both young-of-year Largemouth Bass *M. salmoides* and Smallmouth Bass *M. dolomieu*. Mean catch per hour of Largemouth Bass during the 6 years prior to the spring season was 15.6, compared to 27.8/h over the postchange years ($p = 0.63$). For Smallmouth Bass in Canadargo Lake, prechange catch rates averaged 1.2/h, with a rate of 0.6/h after the change ($p = 0.32$). In Oneida Lake (surface area 20,670 ha), trawl surveys provided an index of young-of-year Smallmouth Bass. Average catch-per-haul during the 6 years prior to the regulation change was 0.4 compared to 1.8/haul during the following 6 years ($p = 0.04$). Gill-net surveys of age-2 Smallmouth Bass in Lake Erie produced a year-class index of 3.0/net over 15 years prior to opening of a spring bass fishery and a catch of 6.0/net over the following 17 years ($p = 0.04$). In three of four cases, year-class production increased following the opening of spring angling for bass, and increases were statistically significant for Smallmouth Bass in Oneida Lake and Lake Erie. Our results provide no evidence that spring fishing for black bass in large lake systems results in negative population level impacts on bass recruitment.

Introduction

Black bass *Micropterus* spp., particularly Largemouth Bass *M. salmoides* and Smallmouth Bass *M. dolomieu*, are the most sought-after sport fish in the United States, accounting for more than 460 million angler-days in the Great Lakes and other inland waters (U.S. Department of the Interior et al. 2012). While the use of regulations to manage black bass populations increased in the last decades of the 1900s, they were predominantly directed towards improvement of population size structure, and use of closed seasons declined (Noble 2002; Quinn 2002). As of the agency survey conducted by Quinn (2002), 38 states employed no seasonal

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restrictions directed at black bass management or used only specific exceptions. Six states allowed only catch-and-release fishing for black bass during the spring, one state had reduced spring harvest regulations, and only four states had closed seasons specifically for black bass during the spring. New York, one of the four states with a closed spring season at the time of Quinn's survey, instituted a catch-and-immediate-release season beginning with the 2007 fishing season.

Historically, closed spring seasons for black bass have been used to protect adults during the spawning season, primarily males during the nest guarding stage (Quinn 2002). Spring closures have variously been enacted due to concerns over easier targeting of large adults when they congregate in spawning areas, higher vulnerability of nest-guarding males to angling due to increased aggressiveness, and loss of eggs and/or progeny from nests when guarding males are removed (Quinn 2002). Implicit in the latter concern is the assumption of a stock–recruitment relationship, whereby loss of potential nest production could result in reduced recruitment. More recently, concerns have arisen over potential genetic consequences of angling for guarding male black bass, resulting from selective removal of more aggressively guarding males from their nests (Suski and Philipp 2004; Philipp et al. 2009).

Factors affecting the vulnerability of black basses to angling have received much attention, often as a result of efforts to increase angler catch rates. Results indicate that angling vulnerability is variable among individuals and populations, and may be a heritable trait (e.g., Garrett 2002; Philipp et al. 2009). However, relatively few studies have specifically addressed angling vulnerability of males actively guarding eggs or young. Allan and Romero (1975), in a study on Lake Mead, had seven anglers target a cove containing 50 well-marked active nests. Anglers fished from afternoon until dark and captured only five male bass. Suski and Philipp (2004), in a study of several southeastern Ontario lakes, concluded that nest guarding males were highly vulnerable to angling, with 70% of Smallmouth Bass and 54% of Largemouth Bass hooked when subjected to directed angling efforts comprised of only two casts each of three different lure types. Furthermore, they found a positive relationship between guarding aggressiveness of males, and hence vulnerability to angling, and the number of eggs in the nest. Cooke et al. (2007) confirmed the heritability of nest guarding aggressiveness, and thereby the potential for angling to selectively remove more aggressive guarding males from fished populations.

Increased mortality of early life stages of the black basses when guarding males are removed from nests is well established in the literature. Neves (1975) found a 75% reduction in the number of fry produced in Smallmouth Bass nests when males were excluded from nests by enclosures. Kieffer et al. (1995), in a study of guarding Smallmouth Bass captured and released, found that physiological stress and time taken to return to nests increased as the amount of time fish were played increased. Similarly, Philipp et al. (1997), in a study of both Largemouth Bass and Smallmouth Bass, found that time for angled males to return to nests increased steadily as handling time, distance of release site from nest, and number of captures increased. They found that the number of predators per nest more than tripled as length of absence of the guarding male increased from 2 min to more than 10 min, and that nest abandonment rates exceeded 50% in cases where males were removed from nests for more than 5 min. They observed no evidence of survival of eggs or fry when abandoned nests were revisited 1 d later. Suski et al. (2003) found that abandonment of nests by male Smallmouth Bass returned to nests following removal increased when brood size was reduced prior to return, suggesting that nests subjected to significant predation when males are captured and released may be abandoned even if some young remain.

