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TECHNICAL REPORT

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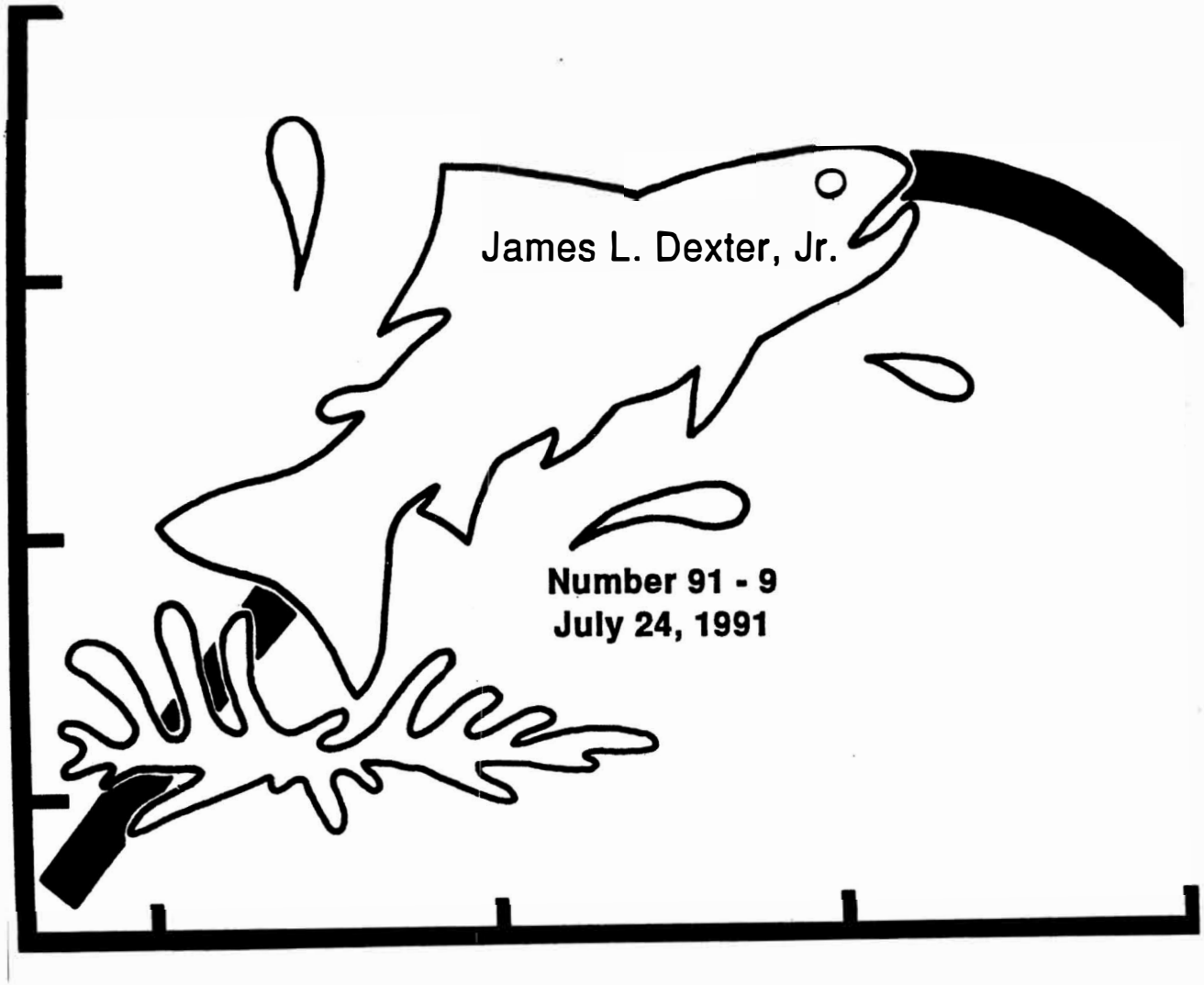

James L. Dexter, Jr.

Number 91 - 9
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Michigan Department of
Natural Resources

MICHIGAN DEPARTMENT OF NATURAL RESOURCES
FISHERIES DIVISION

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Angler Catch and Densities of Stocked and Wild Brown Trout in Augusta Creek, Michigan

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Abstract.—In 1989 and again in 1990, 5,900 spring yearling brown trout (*Salmo trutta*) were stocked in Augusta Creek, Kalamazoo County, Michigan. Fifty percent of the fish in 1989 and 25% in 1990 were tagged with Floy tags to permit an estimate of angler catch rates. Catch rates of stocked brown trout by anglers ranged from 3.3-13.2% in 1989 to 2.8-8.2% in 1990. Catch rates were adjusted to account for tags that were shed over the course of the fishing season. No adjustment was made for non-reporting of trout caught with tags. Floy tag loss in brown trout was up to 77.8%, after 200 days. The average cost per brown trout caught in 1989 and 1990 ranged from $5.70 to $26.31. Fall population densities of brown trout in Augusta Creek (162/acre, 38.3% legal size) did not compare very favorably with several other area streams. Relative densities of stocked versus wild trout decreased substantially through the season. Stocked trout comprised 97% of the estimated number of trout after stocking in April compared to 69% in late October. I believe recruitment of wild trout to legal size (8 inches) was low and may have been negatively impacted by stocking of hatchery trout or a lack of overwinter habitat and cover.

Fisheries managers have used various techniques to determine angler recovery of stocked trout. One technique used for years has been the use of different types of tags (Shetter and Hazzard 1940; Butler 1962; and Weaver and England 1986). In recent years, the Floy anchor tag has been the tag of choice by many managers, because it allows tagging of large numbers of fish relatively easily. Also, it can be easily recognized and removed by anglers.

Managers in Michigan have become concerned in recent years with accurate assessment of the success of trout stockings. I define success as a reasonable use (catch of 5%) of the planted trout by anglers.

