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Black Bass Fishing Seasons in Michigan: Background, Research Review, and Recommendations

Mary T. Bremigan, Gary L. Towns, James E. Breck, Neal A. Godby, Scott K. Hanshue, Robert C. Moody, Thomas J. Rozich, and Michael V. Thomas

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Black Bass Fishing Seasons in Michigan: Background, Research Review, and Recommendations

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Introduction

The Michigan Department of Natural Resources (MDNR) is committed to the conservation, protection, management, use, and enjoyment of the state's natural resources for current and future generations. The mission of Fisheries Division is "to protect and enhance the public trust in populations and habitat of fishes and other forms of aquatic life, and promote optimum use of these resources for the benefit of the people of Michigan." Therefore, Fisheries Division works to maximize recreational fishing opportunities where possible, while ensuring the sustainability and quality of sport fish populations, and the ecosystems in which they live.

Michigan has two species of black bass: largemouth bass *Micropterus salmoides* and smallmouth bass *M. dolomieu*. The harvest season for largemouth bass and smallmouth bass in Michigan is set by statute. Similarly, statutory provisions prohibit fishing for or targeting species outside of the open harvest season. Over the years, bass angling groups have expressed a desire to extend the fishing season for black bass. In lieu of pursuing statutory changes, a study of six lakes was conducted by Fisheries Division in 1988–90 to estimate impacts on bass populations from preseason fishing. Although this study detected no “catastrophic” effects on bass fisheries or bass recruitment, inadequacies of the study design and lack of resources available for sampling prevented rigorous examination of the effects of early season catch-and-release fishing during the bass nesting season on bass fisheries and recruitment.

It became obvious that the study of six lakes mentioned above did not provide the answers needed to determine whether a change in the bass season throughout the state was warranted. Therefore, beginning in 2002, Fisheries Division sought to integrate a wider knowledge base (professional experience and literature review) to evaluate black bass seasonal regulations and the potential effects of an expanded fishing season. At statewide meetings in 2002 and 2003, field and research fisheries biologists discussed the issue at length, reviewed the literature, and entertained presentations by governmental and university researchers from Michigan, Ohio, Indiana, and Ontario, Canada. Several members of the Michigan biologists group (representing division managers and researchers, as well as university faculty) were chosen to serve on the newly formed Smallmouth and Largemouth Bass Regulations Committee (SALBRC). We (the committee) were directed to evaluate current seasonal bass regulations in Michigan and to determine if seasons could be altered to allow for more recreational bass fishing opportunity, without placing undue risk on the sustainability and quality of bass fisheries and their associated fish populations and aquatic ecosystems.

This document summarizes our comprehensive assessment of potential black bass seasonal regulations in Michigan and recommendations that we provided to the division. In particular, we sought to anticipate the potential benefits and risks associated with allowing bass fishing prior to Memorial Day weekend. Doing so would substantially increase the extent to which fishing occurs while black bass are nesting. This issue is a controversial one for both ethical and biological reasons. The decision is made more difficult by existing uncertainties regarding the biological effects of fishing during the nesting season on the sustainability of black bass populations and quality of fishing opportunities in Michigan. The uncertainty regarding the effects of any early season extension on black bass populations requires that the risk of negative effects be characterized as well as possible and weighed against expected benefits of such a regulation change. For example, we agreed that an increase in fishing opportunities (by increasing the duration of the bass fishing season) would not be acceptable if it was likely to substantially reduce the quality (i.e., size structure and density) of bass fisheries. In addition, we sought to identify regulations that could (a) be easily understood by the general public, (b) be applied to most, if not all, bass waters of the state, and (c) simplify enforcement.

In this document, we first provide an overview of the ecological, social, and economic components of the issue upon which our recommendation was based. We then consider Michigan regulations past and present in the context of trends in regulations throughout North America. After providing an overview of black bass biology, we summarize the literature most relevant to the biological effects of fishing during the nesting season on bass populations (specifically, bass recruitment and adult survival). We then integrate this information to characterize the expected benefits, risks, and uncertainties associated with several different management scenarios. Our recommendation was based on this exercise. We close by summarizing the remaining uncertainties that must be addressed (and recommended approach to research) before additional improvements or modifications to black bass regulations can be achieved.

It should be noted that our committee’s efforts occurred during 2003 and 2004. In 2005, subsequent to writing this report, an angler opinion survey was conducted, SALBRC was disbanded, and a meeting between Fisheries Division personnel and the external Coolwater Regulations Steering Committee was conducted. The Fisheries Division Management Team used this report, the angler survey, and additional public feedback to produce their recommendation to the Natural Resources

Commission in fall 2005, which resulted in new regulations (scheduled to "sunset" after five years) taking effect in 2006. These new regulations will allow catch and release of largemouth and smallmouth bass from the last Saturday of April (Lower Peninsula) or May 15 (Upper Peninsula) until the harvest season begins on its 'traditional' day of the Saturday of Memorial Day weekend. These events, discussion, and final decision relating to this new regulation, which occurred subsequent to our 2003–04 efforts as a committee, will be summarized in a forthcoming Fisheries Division document.

Ecological Significance of Black Bass

Black bass in Michigan are ecologically important. Both species of black bass, largemouth bass and smallmouth bass, are native predators found in a wide variety of habitats throughout the state. Black bass are opportunistic foragers, allowing them to take advantage of a wide range of prey items. Large black bass are efficient piscivores (meaning they consume fish), playing a pivotal role in the food web dynamics of north temperate lakes. They co-evolved with the native panfish species in Michigan waters and, under most conditions, facilitate healthy panfish populations, with favorable size structure, through predation. By promoting balanced panfish populations, black bass indirectly help reduce panfish predation on large zooplankton, which helps maintain clear water, thus encouraging healthy aquatic plant communities (Carpenter and Kitchell 1993; Mittelbach et al. 1995; Power et al. 1996). For example, whole-lake experiments in northern Wisconsin have demonstrated that changes in largemouth bass populations can cause three-fold changes in phytoplankton biomass and primary production (Carpenter et al. 1987; Carpenter and Kitchell 1993). Because phytoplankton determine water clarity, in large part, largemouth bass have been recognized as "keystone" species in north temperate lakes, meaning that they have a disproportionately large effect on lake ecosystems.

Black bass predation likewise influences the species composition of fish communities (Lewis and Helms 1964; Tonn and Magnuson 1982). Black bass prefer soft-rayed fishes, such as minnows, over spiny-rayed fishes, such as bluegill and pumpkinseed. When bass are abundant, the abundance of minnows is usually very low, because of direct predation on these preferred prey and because of indirect effects on the prey (Carpenter et al. 1987).

Black bass cause changes in the behavior of their prey. When these important predators are abundant in a lake, potential prey alter their own behavior, reducing the chance of being eaten. Such changes in behavior have been observed in a variety of bass prey, including sunfish *Lepomis* spp. (Mittelbach 1986; Mittelbach and Chesson 1987; Mittelbach and Osenberg 1992), minnows (Carpenter et al. 1987), and crayfish (Stein 1977). One such change in behavior involves change in habitat use. When largemouth bass are present in lakes or ponds, juvenile sunfish of several species and minnows stay predominantly in the littoral zone, where their growth rates are lower but where they are less vulnerable to bass than in the open-water zone (Werner et al. 1983; Werner and Gilliam 1984; Mittelbach 1986; Carpenter et al. 1987). Such influence of bass predators on juvenile prey fish links the population dynamics of those species, even when the adults have distinct food resources (Mittelbach and Chesson 1987; Mittelbach and Osenberg 1992).

Although large black bass are important predators of panfish such as bluegill, small juvenile bass are competitors of juvenile panfish. Juveniles of several species of fish can be found in the littoral zone of lakes, and there can be significant competition among the species. High densities of juvenile panfish can depress the density of aquatic insects and other prey so much that juvenile bass grow slowly and delay their shift to piscivory (Olson et al. 1995). As a result, if panfish abundance increases due to poor predatory control by a reduced bass population, the ability of bass population abundance to recover, through increased recruitment, may be hampered by competition between juvenile bass and juvenile panfish.

Past and ongoing research initiatives demonstrate that effects of bass on lake food webs and water quality are complex and of fundamental importance to lake ecosystems. Thus, maintaining the abundance, size structure, and genetic integrity of bass populations are key components to management of aquatic ecosystems in Michigan.

Social and Economic Significance of Black Bass Fisheries

Fishing for black bass is a major recreational activity in Michigan and across a large region of North America. There are approximately one-half million anglers in Michigan who predominately fish for black bass, representing ~30% of all state licensed anglers (USFWS 1999, USFWS and USBOC 2001). In fact, Michigan ranks 11th nationally in number of bass anglers. Angler-days spent fishing for bass in Michigan account for nearly 23% of the annual total in Michigan (i.e., nearly 4.7 of 19.8 million; USFWS 1999; USFWS and USBOC 2001). Even on the Great Lakes and connecting waterways, where fishing opportunities are exceptionally diverse, black bass rank third in terms of number of anglers and first in effort (days of fishing). As individuals, these anglers spend an average of 13 days per year pursuing bass and invest $642 annually in this pursuit. An estimate of the total economic impact of bass fishing activity in Michigan, $321 million annually, should be considered a minimum given that bass fishing is probably the most heavily marketed fishery of all species and most sponsored fishing tournaments are directed at bass (Schramm et al. 1991). For the entire U.S., there are approximately 11 million bass anglers who spend over $12.8 billion annually, an average exceeding $1000 per angler (B. Shupp, Bass Angler Sportsmen's Society [B.A.S.S.], personal communication). With more than 1,000 tournaments per year, Michigan ranks fourth in the nation, and is the only northern state in the top five tournament states (Kerr and Kamke 2003). By itself, this is a powerful statistic, which attests to the quality of Michigan’s aquatic resources in general and to its bass fisheries in particular. Currently we have no definitive numbers on the trend of bass fishing tournaments in Michigan, although they are likely increasing given general trends. Tournaments are increasing nationwide (B. Shupp, B.A.S.S., personal communication; Wilde 2003), and in another top-five tournament state (Oklahoma), fishing tournaments increased by 55% between 1994 and 1998 (Gilliland 1998).

Despite the increasing abundance of tournaments and visibility of tournament anglers, organized bass anglers represent a relatively small, unique subgroup of the half million bass anglers in Michigan. According to recent statistics (R. Spitler, Michigan Chapter-B.A.S.S., personal communication), there are currently 70 B.A.S.S. Federation clubs in Michigan, with a total membership of about 1,000 people. Although it is estimated that there are approximately 20,000 avid bass anglers in Michigan, of that subgroup, only about 2,000 regularly compete in bass tournaments. Viewed within the context of all anglers, these data indicate that avid bass anglers constitute 1.25% of Michigan's 1.7 million anglers, and regular tournament fishers make up only 0.1% of Michigan's fishing population. Tournament anglers tend to be younger, fish roughly twice as much, belong to a club, and perceive themselves as more skilled than non-tournament anglers (Wilde et al. 1998). In addition, compared with non-tournament anglers, competitive fishers in Texas place greater importance on catching larger, trophy-sized fish, developing their skills, winning a prize, and enjoying the challenge of the sport. Further, tournament anglers place less emphasis on keeping fish and are more likely to believe that bass released from tournaments survive. Though the Wilde et al. (1998) study only evaluated black bass anglers in Texas (another top-five fishing tournament state), the results suggested that the behaviors and attitudes of tournament anglers differ from those of non-tournament anglers, regardless of the target species. In contrast, generalized anglers tend to value the contemplative aspects over the competitive aspects of fishing. For example, in a Michigan study (Driver and Knopf 1976), warmwater lake anglers ranked the following motivations for fishing, in decreasing order of importance: experiencing nature, escaping, making a mental change, exploring, avoiding others’ expectations, enjoying family, releasing tension, achieving, keeping fit, dominating or controlling, and thrill seeking. Similarly, black bass anglers in Texas, as a whole, gave high marks to experiencing natural surroundings, getting away from other people, recreating with family, and experiencing the catch as motivational factors in their fishing activities (Fedler and Ditton 1994). Given the different motivations of these two broad groups, it is perhaps not surprising that non-tournament anglers perceive that bass tournaments negatively affect their fishing experiences, regardless of whether or not released fish survive (Wilde et al. 1998). As resource managers, we need to recognize that we need more specific information from both our tournament and non-tournament anglers in terms of basic fishery statistics (i.e., catch, effort, and harvest rates) and human dimensions data (i.e., perceptions, motivations, and expectations of the resource; see **Research Needs**).

Black Bass Fishing Regulations

North America

Regulations that aim to restrict bass harvest or bass mortality through seasonal restrictions vary widely across the nation (Table 1). Quinn (2002) summarized the national status of bass seasonal restrictions in the year 2000. He reported there were 35 states, mostly southern and western states (primarily outside the native range of largemouth bass, see **Black Bass Biology**), which generally imposed no specific season closures on black bass fishing. A few other states had only minor seasonal restrictions. For example, Idaho, Missouri, and Montana all manage a minority of their waters with seasonal restrictions and/or restrictive minimum size limits and possession limits to promote increased abundance of large bass. In contrast to the southern and western states, the majority of states in the northeastern U.S. and Canadian provinces routinely employ regulations that are more restrictive. Five states (Maine, Michigan, Minnesota, New York, and Vermont) and the province of Ontario had some period of closed bass season in 2000. Quinn (2002) reported that six states, primarily in the northeast U.S. (New Hampshire, Vermont, Pennsylvania, Maryland, New Jersey, and Hawaii) had catch-and-release-only seasons for black bass during the spring. Some states applied special stipulations to their catch-and-release seasons such as no live bait (New Hampshire and Vermont) or no targeting of bass on nests (Pennsylvania). In addition, several other northern states (Minnesota, Wisconsin, and New York) have established special catch-and-release regulations for selected waters, and the Canadian province of Ontario has enacted season restrictions and spawning sanctuaries to protect bass populations. More recently, Ohio has proposed a spawning season harvest restriction on its Lake Erie waters, and Illinois has invoked a spawning season closure on most of its major rivers (see Scenario 5).

It is noteworthy that the total complement of regulations for black bass across these various jurisdictions is highly diversified. Length limits are used by some states (generally 10 to 14 in) to restrict harvest, while others have no length limits. Daily possession limits for summer harvest seasons range from three to six fish across northeastern states. Even the opening date of the harvest season, for those states with closed seasons, varies widely. Among those northeast states with statewide, early catch-and-immediate-release seasons for black bass, the statewide harvest season opens in mid-June (Maryland, New Hampshire, New Jersey, Pennsylvania, and Vermont). Overall, relatively late harvest openings (e.g., mid-June) that occur substantially later than Michigan’s Memorial Day weekend opening likely reflect an effort on the part of fisheries managers to compensate for the increased mortality from hooking by early season catch-and-release anglers. Viewed across the contemporary distribution of black bass, regulations are more restrictive in the northern areas of the species’ native range, reflecting geographic gradients in climate and overall productivity of aquatic systems. Further, the high degree of diversity in regulations used to manage bass fisheries across the northeastern portion of the country reflects not only the wide range of habitats supporting bass fisheries in that region, but also regional diversity in bass anglers, and some level of uncertainty by fisheries managers about the risk to local bass populations associated with statewide early season catch-and-release fishing. As described later in **Effects of Early Season Fishing on Quality and Sustainability**, predicting mortality rates throughout the season continues to challenge fisheries managers, and likely underlies the variation in regulations that is present today.

Michigan

Seasonal restriction of bass fishing in Michigan has become a controversial fisheries management tool. A vocal component of Michigan bass anglers desire relaxed seasonal restrictions, allowing additional bass fishing opportunities, particularly prior to the present legal harvest season opening date (last Saturday before Memorial Day). Some of these anglers are proponents of legal catch-and-immediate-release (CIR) fishing during an extended spring season, while others desire more catch-and-keep or catch-and-delayed-release (CDR) fishing during an extended spring season. Still others oppose season expansion, expressing concern that fishing over nesting bass may be detrimental to the fishery.

Michigan's black bass season and size limits have undergone considerable changes since regulations were first invoked in the early 1900s. The first minimum size limit established was 10 in in 1932 and the daily possession limit was five bass (Table 2). The minimum size limit became more restrictive through time—changing to 12 in in 1976, to 14 in in inland waters in 1993, and to 14 in in Great Lakes waters in 1995. With a few exceptions, daily possession limits have been five fish in combination with walleye *Sander vitreus* and northern pike *Esox lucius*. Bass seasons have also varied from an all-year harvest season in the early 1800s to a May 20 opener in 1900 (Table 3). In 1909, the opening day of bass season was changed to June 15, then in 1929 the opening day was further delayed to June 25. In 1951, the season changed to the 3rd Saturday in June and remained there for most waters until 1962 when it was changed to June 1. In 1968, bass seasons in the St. Clair System (defined here as the St. Clair River, Lake St. Clair, and the Detroit River) remained with mid- to late-June openers, while the remainder of the state went to seasons with late May opening days (Table 2).

Bass fishing in Michigan is currently regulated with a mixture of closed seasons, size limits, and possession limits, in part due to the diversity of perspectives regarding bass populations and their management. In the majority of Michigan waters, the minimum size limit is 14 in, allowing nearly all black bass the opportunity to spawn at least once prior to legal harvest (see **Black Bass Biology**). The daily possession limit is five fish, in combination with other predators such as walleye and northern pike. The possession season (except on some select waters) is from the Saturday of Memorial Day weekend through December 31 (with the exception of a 3rd Saturday in June opening in the Lake St. Clair System). During the closed season, it is illegal to harvest, possess, or attempt to catch bass. The closed season is intended to restrict harvest and possession during spring, when nesting males are particularly vulnerable to fishing (see **Effects of Early Season Fishing on Quality and Sustainability**), thus providing some reduction in total annual fishing mortality. The closed season is also intended to promote bass recruitment to some degree, by minimizing angler disruption of spawning and nest-guarding males.

In addition to the statewide bass season regulation, special seasonal regulations for bass fishing are in place for various waters across the state. Since 1988, a special early bass season has been in effect for six large southern Michigan lakes (Appendix). On these lakes, CIR fishing for bass is legal from April 1 until the Saturday of Memorial Day weekend (the statewide possession season opening day). A total of 16 other lakes are managed with special seasons to provide quality or trophy bass fishing opportunities. Many of these lakes are year-round CIR-only lakes, or lakes with very restrictive possession and size limits.