While the potential impacts of angling on the success of individual nests are well established, population level impacts of angling on year-class strength and recruitment are not well understood. An individual-based model of Smallmouth Bass production predicted that the number of young produced declined as the likelihood of capture of guarding males increased, regardless of whether angling was catch and release or catch and keep (Ridgway and Shuter 1997). This logic implies that there is a positive relationship between the number of nests and year-class strength. Reynolds and Babb (1978) reported a correlation between the number of spawning adults and recruitment for Largemouth Bass in small impoundments. However, no evidence of a stock–recruitment relationship for Largemouth Bass in larger systems has been found for northern or southern populations (Minnesota: Kramer and Smith 1960; Oklahoma: Summerfelt 1975; North Carolina: Jackson and Noble 2000). In a pond experiment, Allen et al. (2011) also found little evidence for a stock–recruitment relationship in Largemouth Bass.

These findings have led to the widespread belief that there is typically a surplus production of eggs and young in black bass populations and that variability in year-class success and recruitment to the fishery is controlled by ecological conditions encountered by young fish after the guarding stage, such as food availability and winter conditions (Ludsin and DeVries 1997). Under this scenario, impacts of angling during the guarding stage might be limited unless angling pressure was high enough to affect a large percentage of active nests.

More recently, some researchers have argued that annual recruitment is not a function of the entire spawning population, but instead dependent upon a relatively small subset of all potential spawners. Studies of Smallmouth Bass have indicated that not all mature adults spawn every year and that decisions to spawn will generally optimize the reproductive success of individual fish (Raffetto et al. 1990). Research by Gross and Kapuscinski (1997) indicated that as few as 5% of nests guarded by spawning male Smallmouth Bass in Lake Opeongo, Ontario produced more than 50% of the age-0 fish that survived through fall. Similar results have been reported from pond studies by Parkos et al. (2011). Suski and Philipp (2004) found that larger males tended to guard progeny more aggressively and therefore were more vulnerable to angling. If the largest males are also those that tend to contribute disproportionately to year-class strength, then the potential impacts of angling could be focused on those fish with the greatest reproductive potential and impacts of angling on year-class strength could be large even with low levels of angling pressure. Gross and Kapuscinski (1997) were unable to predict which males would contribute the most to year-class strength based on size, age, or spawning date. However, Parkos et al. (2011) found that successful broods tended to come from older, larger, and earlier nesting males. These findings suggest that potential impacts of angling on nest-guarding males depends on a more complex suite of variables than simply the number of spawners and that disruption of certain nests could have a disproportionately large impact on recruitment.

Due to the inherent variability in annual year-class strength in black bass populations, evaluations of the effects of regulation changes are difficult. However, Quinn's review (2002) indicated that most agencies did not feel that black bass fisheries were negatively impacted when protection of spawners was relaxed or removed. Reports from Wisconsin, Minnesota, and Michigan did not indicate that black bass fisheries declined as a result of opening of spring catch-and-release seasons (Quinn 2002). A report from Michigan further found that catch rates during spawning were not higher than those observed later in the season, suggesting that anglers were not more successful during the nest guarding stage (Quinn 2002). An Oregon study found that a no-harvest regulation enacted during spring did not improve bass recruitment and removed the regulation (Quinn 2002). In Florida, implementation of protected spawning areas likewise did not improve recruitment relative to reference areas where fishing was allowed (Quinn 2002). However, removal of a spawning sanctuary in Long Point Bay, Lake Erie was identified as a potential contributor to declines in the Smallmouth Bass population (Sztramko 1985).

To our knowledge, no before-and-after evaluations of year-class production of black bass following opening of spring fishing seasons are available in the published literature. Historically, New York waters were closed to black bass fishing until the third Saturday in June. While a review of historic statewide temperature data suggests that the nesting season of black bass was still ongoing at the time the historic season opened in some waters in some years, some or all of the nesting season was protected in most years (Jackson and Brooking 2004). A spring season with restricted harvest regulations was implemented in New York waters of Lake Erie in 1994, and a catch-and-immediate-release season in most of New York's waters was put in place in 2007. In this paper, we present before-and-after comparisons of black bass production from New York waters of Lake Erie and two inland lakes, Canadarago Lake and Oneida Lake, in which long-term sampling programs were in place prior to the regulation changes. The Lake Erie data set allows comparison of year-class production more than 15 years prior to spring fishing and 17 years after the change. For Canadarago and Oneida lakes, we present production data from 6 years pre- and 6 years postchange in each lake.