Summer and fall stream electroshocking surveys conducted by trout managers reveal growth information and give an index of survival of planted trout, and also the relative numbers and growth of wild trout if present. However, the nature of the fishery (numbers and sizes of fish in the catch) is not determined.

Because the current cost of a stocked 4- to 7-inch yearling trout is about 75 cents per fish and the State stocks hundreds of thousands of trout each year, I wanted to evaluate success of plants and continue only those that gave acceptable returns to anglers. Because full-time creel surveys were too costly, I used Floy tags on planted yearling brown trout (*Salmo*

trutta) to estimate angler catch of these trout in Augusta Creek, Michigan.

Study Site

Augusta Creek is a marginal trout stream (based on fish community composition and water temperatures) with limited natural reproduction of trout. It is located mostly in Kalamazoo County, in southwest Michigan (Figure 1). The study site encompassed the lower 8.9 miles of the creek. Here the average stream width is 24 feet, and the depth averages 1.3 feet. It originates as outflow of several small lakes in Barry County, but picks up considerable groundwater enroute to the Kalamazoo River in the Town of Augusta. Temperatures are cooler in downstream reaches. The surrounding soils are mostly glacial outwash in origin.

Stream flow is moderately stable. For a 22-year period (1964-86), the average discharge was 43.9 ft^3/s (United States Geological Survey 1987). The average gradient is about 6.5 feet per mile (Lemmien et al. 1957). The stream bottom is composed mostly of cobble and gravel, although sand and silt areas are common.

Habitat diversity is only fair in this stream. Runs dominate, and there are few pools and riffles. Overhanging brush is common along the water course, and small boulders garnish the bottom. There is a paucity of large woody debris in the creek, because the riparian vegetation is dominated by small wetland plants.

Methods

Augusta Creek was stocked in early spring with 5,900 brown trout yearlings (Soda Lake strain) in 1989, and again in 1990. Fish were planted at five scattered sites in the study area. Trout stocked in 1989 averaged 5.8 inches long, whereas the 1990 stocked trout averaged 6.1 inches long. In 1989, 50% of the fish stocked were tagged with Floy anchor tags (FD-68BC, fine fabric). These tags were fluorescent orange, 1.25 inches in total length, and had the Michigan Department of Natural Resources address and an unique number printed on them. In 1990, 25% of the fish stocked were tagged (FD-68B, fine fabric). Tags were brown and had no label. The color was changed because many people thought that trout predators may be more efficient in catching trout with brightly colored tags.

Trout were anesthetized with MS-222 before tagging. Trout were held 24-48 hours in the hatchery after tagging in separate holding areas of the rearing raceway. In 1989, the untagged trout of the plant were clipped with a right pectoral (RP) fin clip for identification. In 1990, the untagged trout of the plant received a left ventral (LV) clip, while tagged trout also received an adipose clip so that tag loss could be estimated.

Two news releases to local papers were made prior to each trout season to inform anglers of the tagging and evaluation program. Letters explaining the project were also sent to each stream property owner in the study segment of Augusta Creek. After the trout season ended, another news release was made requesting anglers to return tags.

The upper half of the study area was restricted with catch-and-release fishing regulations (Figure 1). Thus, tag return sites were placed only in the lower half of the study area that was subject to normal fishing regulations permitting harvest of trout. A total of five tag return sites were established in 1989. An additional three sites were added in 1990 to cover all known access points. All but two of these eight sites had a metal sign post with a 6-inch long and 1-inch diameter metal tube attached to it for tag deposits. In addition, the post had a 16.5 by 13.5-inch sign explaining the tagging program, and a box containing pencils and pocket size cards to record catch-and-release information (Figure 2). The remaining two tag return sites had a large heavy duty steel tube similar to those used by State forest campgrounds to collect fees. These tubes had a slot in them for depositing tags, and were placed in high visibility areas with the words "trout tag returns" painted on them. Next to these tubes were metal sign posts with the information sign and a catch-and-release data record card box. Two catch-and-release card boxes with

informational signs were established in the lower half of the catch-and-release area in 1989. In 1990, four catch-and-release card boxes with informational signs were added to the upper half of the catch-and-release area. This area previously had no public access.

In the news releases and posted signs, anglers were asked to deposit tags from any harvested trout in the return tubes. For trout caught and released, they were asked to record on cards the tag number (in 1989) or tag color (in 1990) of any tagged trout. Anglers were led to believe that there was more than one color of tag present in 1990. They were also asked to record the date of capture and the approximate size of the fish. Anglers were asked to keep these records through the trout season and either mail them to our office or put them in either of the two large metal tubes. Tags and cards were collected at least once a month. Certificates of appreciation were offered to anglers as an incentive to return information.

Monthly estimates of trout catches were made for both harvested and caught and released fish. First, the number of tagged trout caught each month was estimated by correcting the reported catch for tag loss. The percent of tags lost from brown trout was estimated in 1990 as the percent of adipose-clipped trout captured with no tags. Then, these monthly catch estimates were adjusted by the percentage of stocked trout tagged (50% in 1989 and 25% in 1990). No corrections could be made for non-reporting.

A Michigan State University research project evaluating the population dynamics of stocked and wild brown trout in the same section of Augusta Creek was conducted concurrently with this study. The Department of Natural Resources Fisheries personnel assisted in this sampling. Mark-and-recapture estimates were conducted using 240-V DC electric generator with a two anode probes in April, June, August, and October of 1990. Six 300-foot-long sections were established along the study stretch of stream.

The total area of all six stations combined was 1 acre. Population estimates were calculated using the Bailey modification of the Petersen mark-recapture formula (Bailey 1951). Because sample sites were small and the number of trout collected low, I pooled data from all six sites each sampling period to calculate the population estimate. Then, using the Michigan average length/weight relationship for brown trout, I calculated pounds of trout per acre.

Results

Mortalities of the brown trout tagged were low during the 24- to 48-hour holding period at the hatchery. In 1989, only ten tagged trout (0.17%) died during the holding period. These mortalities were replaced. These 10 mortalities were autopsied and I judged that seven of them died from improper insertion of the tagging needle. No mortalities occurred during the 1990 holding period. No tags were shed before trout were stocked in either year.

