

An Overview of the Smallmouth Bass in Nova Scotia

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Abstract.—Introduced to Nova Scotia waters in 1942, smallmouth bass *Micropterus dolomieu* have provided an alternative fishery to the more popular brook trout *Salvelinus fontinalis* in local areas. In recent years, angler interest in smallmouth bass has increased dramatically, and a modest tournament fishery has developed in addition to noncompetitive angling. Since 1971, illegal transfers and movements of fish within watersheds have been responsible for approximately doubling the distribution of this species over the past 15 years. Estimated annual catch and average catch per angler have increased 32-fold over the same time period. Population structure and length-at-age data from biological surveys in 1992 and 1993 indicated that growth was slower than in other northern waters. Observations of smallmouth bass nesting activity suggest that nest building and spawning commence when water temperature reaches 16–18°C, which typically occurs at the end of May or first week of June in Nova Scotia, and nest guarding is terminated by early July. Management practices focus on restricting the illegal introduction of smallmouth bass to new watersheds and sustaining a quality fishery where smallmouth bass are established.

The northern and eastern limits to the native range of smallmouth bass *Micropterus dolomieu* were bounded by the Appalachian range (MacCrimmon and Robbins 1975); thus there are no indigenous populations in New England or the Maritime Provinces of Canada. Smallmouth bass were first introduced in Nova Scotia via New Brunswick from stock originating in Maine. The first appearance of smallmouth bass in the Maritime Provinces was in the Chiputniticook Lakes on the New Brunswick–Maine border around 1870 (Catt 1949). It has been suggested that they were stocked from a private pond in Maine by a smallmouth bass angling enthusiast (Catt 1949). Over the next 50 years they were introduced and established self-sustaining populations in several watersheds in southwestern New Brunswick, including the Kennebecasis, Lower St. Johns, Magaguadavic, and St. Croix rivers (Smith 1942; Catt 1949). These populations provided the seed stock from which all Nova Scotia introductions were derived. No records indicate that smallmouth bass were ever introduced directly from their indigenous range.

The first successful planting occurred in 1942 when 107 adults were taken from Wheatons Lake, New Brunswick, to Bunker Lake, Yarmouth County, Nova Scotia (Catt 1949). During 1944–1953, 10 lakes in Nova Scotia were stocked with smallmouth bass, 6 of which developed sustaining populations (Catt 1949; Gilhen 1974). After 1953 government-sanctioned stocking of smallmouth bass ceased until 1967. During that interim, lake survey records and angler reports revealed that unauthor-

ized introductions or natural dispersal within watersheds increased the number of lakes inhabited by smallmouth bass.

In 1967 and 1968, the Nova Scotia Department of Lands and Forests, with the approval of the Federal Department of Fisheries and Oceans (DFO) and the Nova Scotia Light and Power Co. Ltd., introduced smallmouth bass into Lumsden Pond, Black River Lake, Gaspereau Lake, and Methals Lake in Kings County (Bain 1993). These and other lakes, by virtue of a hydroelectric power development, form what is known as the Gaspereau–Black River Complex and have developed into the premier smallmouth bass fishery in the province. In 1971, Spectacle Lake, Digby County, was stocked, and a successfully reproducing population was established in coexistence with chain pickerel *Esox niger*. The most recent smallmouth bass introduction occurred in 1984, when Murphy Lake, Kings County, in the Gaspereau–Black River Lake Complex was stocked (B. Sabeau, Nova Scotia Department of Natural Resources, personal communication).

Although unauthorized introductions of smallmouth bass are poorly documented, distributional data from documented introductions, historical lake survey and creel survey data, and interviews with outfitters, government biologists, and local anglers indicated an increase in the waters inhabited by smallmouth bass during 1942–1993. Hebda et al. (1990) compiled much of this information from a wide variety of sources, including interviews with operators of sporting goods stores and tackle supply shops, and an angler survey ques-