Methods

Canadarago Lake

Canadarago Lake is a 770-ha mesotrophic lake northwest of Cooperstown, New York and is one of the headwaters of the Susquehanna River. The lake has a mean depth of 7.5 m and a maximum depth of 13.4 m. Zebra mussels *Dreissena polymorpha* were first detected in the lake in 2002 and water clarity has generally increased over the course of this study, with concomitant increases in nearshore aquatic macrophytes (Brooking et al. 2007). The most abundant potential nest predators are Yellow Perch *Perca flavescens*, Bluegill *Lepomis macrochirus*, and Pumpkinseed *L. gibbosus*. Black bass regulations on Canadarago Lake were consistent with statewide regulations—no targeting of black bass was allowed from December 1 through the third Saturday of June until the 2007 season. Beginning in 2007, a catch-and-immediate-release season was instituted from December 1 through the third Saturday of June, after which traditional catch-and-keep regulations took effect.

Year-class production of Smallmouth Bass and Largemouth Bass in Canadarago Lake has been assessed via night shoreline electrofishing since 1990. Electrofishing samples were collected in the fall, typically October, along a fixed 3.1-km transect on the western shoreline of the lake. Total on time for each sample ranged between 1.1 and 1.4 h during the course of this study, during which all young-of-year black bass were collected. Catches are reported in catch/h and prior to statistical analyses were log-transformed ($\log_{10}$[CPUE + 0.1]).

Oneida Lake

Oneida Lake is the largest lake located entirely within the borders of New York State, with a surface area of 20,670 ha. The lake is shallow, with an average depth of 6.8 m and a maximum depth of 16.8 m. Historically, Oneida Lake has been classified as eutrophic, but nutrient input reductions have resulted in a shift to a more mesotrophic state during the years of the present study. Zebra mussels were first detected in Oneida Lake in 1991, followed by quagga mussels *D. rostriformis bugensis* in 2005, resulting in increases in water clarity and increases in nearshore aquatic macrophytes over the years covered by this study (Jackson et al. 2012). The most abundant potential nest predators in Oneida Lake are Yellow Perch, Pumpkinseed, and Bluegill. Like most New York waters, Oneida Lake had a closed season for black bass from December 1 until the third Saturday in June through 2006. Starting with the 2007 fishing season, a catch-and-immediate-release season for black bass was opened from the first Saturday in May (consistent with the opening of Walleye *Sander vitreus* season) until the traditional black bass opener. Angling effort data based on instantaneous counts were collected from 2002 to 2007 and 2010–2012 (Krueger et al. 2009; Jackson et al. 2012).

Both Largemouth Bass and Smallmouth Bass are present in Oneida Lake, but long-term records of year-class production are only available for Smallmouth Bass. Young-of-year Smallmouth Bass have been indexed by an annual bottom trawl survey since 1960. Trawl catches of young-of-year Smallmouth Bass year-classes are significantly correlated with later gill-net catches at age 4 and age 5 (1984–2007 year-classes, simple linear regression, df = 23, r^2 = 0.44, p = 0.0004). Trawling is conducted with a bottom trawl with a 5.5-m footrope and constructed of 39 mm stretch mesh in the body and 13 mm stretch mesh in the cod end. Sampling is conducted weekly beginning in July and ending in October, and each weekly sample consists of 10 hauls of 5 min at a speed of 3.4 km/h with an area swept of approximately 0.1 ha/haul. Over the period of this study, 13–15 weekly samples were conducted annually. Catches are reported as catch/trawl haul and prior to statistical analyses were log transformed ($\log_{10}$[CPUE + 0.1]).

Lake Erie

New York's waters of Lake Erie comprise 229 km^2 located in the southeastern section of the lake's eastern basin. The eastern basin is the deepest (24.4 m average depth), least productive (oligotrophic) portion of Lake Erie. Zebra mussels were well established in Lake Erie by 1989, and quagga mussels were well established by the mid-1990s. The most abundant potential nest predators in Lake Erie are Yellow Perch and Rock Bass *Ambloplites rupestris*, with Round Goby *Neogobius melanostomus* first reported from the New York waters of Lake Erie in 1998 and becoming abundant by 2000 and thereafter. Beginning with the 1994 season, special black bass regulations were implemented in the New York waters of Lake Erie, moving from a closed spring season to a special season from the first Saturday in May through the third Saturday in June, with a one fish creel limit and a minimum size limit of 381 mm. In 2007, the minimum size limit was increased to 508 mm. Creel data on the black bass fishery have been collected since 1988, following methods detailed in Einhouse et al. (2002).

