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FISHERIES DIVISION

TECHNICAL REPORT

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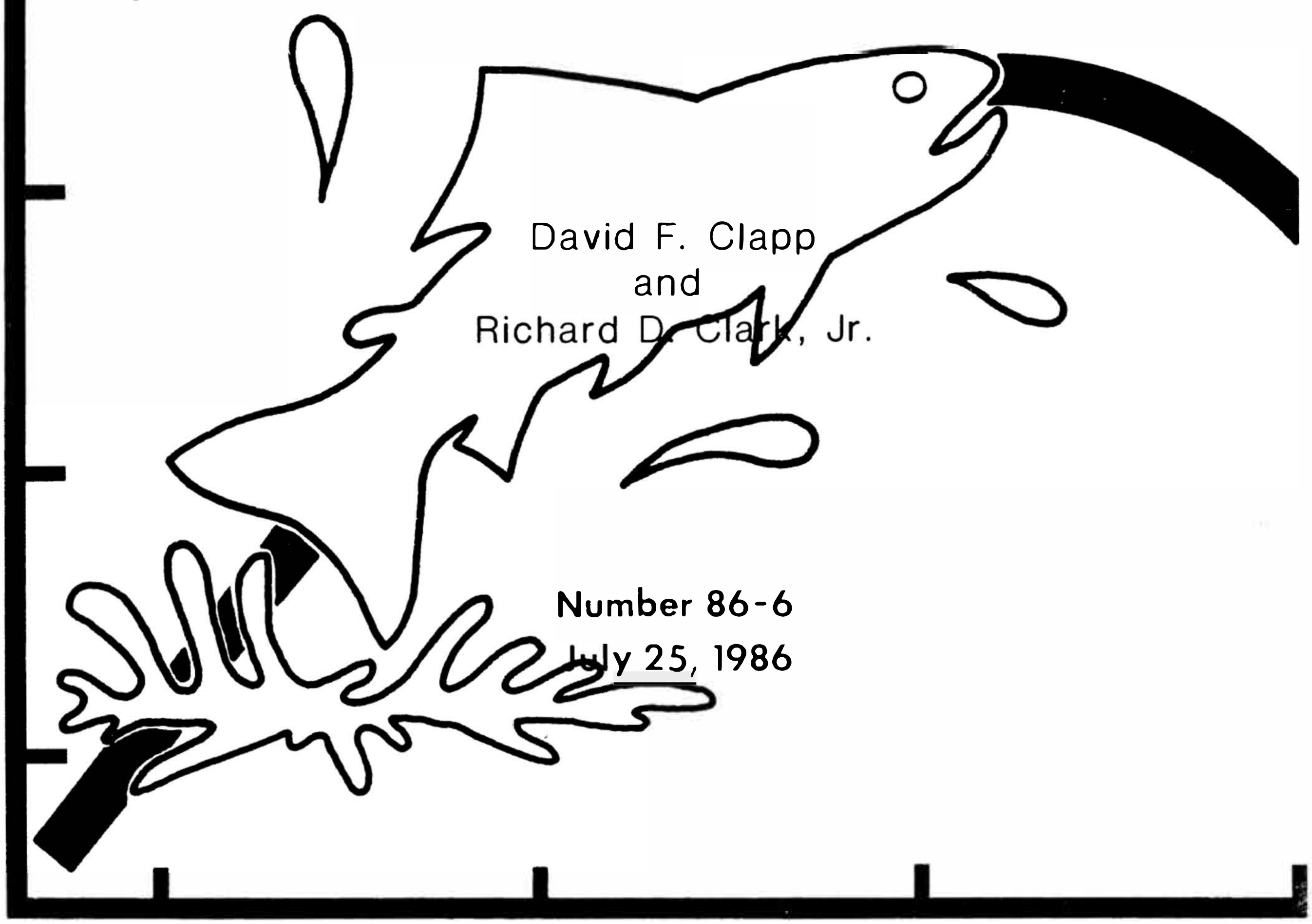

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HOOKING MORTALITY OF SMALLMOUTH BASS CAUGHT ON LIVE MINNOWS AND ARTIFICIAL SPINNERS