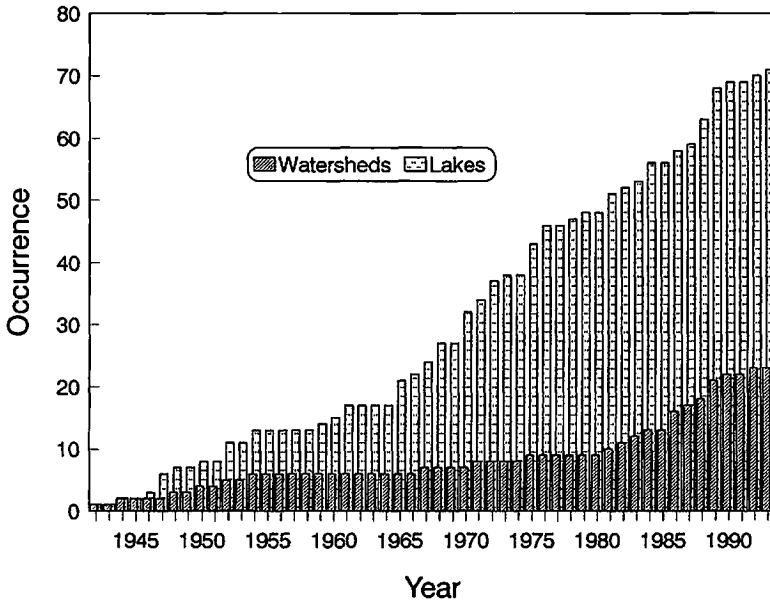


FIGURE 1.—Occurrence of smallmouth bass in watersheds and lakes in Nova Scotia, 1942–1993.

tionnaire distributed to members of 32 fish and wildlife groups in Nova Scotia.

Reliance on angler reports incorporates error in species distributional data. The most common error is species misidentification. In Nova Scotia smallmouth bass are routinely confused with white perch *Morone americana*, striped bass *Morone saxatilis*, and to a lesser degree, yellow perch *Perca flavescens*. For some years between 1966 and 1992, general fishing license stub returns reported smallmouth bass catches in all 18 counties, even though smallmouth bass have probably never existed in 9 of the 18 counties. A second error associated with angler reports is misidentification of the water body, which sometimes happens when there are different local and accepted gazetteer names for a lake or when several lakes in the same county share the same name. Additionally, when angler interviews are relied on to document the year of an illegal introduction, anglers may recall the year they first captured a smallmouth bass, not (unless they were personally involved) the year of the actual introduction.

The Nova Scotia Department of Fisheries (NSDOF) adopted the ranking system of Hebda et al. (1990) to record distributional data for smallmouth bass in Nova Scotia. A rank is assigned to each record of smallmouth bass presence according to the source of information. Ranks, in order of decreasing confidence, were (1) confirmed survey data, (2) reports from two or more independent

anglers, and (3) reports from one angler or party of anglers. No attempt was made to assign a greater or lesser ranking to an angler report based on the competence of the individual, although the observations of a knowledgeable and experienced angler may be as valid as scientific survey data (Hebda et al. 1990). Because level two ranking has never been repudiated by a scientific survey, these reports are considered accurate.

From 1955 to 1979, the majority of “new” smallmouth bass lakes probably resulted from natural colonization through contiguous waters in the same watershed. Only three new watersheds were colonized by smallmouth bass, two of them as a result of government stocking programs. From 1980 to 1993, illegal transfers increased the number of watersheds inhabited by smallmouth bass from 9 to 23 (Figure 1). With the exception of Murphy Lake in 1984, the most recent government-sanctioned introduction occurred in 1971. Since 1971 the number of lakes inhabited by smallmouth bass has approximately doubled, growing from 34 to 71.

The Fishery

Recreational fishery catch and effort statistics were compiled from several sources by the NSDOF and (before 1987) by the Nova Scotia Department of Natural Resources. Since 1966, voluntary angler returns of a survey stub attached to the general fishing license have provided annual

total catches by species and county, and since 1990, effort by species. License stub return rates have ranged from 3.4 to 19.1% of total license sales and averaged 6.6% between 1971 and 1990. The use of voluntary license stub returns may incorporate bias from nonreporting or underreporting by unsuccessful anglers, or overreporting by avid anglers (Clayton and O'Neil 1991). However, if it is assumed that such bias is consistent over time, the trends evident in the data may be reliable even if the absolute values of the catch information are not. Between 1971 and 1990, 30% of respondents caught no fish or did not fish, which suggests that avid anglers were not the only ones returning license stubs.