Smallmouth Bass is the most abundant nearshore predator in open lake waters, with Largemouth Bass largely restricted to a few protected harbors. Smallmouth Bass year-class production is indexed based on catches of age-2 fish in annual nearshore

(<12 m contour depth) gill-net surveys initiated in 1981. Nearshore gill-net surveys are conducted between the first of September and the end of October and consist of 25–48 gill-net sets annually. Nets are 213 m long x 1.8 m deep and comprised of randomly ordered panels of 31, 38, 44, 51, 57, 64, 70, 76, 89, 102, 114, 127, 140, and 152 mm stretch mesh. Nets are set between 1200 hours and sunset and retrieved between sunrise and 1200 hours. Further details on the gill-net survey, including changes in site selection protocol and a shift from multifilament to monofilament nets, can be found in Einhouse et al. (2002). All Smallmouth Bass captured in gill-net samples are aged using scales for calculation of the age-2 index, which is reported in catch/net-night and, prior to statistical analyses, was log-transformed ($\log_{10}$[CPUE + 0.1]).

Results

Canadarago Lake

Electrofishing catch/h of young-of-year Largemouth Bass from 2001 to 2012 ranged from 0.7 to 68.7 and averaged 21.7/h (SE = 5.8; Figure 1). Young-of-year Smallmouth Bass catch/h ranged from 0.0 to 2.2/h and averaged 0.9/h (SE = 0.2; Figure 1). Over the 6 years when the lake was closed to spring black bass fishing, young-of-year Largemouth Bass catch ranged from 1.5 to 40.0/h and averaged 15.6/h (SE = 5.7), while during the following 6 years, young-of-year catch ranged from 0.7 to 68.7/h and averaged 27.8/h (SE = 10.0; Figure 2). A *t*-test of the difference between two means of log-transformed catch data indicated no significant difference in catch per unit effort of young-of-year Largemouth Bass pre- and post-spring fishing (df = 10; *t* ratio –0.4; p = 0.63). Over the 6 years when the lake was closed to spring black bass fishing, young-of-year Smallmouth Bass catch ranged from 0.0 to 12.2/h and averaged 1.2/h (SE = 0.3), while during the following 6 years, young-of-year catch ranged from 0.0 to 1.7/h and averaged 0.6/h (SE = 0.3; Figure 3). A *t*-test of the difference between two means of log-transformed catch data indicated no significant difference in catch per unit effort of young-of-year Smallmouth Bass pre- and postspring fishing (df = 10; *t* ratio –0.5; p = 0.32).

Oneida Lake

Bottom trawl catch of young-of-year Smallmouth Bass in Oneida Lake from 2001 to 2012 ranged from 0.3 to 2.4/trawl haul and averaged 0.8 (SE = 0.2; Figure 4). Over the 6 years when the lake was closed to spring black bass fishing, young-of-year Small-

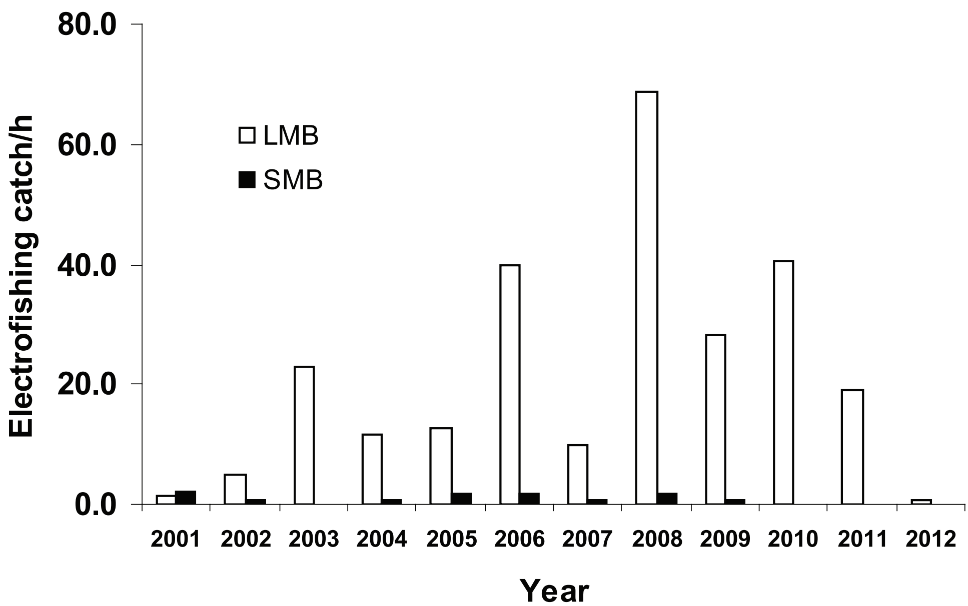

Figure 1. Electrofishing catch/h of young-of-year Largemouth Bass (LMB) and Smallmouth Bass (SMB) in Canadarago Lake, New York, 2001–2012.