The protection afforded to spawning bass by the statewide closed season in Michigan varies greatly depending upon the geographic location within the state and annual variation in spring warming rates. During years with early spring warming, many bass in southern Michigan will complete spawning and nesting activity prior to the season opener. However, in many northern waters, black bass will still be guarding nests in early June. During a year with a cold, delayed spring warm-up, much of the bass spawning in the state may occur after the current season opener. As summarized in **Black Bass Biology**, bass recruitment may be strongest in years when spawning occurs relatively early, resulting in large age-0 fish in the fall that enjoy comparatively high overwinter survival. Therefore, in Michigan, cool years may represent a double threat to bass recruitment in the form of (a) delayed spawning (resulting in smaller age-0 fish in the fall that experience higher overwinter mortality), and (b) increased hooking and harvest mortality due to a greater proportion of the nesting season occurring after the opening of the bass fishing season.

Compliance issues.–The only available data on the level of compliance with the Michigan closed season come from Schneider et al. (1991). These authors reported that 44% of general anglers and 69% of bass anglers regularly fished for bass during the closed season on six southern Michigan lakes. MDNR, Law Enforcement Division does not have compiled records of ticketed violations of closed bass seasons. Anecdotal reports and biologists' observations suggest that compliance has been decreasing in recent years. Moreover, an informal poll of Michigan conservation officers in the southern districts showed agreement that preseason fishing for bass (i.e., non-compliance with the existing season) has been increasing. To quote one synopsis, “Compared to the early 90s, the preseason bass fishing has doubled or even tripled on some lakes. The bad thing that occurs is that these fishermen are targeting bass on their beds.” During April and early May, when the season for northern pike, walleye, and panfish is open, some anglers illegally target black bass for CIR fishing under the guise of fishing for another species. This practice creates a particularly difficult law enforcement situation for conservation officers who must interpret the intent of the angler. Furthermore, Law Enforcement Division is concerned that most county judges and prosecutors would not entertain an “attempt to take fish during closed season” charge because the chance of proving the case is slight, in light of the fact that anglers can legally be fishing for other large predators beginning the last Saturday in April each year.

Likewise, other jurisdictions have reported significant levels of non-compliance with bass seasons. In several Ontario water bodies, for example, average percentage of anglers targeting spawning bass has ranged from 19 to 63 percent (Philipp et al. 1997; Kubacki et al. 2002). In fact, Philipp et al. (1997) concluded that compliance in closed fishing areas can be so minimal that illegal fishing can substantially reduce bass fry production. The identified mechanism was nest abandonment, and was exacerbated by longer angler handling times and predation on fry in unguarded nests. These researchers felt that preseason, illegal fishing was becoming so pervasive that they recommended fisheries managers consider progressive seasonal regulations such as extending closures, length limits, and sanctuaries for the entire province. Other upper-Midwest jurisdictions such as Pennsylvania, Ohio, and Indiana have instituted, or are considering instituting, increasingly conservative management approaches in recognition of new or increasing pressures on their bass fisheries.

Black Bass Biology

Largemouth and smallmouth bass are nearly ubiquitous in Michigan’s cool- and warm-water habitats. Maps of the geographic distribution of these species can be found on the MDNR web site (http://www.michigan.gov/dnr, then choose Publications & Maps | On-line Maps | Fish Atlas). A good understanding of the life history of these species is integral to their management. For example, each of them has life history characteristics that may make them especially vulnerable to fishing pressure at certain times of the year. A brief overview of largemouth and smallmouth bass habitat requirements, population characteristics, and reproductive biology is presented below.

Habitat Requirements

The native range of largemouth bass is the broadest of the black basses and extends from the Atlantic coast west to central Texas. The northern edge of the range includes the Great Lakes basin, exclusive of Lake Superior but including the upper St. Lawrence River (MacCrimmon and Robbins 1975). The species has been introduced and naturalized in many waters outside its native range, including waters in Michigan's Upper Peninsula (Becker 1983), and is now found across the continent from the Gulf Coast to the southern fringe of Canada (MacCrimmon and Robbins 1975) . The largemouth bass is one of the most widely distributed sport fish in Michigan. The habitat of largemouth bass is primarily lakes, ponds, oxbows, and areas of quiet flow in river systems. This species does best in clear waters with abundant vegetation (Trautman 1981). Considered a warmwater species, the largemouth bass prefers water temperatures of 81–86°F (Becker 1983). However, the largemouth bass is intolerant of low dissolved oxygen concentrations and is therefore susceptible to winterkill in its weedy, high-oxygen-demand habitat (Tonn and Magnuson 1982; Magnuson et al. 1998).

In general, largemouth bass can be characterized as an opportunistic predator, with feeding habits that vary somewhat predictably with bass life stage. Foods of fingerling largemouth bass consist of small crustaceans such as copepods, cladocerans, and ostracods. As bass approach 2–3 in long, fish, insects, and aquatic insect larvae become part of the diet. Although adult largemouth bass are primarily fish-eating predators, prey such as crayfish, insects, amphibians, and small mammals are also included in their diets (Mraz et al. 1963; Scott and Crossman 1973; Heidinger 1975).

Smallmouth bass were originally limited in range to eastern central North America, but have been widely stocked elsewhere (Scott and Crossman 1998). The smallmouth bass is a native species common to many Michigan water bodies, and is found in both flowing and static environments. Unlike the warm, weedy lakes and slow moving rivers preferred by the largemouth bass, cooler lakes, streams, and rivers are preferred by smallmouth bass. Lakes that hold populations of smallmouth bass are generally over 100 acres in size, over 30 feet deep and thermally stratified, and have clear water and large areas with rock or gravel substrate (Coble 1975; Scott and Crossman 1998; Olson et al. 2003). In flowing environments, smallmouth bass prefer cool, clear rivers with moderate current, rock and gravel substrate, and nearby cover (Coble 1975). The preferred temperature of smallmouth bass is 68.5–70.3°F (Scott and Crossman 1998). Similar to largemouth bass feeding habits, diet of smallmouth bass also changes as the fish grows. Young bass typically eat copepods and cladocerans, changing to insects and small fish as they grow. Crayfish, insects, and small fish comprise the diet of adult smallmouth bass (Carlander 1977).

While both largemouth and smallmouth bass are distributed throughout Michigan, largemouth bass are more typically found in lakes and smallmouth bass are more typically found in rivers. There are, however, many lakes with excellent smallmouth bass populations, particularly in the northern part of the state. Smallmouth bass are also widely distributed in the nearshore zone of Michigan's Great Lakes waters.

Health Issues

Both largemouth and smallmouth bass are most vulnerable to predation early in their life cycle. Predators on bass eggs and larvae include a variety of native fishes (white sucker *Catostomus* *commersonii*, several species of sunfish, rock bass *Ambloplites rupestris*, yellow perch *Perca flavescens*, and bullhead catfishes *Ictaluridae* spp.) and exotic fishes (common carp *Cyprinus carpio* and round goby *Neogobius melanostomus*), as well as turtles and crayfish (Carlander 1977; Scott and Crossman 1998; Steinhart et al. 2004). Predation on bass eggs and larvae increases when the guarding adult male is removed from or abandons the nest, which is discussed further under **Effects of Early Season Fishing on Quality and Sustainability**.

Largemouth and smallmouth bass are parasitized by a wide variety of organisms including protozoans, nematodes, tremetodes, cestodes, leeches, chestnut lamprey, mollusks, and crustaceans. Of particular concern are those that affect the quality of the flesh (such as black spot and yellow grub) and the bass tapeworm, which can result in sterility of the infected bass and reduce reproductive potential of the affected population (Scott and Crossman 1973; MacCrimmon and Robbins 1975).

An emerging issue: largemouth bass virus.–A recent concern for bass management has been the sudden spread of a new fatal virus. Largemouth bass virus (LMBV) was first discovered in the U.S. in 1995 in the Santee-Cooper Reservoir of South Carolina, where an estimated 1,000 largemouth bass died. The virus has now been found in 17 states. The first reports of this disease in Michigan occurred in 2000 on Lake George, Branch County. It has since been confirmed in several other Michigan lakes. Of 16 lakes tested across southern Lower Michigan in 2002, five were positive for the virus and two of these lakes, which supported popular bass fisheries, suffered significant adult bass mortalities. Reports of significant bass kills in other states are growing. Although indications are that most populations will recover within a few years, not enough is known about the virus to determine if it will have long-lasting effects on bass populations. Fish pathologists suggest that reduced stress on bass populations, especially during the warm summer months, will help bass to be more resistant to the disease. Considering the very important predatory role of largemouth bass in inland lakes, and their importance as a game species, this new disease threat must be treated as another potential risk to bass fisheries when considering management options.

Abundance, Growth Rates, and Mortality Rates

Our (SALBRC's) primary charge has been to anticipate the likely effects of early season fishing on the quality (size structure and density) and sustainability (recruitment) of bass fisheries. Size structure is determined by growth and mortality rates. Recruitment is driven by aspects of adult abundance, fecundity, nesting success, and first year survival. Below, we review the extent to which these population characteristics and rates vary across Michigan waters, in particular, and across the geographic range of each species, more generally. Subsequently, we review the literature regarding the effects of early season fishing on these factors that underlie the quality and sustainability of black bass fisheries.

Black bass abundance is highly variable among aquatic systems, although some general patterns relating abundance to key environmental variables are apparent. The largemouth bass attains its greatest abundance in shallow weedy lakes, drowned-river mouths, and backwaters. Population estimates for largemouth bass exceeding 10 in reported for four southern Michigan lakes ranged from 9 to 50 bass per acre (Goudy 1981). Population estimates for six relatively small (<80 acres) Upper Peninsula inland lakes reported by Wagner (1988) ranged from 1 to 40 individuals per acre and averaged 15.3 per acre. Wagner (1988) concluded that abundance of largemouth bass in southern Michigan lakes was four times greater than in Upper Peninsula lakes and biomass was approximately five times greater. Population densities also differ between exploited and unfished lakes. For example, following the 5-year experimental fishery closure of 136-acre Mill Lake in Washtenaw County, the largemouth bass population was reduced from approximately 14.4 to 8 legal (10 in or greater) bass per acre in 3 days of fishing (Schneider 1973). During those first 3 days after the fishery was re-opened, 685 bass were harvested, representing 35% of the 1,958 bass estimated to be in the lake when it was re-opened to fishing. Similarly, Little Rock Lake in northern Wisconsin was closed to fishing from 1984 to 1990. During the study period, largemouth bass did not become more abundant; however, annual survival increased from 20 to 70 percent leading to an increase in average age and size.

While some eutrophic lakes in Michigan hold populations of smallmouth bass, more often, large, cool, clear lakes with rocky substrates will harbor greater densities of this species than shallow, warm, weedy, turbid lakes. Densities of legal-sized smallmouth bass in Upper Peninsula and northern Lower Peninsula lakes have ranged from 0.9–18.5 individuals per acre in exploited lakes, whereas unexploited populations in the Upper Peninsula can reach densities of 22.6 legal smallmouth bass per acre (J. Schneider, MDNR, unpublished data). The minimum legal size at the time of Schneider's study was 10 in. In comparison, the average density of smallmouth bass exceeding 10 in in the six lake experimental study of early season fishing (Appendix) was approximately 6.7 per acre. Smallmouth bass are also common in many river systems in the state. From 1982 to 1989, several rivers were sampled using rotenone. Of six southern Michigan rivers sampled, the mean density of legal-sized (>12 in) smallmouth bass at stations where smallmouth bass were present ranged from 1 per acre in the Paw Paw River to 4.25 per acre in the Battle Creek River (Towns 1984, 1985, 1987, and 1988; Dexter 1991; Wesley and Duffy 2003).

Similar to abundance, bass growth rates are highly variable and correlated with several environmental factors. Beamesderfer and North (1995) analyzed data from 698 populations of largemouth bass (from 42 states and provinces) and 409 populations of smallmouth bass (from 34 states and provinces), spanning the geographic range of each species in the U.S. and Canada. The age at which largemouth bass reached 11.75 in (300 mm) varied from 1 to 10 years; the age at which smallmouth bass reached 11 in (280 mm) varied from 2 to 9 years. For both species, these ages were positively correlated with latitude and negatively correlated with mean air temperature and degree-days exceeding 50°F. For largemouth bass, these ages were also positively correlated with elevation (i.e., grew slower at higher elevations). In addition, Scott and Crossman (1998) demonstrate that smallmouth bass growth rates vary across different parts of their distribution. For example, fall size of age-0 smallmouth bass increases from north to south (Scott and Crossman 1998). Across Michigan, temperature varies quite broadly, as evidenced by statewide patterns of frost-free days (Figure 1). Somewhat surprisingly, analysis of historic fish survey data collected by Fisheries Division (approximately 300 surveys spanning 1960–2000) indicates that size at age (an indicator of growth) does not differ predictably along a latitudinal gradient within Michigan, for either largemouth or smallmouth bass (Wagner et al. in press). Additional data entry and analyses are underway to better determine if growth rates consistently differ between the lower and upper Peninsulas.

For largemouth bass, feeding and growth cease below 50°F (Mraz et al. 1963). Therefore, in Michigan, growth of largemouth bass is seasonal and occurs June through September (Latta 1974). Based on statewide average growth information, largemouth bass attain legal harvest size of 14 in at an average of age 5. The MDNR, Fisheries Division conducts a Master Angler Program, which results in reports of trophy-sized fish, which meet certain minimum entry sizes for each species. The minimum entry lengths for a Master Angler catch-and-release fish are 22 and 21 in for largemouth and smallmouth bass, respectively. Individuals of this size likely exceed 10 years of age for both species (Schneider et al. 2000).

Reproductive Success and Recruitment

Recruitment is notoriously variable in fishes. Fisheries managers have long sought to determine what factors underlie this variability. In part, much emphasis has been placed on characterizing the relationship between abundance of adult stock (potential spawners) and subsequent offspring that recruit to the population. For both largemouth and smallmouth bass, there appears to be no strong relationship between stock size and number of recruits, except at very low levels of stock size. Kubacki et al. (2002) attribute this *apparent* lack of a stock-recruit relationship to three facets of bass life history. First, the percentage of adults in a bass population that attempt to spawn in a given year is variable and often represents a small fraction of the total (Raffetto et al. 1990). Secondly, those adults that do initiate spawning behavior in a given year experience variable mating success (fertilized eggs). Finally, the reproductive success for those nests receiving fertilized eggs is highly variable. Indeed, the pond experiments of Reynolds and Babb (1978) and Laarman and Merna (1980) showed no consistent relationship between the number of adult largemouth bass and the number of recruits. However, recent studies have begun to delineate empirical relationships for both species of bass (Buynak and Mitchell 1998; Svec 2000, cited by Kubacki et al. 2002). Similarly, using a modeling approach, Ridgway and Shuter (1997) found the abundance of age-0 smallmouth bass declined as the daily probability of capture of nesting males increased. Latta (1974) reviewed the literature on largemouth bass as he considered the implications of increasing Michigan's minimum size limit from 10 to 12 in, a statewide change that was implemented in 1976. In this 1974 review, Latta noted, "the relationship between spawning stock and size of the year class produced is unknown." Almost 30 years later, writing in the summary paper of the recent symposium on black bass, Ridgway and Philipp (2002) express a similar evaluation of our understanding as they comment specifically on the population effects of fishing nesting bass. "Because we lack any clear understanding of the nature of the spawner abundance and recruitment relationship in *Micropterus* species, the population level consequences of this activity remain unclear" (Ridgway and Philipp 2002, p. 722). Ridgway and Philipp (2002) urge fisheries managers to use caution, and quote Hilborn and Walters' (1992) review of stock and recruitment models in fisheries assessments as concluding, "Any fisheries manager who acts as if recruitment will remain constant as a fishery increases is foolish."

Stock-recruitment relationships are difficult to discern, in part, because so many factors can influence recruitment in addition to adult abundance. Intuitively, at some abundance level, and to some unknown extent, adult abundance must contribute to recruitment variability (i.e., zero offspring will be produced by zero adult density). In addition, recruitment of black bass can be influenced by many factors that affect egg production and age-0 survival through the first winter. Some factors may be much more influential than others, and the relative influence of various factors may differ among populations and among years. Generally speaking, the role of temperature in determining recruitment is potentially quite pervasive. Casselman et al. (2002) examined data from 1973 to 1999 on year-class strength of smallmouth bass in eastern Lake Ontario. They found that water temperature in July and August could explain 46% of the annual variation in relative year-class strength, with warmer summer water temperatures associated with larger year classes. Einhouse et al. (2002) also found summer water temperatures played an important role in determining age-0 abundance and subsequent year-class strength. Bryant and Smith (1988) found similar results for smallmouth bass recruitment patterns in Lake St. Clair in the 1970s and early 1980s. Likewise, Clady (1975) demonstrated a positive relationship between smallmouth bass year-class strength and June–October air temperatures during the first year of life in several Sylvania Tract lakes.

Although the quantitative relationships linking temperature and other environmental variables to recruitment continue to be investigated, some of the basic patterns are well understood. The number of young bass surviving their first winter will be the product of three main factors: (1) the abundance of fertilized eggs (a function of individual fecundity, age and size at maturity, and the number of adult spawners); (2) nesting success (a function of hatching success and subsequent survival of fry while on the nest); and (3) first summer-winter survival (post-nest survival of age-0 fish over their first summer and winter of life).