A second source of catch information for the recreational fishery in Nova Scotia is the Survey of Sportfishing in Nova Scotia (sportfishing survey), a part of a national and provincial series of angler surveys published every 5 years, beginning in 1974 (Cumming 1979; DFO 1984, 1988, 1994). In addition to catch by species, the sportfishing survey includes information on licensing trends and angler preferences, effort, motivation, expenditures, and investments. Participants in the survey are chosen at random from the current year's license vendors' stubs and stratified by license type and nationality (e.g., general or salmon license, Canadian resident, Canadian nonresident, or U.S. nonresident). The survey is coordinated by the DFO and the provincial agency responsible for recreational fisheries management. Information is collected by means of a questionnaire that is mailed about 4 months after the end of the fishing season; a reminder notice and second questionnaire are sent after an additional 30 days. Questionnaire returns average about 70%.

Although an avidity bias (Thompson 1991) may be present in the sportfishing survey, such bias is probably less pronounced than in the license stub data because the survey incorporates random sampling. On the other hand, most license stubs are received within 2 months of the end of the angling season, whereas the sportfishing survey questionnaire is generally filled out by respondents 4–6 months after the season ends. Fisher et al. (1991) reported that in general, estimates appear to increase with the length of recall period. In Nova Scotia, total catches calculated from the sportfishing surveys have always been higher than those calculated from license stubs, although the trends are similar.

Total estimated smallmouth bass catches reported from license stub returns increased during

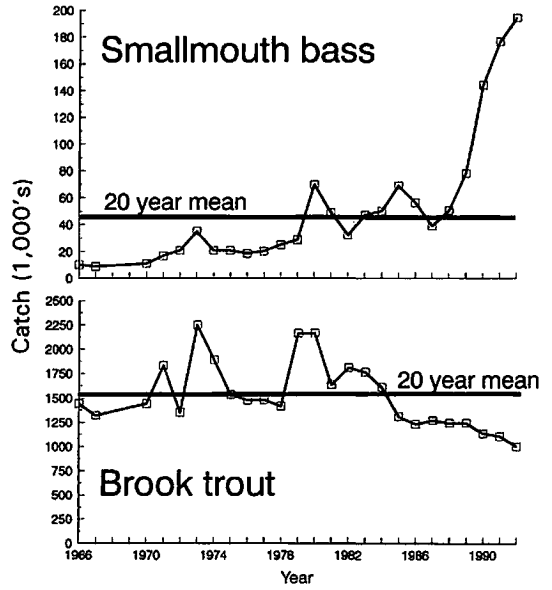


FIGURE 2.—Estimated total catch of smallmouth bass and brook trout by anglers in Nova Scotia, 1966–1992. Estimates were made from voluntary license stub returns. The 20-year mean is for 1971–1990.

1966–1992. There was a substantial increase in catch beginning in 1987, and the 1992 catch was 4.2 times greater than the 20-year average (1971–1990; Figure 2). In contrast, the estimated catch for brook trout *Salvelinus fontinalis* (the most popular game fish in Nova Scotia) decreased after 1983 and in 1992 was 36% lower than the 20-year average. In 1992, average catch per angler for smallmouth bass was four times greater than the 20-year average, whereas for brook trout, the average catch per angler was 20% lower than the 20-year average. Although in 1992 the average catch per angler for smallmouth bass was much lower than that for brook trout (3.1 versus 16.6), the majority of anglers were targeting brook trout; smallmouth bass were only targeted in certain areas. Angler log books indicated that in most cases, catch per hour for smallmouth bass was considerably higher than for brook trout.