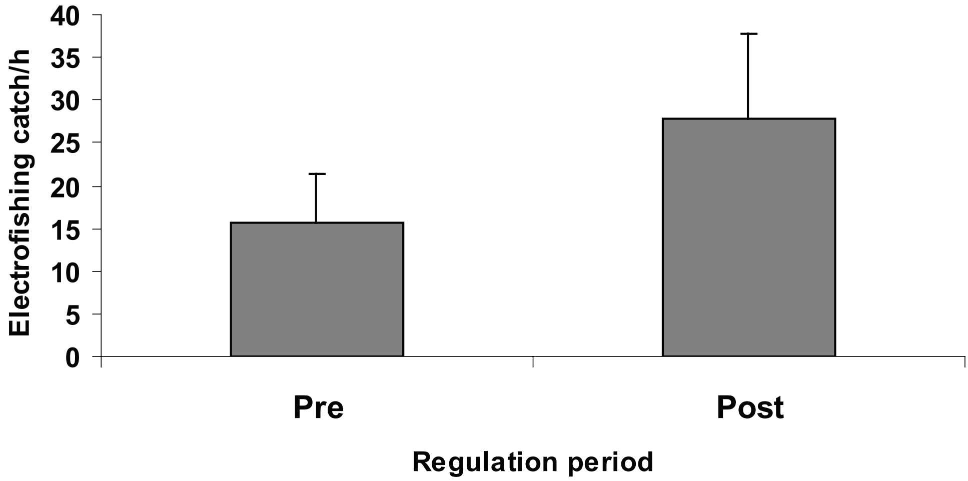

Figure 2. Mean electrofishing catch/h (+1 SE) of young-of-year Largemouth Bass during a period of closed spring fishing (Pre; 2001–2006) and a period of spring catch-and-immediate-release fishing (Post; 2007–2012), in Canadarago Lake, New York.

mouth Bass catch ranged from 0.2 to 0.9/trawl haul and averaged 0.4/trawl haul (SE = 0.1; Figure 5). After spring fishing was opened for 6 years, young-of-year Smallmouth Bass catches ranged from 0.3 to 2.4/trawl haul and averaged 1.2/trawl haul (SE = 0.3; Figure 5). A *t*-test of the difference between two means of log-transformed catch data indicated a significant increase in catch per unit effort of young-of-year Smallmouth Bass following the opening of spring fishing (df = 10; *t* ratio –2.4; $p = 0.04$).

May angling effort, as measured by instantaneous counts, averaged 21,284 angler-hours during the five creel years preceding the regulation change and 53,836 angler-hours during the four creel years following the opening of spring black bass fishing (Krueger et al. 2009; Jackson et al. 2012). June effort averaged 31,828 angler-hours before the regulation change and 44,044 after (Krueger et al. 2009; Jackson et al. 2012). Consistent interview data are not available to precisely quantify the amount of total angling effort devoted to

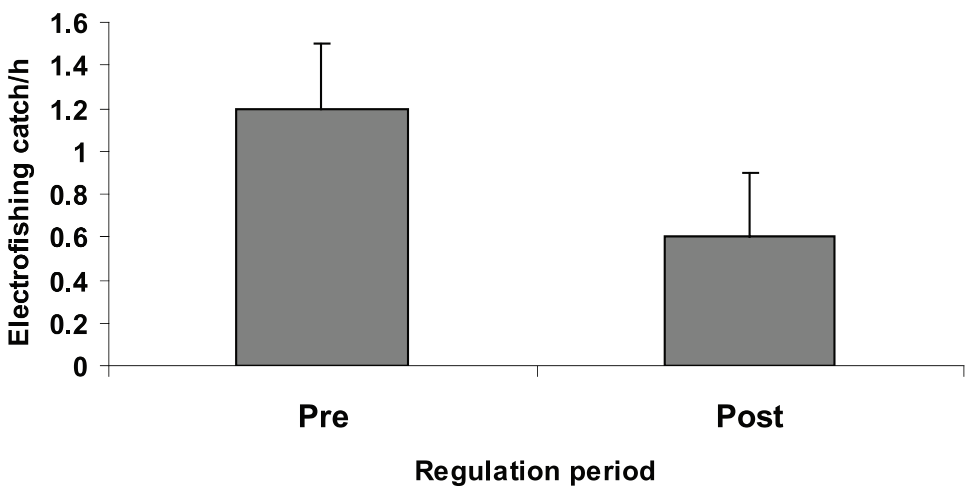

Figure 3. Mean electrofishing catch/h (+1 SE) of young-of-year Smallmouth Bass during a period of closed spring fishing (Pre; 2001–2006) and a period of spring catch- and-immediate-release fishing (Post; 2007–2012), in Canadarago Lake, New York.

