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FISHERIES DIVISION

TECHNICAL REPORT

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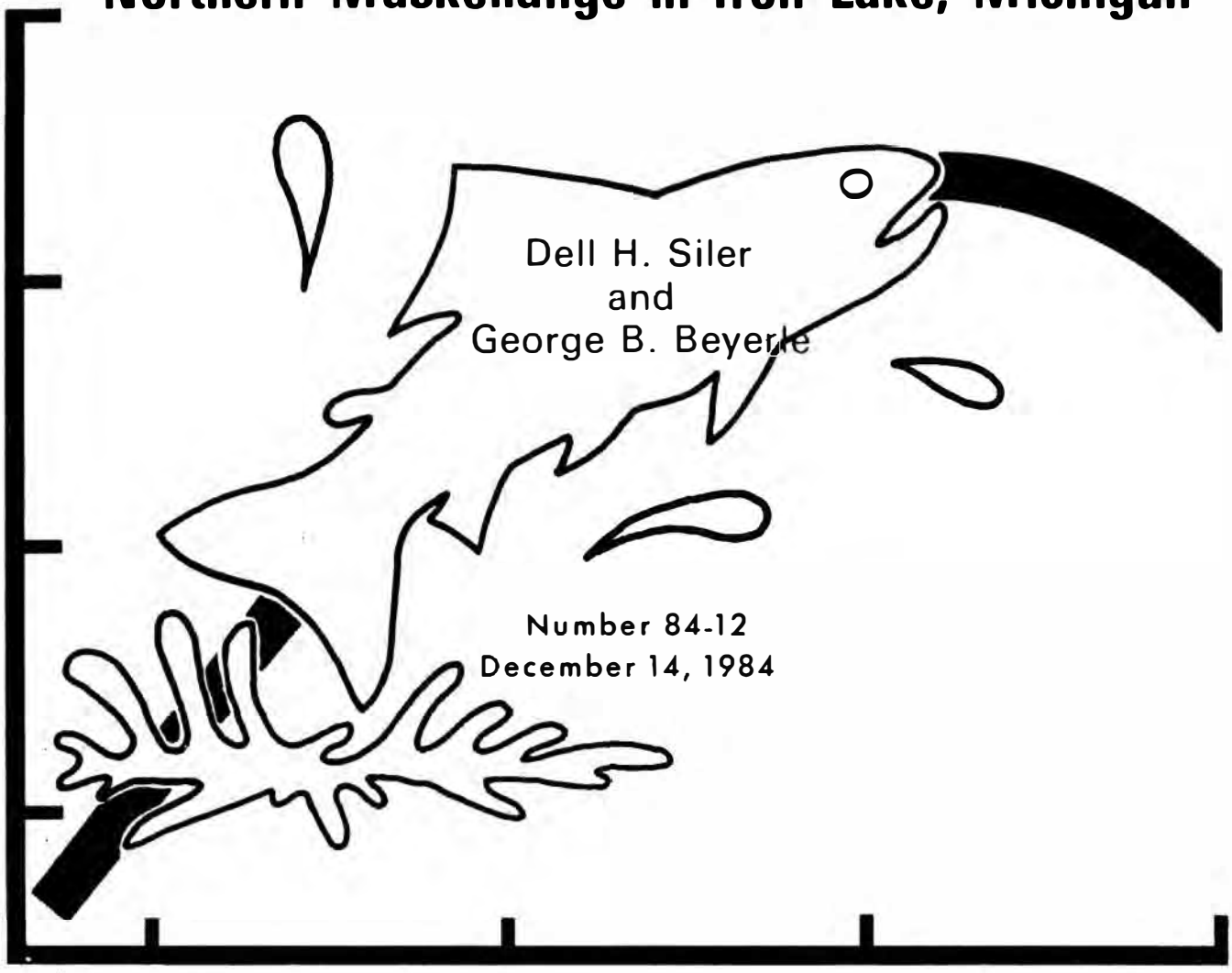

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MICHIGAN DEPARTMENT OF NATURAL RESOURCES
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INTRODUCTION AND MANAGEMENT OF NORTHERN MUSKELLUNGE IN IRON LAKE, MICHIGAN

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Abstract

The Michigan Department of Natural Resources (DNR), in 1962, introduced northern (Wisconsin variety) muskellunge into 396-acre Iron Lake with annual fingerling plants. By 1966 high survival of initial stocks had produced a substantial population of harvestable adult muskellunge.