Stream electroshocking showed that tagged trout experienced a large tag loss (Table 1). At the time of stocking in 1990, the ratio of trout clipped:tagged was 3:1. By fall of the first year this had changed to 10:1. Tag loss from the 1990 plant approached 78% 200 days after stocking (Table 1). At the same time as this study, I was following Floy tag loss rates in brown trout that were being held at a spring pond at Michigan's Wolf Lake State Fish Hatchery. These fish experienced similar tag loss rates (Table 1).

In order to better quantify the angler catch of trout, a linear regression using the information from Table 1 was calculated to estimate tag loss in brown trout over shorter intervals of time (Figure 3). This information allowed for adjustments to be made each month of the fishing season in both 1989 and 1990.

Catch from 1989 Year Class

Tag returns and catch-and-release card returns in 1989 indicated that the greatest catch of stocked brown trout occurred in May (Figure 4). No trout were reported harvested in June and July, but a few were caught and released. The catch increased only slightly in late summer.

From brown trout planted in 1989, anglers returned 28 tags in 1989 and 4 tags in 1990. Catch-and-release cards indicated that 65 brown trout were caught and released. Approximately, 44% were of legal size according to angler estimates. I estimated a minimum of 5.13% of the 1989 plant was caught by anglers in 1989. An additional 0.65% was caught in 1990, yielding a total catch for the 1989 plant of 5.78% (range of 3.29-13.16%, $P = 0.05$). These estimates do not include trout that were caught two or more times. At least five trout in 1989 and one in 1990 (from the 1989 plant) were caught at least twice. Each trout caught cost the State about $13.25 (range of $5.70-$22.80) based on the number of trout stocked and associated costs at that time.

Catch from 1990 Year Class

Tag returns from the 1990 plant were lower than the 1989 plant. All information concerning angler catch from this plant was based only on the 1990 season returns because we did not attempt to collect further data in 1991.

Similar to 1989, the catch of stocked trout in 1990 was highest in May. Returns indicated that fishing success steadily declined from June through September. No trout were harvested after June based on tag returns, but a few were reported caught and released (Figure 5).

A total of only four tags from the 1990 stocking were returned. Catch-and-release card returns accounted for 38 tagged trout caught and released (approximately 39% legal size). The catch from adjusted returns (considering tag loss) was estimated to be a minimum of 3.67% of the plant (range of 2.85-8.22%, $P = 0.05$). Even though the catch was lower in 1990 compared to 1989, the difference was not statistically different. Each trout caught cost the State about $20.50 (range of $9.12-$26.31) based on the number of trout stocked and associated costs at that time.

Trout Densities in 1990

The density of brown trout in the study section decreased quickly by July, and then remained more or less stable through October. Population estimates (number per acre) were 415±216 in April, 145±27 in July, 156±44 in August, and 162±49 in October. In the spring, Augusta Creek brown trout densities compare favorably with several other area streams (Table 2). However, this is after stocking approximately 235 brown trout/acre. In the fall, densities of brown trout in Augusta Creek were about 39% of those in spring.

After the plant of brown trout was made in April, wild brown trout made up only 2.4% of the population. The number and percentage of wild brown trout in Augusta Creek increased each successive sampling period (Figure 6). By October 31, wild brown trout (age 0-1+) comprised 31.1% of the population. This percentage was probably low because we were unable to differentiate between most wild and hatchery brown trout when they were 2 or more years old. The total number of brown trout per acre declined 61% from spring to fall.

The portion of brown trout available to anglers for harvest under normal trout regulations (8-inch size limit) can be determined from length frequencies of population estimates (Figure 7). During the April, July, and August, the number of brown trout that were legal size ranged from 25.0-27.6% of the population. By the last sampling period in late October, the percentage of legal-size brown trout had increased to 38.3%.

The number of brown trout per acre in Augusta Creek and the percent 8 inches and longer were within the range of densities found in several Michigan and Wisconsin streams in the spring (Table 2). However, this estimate was based on a sample taken 2 weeks after the stocking of 235 brown trout/acre. Percent legal-size brown trout in the fall at Augusta Creek was higher than these other streams. However, total brown trout numbers in Augusta Creek decreased over the sampling period, while numbers in other streams listed increased.

Discussion

I began the study with the following assumptions: (1) marked trout would retain their mark throughout the study period, (2) anglers would report all tags encountered, (3) tagged and clipped trout have an equal chance of being captured, and (4) all groups of marked trout experience similar mortality rates. Problems arose with the first two assumptions. While clipped brown trout did retain their clip for identification, the majority of tagged trout lost their tag by the end of the fishing season. Thus, a correction had to be made for tag loss. The second assumption, that all tags would be reported could not be verified in this study.

Several other problems can arise in studies relying on anglers returning tags. Anglers can fail to recognize tags that are on fish caught, tags may be kept as mementoes or good luck pieces, and reward systems may not provide enough incentives to solicit tag returns. All of these factors may be combined to seriously underestimate actual catch of stocked fish. Some anglers in this study reported that when handling 1989 tagged trout prior to release, that several tags were pulled out of the trout while they tried to read the tag number. This is why I requested anglers to record only tag color in 1990.

A review of the reward tag literature by Haas et al. (1988) found that non-reporting rates for various species of fish ranged from 15-75%. Brook trout (*Salvelinus fontinalis*) and rainbow trout (*Oncorhynchus mykiss*) non-reporting rates ranged from 17 to 61%. Because in my study the incentive to return tags and report tagged trout released was just a certificate of appreciation, I think non-reporting of tags most likely occurred. The estimated catch figures for this study can most likely be raised by about 40%, based on average data reported by Haas et al. (1988).

It was very apparent from this study that catch and release plays an important role in the total use of stocked trout in Augusta Creek. This may be explained in part by the fact that a large percentage of the trout captured were sublegal early in the trout season. Also, the upper half of the study site was designated catch and release only. I had no estimate of angling pressure differences between the catch-and-release area and the normal regulation section, but from my observations, I believe that the normal regulation area was fished more intensively.