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ABSTRACT

We collected 56 wild smallmouth bass (Micropterus dolomieui) from 6.3 to 12.6 inches long and tagged them for individual recognition. We divided them into approximately equal groups and released them into artificial stream channels which could be drained to recover each fish. During four 2-week test periods, we hooked and released bass in one channel using live minnows on a single hook (size #6) and in the other channel using a spinner with a treble hook (Mepps #1). Some bass in each channel were not hooked, and we considered these fish as the experimental control. Mortality was 11.1% for bass hooked with minnows, 2.9% for bass hooked with spinners, and 2.3% for bass not hooked. The mortality of bass hooked with minnows was significantly greater than that of the unhooked bass ($P=0.05$), but the mortality of bass hooked with spinners was not. Thus, hooking mortality was about 9% (11.1%–2.3%) for minnow-hooked bass, but was negligible for spinner-hooked bass. The stress of catch and release might have long-term sublethal effects on individual fish. We found that growth was inversely related to the number of hooking events. Some bass were caught numerous times, while others were never caught. We caught one individual nine times, and 10 individuals accounted for 54% of all of our hooking events. Twenty bass were never caught.

INTRODUCTION

Minimum size limits and gear restrictions (such as artificial lures-only) are widely employed to manage sport fisheries. While these regulations are often successful, their benefits can be reduced by hooking mortality of fish caught and released (Pelzman 1978, Wydoski 1980). Hooking mortality has been studied since the early 1930's, but most of the effort was concentrated on salmonids. About 90% of the hooking mortality references cited in a review by Wydoski (1980) concerned salmonids. Perhaps the reason for concentrating on salmonids was the long tradition of sportfishing associated with this family of fishes. However, the popularity of largemouth bass (Micropterus salmoides) and smallmouth bass (Micropterus dolomieui) appears to be growing. In Michigan, bass are common in waters near large metropolitan areas, and maintaining or improving the quality of fishing in these waters has received more emphasis lately. Hooking mortality studies have been conducted on largemouth bass (Peltzman 1978; Rutledge and Pritchard 1980), but we could find no references concerning hooking mortality of smallmouth bass.

The State of Michigan and a number of other states have adopted relatively high 12-inch size limits for smallmouth bass. Most smallmouth bass in Michigan do not reach 12 inches until they are 4 years old (Latta 1975), so they are subjected to several years of catch-and-release fishing under current regulations. The effects of hooking mortality on a fishery can be evaluated with existing management models (Clark 1983), but model parameters, including the probability a fish will die from catch and release, must first be measured in a field experiment.

The purpose of this study was to estimate the hooking mortality of smallmouth bass exposed to catch and release by two common lure types, live minnows and artificial spinners.

METHODS

We collected 56 smallmouth bass from 6.3 to 12.6 inches total length in May of 1985. Six were taken by DC electrofishing gear and 37 were taken by angling from the Huron River in Washtenaw County. Twelve were taken with trap nets in Lake St. Clair in Macomb County. We measured total lengths of all bass and inserted individually numbered Floy anchor tags at the base of their dorsal fin. We divided them into two similar groups with respect to size and method of capture and released them into separate stream channels (Table 1).

Each channel was 15 feet wide by 120 feet long. Depth at the upper end of each channel was about 1 foot and it gradually increased to about 4 feet at the lower end. Water for the channels was drawn from a reservoir at a depth of 8 feet, and this kept the channels cold and allowed small, natural food items to reach the bass. Water temperatures remained below 70°F during the study. Screens prevented fish larger than about 3 inches long from entering or leaving the channels. The channels were designed so they could be drained after each experimental trial and all fish could be recovered.

We rested the bass for 1 week, after their initial capture from the wild, and then we drained the channels to determine if any bass had died due to stress of capture and transport. One of the bass captured by trap nets in Lake St. Clair had died (Table 1). We refilled the stream channels and returned the rest of the bass. We conducted four 2-week fishing trials starting on June 6, 1985. During each trial we fished in one channel using live minnows (Pimephales promelas) on a single hook (size #6) and in the other using a spinner with a treble hook (Mepps #1). Some bass in each channel were not hooked and we considered these bass as the experimental control. This design allowed us to complete the study with fewer fish than if we had used a separate unfished control channel. However, we recognize that natural mortality might be different in a population not fished over.

For each fish hooked and released, we recorded the tag number, location of hook in fish, and time of day. No special care was given to the bass when hooked. They were landed and unhooked in such a way as to simulate normal fishing conditions. At the end of each 2-week trial, the channels were drained and checked for dead fish. Terminal tackle used in each channel was switched after each trial. Data from the four trials were combined and percent mortality for minnow-hooked, spinner-hooked, and unhooked bass were tested for differences using a Chi-square test (comparison of proportions from two independent samples, Snedecor and Cochran 1971). We used the 5% significance level ($P=0.05$) for these tests.