In 1968 Iron Lake was designated a muskellunge brood stock lake and closed to winter angling. Angler harvest of muskellunge was further restricted in 1972 by imposition of an artificial lures only, 36-in minimum size limit for summer anglers. The resulting abnormally high population density of 30-in and larger muskellunge (0.84 per acre) occurred concurrently with a severe decline in previously substantial populations of black crappie and common sucker. In addition, some muskellunge emigrated into two popular brook trout streams. By 1978 public displeasure with the Iron Lake fishery stimulated the DNR to net and remove adult male muskellunge, move the muskellunge egg collection operation elsewhere, and liberalize angling regulations (1981).

By spring 1982, at least 381 muskellunge (0.96 per acre) had been removed by netting and angling, and the catch-per-effort (CPE) of muskellunge in nets declined 93%. Mean annual growth of adults was 0.98 in greater in 1981 than in 1979, and survival of naturally produced young was much higher. Northern pike was threatening to become the dominant large predator. Populations of black crappie and common sucker were increasing again, but yellow perch had, temporarily, become the dominant panfish.

The fish management experience at Iron Lake stresses the importance of carefully examining all possible consequences of any major actions being considered and of intensely monitoring a fish population being subjected to novel management techniques.

Introduction

The muskellunge is the largest member of the pike family, Esocidae, and is native only to the United States and Canada. Throughout its native range, the muskellunge has evolved into several strains with more or less unique characteristics, e.g., spawning habits, markings, etc. Classification of these strains as subspecies is debatable (Hourston 1955; Reeve M. Bailey, personal communication).

The three common strains are the Great Lakes muskellunge, found in the Great Lakes and St. Lawrence basins, southwestern Quebec and eastern Ontario; the Ohio muskellunge, found in the Ohio-Tennessee River system, including western Pennsylvania and New York; and the northern (Wisconsin) muskellunge, found in the headwaters of the Mississippi River and in the western Ontario waters which drain into Hudson Bay (Hourston 1955, Trautman 1957, Hubbs and Lagler 1958).

Two of the muskellunge strains are native to Michigan. The Great Lakes muskellunge is found mainly in Lake St. Clair and in certain other lakes which connect (or were formerly connected) with one of the Great Lakes. The northern muskellunge is native only to a few waters of the Mississippi drainage located in the western Upper Peninsula along the Michigan-Wisconsin boundary in Gogebic County. In the early 1960's the Michigan Department of Natural Resources (DNR) began attempts to expand the range of the northern muskellunge (MacGregor et al. 1960). One purpose of the introductions (Schrouder 1973) was to establish muskellunge brood stock lakes to provide eggs for hatchery production of the hybrid tiger muskellunge (muskellunge x northern pike).

Muskellunge fingerling plants began in 1962. By 1968 the muskellunge population was so substantial that the DNR chose Iron Lake as a source of eggs for hatchery production of northern muskellunge. To protect the egg source, the DNR

closed the lake to all winter fishing and spearing, which caused immediate resentment among the large contingent of local winter spear fishermen and panfish anglers.

To further protect the large muskellunge spawners, a 36-in minimum size limit, artificial-lures-only regulation was adopted in 1972. Black crappie that had dominated the anglers' catch through the 1960's were rarely taken in the early 1970's. Anglers were quick to jump to the conclusion that the substantial muskellunge population was responsible for the declining population of panfish. Muskellunge sightings in two popular brook trout streams downstream from the Iron Lake outlet caused more public relations problems. Despite the removal of 223 male muskellunge in 1978-79, anti-muskellunge public pressure continued. Finally, in 1981 the egg collection operation was moved to another lake. In the winter of 1980-81 the DNR eliminated the ban on winter fishing and spearing in Iron Lake and established a daily creel limit of five esocids of any size. After 1 year of liberalized regulations, standard angling regulations for muskellunge in Michigan (one fish per day at least 30 in long) were reimposed on the Iron Lake fishery.

The objective of this paper is to document the results of making several annual plantings of hatchery-raised fingerling northern muskellunge, and to report observations pertaining to winter spearing of muskellunge and changes in size limit and creel limit regulations in Iron Lake, Iron County, Michigan.

Study Site

Iron Lake, located in central Iron County in the Upper Peninsula of Michigan, has 396 surface acres and a maximum and mean depth of 43 and 10.9 ft, respectively. The water, stained light brown, is moderately soft with an average methyl orange alkalinity of 30 ppm. Littoral areas vary from large sandy flats to bays with loose organic

substrates. The lake has two small inlet streams and an outlet stream (Iron Lake Creek) that drains into the Iron River. Iron River is a top quality brook trout stream. Little information existed about the fish population in Iron Lake prior to the introduction of muskellunge. However, the available data plus angler reports both suggest the existence of substantial populations of black crappies, golden shiners, and white suckers. Largemouth bass and smallmouth bass were present but not abundant.