1. Abundance of fertilized eggs

Fecundity.–For largemouth bass, spawning takes place when water temperatures are 62–65°F. Estimates of largemouth bass fecundity vary widely. Scott and Crossman (1973) report egg counts ranging from 2,000–109,000 per female or 2,000–7,000 per pound of female, whereas Heidinger (1975) provides estimates ranging up to 80,000 eggs per pound of female. In their pond studies of southern Michigan largemouth bass, Laarman and Schneider (1985) found an average of 30,000 eggs per pound of female. Clady (1970) reported Upper Peninsula largemouth bass were less fecund than those in southern Michigan, producing about 10,000 eggs per female. A possible explanation for the wide range in fecundity estimates is the uncertainty associated with judging egg maturity (Laarman and Schneider 1985). A further complication in evaluating fecundity is that not all mature eggs may be released (Clady 1970). Although female age does not have a significant effect on fecundity (after accounting for female weight), fecundity appears to be density-dependent. Female bass growing in low-density situations produce more eggs per pound than female bass growing in high-density situations (Laarman and Merna 1980; Laarman and Schneider 1985). Female largemouth bass may spawn with several males on several different nests. Successful bass nests have been reported to contain approximately 5,000 to 43,000 eggs (Mraz et al. 1963; Heidinger 1975).

Smallmouth bass spawn at somewhat cooler water temperatures, typically 55 to 68°F (Scott and Crossman 1998), usually between late April and early July in Michigan. Estimates of smallmouth bass fecundity vary widely, but it is generally agreed that a female smallmouth bass can produce between 2,000 and 15,000 eggs, or as many as 7,000 eggs per pound of body weight (Coble 1975; Carlander 1977; Scott and Crossman 1998). Like other members of the sunfish family, the reproductive strategy of both largemouth and smallmouth bass is to lay relatively few eggs, but guard them well. Females of many other freshwater species that do not invest as much in parental care typically can produce many more eggs. A female walleye, for example, can produce up to 612,000 eggs, yellow perch up to 109,000 eggs, and northern pike up to about 97,000 eggs (Carlander 1969; Carlander 1977; Scott and Crossman 1998).

Size and age to maturity.–Body size influences age at maturity. In his review of largemouth bass literature, Heidinger (1975) reported sexual maturity of largemouth bass occurs when the females reach a length of approximately 10 in and that males mature at slightly smaller sizes. In a pond experiment in Michigan involving 271 largemouth bass, Laarman and Schneider (1985) reported for both sexes that all bass over 9.0 in which were 2 or more years of age were sexually mature. The results of a study of three Upper Peninsula lakes (Clady 1970) suggest potential regional differences in age of sexual maturity. In the studied populations, largemouth bass reached maturity at larger sizes and older ages (age 5) than southern Michigan populations. However, these results are from a small subset of lakes and may not be representative of northern Michigan largemouth populations.

For typical growth rates of largemouth bass in Michigan, size in May (before spawning begins) is 7.1 in for age-2, 9.4 in for age-3, 11.6 in for age-4, and 13.2 in for age-5 (Schneider et al. 2000). For fish growing at these average rates, age-2 males and females would not yet be mature, but all age-3 males and females would be mature. This means that in populations of largemouth bass growing according to the state average, many male and female largemouth bass would be able to reproduce for three years before entering the fishery (14-in minimum size limit) in the summer as age-5 fish, although not all sexually mature bass spawn each year (see *Number of individuals reproducing*).

Maturity for male smallmouth bass begins at ages 2–4, while females mature at ages 3-5 (Coble 1975). This corresponds to lengths of 7.5–14.4 in and 10.8–15.3 in in Michigan for male and female smallmouth bass, respectively (Schneider et al. 2000). Latta (1963) studied smallmouth bass at Waugoshance Point in northern Lake Michigan (45° 45’ N latitude). He found that males matured at about 10 in and females at about 12.5 in. Ridgway et al. (1991) examined smallmouth bass in Lake Opeongo, Ontario (45° 42' N latitude, about the same latitude as Waugoshance Point and Escanaba, Michigan), and determined that about 20% of the age-4 males were mature, about 78% of the age-5 and age-6 males were mature, and 100% of the age-7 and older males were mature. In Nebish Lake, Wisconsin, the fastest-growing male smallmouth bass matured as early as age-3 (as small as 7.9 in), whereas the slowest-growing males did not mature until age-5; fecundity-length regressions indicated that females matured at 8.7 in (age-4; Raffetto et al. 1990; Baylis et al. 1993).

With typical growth rates of smallmouth bass in Michigan, size in May is 7.5 in for age-2, 10.8 in for age-3, 12.6 in for age-4, and 14.4 in for age-5 (Schneider et al. 2000). Bass growing at the state average rate are 14.0 in in August–September of age 4, and would enter the fishery then. It is likely that many male smallmouth bass would be able to reproduce for 2 years before entering the fishery at age 4. Because of the effect of fish size on maturity (Baylis et al. 1993) and because fish at higher densities tend to grow more slowly, the time to reach maturity often increases with density. So we expect bass growth rates to be lower, and the time to reach maturity to be longer, at higher latitudes, higher elevations, lower mean air temperatures, lower degree-days, and higher densities (Beamesderfer and North 1995).

Number of individuals reproducing.–Only a fraction of the mature bass in a population reproduce in a given year. Raffetto et al. (1990) intensively studied the smallmouth bass population in 111-acre Nebish Lake in north-central Wisconsin. Over a 4-year period only 39% of adult males nested (range: 17–55%) and only 27% of nests (range: 11–33%) actually received eggs (Baylis et al. 1993).

2. Nesting success

Largemouth bass move toward the warmer shallow shorelines shortly after spring ice-out. Nest building in Michigan generally does not occur until the water temperature exceeds 60°F (Scott and Crossman 1973; Heidinger 1975). In southern Michigan, spawning takes place from early May through mid-June. In the Upper Peninsula, spawning occurs from late May through late June (Latta 1974) or mid-July. Prior to spawning, the male bass selects a nest site in 1 to 4 feet of water. Nests may be constructed anywhere in a water body; however, due to site-specific features it is not uncommon to find nests grouped at certain locations (Wagner et al. 2006). These areas are typically warmer, offer better protection from excessive wave action, or have cover. Nests are constructed in a variety of substrates including sand, marl, and soft mud. In general, nests constructed on harder substrates are found in shallower locations (Scott and Crossman 1973; Heidinger 1975).

Smallmouth bass will also move toward shore in early spring. Nest building generally begins when temperatures exceed 55°F, but spawning typically does not take place until temperatures reach 61–65°F (Scott and Crossman 1998). Male smallmouth bass build nests 1 to 6 feet in diameter in 2 to 20 feet of water (Carlander 1977; Scott and Crossman 1998). The timing of spawning activity in Michigan generally occurs from early May to late June, although spawning into early July occurs in some years. Nests are generally built in gravel areas, but sand, silt, or organic substrate may be used when associated with cover (Scott and Crossman 1998; Saunders et al. 2002).

For both species, after eggs are fertilized, the male maintains the nest by continuous fanning of the eggs, and aggressively defends the nest from predators such as bluegills, gobies, and crayfish. During this period, the males do not actively forage, but they will mouth potential predators (fish, crayfish, and artificial lures) and remove them from the nest. Hatching time is short. With stable water temperatures, eggs hatch in 5 to 7 days. The fingerlings remain as a brood for the next several weeks. During this period, the male continues to guard the brood. The male bass will guard the nest and fry up to 28 days after the eggs hatch, during the period when the fry are most vulnerable to predation. This guarding behavior is particularly susceptible to an early catch-and-release season.

3. First summer and winter survival

After dispersal from the nest, bass inhabit littoral (nearshore) areas. Summer growth rates will depend in part on prey availability (especially that of young centrarchids, such as bluegill), habitat features (e.g., aquatic plants may influence foraging success), and temperature. Growth and survival of age-0 black bass are frequently observed to be density-dependent, with lower density leading to faster growth and higher survival (Parkos and Wahl 2002; Ridgway et al. 2002). Most research on post-nesting effects on recruitment has focused on the importance of the size attained by age-0 bass in the fall to overwinter survival. In many cases, larger age-0 bass in the fall may have the energy stores needed for overwinter survival, such that relatively large age-0 fish experience higher overwinter survival rates than smaller age-0 fish (Gutreuter and Anderson 1985; Ludsin and DeVries 1997; Garvey et al. 1998a), and likely contribute the most individuals to the newly formed year class (Pine et al. 2000). The timing of adult reproduction also appears to play an important role in determining age-0 fall size. For example, larger male smallmouth bass tend to spawn earlier than smaller adult males in Lake Opeongo, Ontario (Ridgway et al. 1991). Other studies in northern lakes have also found that larger adult smallmouth bass spawn earlier than smaller adults (Baylis et al. 1993; Lukas and Orth 1995; Wiegmann et al. 1997). Although studies in Ohio reservoirs could detect no such pattern for largemouth bass (Garvey et al. 1998b), in pond experiments large adult largemouth bass tended to spawn earlier than small adults (Goodgame and Miranda 1993).

The general pattern that larger black bass adults tend to spawn earlier has two important implications. First, offspring of larger bass would tend to hatch sooner, have a longer time to grow, and reach a larger size before winter compared to offspring of smaller bass. Thus, reproductive success of large males may be particularly important to recruitment. As a result, fishing on the earlier and larger nesting males may have a more detrimental effect on recruitment than fishing on later and smaller nesting males. Second, it means that fishing for nesting bass during the earliest period of nesting would tend to catch larger bass. This is consistent with data compiled from Michigan's Master Angler Program records, showing that a disproportionately high number of Master Angler black bass tend to be caught in the first week of the bass season in May (Figure 2). This is likely one of the reasons that some anglers would like to see an expansion of the bass season, to early season catch-and-release fishing for bass.

Effects of Early Season Fishing on Quality and Sustainability

Managing fisheries for naturally sustaining fish populations with favorable angler catch rates of large fish requires that individual growth rates of fish be sufficiently high and mortality rates be sufficiently low that appreciable numbers of fish grow and survive to large size. Managers can set fishing regulations (such as minimum length, possession limits, and season limits) that constrain harvest levels of fish to support fish survival to large size. Further, it is a widely held view that catch-and-release fishing can minimize fishing mortality, such that fish grow to large, desired size. However, it may be less well recognized that catch-and-release fishing can result in unintended mortality to fish and disruption of reproductive behavior. For example, in a review by Wilde (1998), typical initial (prior to release) and delayed (within a few days following release) mortality rates of tournament-caught fish were 1.5% and 8.3%, respectively, at 59°F (15°C). These values rose to 7.1% and 26.7% at 86°F (30°C). Temperature is clearly an important determinant of hooking mortality. In addition, aspects of handling, such as playtime, air exposure time, and live well crowding contribute to varying levels of hooking mortality (Meals and Miranda 1994; Gilliland 2002; Wilde 2003). Removal of bass from nests, even if only temporary, can increase predation risk to unguarded nests and the probability of nest abandonment and failure. Therefore, we seek to address the question, "Would an extended catch-and-release fishing season for black bass result in unacceptably high levels of hooking mortality (especially of large fish) or unacceptably low levels of reproductive success?"

Winter Fishing

Currently, bass fishing in Michigan is closed from January 1 to the Memorial Day weekend in late May. Extending the bass fishing season (as either catch-and-release, or catch-and-keep earlier in the year) could involve winter–early-spring months prior to the nesting season, as well as the nesting season. We anticipate that there would be relatively little effect of winter fishing on bass populations. Fishing done in the earliest part of the calendar year will usually be ice fishing. Catch rates for black bass tend to be low during January and February compared with summer. Recent large-lake creel surveys for Houghton Lake and Michigamme Reservoir document this pattern (Clark et al. 2004; Hanchin et al. 2005). Relatively few bass are likely to be caught (compared to several other sport fish) because low temperatures (<50°F) tend to inhibit bass foraging behavior (Johnson and Charlton 1960; Keast 1968; Warden and Lorio 1975, cited by Adams et al. 1982; Garvey et al. 1998a; and Fullerton et al. 2000).

The biological effect of catching and releasing bass in cold temperatures is associated primarily with hooking mortality. Although gear types typically associated with ice fishing are unlikely to minimize the probability of hooking mortality, in general, hooking mortality is reduced at low temperatures (Muoneke and Childress 1994). Therefore, the biological effects of winter fishing are likely to be relatively minimal. In contrast, the biological effects of fishing on nesting bass are likely much greater.

Michigan's Study of Six Lakes

Although MDNR, Fisheries Division, like other fisheries management agencies, has changed black bass fishing regulations repeatedly over the last century (Table 2), robust evaluations of such regulations, at the statewide scale, are not available in the literature. Schneider and Lockwood (1979) evaluated the response of 22 Michigan lakes to regulations during 1946–65. However, the largescale increase in bass fishing popularity since that time challenges our ability to extrapolate their findings. In the late 1980s, an attempt was made to evaluate the effects of an early catch-and-release season on largemouth and smallmouth bass populations using an experimental regulation on six lakes in southern Michigan. As a result of several factors, this study was not effective in evaluating the effect of the regulation on the bass populations in the six lakes (Schneider et al.1989, 1991). The primary problems with the study included a biased selection of lakes, inadequate assessment and analysis of recruitment, and a lack of long-term assessment of the impact on the abundance and size structure of the bass population. All of the lakes were on rivers, so there was opportunity for movement of bass into the lakes, potentially mitigating effects of diminished recruitment and decreasing the chance of detecting any detrimental effects of the regulation. The strength of the evaluation was angler surveys at some of the lakes that produced angler opinion, catch, and effort data. The survey results demonstrated that a majority of the anglers interviewed were bass anglers, regularly practiced catch-and-release fishing, and supported the regulation change. Over 40% of all anglers interviewed admitted to fishing illegally for bass during the closed season in 1987. The angler surveys indicated that the early bass season had little effect on the fisheries of the lakes. A detailed review of the Schneider et al. (1991) report (Appendix) concluded that the six-lake study would have been able to detect only certain extremely large negative effects and that further study was needed to judge whether early season fishing would have long-term negative effects on bass populations in Michigan lakes.

Size Structure: Importance of Adult Physiology and Mortality

Given the shortcomings of this previous evaluation, and in light of more recent research findings, we reviewed the literature to address the questions, “Does catch-and-release fishing during the nesting season result in disproportionately higher hooking mortality (especially of large fish) or lower reproductive success compared to catch-and-release fishing that occurs at other times of the year?” Higher mortality rates of fish during the spawning and nesting season, compared to later in the summer, could result from two main factors: higher catchability of pre-spawning or nesting males in the spawning and nesting season or higher physiological stress of nesting males. Lower reproductive success could result from displacement of adults or reduced ability of adults to protect nests and offspring. We review evidence below.

Catchability.–Nesting males are estimated to be twice as active as non-nesting males; hence, they expend more energy than non-nesting males (Cooke et al. 2000)—especially considering that the nesting period can last up to 5 weeks (Neves 1975). Nesting male bass are also quite vulnerable to fishing because many artificial lures mimic potential brood predators. As a result, nesting male bass will attack these perceived predators. For example, Philipp et al. (1997) reported that over 70% of nesting bass struck a fishing lure cast near the nest. Further, analysis of Master Angler catch data from Michigan waters indicates that large bass may be particularly vulnerable to fishing during the spawning and nesting season (Figure 2). A substantial proportion of the black bass Master Angler entries are caught during the first weeks of the current legal season (starting the Saturday of Memorial Day weekend). In fact, the highest weekly catch of smallmouth bass exceeding 21 in occurred during this time period. Additionally, several master angler catches were reported from preseason weeks, further demonstrating that large bass are vulnerable at this time. Statewide fishing effort data are not available; therefore, we can not determine the extent to which high catch rates early in the legal season reflect particularly high fishing effort levels during the opening weekend in addition to high catchability during that time period.

Other aspects of catchability also are pertinent to the topic of black bass fishing regulations. First, catch-and-release will only be effective if it is likely that an individual bass will be captured again or is able to reproduce after being captured. Generally speaking, the “recatchability” of bass has been clearly demonstrated. However, questions remain. In particular, researchers have speculated that a bass, once captured, may be less likely to be captured in the future. Results to date have been conflicting. Clapp and Clark (1989), in an experimental setting, determined that smallmouth bass recapture rates varied widely among individuals, with large individuals demonstrating the highest recapture rates (although size of fish could not be statistically distinguished from source population). Overall, they documented no decline in capture rate over time. Burkett et al. (1986) also documented that recapture rates varied widely among largemouth bass. However, some evidence exists for catchability declining as a result of previous capture experience, especially for the case of live bait exposure and learned experience, which may persist at least for bass larger than 12 in (Anderson and Heman 1969; Hackney and Linkhouse 1978). In addition, Garrett (2002) reported that vulnerability to fishing can be modified by selective breeding, strongly suggesting that there is a genetic component to catchability. He also noted a behavioral, possibly learned, effect that caused catch rates to decline over the first few days of each fishing experiment. This “opening day effect” (Garrett 2002) was also observed by Schneider (1971) when Mill Lake in Washtenaw County was reopened to fishing after a 5-year closure. Given these findings, and the fact that nesting males are often particularly aggressive, it is plausible that catch rates of black bass may decline throughout the fishing season as a result of reduced aggressiveness in post-nesting bass and reduced catchability of bass due to prior capture experience.

Physiological stress.–Nesting males likely only forage opportunistically while defending their nest and must expend energy to fan the eggs and guard the nest against predators (Hinch and Collins 1991). Hence, physiological disturbances may be particularly detrimental to nesting male black bass (Cooke et al. 2002). For example, research on largemouth bass has documented that individuals show a physiological response to confinement (Carmichael et al. 1984). More notably, nesting and non-nesting largemouth bass males recover from the physiological stress of fishing at different rates. Locomotory impairment of nesting male largemouth bass is evident 24 h after their release, whereas non-nesting males fully recover within 1 h (Cooke et al. 2000). Similar research has not been conducted on smallmouth bass. However, research on smallmouth bass does indicate that the stress of capture may limit the ability of nesting males to return to their nest following release. Specifically, nesting male smallmouth bass played to exhaustion take four times longer to return to their nest than those played less (Kieffer et al. 1995).

Air exposure, in particular, may be harmful to angled bass. Phillip et al. (1997) found that an air exposure time of just 1 min was enough to double the length of time it took for guarding male bass to return to their nests after being caught and released. Suski (2003) documented increased energy depletion, increased accumulation of tissue lactate, and cardiac disturbances associated with air exposure for caught-and-released bass. Caught-and-released rainbow trout were found to experience increased delayed mortality due to air exposure after vigorous exercise (Ferguson and Tufts 1992). In that study, 88% of the fish survived after vigorous exercise with no air exposure, but survival dropped to 62% and 28% after 30 s and 1 min of air exposure, respectively. The increased mortality associated with air exposure was at least partially a function of collapsed gill filament capillaries (Ferguson and Tufts 1992). Overall, we infer from this body of research that nesting male bass, operating in a state of heightened stress, may be more vulnerable to negative effects of catch-and-release fishing. Although we are aware of no studies to date that compare hooking mortality of nesting and non-nesting fish, relationships among aspects of catch-and-release fishing and bass nest abandonment have been investigated, and are summarized below.