Sportfishing survey data indicated an even greater increase in smallmouth bass catches during 1974–1990 (Table 1). The catch for 1990 was 32 times that estimated for 1974. In 1974, smallmouth bass ranked eighth in total catches for sport fish, whereas in 1992 only brook trout and rainbow smelt *Osmerus mordax* were caught in greater numbers (Cumming 1979; DFO 1994). Additionally, the proportion of smallmouth bass released

TABLE 1.—Numbers of licensed anglers, estimated total catch, estimated retained catch, percent released, and annual average catch per angler for smallmouth bass and brook trout from the Nova Scotia sportfishing survey, 1974–1990; NA = data not available.

Year	Licensed anglers	Species	Number of fish		Percent released	Average catch per license
			Caught	Retained		
1974	73,419	Smallmouth bass	13,800	NA	NA	0.2
		Brook trout	1,706,500	NA	NA	23.2
1980	82,449	Smallmouth bass	NA	NA	NA	NA
		Brook trout	2,712,503	2,541,687	6	32.9
1985	78,095	Smallmouth bass	81,035	18,007	78	1.0
		Brook trout	2,295,695	1,711,875	25	29.4
1990	68,276	Smallmouth bass	439,074	15,482	96	6.4
		Brook trout	2,035,523	1,232,482	39	29.8

by anglers increased from 78% in 1985 to 96% in 1990; in contrast, brook trout anglers released 25% of their catch in 1985 and 39% in 1990.

Tournaments

The increased interest in smallmouth bass angling has given rise to a modest tournament fishery in recent years. A tournament is defined as having at least 25 participants who compete according to a set of regulations designed to test fishing prowess. Winners are ranked according to the total weight of successfully released fish. The number of fish allowed for weigh-in is usually six, and penalties are assessed for dead fish. When minimum length limits are enforced, they are either 254 or 305 mm total length. Although tournaments are currently organized by a number of groups, they have similar regulations, and many share the same sponsors. The number of tournaments has grown from a single tournament that has operated annually since 1982 to 31 events in 1995. These tournaments have met with little opposition from conservation groups or local residents, other than the complaints of litter and minor property damage normally associated with large groups. The NSDOF has adopted a "hands off" approach to tournament fishing, provided general angling regulations are observed.

A number of problems exist with the collection of catch data and population structure information from smallmouth bass tournaments. Willis and Hartmann (1986) reviewed surveys from Shupp (1978) and Duttweiler (1985), both of whom reported that a majority (64 and 72%) of responding state agencies only occasionally collected data from tournaments. Problems associated with stationing employees at a large number of tournament weigh-ins, compounded by the bias incurred from length limits, may account for the languid effort

by state conservation agencies (Willis and Hartmann 1986). In Nova Scotia, catch per unit effort and structural indices derived from tournament catches have provided relative comparisons of abundance and population structure between lakes, or trends within one lake over time.

Smallmouth Bass Growth and Reproduction

Smallmouth bass exhibit a wide range of growth rates throughout their native and naturalized range in North America. Length at age of smallmouth bass from various locations has been reported by several authors (Scott and Crossman 1973; Chance et al. 1975; Coble 1975; Garrett 1983; Bennett et al. 1991; Dunsmoor et al. 1991). Notwithstanding some exceptions, growth of smallmouth bass is inversely related to latitude.

Nova Scotia is the easternmost extent of the naturalized range of this species and is close to the northern limit. The average number of frost-free days in Nova Scotia ranges from 110 to 170 (Dzikowski 1985) in areas inhabited by smallmouth bass. Nova Scotia lakes can be classified as relatively unproductive (Alexander et al. 1986). Because of the short growing season and unproductive environmental conditions, smallmouth bass grow slowly in Nova Scotia.

In 1992 and 1993 smallmouth bass were collected from Black River Lake (Kings County), Grand Lake (Halifax County), and Elliot Lake (Annapolis County) by trapnetting, gillnetting, and electrofishing. Age and growth were estimated by scale reading. Smallmouth bass in Black River and Grand lakes exhibited growth similar to or slightly lower than other smallmouth bass in the northeast (Smith 1942; Stone et al. 1954; Turner and MacCrimmon 1970). Fish were 5–6 years old before they reached 300 mm fork length (FL) and took about 10 years to reach 400 mm. Smallmouth

TABLE 2.—Mean fork length (mm) at age for smallmouth bass from three lakes in Nova Scotia. Values in parentheses are sample sizes (left) and standard deviations (right).