Many factors can influence the rate of harvest, including time of stocking, size of trout, species, stocking density, fishing pressure, angler ability, angler access, and the presence of wild trout. Many studies in the literature have higher rates of harvest than Augusta Creek, most likely because of the difference in the size of the fish stocked and the lower vulnerability of brown trout to angling (Shetter and Hazzard 1940; Shetter 1944; Lemmien et al. 1957; Johnson 1983). Most studies I encountered in the literature involved planting of legal-size trout. This fact alone makes it difficult to compare harvest rates of trout between Augusta Creek and other waters throughout the country. Considering that no adjustments were made for non-reporting, I think the Augusta Creek estimates were within an acceptable range of use. If these adjustments were made, the cost per trout caught would come down substantially.

Many of the studies reviewed involved the use of rainbow trout, not brown trout as in Augusta Creek. Previous studies (Shetter and Hazzard 1940; Shetter 1944; Lemmien et al. 1957) have shown that brown trout typically have lower harvest rates than rainbows. Shetter and Hazzard (1940) reported stocked brown trout harvest rates of 2.0 to 19.2% of the number stocked. Rainbow trout and brook trout harvest rates ranged from 0.6 to 61.1%. These were minimum estimates not accounting for tag or mark loss, non-reporting, and catch and release. Shetter (1944) further determined that recoveries of stocked trout of all species was very low in the second and third fishing seasons after stocking, 0.0 to 2.5% and 0.0 to 0.5%, respectively. The catch rates I found at Augusta Creek were within the range of rates reported for brown trout in the studies cited above.

A 10-year creel census of a portion of Augusta Creek (Lemmien et al. 1957) showed that 62% of all stocked rainbow trout and

44% of all stocked brown trout were harvested. These returns were much higher than those determined in this current study of Augusta Creek. However, in the 1940s and 1950s, the Michigan Department of Conservation stocked only legal-size trout at several intervals throughout the season.

The State of Indiana has used Floy tags to study harvest rates of stocked trout in their streams and lakes for the last 10 years. However, their studies were also evaluations of rainbow trout stocked at catchable size. Indiana biologists tagged 50% of their stockings for evaluation, and their fish average 10 to 11 inches when they were stocked. While in Indiana, I recorded harvest rates of 60.5% and 62.0% for two northwest Indiana streams (Dexter 1987a, 1987b). Other Indiana studies have recorded catch rates ranging from 7 to 54% (Ledet 1983, Robertson 1987). These estimates did not include adjustment for tag loss, non-reporting, or trout caught and released. Almost all harvest of trout in these streams occurred in the first 2 weeks of the season.

At Lake Lanier, Georgia, in 1982 Weaver and England (1986) conducted a Floy tag program on rainbow trout. They estimated a harvest of 8.1% of the total trout stocked. Their estimate was based on using the same methods I used of multiplying returns by the proportion of those fish not tagged. The monetary reward system they used ($0 to $20) provided no evidence of an increased incentive to return tags. In fact, the reward category of $0 had the highest rate of tag returns.

The reasons for low abundance of wild brown trout in Augusta Creek is not known. One reason could be the competition between the wild fish and hatchery fish. Bachman (1984) showed that stocking hatchery brown trout into a stream containing wild brown trout resulted in many agonistic encounters between the two. Larger hatchery trout were observed displacing smaller wild trout from their territories and probably caused increased mortality of wild fish. Stocking hatchery fish in Augusta Creek could be having the same affect. Yearling brown trout stocked each spring were slightly larger than wild yearlings in the stream, and perhaps some wild fish were displaced. Hatchery yearlings could also compete with wild, young-of-the-year trout.

Studies at Augusta Creek in the 1940s and 1950s (Lemmien et al. 1957) showed that anglers still caught some wild brown trout, even with high stocking rates of legal-size trout (100-400/acre). Wild brown trout were estimated to comprise 3% of the total brown trout harvested during that study. The proportion of wild versus hatchery trout does not appear to be much different today than it was 40 years ago.

Most trout streams with at least moderate recruitment of wild fish show an increase in the numbers of trout present from spring to fall. This occurs because wild, young-of-the-year trout grow into the size range vulnerable to capture by electrofishing gear as the season progresses. Augusta Creek shows this trend for the wild component of the population, but not for total trout. This must be due to a lower survival for hatchery trout.

A decline in the hatchery component of the trout population of the degree experienced at Augusta Creek is not uncommon. Johnson (1983) found that of 13 stocked trout streams in Wisconsin the average survival rate for yearling brown trout was 11.3% after 60 to 120 days in the streams. An annual survival rate of 16% for yearling brown trout was determined by Alexander and Peterson (1981) for Newton Creek, Michigan. Survival of stocked yearling brown trout at Augusta Creek 200 days after stocking was 27.4%. Annual survival of these fish in Augusta Creek would most likely be less than the 16% found in Newton Creek.

Conclusions

Angler catch of stocked trout in Augusta Creek appears to be consistent with the catch of stocked brown trout in other streams when considering the size of the trout stocked. Stocked trout are the major component of the recreational fishery in Augusta Creek. This does not imply, however, that wild trout cannot also provide this potential. At the present time, wild trout production is too low to provide much fishing. Hopefully, we can

improve habitat to increase trout survival and production in the future.

The use of Floy tags to measure angler catch of stocked fish appears to be a viable assessment tool. However, since Floy tag loss can be high, managers should adjust tag return data to obtain the more accurate estimates. Floy tags can be used very successfully, especially for short-term projects.

I feel that returns of smaller planted trout in Augusta Creek represent an acceptable use of stocked trout. Stocking larger trout would result in higher returns, and undoubtedly would increase angler effort and catch of legal-sized fish. It could also allow managers to decrease numbers stocked and may reduce potential competition on wild trout. Present Fishery Division policy prohibits the stocking of legal-size trout in public waters.