We measured total length of each bass again at the end of the experiment to determine increments of growth. We compared growth increments of bass between stream channels to check the equality of these environments and between groups of fish that were hooked and released versus those that were not hooked to check for sublethal hooking effects. We tested for differences with a t-test ($P=0.05$).

We assumed (1) a fish which did not die within 48 hours after being hooked would survive that hooking, (2) any mortality observed occurred as a result of the last recorded hooking event (any previous hooking events were assumed non-lethal), and (3) any fish dying after being hooked, died as a result of that hooking (no autopsies were performed to determine actual cause of death).

RESULTS

Mortality was 11.1% for bass hooked with minnows, 2.9% for bass hooked with spinners, and 2.3% for bass not hooked (Table 2). There was no significant difference between mortalities of bass hooked with minnows versus spinners ($P=0.05$), but this was probably due to the small sample sizes of bass hooked. The mortality of bass hooked with minnows was significantly greater than that of unhooked bass, while the mortality of bass hooked with spinners was not.

The smallmouth bass grew an average of 0.32 inches in length during our study. This was slower growth than that of the wild populations in our area. According to Latta (1975), bass in this size range should have grown from 1.0 to 1.5 inches in length. The slow growth in our stream channels could have been due to colder-than-normal water temperatures, stress from carrying Floy tags, stress from handling, or scarcity of food. We found no significant difference in the mean growth increment of fish between the two channels. Growth of bass appeared to be inversely related to number of hooking events experienced by individual fish. Mean growth of the fish never hooked, hooked one time, and hooked two or more times was 0.43, 0.41, and 0.075 inches, respectively. A regression of growth on number of hooking events was statistically significant ($P<0.05$).

The catchability of bass was related to either their size, their original method and location of capture, or both. We could not determine which of these was the most important factor with our data. The 10.0- to 11.9-inch group provided 62.9% of all hooking events, but contained only 34.6% of the total number of bass (Table 3). The bass taken in trap nets from Lake St. Clair provided 52.9% of the hooking events, but were only 21.8% of the total number of bass (Table 4). Unfortunately, most of the bass in the 10.0- to 11.9-inch group were also taken in trap nets from Lake St. Clair (Table 1), so we could not separate the two factors.

The catchability of individual bass varied greatly (Table 5). Twenty of the original 55 bass in the experiment were never caught. Ten bass were caught three or more times and accounted for 54% of all the hooking events. One bass was caught nine times and another was caught five times, and both survived to the end of the study.

Catch of bass per hour of fishing varied over the trial periods for the two lure types, but total catch per hour over the entire experiment was about the same for each lure type (Table 6). The combined catch per hour for both lure types increased from the first to the second trial, but decreased from the second to the fourth trial. This trend could have been due to a seasonal activity cycle of the bass, that is, bass might be more active and easier to catch in June than July, or some bass could have learned to avoid capture by the last trial.

DISCUSSION

The actual hooking mortality for minnow-hooked smallmouth bass was about 9%, that is, 11.1% total mortality minus 2.3% natural mortality. The latter was the mortality we observed in unhooked bass. The actual hooking mortality was negligible for spinner-hooked bass (2.9% minus 2.3%). Our results would have been more conclusive if we could have gotten a larger sample size of hooking events for each lure type. It appears that 50 or more individual hooking observations per lure type would be needed to detect direct differences in mortality at the 5% level of significance. Our indirect evidence was based on the fact that minnow-hooked bass had significantly higher mortality than unhooked bass, while spinner-hooked bass did not. The larger sample size of unhooked bass (Table 2) was probably the reason we could detect this difference.

Temperatures in our stream channels were about 10°F colder than the natural rivers in our area, and it is possible that hooking mortality would be higher in warmer water. For example, hooking injuries could receive higher rates of bacterial or fungal infection in warmer water. Rutledge and Pritchard (1980) observed a high degree of delayed mortality from secondary infections in largemouth bass hooked in warm Texas ponds. Hunsaker et al. (1970) found that hooking mortality of cutthroat trout (Salmo clarki) increased as water temperature increased. The effects of temperature on hooking mortality should be investigated more thoroughly.