Age	Black River Lake 44°56'N, 64°24'W 668 ha	Grand Lake 44°55'N, 63°36'W 1,841 ha	Elliot Lake 44°56'N, 65°11'W 18 ha
2		122 (5, 15)	132 (8, 7)
3	174 (24, 20)	167 (11, 15)	172 (12, 10)
4	232 (23, 32)	203 (6, 8)	194 (8, 13)
5	285 (10, 21)	257 (16, 29)	218 (1)
6	329 (6, 29)	300 (16, 20)	229 (4, 5)
7	350 (2, 2)	322 (17, 17)	244 (3, 9)
8	369 (9, 14)	336 (17, 21)	248 (3, 9)
9	390 (4, 13)	364 (5, 10)	258 (1)
10	395 (2, 11)	386 (5, 14)	
11	411 (3, 11)	370 (2, 0)	
12	421 (1)		
13	469 (1)	427 (3, 24)	

bass in Elliot Lake, however, exhibited slower growth than any recorded in the literature; the oldest specimen collected was age 9 and only 258 mm FL (Table 2). A mark-recapture population estimate done in 1992 in Elliot Lake indicated the density of smallmouth bass (all ages) was 254/ha (SD = 94), which suggests that crowding probably contributed to slow growth.

The reproductive biology of smallmouth bass in Nova Scotia, including water temperature at spawning, duration of nest guarding, nest site selection, and spawning success, was similar to that reported by Doan (1940), Turner and MacCrimmon (1970), Coble (1975), and Cantin and Bromage (1991). In 1969, Bain (1993) collected information from 18 smallmouth bass nests observed in Lumsden Pond (Kings County), Nova Scotia. Nest building began in late May at a water temperature of 16°C. Sixteen of the 18 nests observed were successful in producing swim-up fry, and nest guarding was terminated by the first week of July. Seventeen nests were in close association with stumps or boulders. Average water depth at the nest was 104 cm and the mean distance from shore was 3.4 m. Nest substrate ranged from silt to gravel (Bain 1993).

In 1993 the NSDOF undertook a more detailed study of smallmouth bass reproduction in Second Lake (Halifax County). Nesting stage, nest density, water depth, distance from shore, nest cover, and substrate were observed every 2–3 d along four shoreline transects from mid-May to mid-July. Eighty-six nests were observed along 1,610 m of shoreline. Nesting stage was arbitrarily divided into four categories: excavated or newly constructed nests without eggs or fry; nests with

eggs present; nests with hatched fry in close association with the substrate; and nests in which the fry were dispersed in the water column, along shore, or in nearby cover (Figure 3). Newly excavated nests were first observed on June 9 and many had eggs present, although these nests were not observed 2 d earlier. Excavation of new nests continued through June 18, after which no new nests were observed. Egg deposition peaked around the middle of June and continued until the end of June; hatching peaked around the third week of June and was complete by early July. Fry were dispersed from the nest and parental guarding ended by the first week of July.

The four shoreline transects observed represented different habitats: (1) shallow (gradient <10%) with nesting cover consisting of logs, stumps, or boulders; (2) shallow with no cover; (3) deep (gradient ≥10%) with cover; and (4) shallow, marshy areas (Table 3). Nest density was highest (10.8/100 m) in shallow areas with adequate cover and gravel or silt substrate, and lowest (1.7/100 m) in shallow marshy, silty areas where the substrate consisted of dense vegetation and detritus. These observations are consistent with those of Turner and MacCrimmon (1970) and Coble (1975). Mean water depth at the nest site and mean distance from shore were 130 cm and 18.7 m in favorable habitat and 56 cm and 3 m in poor habitat. Nesting success, defined as the proportion of nests observed that produced swim-up fry, ranged from 38 to 68% and was not closely related to habitat; however, the lowest success occurred in poor habitat. Doan (1940) reported nesting success rates from 0 to 57% in Georgian Bay, Lake Huron, and Reynolds and O'Bara (1991) observed success rates of 73% and 35% over two years in Tennessee streams.