Future research on Augusta Creek should address habitat deficiencies for trout reproduction, nursery habitat, and overwintering habitat. Promotion of wild trout would allow the decreased use of hatchery stock.

Acknowledgements

The author wishes to express his appreciation to the Kalamazoo Valley Chapter of Trout Unlimited for financial support of the tag study. Michigan State University, Associate Professor Thomas Coon, graduate research assistant Tim Watkins, and their associated crews assisted in the marking of stocked trout, and the electroshocking. Roger Lockwood of the Institute for Fisheries Research in Ann Arbor provided the statistical analysis. The personnel of Harrietta State Fish Hatchery also helped in coordinating the marking of trout for the study. Gaylord Alexander and Andy Nuhfer contributed to my understanding of the dynamic processes involved with a study such as this. Mike Herman of District 13 in Jackson provided the signs used on the creek for the tag study.

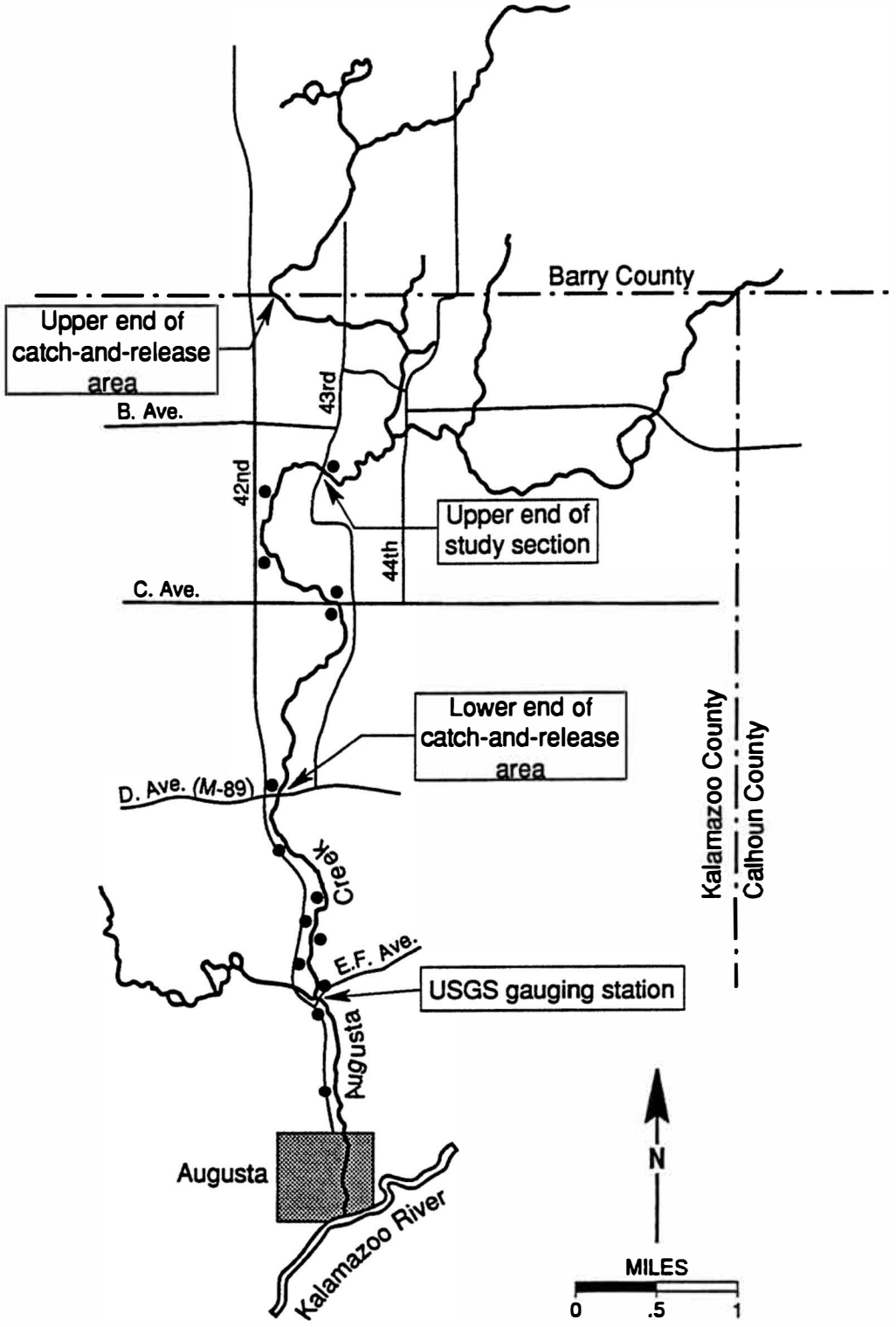

Figure 1.—Augusta Creek study site showing access points (●) that contained informational signs, catch-and-release cards, and tag return tubes.

Figure 2.—Type of record used by anglers to record catch and release of tagged brown trout in Augusta Creek in 1990. The 1989 card asked for tag number.