The stress of catch and release might have long-term sublethal effects on individual fish. We found that growth was inversely related to the number of hooking events. Thus, it is possible that heavy fishing pressure under a catch-and-release regulation could directly reduce the growth rate of a fish population. An alternative hypothesis would be that the hooked fish grew less because they were larger than unhooked fish. Growth increments in most fish populations decrease with age and size. The mean lengths of fish never hooked, hooked one time, and hooked two or more times was 8.3, 9.0, 10.5 inches, respectively. More research is needed to get a definitive answer on the question of sublethal effects.

The difference we found in the catchability of individual fish has interesting implications. Some fish were "catch happy" while others were never caught. The stream channels had smooth mud and gravel bottoms and contained no rocks, logs, or other structures where bass could hide and make themselves more or less vulnerable to the fishing gear. Thus, the degree to which a bass was susceptible to angling appeared to be an individual characteristic. Burkett et al. (1986) got similar results for largemouth bass, and they suggested that hook-and-line vulnerability was a heritable trait. Obviously, the "catch-happy" fish would be harvested very quickly in a fishery with a low minimum size limit, and their removal would reduce the catch rate in the fishery faster than expected based on the number of fish still surviving. On the other hand, a fishery with a high minimum size limit or a catch-and-release regulation might have a higher than expected catch rate because the "catch-happy" fish would survive longer. In our experiment, "catch-happy" bass accounted for more than half of our total catch.

We think there is potential for improving smallmouth bass fisheries in southern Michigan streams by adopting some of the same kinds of quality fishing regulations which are common in trout streams. Based on our results, hooking mortality would be negligible in smallmouth bass fisheries placed under high minimum size limits or catch-and-release regulations if they were combined with artificial-lures-only rules.

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Table 1. Size and method of capture of smallmouth bass released in experimental stream channels. Bass captured by electrofishing and angling were taken from the Huron River. Bass captured by trap nets were taken in Lake St. Clair.

Length group (inches)	North channel				South channel			
	Electro-fishing	Angling	Trap net	Total	Electro-fishing	Angling	Trap net	Total
6.0–7.9	1	4	0	5	1	6	0	7
8.0–9.9	0	14	0	14	1	7	0	8
10.0–11.9	1	2	6[1]	9[1]	2	4	5	11
12.0 +	0	0	1	1	0	0	1	1
Total	2	20	7	29	4	17	6	27

[1]One of these fish died before experimental trials were started.

Table 2. Percent mortality for smallmouth bass hooked and released on minnows and spinners compared to percent mortality of smallmouth bass that were not hooked (controls). Data from the four 2-week trials were combined.

	Minnows	Spinners	Controls
Number hooked	36	34	87[1]
Number dying	4	1	2
Percent mortality	11.1	2.9	2.3

[1]For control fish, this was the number that were not hooked.

Table 3. Number and percent of total smallmouth bass and hooking events by size group.

Length group (inches)	Total bass		Hooking events	
	Number	Percent	Number	Percent
6.0–7.9	12	21.8	4	5.7
8.0–9.9	22	40.0	19	27.1
10.0–11.9	19	34.6	44	62.9
12.0 +	2	3.6	3	4.3
Total	55	100.0	70	100.0

Table 4. Number and percent of total smallmouth bass and hooking events by method and location of capture.

Capture		Total bass		Hooking events	
Method	Location	Number	Percent	Number	Percent
Electrofishing	Huron River	6	10.9	7	10.0
Angling	Huron River	37	67.3	26	37.1
Trap nets	Lake St. Clair	12	21.8	37	52.9

Table 5. Hooking rates of smallmouth bass.

Number of lines hooked	Number of fish	Cumulative number of hooking
0	20	0
1	18	18
2	7	14
3	8	24
4	0	0
5	1	5
6	0	0
7	0	0
8	0	0
9	1	9
Total	55	70

Table 6. Catch per hour for each gear type and 2-week trial.

	Date		Catch per hour		
Trial	Started feeding	Drained channels	Minnows	Spinners	Combined
1	Jun 3	Jun 14	2.01	0.92	1.53
2	Jun 17	Jun 28	1.14	3.68	2.16
3	Jul 8	Jul 19	1.99	1.69	1.84
4	Jul 22	Aug 2	0.58	0.58	0.58
Total	—	—	1.46	1.48	1.47

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