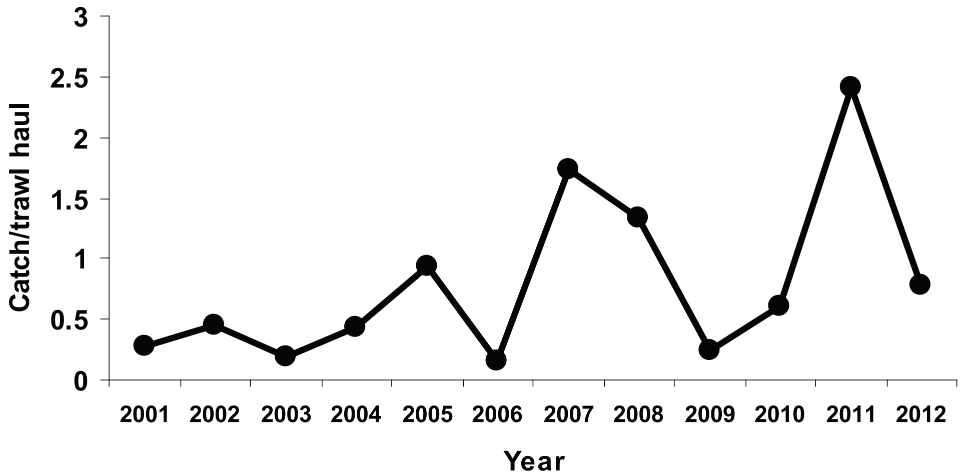

Figure 4. Catch/trawl haul of young-of-year Smallmouth Bass in Oneida Lake, New York, 2001–2012.

black bass in the spring from all creel seasons, but anglers targeting black bass typically accounted for 19–36% of all open-water effort for years when interview data are available (Krueger et al. 2009).

Lake Erie

Gill-net catch of age-2 Smallmouth Bass in New York waters of Lake Erie ranged from 0.2 to 24.6/net-night from 1981 to 2012 (reflecting the 1979–2010 year-classes), and averaged 4.6/net-night (SE = 1.0; Figure 6). Catch reflecting year-classes from the 15 years when the area was closed to spring black bass fishing ranged from 0.0 to 18.0/net-night and averaged 3.0/net-night (SE = 1.2; Figure 7), while catch from year-classes over the 17 years following the opening of a special spring fishing season ranged from 0.5 to 24.6/net-night and averaged 6.0/net-night (SE = 1.5; Figure 7). A t-test of the difference between two means of log-transformed catch data indicated a significant increase in catch per unit effort from year-classes of Smallmouth Bass following the opening of spring fishing (df = 30; t ratio –2.2; $p = 0.04$).

Mean annual open-water angling effort for black bass from 1988 to 1993 (prior to the special

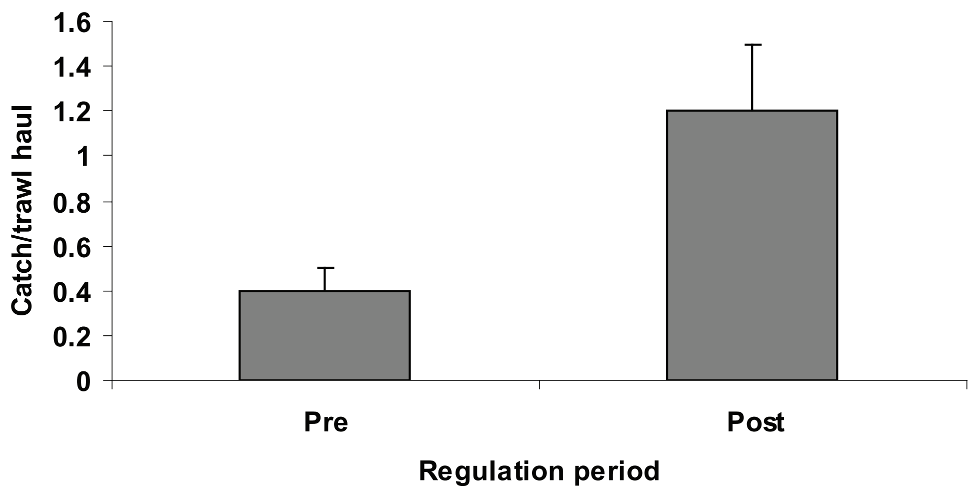

Figure 5. Mean catch/trawl haul (+1 SE) of young-of-year Smallmouth Bass during a period of closed spring fishing (Pre; 2001–2006) and a period of spring catch-and-immediate-release fishing (Post; 2007–2012), in Oneida Lake, New York.