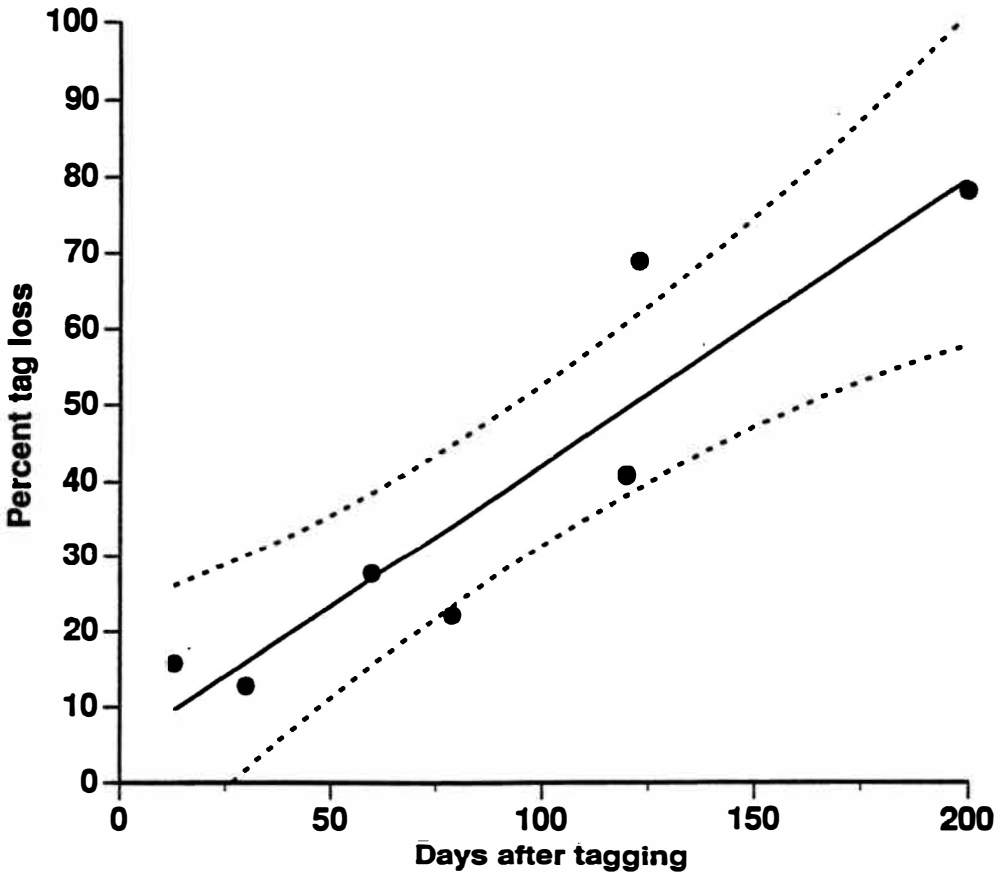

Figure 3.—Regression of tag loss in brown trout at Augusta Creek and Wolf Lake State Fish Hatchery, 1990 (R^2=0.85). Solid line is regression, while dashed lines are 95% confidence limits.

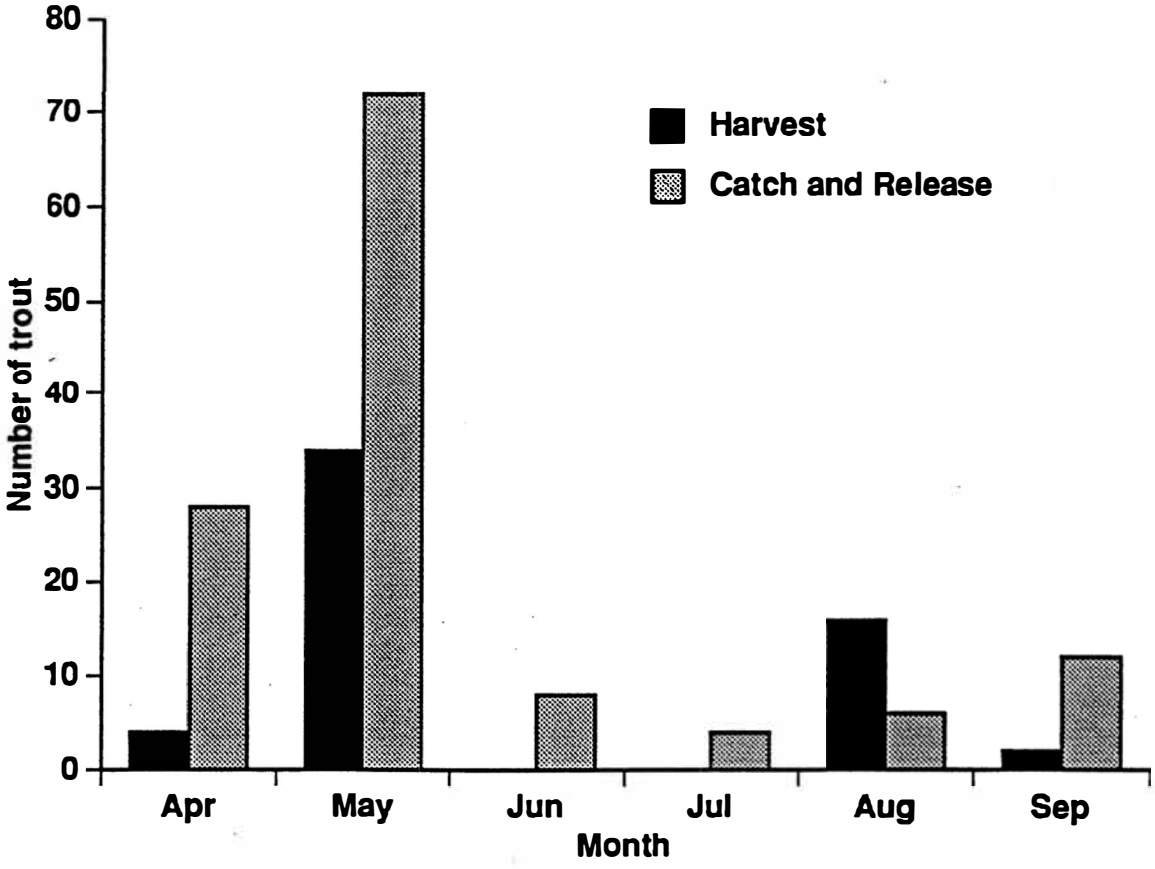

Figure 4.—Comparison of estimated harvest and catch and release of stocked trout in Augusta Creek in 1989.