Reproductive Success: Importance of Displacement and Nest Predation

Displacement.–As previously discussed, the physiological stress of capture may compromise the ability of a bass to return to its nest, even if it is released near the site of capture. However, bass anglers, particularly in tournaments, typically release bass at a common location, often quite distant from where each fish was caught. Wilde (2003) reviewed 12 published studies and concluded that the available evidence does not support the notion that tournament-caught black bass return to their capture site after release. The probability of return appeared to vary between species, with 14% of largemouth bass and 32% of smallmouth bass returning to their site of capture. Most bass traveled a relatively short distance (<1 mile) in the first 14–40 days following release. Across the 12 available studies, mean distance dispersed by largemouth and smallmouth bass ranged 0.75–5.5 miles and 2.4–5.7 miles, respectively. Ridgway (2002) determined that the success of largemouth bass in returning to the site of capture is inversely related to displacement distance, with no largemouth bass displaced more than about 5 miles (8 km) returning to the site of capture for at least 1 year. Yet even movement by displaced bass over shorter distances was delayed. For example, it took approximately 2 weeks for displaced largemouth bass to move more than 0.25 miles (400 m) from the release site (Ridgway 2002). Overall, displacement of bass raises concern among managers for many reasons. Most notably, the existing findings clearly demonstrate that long-distance displacement of nesting bass will negatively affect success of nests (see *Nest predation*). In addition, displacement and release at a common site may result in bass that are disproportionately more vulnerable to fishing and hooking mortality shortly after release (see *Bass Tournaments*). Further, displacement that transports bass between connected or separate lakes poses a potential threat to the genetic integrity of bass populations, and represents a possible vector for invasive species, such as the zebra mussel and Eurasian water-milfoil, as well.

Nest predation.–Even if bass are immediately released at the capture site, some risk remains. Fishing an adult male from a nest usually results in reduction of the number of fry produced from that nest. The amount of fry reduction depends on several factors, including the length of time that the male is away from the nest, the stress level of the male caused by fishing, the stage of development of the offspring, and the density of nest predators.

As stated previously, angled male bass are physiologically stressed by the experience (Kieffer et al. 1995; Suski et al. 2003) and may be impaired in their ability to return to the site of capture. The longer the male is away from the nest, the more time there is for nest predators to move into the nest and consume offspring. In Charleston Lake, Ontario, nest predators (juvenile sunfish and yellow perch) entered half the nests of exhaustively played male smallmouth bass and 35% of the briefly played males; longer absence of the male resulted in more time for predators to eat offspring (Kieffer et al. 1995). In a lake in Maine, nests where male smallmouth bass were permanently removed had all eggs and fry consumed by other fishes (Neves 1975). In Lake Opeongo in Ontario, removal of adult males from 10 nests containing hatched embryos (wrigglers) resulted in loss of all offspring within 24 h (Ridgway 1988).

Abandonment of the nest is a consequence of both physiological stress and behavioral response of the guardian male to temporary removal from the nest site (Philipp et al. 1997). Angled males that return to the nest give a reduced level of parental care, due to the stress of being angled (Suski et al. 2003). In the lake studied by Suski et al. (2003), upon return to the nest, angled males were less aggressive in defending the nest and more likely to abandon the nest than males that had not been angled. Empirically, nest abandonment may exceed 50% when return time of a caught-and-released fish is greater than 5 minutes (Philipp et al. 1997). Further, as the number of times an individual smallmouth bass is angled from a nest increases from one to three times, there is a concomitant increase in the frequency of nest abandonment, from 16 to 75 %. Predation of fry also plays a role in nest abandonment, exacerbating the impact of angler handling time.

The amount of fry reduction depends on the offspring's stage of development. Ridgway and Shuter (1997) judged that, if the guarding male was removed and did not return, the brood would not survive if the removal occurred during the period from spawning to 10 days after swim-up (Ridgway 1988). Day 10 after swim-up marks the time of metamorphosis from larva to juvenile, which is associated with improvements in anti-predator skills of young fish. If the timing of male removal occurs later than metamorphosis, there is an increasing chance that the brood will survive. Ridgway and Shuter (1997) assumed the probability of brood survival would increase linearly from 0 to 1.0 as the timing of male removal increased from day 10 to day 21 after swim-up.

A variety of species consume, at least to some extent, black bass eggs. These potential predators include various cyprinids, catastomids, ictalurids, juvenile panfish, crayfish, and older bass. Certainly black bass populations have evolved with some level of nest predation. However, as described above, removal of guarding bass from the nest will increase nest predation. The negative effects of nest predation may be particularly strong when the density of nest predators is high (Neves 1975) or exotic predators have entered the system. For example, in Lake St. Clair, Lake Erie, and Saginaw Bay, round gobies are present in high densities, and in only a few minutes gobies can consume a large fraction of the eggs or fry in an unguarded bass nest (Steinhart et al. 2004). Ohio fisheries managers have recently proposed a closed harvest season during the smallmouth bass nesting period in Lake

Erie as a result of research on egg predation by gobies and rising pressure from anglers to invoke such a closure. Situations with high densities of nest predators warrant additional caution from managers.

Post-nesting brood predation.–Male black bass continue to guard their broods for 2-3 weeks after the fry leave the nest (Ridgway 1988), with the total time spent guarding the nest and the brood extending 3, 4, or even 6 weeks past spawning (Kubacki et al. 2002). Experiments in laboratory aquaria have demonstrated that age-0 largemouth bass can cannibalize fry that are half their body length or smaller, and that age-0 bass as small as about 0.4 in (10–11 mm) have the potential to be cannibalistic predators of swim-up fry (Johnson and Post 1996), which are about 0.25 in (6 mm) in length (Brown 1984). However, because broods are guarded until the fry reach a size of about 0.75 in (15–20 mm), they are usually safe from age-0 predators that are smaller than 1.5 in (30–40 mm; Brown 1984; Ridgway and Friesen 1992; Johnson and Post 1996). Removal of a brooding male would make the brood more vulnerable to predators, including potentially abundant age-0 or age-1 largemouth bass.

Fishing non-nesting bass during the nesting season.–During the nesting season, some anglers may catch females or non-nesting males. Females are at the nest only for the short duration of spawning, about 1–2 h per female, based on observations by Neves (1975). Non-nesting males can be a large fraction of the total adult male smallmouth bass population (Raffetto et al. 1990; Ridgway et al. 1991). The major effect on the bass population from fishing non-nesting bass would be due to hooking mortality or harvest of these bass.

Bass Tournaments: Implications for Mortality and Spawning Success

Bass tournaments are apparently becoming more frequent and widespread in Michigan. Indeed, bass fishing tournaments may be one of the few freshwater fishing activities that continue to grow (Schupp 2002). In **Effects of Early Season Fishing on Quality and Sustainability**, we briefly mentioned tournaments in our examination of effects of early season fishing on quality and sustainability of bass fisheries. Specifically, we reviewed recent literature that quantified the effects of various factors on delayed mortality of fish caught and released in tournaments. We also considered the impacts of displacement of nesting fish by tournament anglers on nesting success. However, we believe that tournaments deserve additional attention due to their popularity and potential for affecting bass populations in several other ways.

First, we submit that a description of the "typical" Michigan bass tournament is prerequisite for this discussion. Nearly all Michigan bass tournaments follow a CDR format. Anglers fish for some predetermined period of time, sometimes for up to 8 h, and retain several of the largest bass caught during this time period. The fish are kept alive in a live well on board the angler's boat. Particularly successful anglers often "cull" or "high grade" their catch, once they have reached the maximum number of fish they are allowed to weigh-in for the day. In other words, when a larger fish is caught, it replaces one previously placed in the live well, and the smaller fish is released. The released fish may be released very near, or at great distance from the location where it was originally captured. At the end of the fishing period allowed by the tournament organizers, the fish are transported to a common and specific location for weighing, then generally, all are released at that location. Most tournaments levy some type of penalty for dead bass brought to the weigh-in, so tournament anglers attempt to keep their fish alive. However, little if any monitoring of delayed mortality occurs. This CDR format has numerous implications for bass mortality and spawning success.

Many tournament organizers and participants believe that there is little or no harm done to the bass captured and released at tournaments. Wilde (1998) compiled estimates of tournament-associated mortality in bass for 130 tournaments held between 1972 and 1996. While initial mortality has been low in more recent years (6.5% during the 1990s), delayed and total mortality were estimated to be 23.3% and 28.3%, respectively. Estimates of initial mortality (those fish that are obviously dead during the weigh-in period of tournaments) indicate the minimum magnitude of total tournament-associated mortality, but are not predictive of total tournament mortality. For example, in some situations, low initial tournament mortality is followed by high delayed mortality. Therefore, both initial and delayed mortality must be measured to assess the total mortality attributable to tournament fishing. This study indicates that in the 1990s, an average of 28.3% of the bass brought in to tournament weigh-in sites either were already dead or died within a short time period. These findings underscore the importance of education of bass anglers, cooperation by tournament coordinators, and enforcement of guidelines regarding techniques for minimizing hooking mortality of black bass.

The opening day of the current possession season in Michigan allows tournament anglers to fish for spawning bass in most years, particularly for waters in northern Michigan. Tournaments following the CDR format result in the displacement of nest-guarding males. Both culled and weigh-in fish are displaced with severe implications for the nests and broods of those fish. Culling essentially multiplies the number of nests that can potentially be affected through fish displacement by a single angler. The objective of culling is to maximize the size of the fish kept for the weigh-in event. Wilde (1998) found that larger bass tended to experience higher total (initial + delayed) mortality rates than smaller bass subjected to weigh-in procedures. Thus, it is apparent that highly successful tournament anglers can inadvertently increase the fishing mortality of captured bass by culling small fish and retaining the larger bass caught during their fishing time. Accordingly, Meals and Miranda (1994) hypothesized that size-related mortality of tournament-caught bass could have population-level impacts when certain conditions apply, including high percentage of large (>18 in) individuals captured, high total number of captures (as with tournament activity), and high post-release mortality.

Typical tournament CDR formats may facilitate increased disease transmission among bass in a population. Bass held together in a live well for several hours are likely to share various infections and parasites. Culling can further magnify this problem by increasing the numbers of fish exposed.

Displacement of bass by tournaments has further implications for overall bass fishing mortality. Wilde (2003) found that tournament-displaced bass that survive the weigh-in tend to remain concentrated in the release area. Because the release sites tend to be easily accessible to numerous anglers, these displaced bass can experience unusually high fishing pressure and elevated mortality rates.

Displacement of bass in tournaments may also have genetic implications for Michigan bass populations. Some tournaments are held in locations where anglers are able to travel by boat between several water bodies. In some instances, anglers may travel up to 50 miles by boat to fish, and bring captured fish back to the weigh-in site, where they are finally released. This practice, particularly during the spawning season, may be unwisely mixing genetically distinct stocks of black bass. Further, it should be noted that this activity is considered to be stocking without a permit, a violation of MCL 324.48735, per MDNR, Law Enforcement Division. This law reads, in part:

> A person shall not plant any spawn, fry, or fish of any kind in any of the public waters of this state or any other waters under the jurisdiction of this state without first obtaining a permit from the department that states the species, number, and approximate size or age of the spawn, fry, or fish to be planted and the name and location of the waters where the spawn, fry, or fish shall be planted.

As such, two lakes connected by a stream are considered separate and distinct water bodies. This law applies to both catch-and-release and catch-and-keep fishing.

Tournament anglers usually “practice fish" a body of water prior to the actual tournament. In some cases, when tournament prizes are particularly lucrative, anglers will practice fish the area for several days or even weeks. While the fish they catch during this time are usually released immediately, there will undoubtedly be some hooking mortality. Thus, efforts to measure tournament effects should not overlook the pre-tournament "practice" activity. A small minority of competitive bass anglers may even resort to catching large fish prior to a tournament, moving them to a different or "secret" location, then releasing them with the intention of returning to quickly capture them during the tournament. Thus, displacement of fish may occur even beyond that resulting from culling and weigh-ins. While this practice is not prevalent, it has been known to occur, and further illustrates, in our opinion, the diversity of angler practices that exists.

Remaining Uncertainties

There seems to be little doubt that catching and releasing male black bass that are guarding nests will tend to increase nesting male physiological stress and decrease the number of eggs or fry in those nests because of nest predation. Qualitatively similar results might be expected for catching and releasing adult males that are guarding older broods after they have left the nest. However, the major and unresolved question is, "How much do these effects ultimately alter the quality and sustainability of bass populations and the fisheries they support?" Answering this question requires information on the extent to which fishing (and resultant physiological stress) results in mortality or reduced growth, the relative importance of all factors influencing bass recruitment, and the strength of density-dependent (compensatory) responses of the bass population at all life stages.

Currently, it is not possible to reach scientific consensus on the quantitative level of long-term, population-level effects of early-season fishing on black bass populations because there are still too many unknowns about density-dependent processes and compensatory reserve in black bass. Several factors make prediction of the effects of early season fishing difficult: (a) indirect effects (e.g., effects of nest predators on black bass nest success may depend on fishing practices); (b) time lags (e.g., small increases in hooking mortality of large fish may not result in noticeable changes in a population's size structure for several years, and negative effects of catch-and-release fishing during the nesting season may be evident only in years with unusual spring warming and precipitation rates); (c) insufficient data (e.g., black bass are not well sampled by Fisheries Division's typical netting surveys); and (d) uncertainty regarding the future amount of early season fishing.

Bass seem to be very wary of nets and tend to avoid capture in either trap or gill nets. Because black bass are not well sampled in Fisheries Division typical surveys, sample sizes may often be inadequate to characterize the size and age-frequency distributions, and sometimes growth rates for the populations. Fisheries Division has very few estimates of recruitment and very few black bass population estimates. With current surveys, unless there were concurrent large changes in growth rate or size structure, it would be very difficult to detect declines in bass population abundances. More generally, few if any data sets exist anywhere that quantify fishing pressure, nesting success, and subsequent recruitment and hooking mortality rates.

Management in the face of uncertainty is a challenge common to fisheries management. One important component is to evaluate the documented direct effects (i.e., focus on what is known). In addition, tools such as decision analysis (Lindley 1985; Ludwig et al. 1993; Peterson and Evans 2003) provide important insights by evaluating management options in light of what is known and associated levels of uncertainty. Overall, fisheries management experts advise using the "precautionary principle" (exercising caution in favor of conservation when uncertainty is prevalent, Hilborn 1997). This principle is applied in circumstances in which there are reasonable grounds for concern that an activity could cause harm, but in which there is uncertainty about the probability of the risk and the degree of harm. In that spirit, we evaluate a series of management scenarios in light of known facts and key uncertainties, with the goal of identifying management options most likely to enhance bass fishing opportunities while protecting the quality and sustainability of bass populations and fisheries. We provide the following recommendations regarding an approach to research and management likely to improve our understanding and management of black bass populations.

Considering Regulation Change – Reaching a Conclusion

In order to reach a recommendation regarding a change in statewide bass fishing season regulations, we analyzed several possible regulation scenarios (Figure 3). With each scenario, we evaluated the potential risk to present bass fisheries based on what we learned in the review of the literature (see **Effects of Early Season Fishing on Quality and Sustainability**), past fishery management experience in Michigan, angler attitudes as understood by field managers, studies of angler attitudes and behavior, consultation with fisheries biologists and researchers from other states and Canadian provinces, and regulatory concerns for other Michigan fish species.

We considered whether regulations should differ between the upper and lower peninsulas, and decided that typical differences in the timing of spawning and nesting between peninsulas should be taken into consideration. Several of the scenarios discussed below reflect this emphasis, including the scenario we recommended. We compared other biological and social features between the two peninsulas. Overall productivity of bass populations is generally understood to be lower in the Upper than Lower Peninsula. This difference may be driven in large part by differences in abundance, given that marked differences in size at age (growth rates) were not detected across the state. We reasoned that because fishing pressure on bass populations is generally lower in Upper Peninsula waters as well (less effort and far fewer tournaments), similar regulations in both peninsulas, in terms of size and possession limits, are acceptable.

We were strongly united regarding the importance of protecting the spawning seasons of other major predators. Northern pike, muskellunge, and walleye often congregate in small areas of relatively unique habitat during their spawning periods in early spring, making them highly vulnerable to anglers. Therefore, fishing for these species has been closely regulated to protect them during this time period. Unlike bass, these other species, especially walleye, are well known as excellent table fare, and this has lead to many cases in which poachers have been caught illegally fishing, snagging, netting, spearing or otherwise harvesting these fish during spawning runs. Under present law, the situation is manageable for conservation officers, as boating and fishing activities during this early spring period are at a low and observable level. We did not want to open bass fishing during this period because it would very likely lead to illegal harvest activities of other species under the guise of "bass fishing." Indeed, many anglers have demonstrated their disregard for the law, especially in the past few decades, by fishing for bass prior to the legal bass season.

We made the assumption that present bass populations were acceptable to anglers, but that the vast majority of anglers would not wish to see fishery quality diminished in order to achieve more harvest or fishing opportunity. This exercise then became a balancing act, weighing the anticipated risks versus the anticipated benefits that each regulation change would have on bass fisheries, whole fish populations, water quality, and other factors. Also, we desired to follow the recent trend in Michigan fishing regulations to make such regulations uncomplicated and statewide, thus responding to angler desires for less complicated fishing regulations with fewer exceptions or special circumstances.