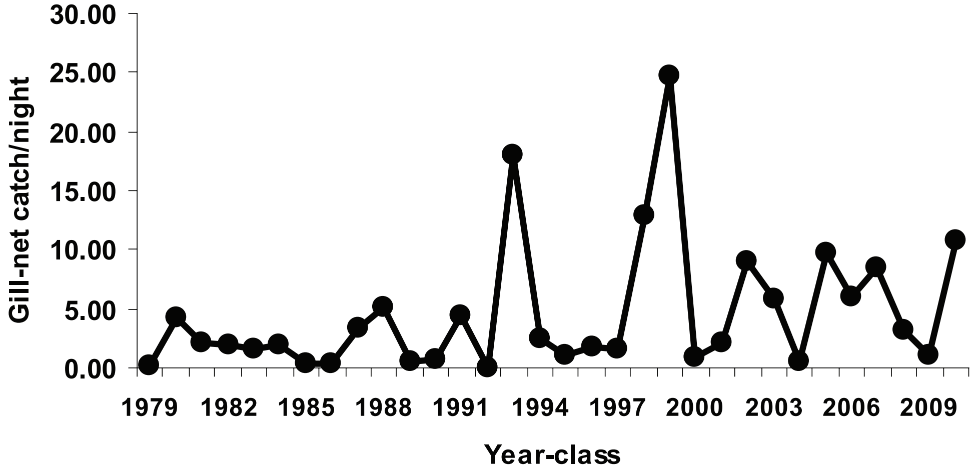

Figure 6. Mean gill-net catch/net-night of age-2 Smallmouth Bass in New York waters of Lake Erie, 1981–2012 (reflecting year-classes from 1979 to 2010).

season) was 64,000 h. From 1994 to 2006, when the 381-mm size limit was in effect, annual effort for black bass increased to 141,000 h. It declined to 78,000 h from 2007 to 2012, after the minimum size was increased to 508 mm.

Discussion

Closed seasons to protect spawning Largemouth Bass and Smallmouth Bass are currently utilized in only a few states, predominantly in the northern portions of the species' ranges. While angler attitudes are variable, many states with closed seasons receive requests for more liberalized regulations, and current justifications for closures generally lack strong or consistent support in the published literature (Quinn 2002). Nonetheless, growing evidence of potential genetic selection related to angling guarding males (Suski and Philipp 2004; Philipp et al. 2009) combined with current and future perturbations associated with invasive species and climate change dictate that potential impacts of regulations be care-

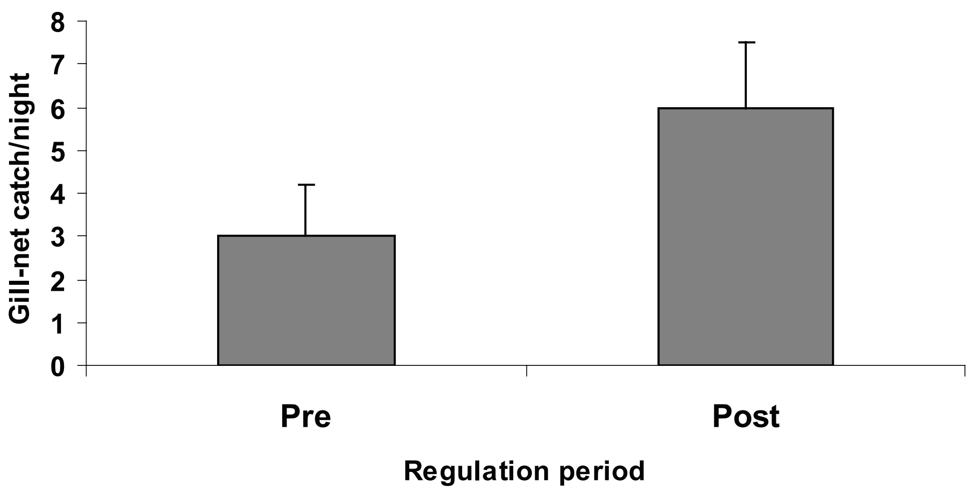

Figure 7. Mean gill-net catch/net-night (+1 SE) of age-2 Smallmouth Bass reflecting year-classes during a period of closed spring fishing (Pre; 1979–1993) and a period with special spring regulations (Post; 1994–2010), in New York waters of Lake Erie.

fully considered. While potential impacts on individual nests of removing guarding males are well established (Neves 1975; Kieffer et al. 1995; Philipp et al. 1997; Suski et al. 2003), threats of spring fishing to the sustainability of black bass fisheries are more appropriately assessed at the population level (Quinn 2002). Due to the time frames involved to accurately assess potential impacts of spring fishing on population recruitment levels, controlled experimental studies are often unfeasible. To our knowledge, before-and-after assessments of recruitment impacts due to spring fishing for black bass are lacking in the published literature.