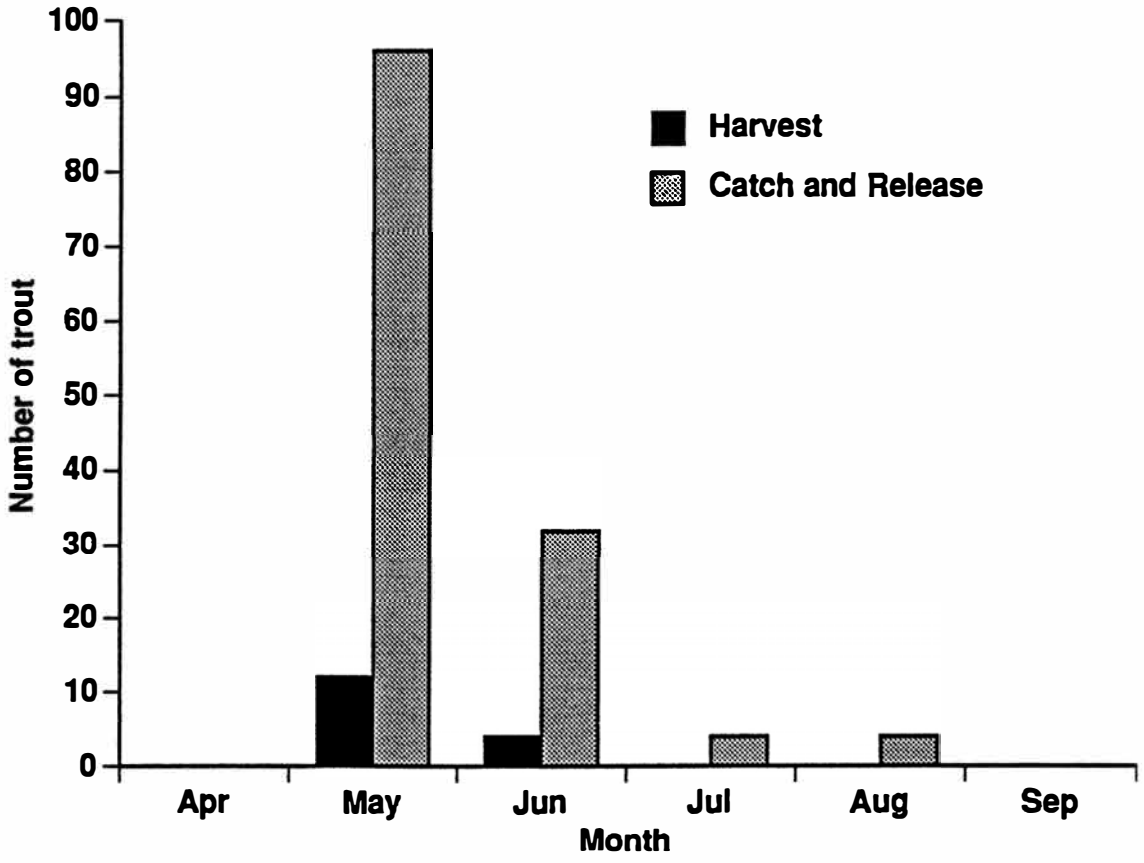

Figure 5.—Comparison of estimated harvest and catch and release of stocked trout in Augusta Creek in 1990.

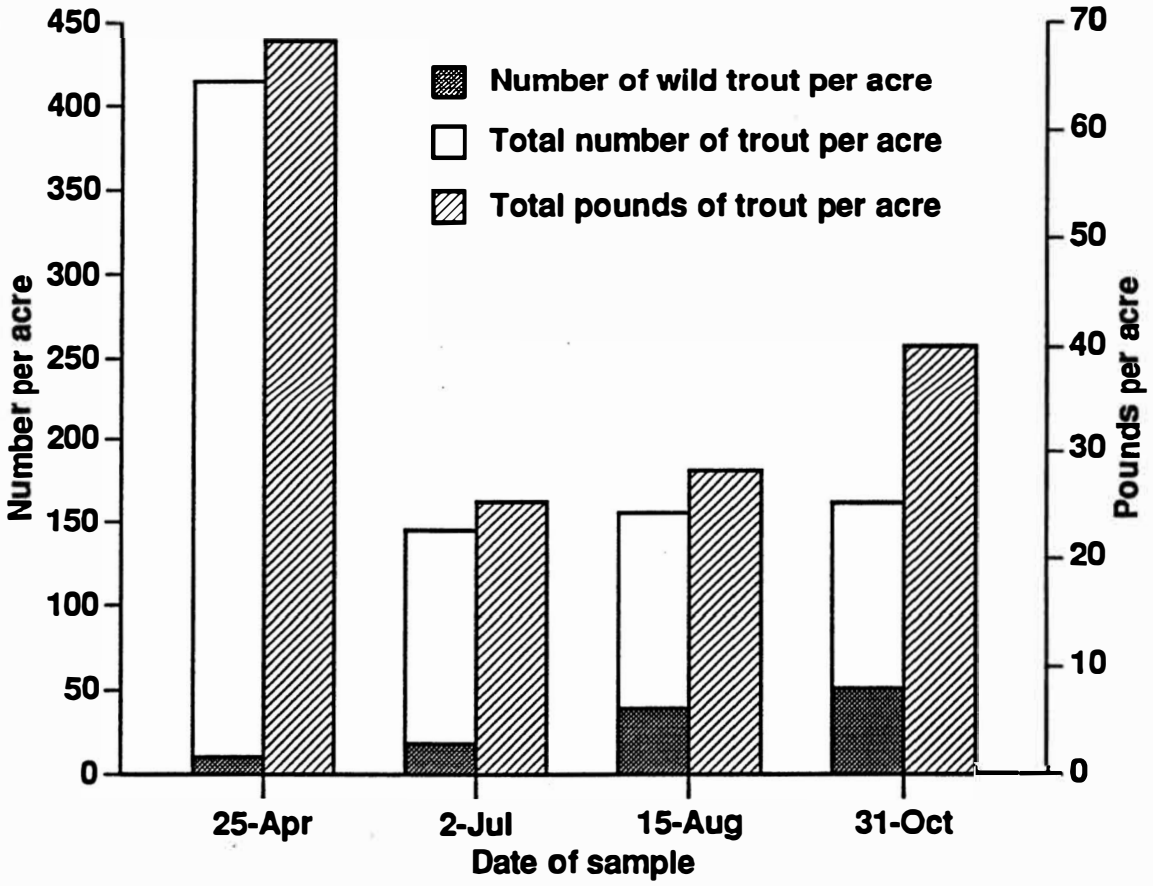

Figure 6.—Numbers per acre of wild brown trout compared to total brown trout present in Augusta Creek during four sampling periods in 1990. The diagonal bar represents the estimated pounds of brown trout per acre using State average weights at length applied to the number estimated in each inch group.