The risk assessment of each regulation scenario carried many uncertainties, making judgments difficult. As previously discussed, much biological information simply does not exist in the literature, and in-depth angler preference surveys of Michigan anglers and economic analyses have rarely been done in recent years. The most fundamental uncertainties we face when evaluating the issue of bass fishing season regulations regard:

- population-level effects of fishing on bass recruitment during the nesting season;
- ecosystem changes that will alter the response of black bass populations to regulations (most notably prevalence of exotic species such as round gobies and zebra mussels, global climate change, changes in nutrient loading, spread of largemouth bass virus and other diseases, etc.);

- response of human behavior (angler participation, reactions due to ethics, trends in peer-driven behavior) to changes in regulations; and
- economic effects of changes in fishing regulations (e.g., if the harvest season is shortened, but a CIR season is created, then the angler response and economic impacts are not predictable).

SALBRC's Recommendation Process

Due to the many uncertainties involved, Fisheries Division devoted two meetings of its fisheries managers and researchers for discussion of bass regulations and compilation of opinions based on collective experience. At the first meeting in October 2002, which was internal, research and management biologists held an in-depth discussion of the issue of current bass regulations and possible changes, thereby encouraging input from the combined experience of the attendees. At the second meeting in March 2003, research biologists from Indiana, Ohio, Ontario, and Michigan gave presentations regarding the most recent bass research to the same group of Michigan biologists. The Smallmouth and Largemouth Bass Regulations Committee was formed from that group of Michigan biologists. With this background of information, we then delved further into the literature and interviewed other biologists over the summer of 2003. We sought to capture the current state of understanding regarding black bass populations and their response to fishing so that we could make the best possible judgments regarding bass fishing regulations in Michigan. Ultimately, decisions relating to the risk of various regulation scenarios on bass fisheries came from what is known in the scientific body of literature. Where there was no clear answer, we reached consensus decisions based on professional judgment.

The Matrix and Regulatory Scenarios

We developed a matrix (Table 4) to delineate some of the most important differences when balancing risk and benefit of seven possible regulation scenarios. The seven regulation scenarios represent a gradient of change relative to current regulations and perceived risk. Here, risk is defined in biological terms, as a threat to the integrity and quality of bass populations and fisheries. We ranked fishing activities according to risk level, or probable intensity of effect on bass populations. Possession (harvest as well as CDR) during the nesting season represents the fishing activity that poses the greatest threat to bass populations. Possession during the non-nesting season ranks second. CIR fishing during the nesting period ranks third and CIR fishing during the non-nesting period ranks fourth. The seven scenarios were ordered from highest (1) to lowest (7) risk level, and are discussed in that order. As detailed in Scenario 3, the existing regulations were used as the baseline for assessing the relative risk level of each scenario. In general, as risk decreases from Scenario 1 to Scenario 7, so does angler opportunity, from the standpoint of duration of the harvest season. This illustrates the challenge to developing regulations that balance angler opportunity and biological risk.

We reached consensus decisions on the likely positive or negative effects of each scenario, relative to current regulations, on factors relating to bass populations, whole fish communities, and human dimensions (Table 4). Some effects were well documented in the literature and the reader is referred to various sections in the report where such effects are thoroughly discussed, but some had to be derived from the combined and consensus opinions of the committee based on our available information and experience, as described in **SALBRC's Recommendation Process**. Each scenario is discussed below. Anticipated benefits and risks from each scenario are listed, as well as our recommendation to the division regarding each scenario. Based on this recommendation and additional feedback from the Fisheries Division Management Team, three of the seven scenarios were presented for public review in 2004: Scenario 3, representing current regulations, and scenarios

5 and 6, which represent increased recreational fishing opportunities. We agreed by consensus that scenarios 5 and 6 represent an acceptable balance between angler opportunity and biological risk. Scenarios 5 and 6 differ only according to bass regulations during winter.

Scenarios

In this discussion, the term possession refers to catch-and-delayed-release (CDR) plus catch-and-keep (harvest), and CIR refers to catch-and-immediate-release. Scenarios are ordered according to their relative change from current regulations (Scenario 3) and perceived risk to bass populations. Scenario names specify winter (January 1–March 15), spring (late April–mid-June), and summer (late June onward) regulations. Note that all but Scenario 2 involve closed fishing from mid-March to mid- or late-April to coincide with seasonal closure of other early-spawning fishes.

1) Winter, spring, and summer possession—Highest risk.–This scenario would:

- allow possession from January 1 through March 15;
- close the season from March 16 until the last Saturday in April; and
- allow possession from the last Saturday in April through December 31.

This scenario is clearly the most liberal of all seven scenarios from the possession perspective. It would allow possession of bass during the nesting season and in all but about 6 weeks of the year (when walleye, northern pike, and muskellunge have closed seasons). Scenario 1:

a. would allow anglers to fish more days in the early part of the year compared to the present season (Scenario 3) and legitimatize current illegal preseason fishing activity;

b. would allow harvest of bass caught while ice fishing January 1 through March 15:

c. would preserve a statewide, uniform closed bass season during walleye, muskellunge, and northern pike spawning periods, discouraging human disruption of these species during that critical time period (see Scenario 2, k);

d. would allow the highest number of legal harvest days (year-around harvest except 1.5 months), have the highest risks of bass mortality, and could increase over harvest, reducing fishing quality;

e. would result in the highest nest disruption and abandonment rates because standard bass tournaments (CDR) and harvest would be allowed during the entire nesting season;

f. may negatively affect fishing quality as a result of anticipated reductions in bass size structure, and potentially, bass density;

g. would probably result in increased total angler effort because of the added spring season, however, bass fishing effort could remain constant, with just a re-distribution of effort over a longer time period (see Scenario 2, c);

h. would very likely increase spring fishing pressure on bass populations, particularly nesting bass, potentially as much as 40% (see Scenario 2, d);

i. would result in increased hooking mortality in the spring when bass are particularly vulnerable to capture, and many bass would be caught with live bait, which results in higher mortalities than artificial baits (see Scenario 2, e);

j. would increase mortality of the largest bass in bass populations, which are especially vulnerable in the spring (Figure 2), and that may have negative effects on recruitment (see Scenario 2, f);

k. may result in decreased summer catch rates during the harvest season if bass become “hook shy” due to fishing during the nesting season (see **Effects of Early Season Fishing on Quality and Sustainability**);

l. would likely lead to reduced quality of panfish populations and reduced water clarity (see **Introduction**, *Ecological Significance of Black Bass*);

m. would likely meet with significant public opposition (see Scenario 2, l);

n. would require legislative approval because it represents a liberalization of the current season, which is listed in statute, and it would require the modification of 1994 PA 451, Part 487 Sportfishing, which contains most laws governing recreational fishing;

o. would not help to protect walleye, northern pike and muskellunge during their entire spawning period in the Upper Peninsula where the open season for these species begins on May 15 (see Scenario 2, k).

We believe that of all the scenarios, this one represents the highest potential fishing mortality rates (hooking and harvest) and the highest overall risk to bass fisheries, lake food webs, and the ecology of lake ecosystems. Furthermore, we do not believe that the majority of bass anglers would favor this scenario. In our presentation to the division, we ranked this as the greatest risk to bass populations of all seven scenarios and did not endorse it. Also, legislative approval would be required to allow for this increased harvest period.

2) Winter and spring CIR/traditional summer possession seasons.–This scenario would:

- allow CIR from January 1 until the Saturday preceding Memorial Day;
- allow possession from the Saturday preceding Memorial Day through December 31.

This scenario provides the greatest number of legalized fishing days for bass. It would expand fishing opportunity by allowing catch-and-immediate-release fishing during what is currently the closed season, when anglers can not “take or attempt to take bass.” Scenario 2:

a. would provide anglers more days to legally fish for bass in the spring (legitimatizing current illegal preseason fishing practices) and anglers could legally fish for bass all year.

b. would preserve the historical opening day of the possession (harvest) season;

c. would probably increase total angler days of fishing (Changes in fishing effort are difficult to anticipate. However, with bass fishing popularity continuing to increase [see **Introduction**] it is likely that total effort will increase. Granted, angler hours could go unchanged, and simply shift to earlier in the year. However, this scenario would still increase the overlap with spawning activity, when there are higher potential hooking mortality rates due to the physiological stress of spawning behavior);

d. would increase spring fishing pressure on bass populations, particularly nesting bass, potentially by as much as 40% (Appendix; many of those anglers presently abiding by the law [estimated at 56% in 1989, Schneider et al. 1991] likely would now enter the fishery during the entire nesting season.);

e. would result in increased hooking mortalities of bass because of increased spring fishing pressure (Many bass would be caught with live bait, which would add to fishing mortality because of deep hook wounds. A no-live bait restriction is not recommended because it is impossible to enforce when other species have open seasons with no bait restrictions, e.g., crappie, pike, walleye, etc.);

f. would increase fishing mortality of the largest bass in bass populations, negatively affecting large bass standing crop, fishing quality, and production of offspring (The largest bass are more vulnerable in the spring when they spawn earliest, guard best, and likely produce more successful offspring than smaller bass; see **Effects of Early Season Fishing on Quality and Sustainability of Bass Fisheries.**);

g. may result in decreased catch rates during the possession season if bass become "hook shy" due to fishing during the CIR season (see **Effects of Early Season Fishing on Quality and Sustainability**);

h. would likely reduce the number of spawners and increase nest abandonment due to increased CIR fishing in the spring. This will lead to reduced fry production, and could ultimately lead to reduced bass recruitment (see **Effects of Early Season Fishing on Quality and Sustainability**);

i. would likely lead to reduced quality of panfish populations and could ultimately result in reduced water clarity (see **Introduction**, *Ecological Significance of Black Bass*) if the number of large bass is reduced through an increase in mortality associated with more CIR;

j. would allow CIR fishing during the entire nesting period and harvest fishing during the nesting season in the south for some years and in the northern parts of Michigan nearly every year (During some years, warm spring temperatures allow bass to finish nesting prior to the current opening day, especially in southern Lower Michigan.);

k. has no consideration for other predatory species (walleye, northern pike, and muskellunge) that may be concentrated and vulnerable to bass fishing techniques in late March and April, and could encourage illegal fishing for these species (Walleye, northern pike, and muskellunge seasons are closed during these times because these species become concentrated in spawning areas and should not be disturbed. With an open bass season during this period, anglers may fish for these other species under the guise of bass fishing, using tackle that might be used for any of these predators during the regular season. Indeed, many bass anglers have blatantly disobeyed the law during the past several years by "attempting to take fish out of season;" see **Regulations**, *Compliance Issues*. Therefore, creating an early spring open catch-and-release bass season during the closed season for other species could encourage illegal pike, walleye and muskellunge fishing.);

l. would likely meet with significant public opposition (There is a perception among some lake riparians and anglers that even CIR fishing prior to Memorial Day will diminish the bass fishing quality of some lakes. Some lakes were not included in Michigan's Early Season, Catch-and-Release Bass Fishing Study because anglers and riparians refused to allow those lakes to be subjected to the additional pressure on bass [Schneider et al. 1989]. Specifically, Gun Lake, Barry County and Duck Lake, Calhoun County were included in this list.);

m. would, as in Scenario 1, n, require legislative approval because it represents a liberalization of the current bass season, which is listed in statute.

We believe this scenario will lead to unacceptable levels of risk for many bass populations in Michigan as well as populations of other game fish. With the opening day of the possession season remaining as the Saturday before Memorial Day, combined with increased pressure and hooking mortalities from legalized pre-spawn fishing, and harvest fishing during the nesting season, bass populations and fisheries would be negatively affected when compared to the present day (Scenario 3). Some of the most productive populations may be able to compensate for increased spring fishing mortalities and nesting failures, but many fisheries would likely suffer reduced fishing quality and negative impacts on associated panfish and other forage populations. This may in turn lead to decreased water transparency and less aquatic vascular plant growth, further inhibiting bass populations. Nothing in this scenario sufficiently compensates for the losses that are inevitable to bass populations with increased spring fishing activity. Also, legislative approval would be required to allow for this increased fishing period.

We believe this scenario would diminish current bass populations and fishing quality. We also believe that the majority of bass anglers do not wish to diminish bass fishing quality for the opportunity to fish more days. We find that the risk level is second highest of the seven regulation scenarios considered. In our presentation to the division, we did not endorse this scenario.

3) No regulatory change—Moderate risk.–This scenario is the current regulation and would continue to:

- close the season from January 1 until the Saturday preceding Memorial Day; and
- allow possession from the Saturday preceding Memorial Day through December 31.

Bass fishing regulations in Michigan have evolved over the past 100 years (Tables 2 and 3), and present regulations on seasons and daily possession limits have been in place for 33 years on most waters. The 1993 minimum size limit change from 12 to 14 in has resulted in generally positive feedback from bass anglers. Perceptions, based on questionnaires in years following this change, found 78% of anglers approved of the bass size limit change. Although most anglers said they did not detect an improvement in quality of fishing or size of fish, Schneider et al. (unpublished data) documented a general improvement in bass population size structure. Michigan fisheries managers in recent years have continued to receive favorable comments from anglers regarding bass fishing, and reports from out-of-state anglers have been especially complimentary of Michigan's bass fisheries.

Michigan has continued to manage bass as self-sustaining populations and as important components of entire lake food webs, serving a predatory role on panfish and other forage species. In some cases, it appears that bass populations have received too much pressure from current regulations, greatly diminishing population size and structure (Twin Lakes, Luce County), and special regulations have been imposed to reduce fishing mortality. However, in most waters the current regulation has seemed to provide a safe balance of providing extensive recreational fishing opportunity, while being able to compensate for fishing mortality. We believe this has only been possible because of the growth of a catch-and-release ethic in bass fishing over the past 3 decades. Indeed, with the increased popularity and the advanced techniques of bass fishing, if more anglers were not practicing catch-and-release (both CIR and CDR), reductions in the bass daily possession limit and or the length of the possession season would likely have been necessary years ago in order to maintain fishing quality and the predatory role of black bass.

Also, it must be understood that some bass populations have been subjected to what we believe to be a significant amount of illegal CIR preseason bass fishing over the past 2 or 3 decades. This activity may have affected bass recruitment, population size structure, and fishing quality, but these effects would be extremely difficult to measure and they remain unknown. The only recent study in Michigan that addresses some of these concerns is the six-lake early season bass fishing study discussed in this report (Appendix). We believe that study to be of limited utility, in part because the fisheries involved were not representative of most Michigan bass fisheries and were less vulnerable than most to the potential negative effects of early season CIR fishing. Still, Michigan bass fisheries have been under a perceived increasing degree of preseason (illegal) fishing and fishing quality has remained acceptable for most anglers. This fact leads us to believe that there is capability in many bass populations to compensate for at least some increased legalized fishing pressure in the early part of the year.

Therefore, with anglers generally satisfied with current fisheries and with current bass populations adequate, in most cases, to serve their important predatory function of keeping other fish species populations healthy, we used the present regulation as a baseline and balanced risk or benefit of all other regulation scenarios against it. Scenario 3:

a. maintains the present opening day, which has been used for 33 years continuing fishing traditions around this historical event;
b. allows bass to finish nesting in years with warm or early spring weather, especially in the southern part of the state, before being subjected to the possession season;

c. apparently allows bass fisheries and fishing quality to be acceptable to anglers, at least under current environmental and social conditions;

d. could result in reduced bass recruitment in the future on waters with poor habitat or low productivity, given that bass fishing is becoming increasingly popular, with greater participation (see **Introduction** and **Black Bass Biology**);

e. would continue to foster illegal preseason fishing activity, in which anglers target bass during the open seasons for pike, walleye and muskellunge;

f. does not protect nesting bass in Michigan's Upper Peninsula (UP) in most spawning seasons, or spawning bass and nest-guarding bass in the Lower Peninsula (LP) during some (cooler) spawning seasons;

g. would continue to displace bass (through long-distance tournaments) immediately prior to or during spawning time, which may lead to unwise mixing of genetically-distinct stocks of bass (such displacement is ill-advised throughout the year, but may be particularly influential during spring if displaced bass spawn in their new location).

We believe that item (e) above is particularly troublesome. The inability of conservation officers to enforce the present law ("illegal to take or attempt to take fish out of season"), combined with the increasing popularity of bass fishing has caused confusion and conflict among angler groups and riparians. Law-abiding catch-and-keep anglers feel slighted as many bass are illegally caught and reportedly released numerous times prior to opening day. Furthermore, illegal preseason bass fishing will likely lead to increased public disregard for other fishing regulations such as the closed season for walleye, muskellunge, and lake sturgeon. In addition, factors listed in items d and f will likely become more important to the maintenance of bass fishing quality with increasing pressure on bass. If this scenario is maintained as the bass season management tool in the future, we expect a public education program will be necessary to increase angler compliance with the closed season. To be successful, this education program would require participation and commitment by both Fisheries Division and bass fishing organizations. Fisheries Division should also continue to encourage strict enforcement of the regulation by Law Enforcement Division. However, we believe there is adequate compensatory capability in the vast majority of bass populations to allow legalized early season fishing if the harvest season is shortened to allow more bass to finish nesting and to reduce harvest mortality. Therefore, in our presentation to the division, we did not endorse this scenario and instead recommended Scenario 5 or 6 as a change in the current bass season regulation.

4) Winter possession/spring CIR/delayed summer possession.–This scenario would:

- allow possession from January 1 through March 15;
- close the season March 16 until the last Saturday in April (LP) or May 15 (UP);
- allow catch-and-immediate release from the last Saturday in April (LP) or May 15 (UP) until the 3rd Saturday in June; and
- allow possession from 3rd Saturday in June through December 31.

This regulation would allow ice fishing harvest of bass, some limited open-water fishing following ice-out with possession, and create an early CIR fishing season. Scenario 4:

a. would increase the overall possession period by about 6 weeks, but would reduce the peak open-water possession season by 2 to 3 weeks (typical bass tournaments—catch-and-delayed-release—would not be allowed during the closed season or the CIR season);

b. would include all benefits and concerns listed in Scenario 1, a, b, c and n; and Scenario 2, c, d, e, f, g, and h;

c. would preserve a closed bass season coinciding with walleye, muskellunge and northern pike spawning periods unique to the upper and lower peninsulas, discouraging human disruption of those species during those critical time periods by "bass anglers" (see Scenario 2, k);

d. would likely meet with some public opposition. There is a perception among some lake riparians and anglers that additional CIR fishing prior to Memorial Day will diminish bass fishing quality (see Scenario 2, l). This scenario includes legalized CIR as well as 2.5 additional months of possession season, all of which may not be well received by riparians and some user groups;

e. would increase early season large bass mortality during the CIR period (as described in scenario 2, f), but total large bass mortality would likely not be as severe as in Scenario 2 since there is less CIR season and less possession season during the spawning period;

f. would require, as in Scenario 1, n, legislative approval because it represents liberalization or lengthening of the bass season compared to the current season, which is listed in statute.