Changes to more liberalized spring fishing regulations for black bass in New York State included waters where long-term monitoring of young-of-year black bass abundance or indexing of year-class strength were already in place, facilitating before-and-after assessment of potential population level impacts on year-class production. Our results provide no evidence that opening of these waters to spring fishing has had a negative impact on year-class production of black bass. In two systems, year-class production of Smallmouth Bass actually exhibited statistically significant increases following liberalization of black bass regulations, with indices of year-class size doubling in the New York waters of Lake Erie and tripling in Oneida Lake following opening of a spring fishing season. No significant changes in black bass year-class size were detected in Canadarago Lake. Based on available creel data from Oneida Lake and Lake Erie, angling effort increased in response to creation of spring fishing opportunities, so our results occurred despite apparent increases in black bass angling during the nest guarding season.

In the cases of Oneida Lake and Canadarago Lake, regulation changes allowing spring black bass fishing represented the most conservative approach other than a closed season. Catch-and-immediate-release regulations, assuming high angler compliance, have the potential to reduce nest predation and nest abandonment by males by minimizing time off the nest, thereby reducing nest loss and potential selective impacts (Neves 1975; Kieffer et al. 1995; Philipp et al. 1997; Suski et al. 2003). Regulation changes on Lake Erie, by contrast, not only opened fishing during the nesting season, but also allowed limited harvest. The intent of the one fish creel limit accompanied by a higher minimum length limit on Lake Erie was to allow harvest of a trophy, but we observed that even a restrictive 1-fish limit was enough to trigger tournament fishing, so potential nest impacts included both measured harvest and delayed release. The increased minimum size for harvest in Lake Erie would have presumably concentrated harvest on the largest fish, potentially increasing the likelihood of negative impacts on year-class production over the long term (Parkos et al. 2011). However, our results show the opposite; year-class production has increased in Lake Erie since institution of the spring special season. It should be further noted that observed increases in year-class production in Lake Erie after the special season was opened cooccurred with establishment of Round Goby, an invasive species previously shown to be a highly capable nest predator when male black bass are removed from nests (Steinhart et al. 2004).

It is highly unlikely that our observed increases in year-class production of Smallmouth Bass in Oneida Lake and Lake Erie were a direct result of liberalized regulations allowing spring fishing. Both systems have undergone changes throughout the period our study covers. Reductions in nutrient inputs and establishment of Driessenid mussels have resulted in increases in water clarity in both systems, conditions that have been documented as favoring black bass over other native piscivores such as Walleye (Robillard and Fox 2006). Similarly, summer water temperatures have increased significantly in both systems (Einhouse et al. 2002; Jackson et al. 2008). Previous studies have shown that at the latitudes of our study waters, year-class strength of Smallmouth Bass is positively correlated with summer water temperatures (Casselman et al. 2002). Similarly, Einhouse et al. (2002) found a significant correlation between water temperatures experienced by young-of-year Smallmouth Bass and recruitment to the age-2 index in Lake Erie. In Oneida Lake, we have observed a significant, but weak relationship between summer water temperatures and age-0 Smallmouth Bass trawl catches, and long-term increases in the Smallmouth Bass population have cooccurred with increasing summer water temperatures (Jackson et al. 2012). Canadarago Lake has experienced similar changes in water clarity and summer temperatures as our other two study waters. While this has not led to significant changes in black bass production, environmental conditions may also contribute to our failure to observe impacts of spring fishing in Canadarago Lake (Brooking et al. 2007).

Our assessment of black bass year-class production in New York waters before and after implementation of spring fishing seasons revealed no evidence that angling during the nesting season had any negative impact on young-of-year production or recruitment. These results suggest that while nest-specific impacts may occur when guarding males are removed from nests, this does not necessarily translate to population level effects. Environmental changes over the period of our study likely contributed to observed post-regulation change production increases, suggesting that any effects of spring angling were completely overshadowed by environmental conditions. Our results suggest that in large lake systems, providing spring fishing opportunities for black bass does not appear to involve undue risk to the sustainability of black bass fisheries.

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