Selection of a nest site close to some form of cover has been documented by several studies (Doan 1940; Turner and MacCrimmon 1970; Coble 1975). In Second Lake, 76–100% of all nests observed in each of the four habitats were located close to boulders, logs or stumps, and occasionally human debris such as submerged boats or tires. Smallmouth bass usually nest over gravel or rocky substrate, or, more rarely, woody debris or dense vegetation (Turner and MacCrimmon 1970; Scott and Crossman 1973). In Second Lake, substrate in all four nesting habitats varied; smallmouth bass preferred a gravel-cobble mixture over mud or silt, followed by boulder or rock, and finally detritus or vegetation.

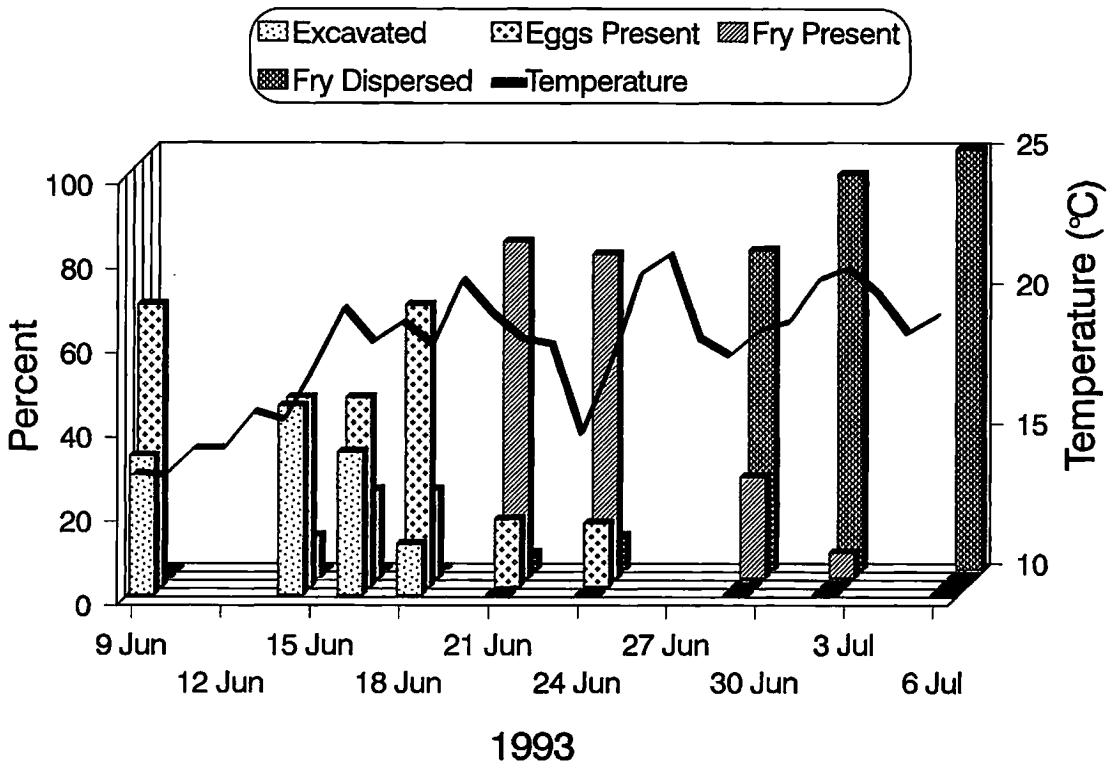


FIGURE 3.—Nesting stages by date and water temperature for smallmouth bass in Second Lake, Halifax County, Nova Scotia, 1993.

Discussion

For many years after the initial introductions, smallmouth bass in Nova Scotia were largely unknown to most anglers except in a few localized areas. Within the last 25 years, and particularly since the early 1980s, the fishery has undergone a remarkable expansion, and the species is now considered a prime game fish throughout much of the

province. The increase in average catch per angler per year has closely mirrored total estimated catches, which suggests a real increase in stock abundance rather than elevated catch as a result of increased effort.