We believe the increased harvest season in the January 1–March 15 period would result in inconsequential losses to bass populations because bass activity would be very low due to cold water temperatures. Given this factor, it is also not very likely that standard tournaments would be held during this period and bass harvesters would not take much advantage of this early season. However, we also believe that the vast majority of anglers consider bass to be best utilized as a sport species during the open water period, rather than harvested during the ice-fishing season. Therefore, any harvest of bass during the winter is contrary to the primary effort of changing bass regulations to increase angler opportunity. Also, legislative approval would be needed to allow for this increased harvest period. This would require the modification of 1994 PA 451, Part 487 Sportfishing, which contains most laws governing recreational fishing. This is a complicated and tedious process. In our presentation to the division, we argued that the desired goal of providing more valued fishing opportunity can be better achieved with scenarios 5 and 6.

5) Winter and spring CIR/delayed summer possession—Recommended.–This scenario would:

- allow catch-and-immediate release from January 1 through March 15;
- close the season March 16 until the last Saturday in April (LP) or until May 15 (UP);
- allow catch-and-immediate release from the last Saturday in April (LP) or May 15 (UP) until the 3rd Saturday in June; and
- allow possession from 3rd Saturday in June through December 31.

This scenario would allow many more days of bass fishing opportunity relative to the current regulations, while the delayed possession and harvest season would reduce harvest and displacement during the vulnerable nesting period. Specifically, Scenario 5:

a. would allow for legalized bass fishing for 46 weeks (10.5 months) during the year compared to the present 31 weeks (7.5 months);

b. would take advantage of a time period that is presently closed in the earliest part of the year (January 1–March 15) when bass are not spawning and probably least vulnerable to fishing, but may offer some early season fishing opportunity. While some southern Michigan lakes in some years are free of ice in early March and could be fished with boats, because water temperatures will still be very cold, the threat of hooking mortality will be minimal;

c. would reduce the possession (harvest and CDR) season by about 3 weeks;

d. would prevent possession (harvest and CDR) for most of the nesting period throughout the state, which will help minimize negative effects of fishing on reproductive success; benefits from the delayed harvest season would likely compensate for risks with the earlier CIR seasons;

e. would preserve a statewide, uniform closed bass season during walleye, muskellunge, and northern pike spawning periods discouraging human disruption of these species during those critical time periods by bass anglers (Scenario 2, k);

f. would allow anglers to fish more days in the early part of the year compared to the present season (Scenario 3), legitimatizing most of the current illegal preseason fishing activity;

g. would probably increase total angler days of fishing. Changes in fishing effort are difficult to anticipate; however, with bass fishing popularity continuing to increase (see **Introduction**), it is likely that total effort will increase. In contrast, angler hours could go unchanged, and simply shift to earlier in the year.

h. would increase spring fishing pressure on bass populations, particularly nesting bass, potentially by as much as 40% (Appendix; many anglers presently abiding by the law [estimated at 56% in 1989; Schneider et al. 1991] likely would now enter the fishery during the entire nesting season);

i. would result in increased hooking mortalities of bass because of increased spring fishing pressure (Many bass would be caught with live bait, which would add to fishing mortality because of deep hook wounds. Bait restrictions are not recommended because they are impossible to enforce when other species have open seasons with no bait restrictions, e.g., crappie, pike, walleye, etc.);

j. may result in decreased catch rates during the possession season if bass become “hook shy” due to fishing during the CIR season (see **Effects of Early Season Fishing on Quality and Sustainability**);

k. would, as in Scenario 1, n, require legislative approval because it represents liberalization or lengthening of the bass season compared to the current season, which is listed in statute.

The increased hooking mortality expected because of more early-season CIR fishing would likely be compensated for by benefits associated with the delayed possession season, allowing more male bass to complete nest guarding by protecting these bass from harvest and displacement. Bass fishing would be legal for all but 6 weeks each year, but the possession season would be reduced by 2 to 3 weeks from the present season. Typical bass tournaments (catch-and-delayed-release) would *not* be allowed during the CIR or closed seasons, but other types of tournaments conducive to catch-and-immediate-release (such as total numbers or inches of bass caught) could be held during the CIR period. This scenario also respects the spring spawning seasons of northern pike, muskellunge, and walleye and would strengthen conservation officers’ ability to enforce seasonal fishing closures for large predators. In our presentation to the division, we recommended that this scenario be adopted as the new black bass fishing regulation for Michigan.

This scenario actually would make Michigan’s harvest season quite similar to those of several other northern states and the Province of Ontario, nearly all of which have mid-June opening dates (Table 1). In addition to those listed in Table 1, the state of Ohio has recently enacted a closed possession season for bass in its Lake Erie waters. Their closed season runs from May 1 to the last Saturday in June, and is supported by the B.A.S.S. Federation, Ohio Chapter and other sportfishing groups. Also, Illinois has instituted a catch-and-immediate-release rule during smallmouth bass spawning season on most of its rivers with a June 15 opening day for possession.

The Pennsylvania Fish and Boat Commission recently conducted a review of its bass regulations (Pennsylvania Fish and Boat Commission 1998). They reviewed the available literature and used angler focus groups to discuss options. In the end, they decided that direct losses associated with catch-and-release mortality could be mitigated by reducing harvest-related mortality through greater restrictions on harvest during the open season. In other words, they chose a seasonal option very similar to Scenario 5 above with catch-and-immediate-release fishing from mid-April to mid-June, but added some limited possession in the spring and fall. None of the new Pennsylvania regulations allows tournaments during the mid-April to mid-June period. They also made it unlawful to cast to visible bass spawning nests—a law that their enforcement personnel have said is very difficult to enforce. However, follow-up surveys of age-0 bass production have shown diminished age-0 densities in Pennsylvania rivers (Lorantas 2003a), reservoirs, and lakes (Lorantas 2003b) since the new regulations were invoked. While these lower densities may be due to factors other than fishing (such as high flow rates during the nesting period), more study is underway. These findings, although preliminary, argue against adopting regulations in Michigan that are associated with a risk level greater than that of Scenario 5.

6) Closed winter/spring CIR/delayed summer possession.–This scenario would:

- close the season January 1 to last Saturday in April;
- allow catch-and-immediate release from the last Saturday in April (LP) or May 15 (UP) until the 3rd Saturday in June; and
- allow possession 3rd Saturday in June to December 31.

Benefits of this scenario include increased fishing opportunity in terms of total days fishing, while the harvest period is delayed in order to better protect bass during the nesting period. Specifically, Scenario 6:

a. would include all benefits and concerns listed in Scenario 1, a, c, and n; and Scenario 2, c, d, e, g, and h;

b. would increase early season large bass mortality during the CIR period (as described in scenario 2, f), but not as severely as in Scenario 2 because CIR and possession seasons are more restricted in this scenario;

c. would prevent possession (harvest) for the duration of the nesting season throughout the state, so most bass caught during the spawning season would survive to complete spawning. Increased nesting success and survival of spawning (vulnerable) bass due to the reduced harvest season, relative to current regulations, would likely compensate for bass lost by increased hooking mortality in the earlier CIR season;

d. does not take advantage of possible angler days in the earliest part of the year (January 1–March 15), although bass populations are probably least vulnerable this time of year, so actual loss of fishing opportunity relative to other scenarios may be minimal;

e. would preserve a closed bass season coinciding with walleye, muskellunge, and northern pike spawning periods unique to the Upper and Lower peninsulas, discouraging human disruption of these species during those critical time periods by bass anglers (see Scenario 2, k);

f. would likely meet with some public opposition as discussed in Scenario 2, l; (There is a perception among some lake riparians and anglers that legalized, additional CIR fishing prior to Memorial Day will diminish bass fishing quality [see Scenario 2, l]. However, since the regular harvest season is shortened to compensate for losses in the CIR season, it is expected that the vast majority of riparians and anglers will favor this scenario);

With this scenario there may actually be a positive effect on adult largemouth bass survival as the delayed harvest season (beyond the nesting period when bass are most vulnerable) could result in reduced total harvest mortality. But, there is likely a compensatory tradeoff, in both bass biology and angler opportunity. More legal fishing days in the spring will likely lead to more hooking mortality during the CIR season, but this should be offset with less harvest mortality due to the shortened harvest season. All anglers will have more days to fish, but harvest and CDR anglers will be more restricted. There are unknowns. For example, the extended CIR season could result in higher than anticipated hooking mortality rates. The outcome will depend in large part on fishing effort levels and the maintenance (or even increase) of the catch-and-release ethic during the harvest season. These factors are difficult to anticipate. Also, fishing pressure during the CIR season could diminish some fishing quality later in the summer given that bass, caught and released in the spring, may be less likely to be caught during the possession season (see **Effects of Early Season Fishing on Quality and Sustainability**).

We believe Scenario 6 to be of low and acceptable risk to bass populations and associated food webs, while providing more days of legal fishing opportunity than the status quo. We feel, however, that this scenario may be more restrictive than what is necessary given that CIR fishing could be allowed earlier in the year (until March 15). Also, legislative approval would be needed in order to allow for this increased fishing period. This would require the modification of 1994 PA 451, Part 487 Sportfishing, which contains most laws governing recreational fishing. In our presentation to the division, we recommended this scenario be adopted if Scenario 5 is not chosen.

7) Closed winter and spring/delayed summer possession—Lowest risk.–This scenario would:

- close the season January 1 through July 14; and
- allow possession from July 15 through December 31.

This is clearly the most conservative scenario from the biological perspective, and is the most restrictive for anglers. Scenario 7:

a. would provide the most protection to spawning bass populations, maximizing the likelihood of reproductive success, recruitment (and hence population abundance), and survival of large adults statewide in inland and Great Lakes waters;

b. would minimize fishing during the spawning period, which can compromise success of individual nests due to physiological stress, nest predation, poor brood guarding, and nest abandonment (see **Effects of Early Season Fishing on Quality and Sustainability**);

c. would potentially improve the size structure of bass in some populations given that fewer adult bass would be killed from fishing (hooking or harvest mortality) because of a shortened harvest season, and the absence of a CIR season when there is heightened vulnerability of bass to fishing;

d. would have the most chance of promoting food web interactions that result in predator and prey balance and promote water clarity as a result of higher densities of large bass;

e. would provide the least number of calendar days for legal fishing of any of the seven scenarios, which could lead to a disproportionately larger reduction in angler effort because the spring nesting season represents a time of relatively high catch rates and high angler effort (see **Effects of Early Season Fishing on Quality and Sustainability**). This could have a negative effect on economic benefit (at least short term) due to the shortened season; however, many uncertainties regarding economic benefit persist, warranting further study;

f. would be extremely difficult to enforce because of open seasons for other large predatory species during the closed bass season. This challenge is associated with current regulations as well, but this scenario would lengthen the time of year during which it occurs;

g. would preserve a closed bass season while seasons for other predators are closed (Scenario 6, e and Scenario 2, k);

h. would be the closest of any scenario to regulations on the Canadian waters of the St. Clair System and Lake Erie where Ontario fisheries biologists believe protection of spawning smallmouth bass with seasonal closures or sanctuaries is critical for population sustainability and fishing quality. Likewise, Ohio fisheries biologists have recently recommended a bass spawning season harvest closure on their Lake Erie waters;

i. would require a change in legislation, as in Scenario 1, n, due to liberalization of the bass season relative to statute.

In our presentation to the division, we argued that this scenario represented the safest approach in light of uncertainty regarding population effects of fishing, but fishing opportunity would be unnecessarily restricted. Angler compliance with this regulation would be similar, or lower than it is with the present regulation (Scenario 3). While this scenario, more than any other, would give bass populations and the associated aquatic environment the best chance for sustained recruitment, good size structure and ecological health, we believe the vast majority of bass populations do not need this much protection and could withstand, with acceptable risk, the increased CIR with delayed possession fishing proposed in scenarios 5 and 6.

In summary, SALBRC and Fisheries Division biologists agreed in 2004 that scenarios 1 and 2 were not viable options because they represent an unacceptable increase in risk to bass populations. Also, Scenario 7 was viewed not a viable option because of its excessive restriction to bass fishing. Consequently, the division recommended that four scenarios be considered by the public: scenarios 5 and 6, which SALBRC endorsed, as well as scenarios 3 and 4.

Research Needs

As described above, in the short term, guided by the precautionary principle and our current state of knowledge, we sought to identify the management option most likely to optimize the balance between fishing opportunities and risk to the quality and sustainability of black bass populations. For the longer term, we face the questions, "What knowledge gaps most constrain our ability to manage black bass in Michigan?" and "What resources and approaches are required to attain this understanding?" In short, we can make a more informed management decision if (1) the status of black bass populations is documented better, and (2) risk and opportunity are quantified better. Within this context, we identified key questions to be addressed:

Status

- What benchmarks could be measured to better assess the status of bass populations? What sampling strategies and methods would provide the data needed to measure the benchmarks in a cost-effective manner? What additional information would be useful for management?
- Do we need our regulatory efforts to vary among lakes? Are some bass populations more vulnerable to overfishing than others?
- To what extent do characteristics of adult bass populations (abundance, size structure, etc.) predict recruitment? To what extent do compensatory mechanisms structure bass populations?

Risk

- What are the bass population level effects (adult mortality, size structure, and reproductive success) associated with different levels of fishing intensity for different management options (seasons, size regulations, etc.) and fishing behaviors (tournaments of assorted types, non-tournament anglers, compliance, etc.).
- How do changing environmental factors affect the susceptibility of bass populations to negative effects of fishing? Included in these factors are largemouth bass virus, exotic species (e.g., round gobies), global climate change and aquatic plant management.
- How do angler attitudes determine total fishing pressure and practices (i.e., CIR, CDR, harvest, and compliance)?
- What are the short- and long-term effects of tournaments on black bass populations? If an early CIR season for black bass is established, can pressures for early-season CDR tournaments be resisted?

Opportunity

- What are the economic benefits to the State of Michigan associated with different management options (seasons, size regulations, etc.) and fishing behaviors (tournaments of assorted types, non-tournament anglers, etc.)?

- What are the total fishing hours, catch rates, angler compliance levels, and angler satisfaction associated with different management options (seasons, size regulations, etc.)?

We were directed to recommend a course of action if additional research was needed to determine how to best manage black bass populations in Michigan. In particular, we were directed to determine if research was needed to measure the effects of early season fishing on bass populations, fisheries, and ecosystems. However, given the breadth of the topic, our critical information gaps will not be resolved by a single research project. Rather, a larger and more long-term program is required. Of course, the personnel and resource demands of such a program must be weighed against other demands and priorities of Fisheries Division—something that is outside the purview of this committee. Rather, we summarize the major challenges facing black bass research and provide initial recommendations for further deliberation.

Challenges to Solving Critical Uncertainties

An example.–First, we provide an example to illustrate the difficulty associated with addressing just a subcomponent of the above questions, and hence why a single study is inadequate to address all of the most critical uncertainties.

Question: Is there any impact to adult bass abundance or size structure from fishing during the spawning season?

Background: This question has been recognized as crucially important for fisheries management for at least the last 15 years. The fact that it remains unanswered is not evidence that there is no effect, but rather evidence of the difficulty in conducting the research necessary to answer the question definitively. The issue of size structure effects is particularly challenging. Trophy bass in Michigan, those individuals over 20 in in length, are generally at least 10 years old. Therefore, a change in the abundance of trophy bass, resulting from decreased recruitment, could take at least 10 years to become apparent and a well-designed study would need to extend over 15 to 20 years. That kind of time span alone presents serious difficulties for most natural resource agencies. In addition, the issue of variability among Michigan lakes is equally challenging. Given the diversity of habitats throughout Michigan, it is unlikely that the effects of fishing during the spawning season will be the same among all lakes. This situation calls for a study design that groups lakes that are ecologically similar. Then, within these groups, comparisons between treatment (nesting season fishing) and reference groups (closed season) would be conducted.

Study design:

- stratify lakes by ecoregion (n = 4 Michigan ecoregions)
- within each ecoregion, stratify by lake size (n = 4 size classes, 16 ecoregion and size combinations)
- within each ecoregion and size group, stratify by dominant black bass species (n = 32 ecoregion by size by species combinations)
- within each ecoregion by size by species group, stratify by treatment and reference lakes. For simplicity, assume that three lakes per treatment group will provide sufficient statistical ability to thoroughly evaluate. (N = 32·2·3 = 192 lakes)

Protocol: Fishing (for all species) during the study would be strictly controlled (ideally prohibited during the pretreatment phase). At least five years of pretreatment and 10 years of posttreatment data would be needed to evaluate the recruitment and size structure of the adult bass originating from the spawning events study. Ideally, we would want to conduct fall recruitment surveys on each lake, as well as intensive nest monitoring and adult bass surveys (by summer night electrofishing) each year. Over 15 years this would correspond to 2,880 surveys. If we sought to compare the effects of different fishing levels (angler hours) or practices (e.g., CIR versus CDR), this design would at least double the number of lakes and required surveys.

Given the daunting number of lakes required in this design, alternative approaches could be adopted. These alternatives would be more constrained in the extent to which findings could be extrapolated to the population of Michigan lakes as a whole. But, additional studies could be designed that build on findings from the initial study. Alternative approaches could include a pond experiment, in which bass populations are established in experimental ponds, and assigned to treatments representing fishing pressure and practice. Alternatively, the first generation study could identify lakes with bass populations most likely to be affected by early season fishing. This situation would correspond to small lakes with high fishing pressure and few bass. The reasoning would be if no effect is detected despite sufficiently rigorous research in these most sensitive systems, then we could conclude that fishing in all Michigan waters during the nesting season does not negatively affect black bass populations.