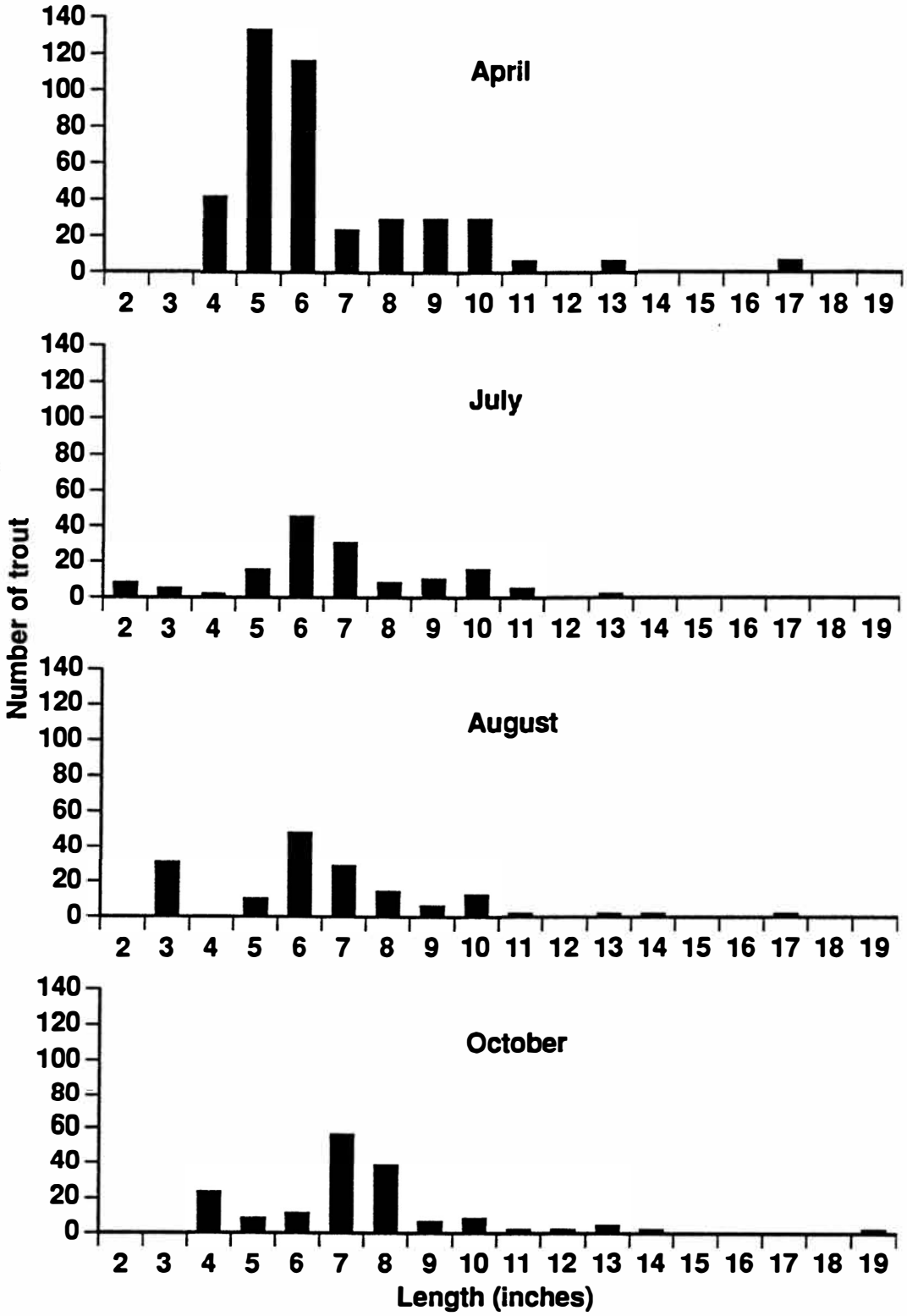

Figure 7.—Estimated numbers of brown trout by inch group in Augusta Creek in months of April, July, August, and October. Inch group 2 includes trout from 2.0 to 2.9 inches, 3 includes trout from 3.0 to 3.9, and so on.

Table 1.—Floy tag loss from brown trout over a 200-day period in 1990.

Day	Tags lost	Number examined	Percent loss
13	3	19	15.8
30[1]	32	250	12.8
60[1]	31	112	27.7
79	4	18	22.2
120[1]	20	49	40.8
123	11	16	68.8
200	14	18	77.8

[1]Samples collected from a pond experiment at Wolf Lake State Fish Hatchery. All others are from Augusta Creek.

Table 2.—A comparison of some spring and fall densities of brown trout in our region. Augusta and Newton creeks are stocked each year. The number in parentheses indicates the percentage of trout 8 inches and over. August Creek size limit was 8 inches.

Stream	Spring	Fall
Augusta Creek, MI 1990	415/acre (25.0)	162/acre (39.5)
Emmons Creek, WI[1] average of 1975-77	620/acre (16.2)	722/acre (20.4)
Mecan Creek, WI[1] average of 1975-77	245/acre (25.1)	569/acre (10.7)
Rifle River, MI[2]	296/acre (—)	492/acre (13.7)
Gamble Creek, MI[2]	2,564/acre (—)	3,572/acre (31.8)
Newton Creek, MI[3]	233/acre (37.0)	333/acre (22.8)

[1]Six-inch minimum size limit (Avery and Hunt 1981).

[2]Seven-inch minimum size limit (Gowing and Alexander 1980).

[3]Ten-inch minimum size limit (Alexander and Peterson 1981).

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