A number of factors have contributed to this growth, the most notable being the rate at which smallmouth bass are colonizing new waters through natural migration or illegal transfers. As a result of these movements, the most compelling concern is the potential for interspecific impacts upon indigenous species. It is uncertain whether or not smallmouth bass adversely affect salmonids. Indeed, demonstrating that smallmouth bass have actually caused or contributed to the decline of salmonids is difficult (Fletcher 1991). Catt (1949) reported rapid diminution of brook trout and landlocked Atlantic salmon *Salmo salar* populations in Chiputniticook and Magaguadavic lakes, New Brunswick, following the introduction of smallmouth bass. Extensive sampling and many angler interviews in 1992 failed to record brook trout in Elliot Lake, where they were reported to be plentiful before the arrival of smallmouth bass. On the

TABLE 3.—Nesting characteristics for smallmouth bass from four habitats in Second Lake (44°47'N, 63°39'W), Nova Scotia, 1993.

Characteristic	Habitat type			
	Cover, shallow	No cover, shallow	Cover, deep	Marshy, shallow
Shoreline length (m)	510	360	270	470
Nests				
Number	55	17	6	8
Density (nests/100 m)	10.8	4.7	2.2	1.7
% successful	68	65	83	38
Mean depth (cm)	130	86	59	56
Mean distance to shore (m)	18.7	5.8	2.7	3

other hand, Fletcher (1991) reviewed 10 case histories from the northwestern United States and found no indications of reduced salmonid survival after smallmouth bass introductions.

In Nova Scotia, it is against the law to transfer any fish species between water bodies, and general bait provisions prohibit the use of smallmouth bass as bait. Through articles in newspapers and the popular literature and participation in fishing and outdoor recreation exhibitions, the NSDOF has attempted to educate anglers regarding the potential adverse effects of the indiscriminate stocking of smallmouth bass. A smallmouth bass introduction policy was developed in 1992 to address the concerns of anglers who must travel considerable distances to reach smallmouth bass waters. Through careful selection of watersheds that are suitable for smallmouth bass but marginal for salmonids, controlled introductions of smallmouth bass may curtail further indiscriminate stocking. Conversely, such introductions may serve to exacerbate the problem by creating a local stock for illegal transfers into neighboring waters.

A second factor in the growth of the smallmouth bass fishery is the dramatic increase in angler participation. The Canadian Association of Smallmouth Anglers (CASA), founded in Nova Scotia in 1989 by 16 smallmouth bass enthusiasts, claimed over 200 members in 1993. A tackle shop dedicated exclusively to smallmouth bass has opened in response to the demand. Improved skills may also contribute to increased catches, as anglers new to the sport tailor their techniques towards catching smallmouth bass.

The practice of catch and release cannot be overlooked with respect to the smallmouth bass fishery in Nova Scotia. In 1990, there was a 10-fish limit and no length restriction for smallmouth bass. Evidence from angler diaries, license stub returns, and personal observations suggested that most of the releases were voluntary and not a result of the limit. The proportion of smallmouth bass caught and released in 1990 (96%) was the highest recorded for any game fish in the sportfishing survey data for Nova Scotia. The widespread opinion of anglers that smallmouth bass are not as palatable as brook trout or other game fish may contribute to the release of many fish.

The promotional efforts of state conservation agencies, angling groups such as the Bass Anglers Sportsman Society, outdoor writers, and syndicated televised fishing programs have resulted in widespread voluntary catch and release (Clark 1982; Graff 1988). In Nova Scotia, the NSDOF

and CASA have promoted catch and release. Because hooking mortality is relatively low for smallmouth bass (Weidlein 1987; Green et al. 1988), catch and release represents a valuable management option. Generally, anglers are compliant because they are confident most of the fish they release will survive. Because the relatively new smallmouth bass fishery in Nova Scotia has developed concurrently with the practice of catch and release and because there was no tradition of harvesting fish for consumption as in the case of other game fish species, harvest of smallmouth bass is low. However, a substantial trophy smallmouth bass fishery in Nova Scotia is unlikely because of the climate and low aquatic productivity.

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