Generalities and recommended approach.–The above example illustrates the complexity and breadth of research required to address critical uncertainties regarding black bass fisheries. Some generalities can be drawn regarding the largest challenges to these efforts:

- A single research study will not suffice.
- The temporal scale of study must recognize the generation time of black bass.
- The spatial scale of study must recognize the diversity of habitats in Michigan and the likelihood that these environmental factors will mediate the response of black bass to fishing.
- Better monitoring of black bass populations is needed, allowing us to truly assess the status of these populations, and the important fisheries that they support, on a statewide basis.

Rather than conclude that the task is insurmountable, we suggest that our discussion illustrates the need for an adaptive approach to managing black bass populations in Michigan—an approach by which we integrate research and management to “learn by doing.” Indeed, the difficulty in making predictions about long-term impacts of management actions on fish populations is one of the reasons that experts have endorsed adaptive management of natural resources (Lee 1993). This approach is being increasingly applied in situations such as the Pacific Northwest salmon fisheries, the Colorado River, and the Florida Everglades.

Future Issues

During our examination of the scientific literature and Michigan black bass fisheries, we recognized several issues, beyond that of bass fishing seasons, which call for attention and evaluation by Michigan fisheries managers in the near term. Indeed, we recognized the difficulty in determining appropriate bass seasons in the context of critical biological and social uncertainties, and ever changing biological circumstances and public values and practices. These issues are beyond the scope of our committee, although certainly of interest to each of us, and pertinent to the bass season fishing regulations which this report addresses. Therefore, we recommend that Fisheries Division establish a program for long-term research on black bass. We close with a list of ideas regarding potential actions and studies that could serve as the starting ground for development of a long-term research program on Michigan’s black bass fisheries.

Quantify Effects of Tournament Fishing Practices

- Collect basic information on number of tournaments, their locations, number of anglers per tournament, species targeted, fishing effort, catch rates, initial and delayed mortality rates, angler demographics, weigh-in format, and weigh-in practices. Determine the effects of tournament practices, such as delayed release and “fizzing” (i.e., releasing of air from the swim bladder) on bass mortality (see **Effects of Early Season Fishing on Quality and Sustainability**).
- Combine information on prevalence of tournaments and associated delayed mortality rates, and general angler practices and demographics to generate estimates of total mortality attributable to fishing.
- Educate anglers regarding the extent to which hooking mortality rates (and physiological stress) vary with handling, and promote techniques for minimizing hooking mortality.
- Investigate the effects of tournament displacements and angler transfers of black bass within large water bodies and between smaller water bodies. The genetics of black bass in Michigan are poorly understood. Displacement may be adversely affecting the genetic structure of Michigan’s black bass populations.
- Educate anglers regarding the negative effects (and potential legal implications) of displacement activities and develop bass-handling guidelines to minimize displacement of released bass.
- Encourage tournament anglers to adopt a "no cull" rule to minimize displacement, disease transmission, and hooking mortality.

Characterize Anglers and Quantify Effort, Harvest, and Economic Benefits of Fishing

- Conduct surveys of Michigan anglers including questions critical to characterize perceptions, expectations, and practices of bass anglers.
- Conduct follow-up study of the six experimental catch-and-release lakes (Appendix). Assess the size structure and abundance of the bass populations. Include creel surveys on the lakes to determine current levels of early season fishing, harvest, and opinions regarding the early season.

Garner Broad Support

- The Fisheries Division Management Team should request that certain funding agencies support research related to black bass management. Fisheries Division could contact Michigan Sea Grant, Great Lakes Fishery Trust, and Great Lakes Fishery Commission. These groups usually fund Great Lakes research, and quite a bit of black bass fishing occurs in Great Lakes waters. Inland and Great Lakes research could be integrated.
- Consult with bass clubs and federations about support for black bass research. Encourage them to invest in black bass research.

Quantify Compensatory Dynamics and Response to Fishing

- Evaluate the relationships among adult stock size, density, size structure, and recruitment and monitor other key elements of lake ecosystems (water temperature, water chemistry, zooplankton, forage fish, etc.). Deploy temperature loggers in waters with significant bass fisheries so that the timing of bass reproduction can be estimated and compared with the fishing season. Measure angler effort, catch, and harvest in significant bass fisheries.

- Determine the characteristics of lakes with similar bass population dynamics. Evaluate the extent to which lakes within groups respond similarly to early season (or other) fishing, and other changing environmental conditions.
- Determine the extent to which a delayed harvest season compensates for any negative effects of CIR fishing on bass reproductive success.
- Evaluate how changing environmental conditions mediate the response of black bass to fishing:
  - Evaluate the role of aquatic plants in influencing black bass populations. Quantify the relationships among aquatic plant management, fish populations, and fisheries in Michigan lakes.
  - Evaluate the relationship between shoreline development, shoreline habitat, and black bass populations. Bass populations in highly modified lakes may be more vulnerable to effects of fishing, because of reduced population abundance, reduced recruitment, lower compensatory reserve, higher vulnerability to fishing, etc.
  - Compare bass populations where largemouth bass virus (or other new diseases) has been found versus where it has not (yet) been found.
  - Conduct research on the effects of exotic species, such as the round goby, on bass populations in both Great Lakes and inland waters of the state. Identify waters most vulnerable to invasion by these exotic species.
- Develop models of black bass population dynamics to illustrate the consequences of our hypotheses, design powerful experiments, explain the results of experiments or monitoring data, and evaluate predicted effects of alternative management actions.
- Integrate field sampling, the Status and Trends Program, pond experiments, and modeling to address critical uncertainties. Treat regulation changes as whole-system experiments with rigorous statistical design, before and after data collection, power analysis to determine the number of lakes to be included, etc.
- Use decision analysis to synthesize our current understanding, highlight uncertainties, and explore implications of management options within this context.

Summary

Herein, we thoroughly reviewed pertinent scientific literature, considered the specifics of black bass biology in Michigan relative to its biology throughout its North American geographic distribution, and reviewed black bass regulations throughout North America—specifically in the north temperate region (northern U.S. states and Canadian provinces). We then considered seven seasonal regulation scenarios that spanned a full range of angler opportunities and likely risks to the size structure and reproductive success of bass populations in Michigan. Of these seven scenarios, four were presented for public review: Scenario 3, representing current regulations, and scenarios 4, 5 and 6. SALBRC agreed by consensus that scenarios 5 and 6 represented an acceptable balance between angler opportunity and biological risk, and we recommended Scenario 5 to the division. Scenarios 5 and 6 differed only according to bass regulations during winter. More importantly, scenarios 5 and 6 entailed:

- establishment of catch-and-*immediate*-release (CIR) seasons during winter and late spring;
- maintenance of a closed early spring season that coincides with closed seasons for other large, coolwater predatory sport fish; and
- delay of the possession season, including harvest and catch-and-delayed-release (CDR), to better coincide with the completion of the bass nesting period and to compensate for expected increases in hooking mortality and nesting disruption associated with the new CIR seasons.

Scenarios 5 and 6 were intended to:

- expand black bass fishing opportunities by establishing CIR seasons in winter and late spring;
- protect other cool- and warmwater predatory sport fish during their spawning season, while also simplifying regulations and their enforcement by creating a common closed season;
- protect black bass populations from displacement and harvest during most of the nesting season; and
- balance the increase in nesting disruption resulting from the late spring CIR season by delaying the harvest season.

In addition, we recommended that Fisheries Division:

- develop and implement a plan to monitor the state's black bass fisheries to detect significant changes in fish populations and fisheries; and
- develop and implement an educational program through which anglers are informed of the effects of handling, delayed release, and displacement on black bass.

These more general recommendations were intended to:

- provide researchers and fisheries managers with pertinent biological data on which to base bass management; and
- increase survival of caught-and-released bass by improving or increasing angler awareness of beneficial handling techniques and weigh-in practices.

Finally, as stated in the **Introduction**, it should be noted that our committee's efforts occurred during 2003 and 2004. In 2005, subsequent to writing this report, an angler opinion survey was conducted, SALBRC was disbanded, and a meeting between Fisheries Division personnel and the external Coolwater Regulations Steering Committee was conducted. The Fisheries Division Management Team used this report, the angler survey, and additional public feedback to produce their recommendation to the Natural Resources Commission in fall 2005, which resulted in new regulations (scheduled to "sunset" after five years) taking effect in 2006. These new regulations will allow catch and release from the last Saturday of April (Lower Peninsula) or May 15 (Upper Peninsula) until the harvest season begins on its 'traditional' day of the Saturday of Memorial Day weekend. The events, discussion, and final decision relating to this new regulation, which occurred subsequent to our 2003–04 efforts as a committee, will be summarized in a forthcoming Fisheries Division document.

Figure 1.–Estimated average number of days between last spring and first fall 32° F occurrences during 1930–79 (Eichenlaub et al. 1990).

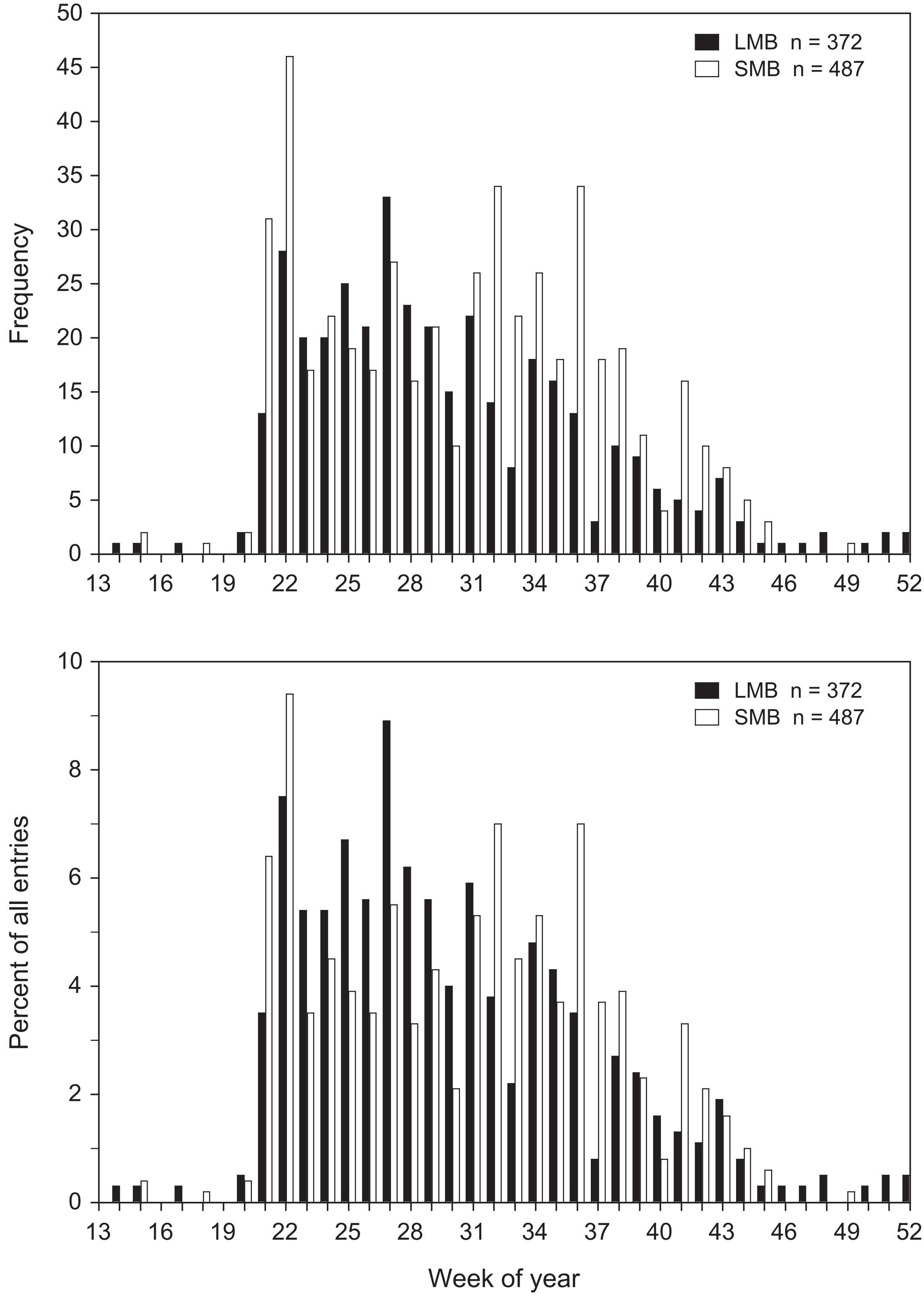

Figure 2.–Percent of all largemouth and smallmouth bass Master Angler entries for each week from 1992 through 2002. During this time period legal bass fishing began the Saturday of Memorial Day weekend (during the 21st week of the year) in the majority of the state's waters.

Table 1.–Summary of general black bass regulations in states (and Ontario) with seasonal closures (CIR = catch-and-immediate-release, MSL = minimum size limit).

State	Harvest season opening date	CIR legal during closed season	CIR special early season	MSL (in)	Regular season daily possession limit
Maine	Apr 1	No	Late CIR season Oct–Nov	12.0	1 fish - Apr 1–Jun 20 3 fish - Jun 21–Sep 30
Maryland	Jun 15	March 1–Jun 15		12.0	5
Michigan	Saturday of Memorial Day weekend	No	Yes, on six lakes	14.0	5
Minnesota	Saturday of Memorial Day weekend	No	SMB CIR only from Sep–Feb	None	6
New Hampshire	2nd Saturday in Jun	Yes	CIR at site of catch, artificials only, May 15–Jun 15	None	5 fish - July 1–ice in; 2 fish - ice in–May 14
New Jersey	Jun 16	Apr 15–Jun 15		12.0	5
New York	3rd Saturday of Jun	No	CIR on selected lakes, study underway; special early Lake Erie season, 1 fish >15 in, Apr 1 to opener	12.0	5
Pennsylvania	2nd Saturday in Jun	mid-Apr–mid-Jun	“Illegal to cast to beds”	12.0	6
Vermont	2nd Saturday in Jun	No		None	5
Wisconsin	3rd Saturday of Jun	No	CIR only May–Jun 15, “illegal to sort fish”	14.0	5
Ontario	Last Saturday of Jun	No	Spawning sanctuaries	None	6

Table 2.–History of minimum size and daily possession limit regulations for sportfishing for bass (largemouth and smallmouth) in Michigan.

Inland Lakes and Streams			Great Lakes		
Year	Legal size (in)	Daily limit	Year	Legal size (in)	Daily limit
1932–68	10	5	1932–39	10	5
1969–75	10	5 single or combined [a]	1940–41	10	5 LMB; 10 SMB
1976–92	12	5 single or combined [a]	1942–50	10	5 single or 10 combined
1993–2003	14	5 single or combined [a]	1951–75	10	5 single or combined [a]
			1976–94	12	5 single or combined [a]
			1995–2003	14	5 single or combined [a]

[a] Combined with northern pike, walleye, and others.

Table 3.–History of fishing season regulations for sportfishing for bass (largemouth and smallmouth) in Michigan.

Inland and Great Lakes [a]		St. Clair system [b]	
Year	Open season	Year	Open season
1865	All year	1865	All year
1900 (?)	May 20–Mar 31	1900 (?)	May 20–Mar 31
1909	Jun 15–Jan 31	1909	Jun 15–Jan 31
1929	Jun 25–Dec 31	1929	Jun 25–Dec 31
1951	3rd Saturday in Jun–Dec 31	1951	3rd Saturday in Jun–Dec 31
1962	Jun 1–Dec 31	1970	4th Saturday in Jun–Dec 31
1968	May 30–Dec 31	1976–2003	3rd Saturday in Jun–Dec 31
1969	Memorial Day–Dec 31		
1970–2003	Saturday preceding Memorial Day–Dec 31		

[a] Except on trout streams.
[b] Includes St. Clair River, Lake St. Clair, and Detroit River.

Table 4.–Matrix of risks and benefits associated with different fishing season scenarios considered by SALBRC. Possess = catch-and-delayed-release + catch-and-keep, CIR = catch-and-immediate-release, "+" = regulation is expected to have a positive effect on this parameter, "–" = regulation is expected to have a negative effect on this parameter, "?" = regulation will have unknown effect, and "NCE" = no change expected.

		Fish community		Bass population			Human dimensions			
Scenarios	Requires legislative approval	Predator-prey balance	Enforcement (non-target species)	Nest success	Survival to Age 1+	Survival of legal bass	Density of master angler bass	Recreational fishing opportunities	Compliance with bass regulations	Bass fishing quality
1 Winter, spring, and summer possession—Highest risk [a]	Yes	–	+	–	–	–	–	+	+	–
2 Winter and spring CIR/traditional summer possession [b]	No	–	–	–	–	–	–	+	+	–
3 No regulatory change—Moderate risk [c]	No	NCE	NCE	NCE	NCE	NCE	NCE	NCE	NCE	NCE
4 Winter possession/spring CIR/delayed summer possession [d]	Yes	+?	+	?	?	+?	?	+	+	+?
5 Winter and spring CIR/delayed summer possession—Recommended [e]	No	+	+	?	?	+	?	+	+	+?
6 Closed winter/spring CIR/and delayed summer possession [f]	No	+	+	?	?	+	?	+	+	+?
7 Closed winter and spring/delayed summer possession—Lowest risk [g]	No	+	+	+	+	+	+	–	–	+

[a] Possession Jan 1–Mar 15; closed Mar 16–last Sat in Apr; possession last Sat in Apr–Dec 31.

[b] CIR Jan 1–Sat before Memorial Day; possession Sat before Memorial Day–Dec 31.

[c] Current regulations—possession Sat before Memorial Day–Dec 31.

[d] Lower Peninsula: possession Jan 1–Mar 15; closed Mar 16–last Sat in Apr; CIR last Sat in April–3rd Sat in Jun; possession 3rd Sat in Jun–Dec 31. Upper Peninsula: possession Jan 1–Mar 15; closed Mar 16–May 15; CIR May 15–3rd Sat in Jun; possession 3rd Sat in Jun–Dec 31.

[e] Lower Peninsula: CIR Jan 1–Mar 15; closed Mar 16–last Sat in April; CIR last Sat in April–3rd Sat in Jun; possession 3rd Sat in Jun–Dec 31. Upper Peninsula: CIR Jan 1–Mar 15; closed Mar 16–May 15; CIR May 15–3rd Sat in Jun; possession 3rd Sat in Jun–Dec 31.

[f] Lower Peninsula: closed Jan 1–last Sat in Apr; CIR last Sat in Apr–3rd Sat in Jun; possession 3rd Sat in Jun–Dec 31. Upper Peninsula: closed Jan 1–May 15; CIR May 15–3rd Sat in Jun; possession 3rd Sat in Jun–Dec 31.

[g] Closed Jan 1–Jul 14; possession Jul 15–Dec 31.

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Appendix:
A Review of the Schneider (1991) Michigan Early Bass Season Study Report

Introduction

In 1988, an experimental early catch-and-release season for black bass was established on six large southern Michigan lakes. This regulatory change was brought about by organized pressure from bass fishing interest groups seeking expanded bass fishing opportunities in Michigan. The spontaneous nature of the experimental regulation precluded a thorough evaluation of the effects (if any) on the bass populations in the lakes with a properly designed study. Perhaps most regrettable was the lack of any systematic attempt to quantify the status of the bass populations in the lakes prior to the experimental regulation. Recognizing this problem, fisheries managers and researchers attempted to assemble enough information to document if any short-term catastrophic events occurred in the fishery or with bass recruitment. Schneider et al. (1991) summarized those efforts to monitor the fisheries and bass recruitment on the lakes between 1988 and 1990. It is the objective of this section to review the findings reported by Schneider et al. (1991) and to identify the strengths and weaknesses inherent in the study design. In addition, an update on the recent condition of the bass population or fishery in each of the study lakes follows.

Lake Selection Process

A special regulation allowing catch-and-release fishing for bass from April 1 to the regular season opener (Saturday before Memorial Day) was tested on six lakes in southern Michigan from 1988 to 1990 (Table A.1). The selection process for the six lakes included in the study was not discussed in Schneider et al. (1991). Institutional memory suggests that district fisheries managers were requested to provide candidate lakes with good bass populations. At least two lakes originally suggested for the experiment were not included because of strong local opposition to the proposed regulation change (Gun Lake, Barry County; Duck Lake, Calhoun County). Public concerns about the proposed early bass season at Duck Lake included expected increases in boat traffic in the spring, fears of increased illegal harvest, expectations of increased conflict between bass anglers and other anglers, both on the lake and at the public access site. Local Duck Lake anglers and residents were also unconvinced that the MDNR forecast of low catch-and-release mortality rates during the early season were accurate. In the end, fisheries managers felt reassured when the lakes finally selected for the special regulation (Table 1) were on river systems because these lakes would potentially be replenished with bass from upstream bass populations if early season fishing devastated the fisheries. Some noteworthy features of the lakes include: (1) the smallest (Pontiac Lake) is 585 acres in surface area and all others were at least 1,000 acres surface area; (2) four of the lakes have extensive expanses of publicly owned shoreline with little shoreline development (Hardy Pond, Holloway Reservoir, Kent Lake, and Muskegon Lake); (3) four of the lakes are impoundments (Hardy Pond, Holloway Reservoir, Kent Lake, and Pontiac Lake); (4) Muskegon Lake is a drown-river mouth lake with open connection to Lake Michigan and fed by a major river system, the Muskegon River; and (5) Cass Lake, although not an impoundment, is a “flow-through” water body on the Clinton River, with other lakes situated upstream and downstream. In summary, all six lakes included in the study were open to bass recruitment or bass immigration from other waters. Clearly, this non-random selection process resulted in a biased sample of the types of waters supporting black bass populations in Michigan.

The size of the lakes selected for the special regulation was not representative of Michigan inland waters. More than 99% of Michigan’s 64,796 inland lakes are smaller than 300 acres in surface area (Breck 2002). All six lakes included in the special regulation exceeded 500 acres in surface area. Extrapolation of the results of the special regulation on the six large lakes to the numerous lakes less than 500 acres in size is tenuous. The potential for higher pressure, higher proportion of individual nests impacted, and higher proportion of large fish hooked is much greater on smaller waters.

Study Approach and Results

The effects of the regulation on the fishery and fish populations were evaluated by (1) conducting an opinion survey to determine angler acceptance and usage at four of the lakes during spring and summer 1988 and 1990; (2) conducting a creel survey during the open-water fishing period at two of the lakes (those for which recent prior data existed) in 1988 and some partial catch survey data from the other four lakes in 1988 and 1990; and (3) monitoring trends in bass recruitment at all six lakes in 1988 and five of the lakes in 1990.

The strength of the evaluation was probably the angler opinion survey conducted at four of the lakes. The survey results clearly demonstrated that a majority of the anglers interviewed were bass anglers, regularly practiced catch-and-release, and supported the regulation change. Across all lakes, 44% of all anglers admitted to fishing for bass during the closed season in 1987. It would have been highly desirable to conduct a similar opinion survey at other lakes not included in the regulation for comparison purposes, since the sample at the six lakes was likely biased towards those anglers interested in and supporting the early bass season regulation.

The catch surveys indicated that the early bass season had little effect on the fisheries of the lakes. Cass, Kent, and Muskegon lakes saw increased interest in bass during the third year of the early bass season. There was little bass fishing recorded at Holloway Reservoir in 1988, so no catch sampling occurred in 1990. Pontiac Lake had light fishing effort, but a high proportion of the fishing effort was targeting bass during both 1988 and 1990. Largemouth bass catch rates were higher during the regular season than during the early season at all the lakes. However, smallmouth bass catch rates at Muskegon Lake, which had a more abundant smallmouth bass population than any of the other lakes, were slightly higher during the early season.

Recruitment was monitored with fall electrofishing surveys in 1988 and 1990. The report (Schneider et al. 1991) indicates that adequate numbers of small bass were found in one or both years. However, there was no elaboration on the definition of “adequate.” In fact, the catch of young-of-year largemouth bass was so poor at Holloway Reservoir, that it was not even included in the recruitment survey data table in the report. At Hardy Pond, no largemouth bass young of the year or yearlings were collected with sampling in 1990, the third year of the early bass season regulation. For the other lakes, young of the year largemouth bass catch rates ranged from 1.3 to 12.7 per h of shocking in 1988. In 1990, the year when fishing effort was reportedly low due to inclement weather conditions, the young of the year largemouth bass catch rate at Kent Lake was the highest observed for any lake in either year, 45.8 fish per h of shocking. The largemouth bass young of the year catch rate in 1990 for the other four lakes surveyed ranged from 0.0 to 3.5 fish per h. For those lakes that supported both species of black bass, the smallmouth bass young of the year catch rates were generally lower than those observed for largemouth bass. In 1990, no young smallmouth bass were caught in Cass, Kent, or Muskegon lakes, and their catch rate at Hardy Pond was only 0.8 fish per h of shocking. It is particularly perplexing that these extremely low catch rates did not receive any significant discussion by Schneider et al. (1991). Furthermore, the lack of any comparable recruitment data from the lakes prior to the regulation change or contemporary recruitment data from other lakes not included in the early season regulation provides no context for evaluating the recruitment data collected for the study lakes. Schneider et al. (1991) recognized that the sample sizes were too small, too variable, and occurred over too short of a time period to detect if anything other than an immediate and catastrophic impact to recruitment had occurred.

Review of Discussion and Recommendations

The discussion section of the report included substantial discourse on the social aspects of the special early bass season regulation. Again, the strong support among the anglers interviewed at the lakes for the expanded early season bass fishing opportunities was highlighted. However, it was also noted that fishing pressure increased less than expected during the first 3 years of the new regulation. Also, the authors pointed out that 69% of the interviewed bass anglers admitted to fishing illegally for bass prior to the season opener in 1987. Reasonably, the authors suggested that the closed season on bass was not providing much of a deterrent to bass fishing and therefore the special season basically legitimized an already pervasive angler behavior.

Another interesting social aspect mentioned in the discussion regarded an initial concern about bass clubs taking advantage of the early season regulation to hold additional tournaments. Apparently, some bass clubs agreed not to hold tournaments prior to the regular season opener in 1988. The authors indicated that by 1990, just 3 years after the early season regulation was initiated, pressure to allow tournaments on the six lakes had increased substantially. As a result, Fisheries Division "officially sanctioned" two tournaments, but the authors were aware of at least two other "unapproved" tournaments and suspected that more had taken place. It is unclear from Schneider et al. (1991) if the tournaments were "immediate" release format or if fish were held in live wells, weighed-in at the end of the event, and then released. Thus, a troubling pattern of bass angler disregard for regulatory authority seemed to emerge. Why did a high proportion of Michigan bass anglers ignore the closed season and fish for bass anyways? Why did bass clubs find it acceptable to hold illegitimate tournaments in just the third year of the special season, while a study was underway? This could be a ripe area for fisheries human dimension research in Michigan.

The discussion of the report covered a few biological aspects of the special season. The authors noted that largemouth bass catch rates during the early season were no different than during the regular season. However, smallmouth bass catch rates were slightly higher and this was consistent with previous studies on other waters. Unfortunately, size specific catch rates were limited to sublegal or legal size categories. Since larger bass spawn earlier, it would have been particularly appropriate to examine the catch rates for large or trophy size bass.

Schneider et al. (1991) also pointed out that an increasing trend in bass fishing interest was apparent (based on a review of some historical data), resulting in a high demand for bass fishing opportunities. They also warned that while a catch-and-release early season could reduce harvest during the regular season due to bass learning to avoid capture, elevated levels of spring catch-and-release fishing could result in hooking mortality high enough to affect overall bass abundance. It might be reasonable to further speculate that since larger bass spawn earlier, such early season hooking mortality could differentially affect the largest spawners in the population, resulting in a slow erosion of the upper end of the population size structure.

Schneider et al. (1991) wrapped up the discussion section of the report with a fair treatment of the clear negative effect on individual nests by fishing of nest guarding males as documented in other studies, while also identifying the lack of evidence that there was any population level effect. The report concluded with a list of recommendations, provided here in full:

1. From a biological perspective, the special early bass season could be continued at the study lakes. However, their bass populations should be surveyed periodically to confirm that recruitment is adequate.

2. Likewise, this concept could be extended to other selected southern Michigan lakes. Popular support is essential in the selection process. These lakes should be relatively large, have good populations of bass, have consistent recruitment of bass, and not have stunted panfish problems. Smallmouth bass, if present, should be of special concern.

3. Spring bass pressure should be maintained at a modest level. High pressure, as might be generated by unrestricted bass fishing tournaments, should not be promoted.

4. Fisheries Division policy on bass seasons should be reevaluated. Both biological and sociological factors should be considered.

The special early bass season was continued at all six lakes as suggested in Recommendation 1, and continued through at least 2006. Recommendation 2 suggested that other lakes could be considered for inclusion in the special early bass season, but with several caveats. First, Schneider et al. (1991) recognized that a social factor, namely local public support, would be essential for extension of the regulation to new water bodies. Secondly, since the special regulation had only been "tested" on relatively large lakes, the authors suggested that similar lakes should be considered for any further expansion of the regulation. Likewise, lakes with good largemouth bass populations and healthy panfish populations were preferred as likely options by Schneider et al. (1991). Special concern was noted for lakes with smallmouth bass as the dominant black bass species. Recommendation 3 suggested that spring bass pressure should be maintained at a modest level and that high spring pressure should be avoided. However, terms such as "modest" or "high" were not quantified in the report, and no management strategy for promoting "modest" spring pressure under the new early bass season was discussed in the report, other than to suggest that tournaments should not be "unrestricted." The preparation of this report could be viewed as a long overdue step by Fisheries Division in addressing Recommendation 4.

Updated Status of the Six Lakes Bass Fisheries and Populations

Since 1990, the early bass season has remained in effect on the six lakes. Unfortunately, there has been essentially no follow-up monitoring effort at any of the lakes. In many cases, changes or perturbations with significant ecological impacts have occurred at these lakes. For example, the statewide black bass minimum size limit increased from 12 to 14 in in 1993, along with increased size limits for northern pike. A short discussion of other changes impacting each lake and current knowledge regarding the bass populations is provided below.

Cass Lake.–In the mid-1990s zebra mussels colonized Cass Lake. Walleye stocking continued through the decade of the 1990s, with increased frequency and higher stocking rates than during the previous decade. In general, trap net surveys since 1992 caught low numbers of bass, with largemouth bass outnumbering smallmouth. An exception was the April 8 to 19, 1996 survey when 420 largemouth bass were captured for a CPE of 5.0. The growth index for that survey indicated Cass Lake largemouth bass were growing well below the state average. Anecdotal fishing reports indicate that bass fishing at Cass Lake has not changed appreciably since 1990. There were 16 permits issued for bass tournaments at the Dodge State Park public launch site on Cass Lake for 2003.

Hardy Pond.–It is suspected that zebra mussels colonized Hardy Pond in the mid-1990s, since upstream waters contained zebra mussels as early as 1993. No other major changes or perturbations are known to have affected the lake since 1990. Smallmouth bass remain the dominant species of black bass in the system. Anecdotal fishing reports indicate that bass fishing at Hardy Pond has not changed significantly since 1990. A few bass tournaments are held at the county park launch site each year.

Holloway Reservoir.–Holloway Reservoir has undergone several important changes since the late 1980s. A total fish reclamation using rotenone was completed in 1976. Gizzard shad were first found in the lake in 1986, just 2 years before the special bass regulation went into effect. Walleye stocking was discontinued in 1992, when the population achieved a self-sustaining level. Bryant (1992) noted that smallmouth bass were more abundant than largemouth bass, possibly due to algae-induced low dissolved oxygen levels in the lower lake where largemouth bass nesting would be affected. By 1995, the walleye density in the lake was estimated at 6 to 9 fish per acre, and the lake had become known primarily for the walleye fishery. Zebra mussels were first identified in the lake in 1995. Three years later, round gobies were reported from Holloway as well. By 1999, walleye abundances had declined and channel catfish *Ictalurus punctatus* had become the dominant piscivore in the lake. Drought conditions in the late 1990s and early 2000s often resulted in minimal flows through the lake. Fisheries managers indicate that while the lake has never been considered a "good" bass lake, the smallmouth bass population may have declined slightly since the 1980s. Currently, the lake does not draw much bass fishing interest and few if any bass tournaments are known to be held there.

Kent Lake.–Zebra mussels were first found in Kent Lake in 1994. Walleye stocking became more consistent and stocking rates were increased through 1996. Panfish became scarce by the mid to late 1990s and all walleye stocking ceased. The fish community had shifted from one dominated by small bluegills and crappie, to one dominated by walleye and bass. Largemouth bass are presently the dominant black bass species in the lake, but a population of smallmouth bass has persisted. Anecdotal angler reports indicate bass fishing during the early season is productive, but catch rates diminish greatly as the regular season progresses. Kent Lake is a popular site for bass tournaments. The Huron Clinton Metropolitan Authority (HCMA) requires a permit for any fishing tournaments at Kent Lake and only allows one tournament per weekend. In 2003, eleven tournaments were scheduled between the regular season opener and September 21 (Richard Schafer, HCMA, Kensington Metropark, personal communication).

Muskegon Lake.–By the mid-1990s zebra mussels had colonized Muskegon Lake. This invasion was followed by round goby colonization in the late 1990s. As a drown river-mouth lake, the lake has been affected by fluctuating Great Lakes water levels as well as yellow perch and alewife *Alosa pseudoharengus* population fluctuations. The walleye population appears to have been relatively stable at around 45,000 fish through this time period. Smallmouth bass remain the dominant black bass species in the system. Anecdotal angler reports suggest that bass fishing has remained relatively unchanged since 1990. Numerous bass tournaments take place each year on the lake. Tournament anglers often choose to leave the lake to fish on Lake Michigan or to travel to other drown river mouth locations along the shoreline, when weather conditions are favorable.

Pontiac Lake.–Through the 1980s and into the early 1990s, Pontiac Lake had the reputation among bass anglers as a lake with an abundant largemouth bass population that included good numbers of large fish. Several important changes have occurred at Pontiac Lake since 1990. First, walleye stocking was initiated in 1990, and continued through the decade (sometimes at extremely high rates), in an attempt to control a severe panfish stunting problem. In 1992, the lake was treated with the herbicide Sonar and the aquatic plant community was practically eliminated. In 1999, lake levels declined due to drought and have remained low. By 2000, zebra mussels had colonized the lake. The fish community responded to the various changes with a decline in abundance of panfish and improved panfish growth rates. Walleye and catfish populations expanded through the 1990s. A fall 1992 electroshocking survey collected no age-0 or age-1 largemouth bass in 1.5 h of shocking (Thomas 1993). Further, a distinct absence of 12- to 14-in largemouth bass was also noted. Since 2000, some angler complaints about a perceived lack of large bass have been recorded. In fact, MDNR efforts to collect legal-size bass for contaminant analysis have been unsuccessful, despite 4 h of night electrofishing in August 2003, suggesting that the angler reports may be credible. In 2002, there were only three permits issued for bass tournaments at the Pontiac Lake State Recreation Area public launch site. Four permits had been issued for 2003. Bass tournaments on Pontiac Lake can also occur without permit if held at the private launch site on the west end of the lake.

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Table A.1.–Alphabetical listing of the six lakes included in the early bass season regulation in 1988 with basic physical and biological information, and relative abundance of largemouth bass and smallmouth bass.

Lake County Type	Area (acres)	Max. depth (ft.)	Productivity	Bass abundance Largemouth	 Smallmouth	Comments
Cass Lake Oakland Natural	1,280	121	Low	Common	Common	Clear, deep, diverse, much recreational boating
Hardy Pond Newaygo Impoundment	2,845	115	Low	Sparse	Abundant	Perch and walleye abundant
Holloway Res. Genesee Impoundment	1,973	21	Very high	Sparse	Sparse	Turbid. Crappie, walleye and gizzard shad abundant
Kent Lake Oakland Imp. + Natural	1,000	38	High	Abundant	Common	Bluegill and crappie abundant, walleye common
Muskegon Lake Muskegon Natural	4,150	70	Medium	Abundant	Abundant	Perch and walleye abundant. Lake Michigan migrants. Muskegon River major tributary
Pontiac Lake Oakland Imp. + Natural	585	34	Medium-high	Abundant	None	Very weedy. Stunted bluegill.