Methods

Northern muskellunge fingerlings were stocked annually in Iron Lake from 1962 through 1972, except for 1968. The planting time varied from June to August. Stocking rates and size of fingerlings varied considerably (Table 1). Annual trap and/or fyke netting of muskellunge took place from 1966 through 1982, except for 1973 and 1981 (Table 2). The first netting surveys, to check survival and growth, were in August 1966 and May 1967. The trap nets used had 4-ft pots, and the fyke nets had 4-ft diameter hoops. Mesh size in both types of nets was 0.75-in bar. Total net numbers used in each survey and the combination of fykes and traps was highly variable. All comparisons were made on the basis of catch per unit of effort (CPE). Beginning in 1968, the annual netting operations were oriented to muskellunge egg collection, although data were collected on muskellunge CPE and mean lengths for spawned fish. Data on CPE of native fishes were obtained in 1967 and 1979. Between those years, data on fishes other than muskellunge were not recorded.

During the 1970 and 1979 nettings, the population of mature muskellunge was estimated by mark and recapture, using a multiple census formula of Schumacher and Eschmeyer (Ricker 1975). During the 1978 and 1979 netting operations, all captured male muskies were removed from Iron Lake to

reduce the overall population without jeopardizing egg taking potential. Following the liberalizing of fishing regulations in 1981, an intensive creel census was conducted during the 2-month (January and February) 1981 winter fishing season and again the next summer (May through July).

Catch estimates for the 59-day 1981 winter creel census (Table 3) were based on the assumption that on each day of the census, all anglers (spearers) and all captured muskellunge were checked by census clerks. Limited access to Iron Lake and the fact that all spearing was done from shanties theoretically made the assumption valid (James R. Ryckman, personal communication).

Estimates were made of total anglers, total hours fished, and muskellunge speared for each day of the fishery, with January 1 as day 1 and February 28 as day 59. The formula for the total anglers per day (F) was:

(1) $F = 31.25 - 1.03 X + 0.0095 X^2$

$R^2 = 0.89,$

where X = day,

the formula for total hours fished per day (H) was:

(2) $H = 123.18 - 4.50 X + 0.0452 X^2$

$R^2 = 0.85,$

and the formula for total muskellunge speared per day (M) was:

(3) $M = 14.02 - 0.78 X + 0.0098 X^2$

$R^2 = 0.74.$

The variance on each of these estimates was calculated by the following formula:

$$(4)\ \mathrm{Var}(\hat{Y}) = [S_{Y.XU}\ \ 1/n\ (\bar{X}-X)^2/\sum x^2 + (\bar{U}-U)^2/\sum u^2]^2$$

where,

$\hat{Y}$ = estimate F, H, or M

$S_{Y.XZ}$ = standard deviation of $\hat{Y}$

n = total sample size

X = day

U = day^2

$\sum x^2 = \sum X^2 - (\sum X)^2/n$ = corrected sums of squares

$\sum u^2 = \sum U^2 - (\sum U)^2/n$ = corrected sums of squares

The daily estimates and their variance were summed to give monthly estimates and the monthly estimates were summed to give seasonal estimates.

The summer census was conducted using standard instantaneous counts and random interviews (Merna et al. 1981).

Results

Netting operations

The first post-stocking survey in August 1966 produced eight fish ranging in size from 18.3 to 35.6 in (Table 2). A similar survey in May 1967 captured 33 fish from 20.3 to 31.0 in (mean 27.1 in). Although ages were not determined, the wide variation in lengths suggest the presence of at least 2 year classes.

In the 1967 survey, white suckers and black crappies dominated the catch of native fishes (Fig. 1). Pumpkinseed, yellow perch, and largemouth bass were captured in fewer numbers. This order of abundance was supported by a boomshocking survey in August of 1966. By early 1970's

white suckers and black crappies were only rarely collected during netting operations (visual observations).

From 1969 through 1978, the annual CPE of netted muskellunge was relatively constant (7.2 to 10.3) except for 1971, 1972, and 1975, when it was only 2.5, 3.4, and 4.0, respectively (Table 2). The mean length of spawned female muskellunge through 1974 averaged 34.7 in, then fell in 1975 to 32.9 in, in 1976 to 30.6 in, and in 1977 to 30.2 in (Table 2, Fig. 2).

During the 1978 and 1979 netting operations, 97 and 126 adult male muskellunge, respectively, were transferred to another lake with an established muskellunge population. The removal of the 223 fish, ranging in size from 23.7 to 35.4 in was reflected in the subsequent netting CPE for total adults, which decreased from an average of 7.6 muskellunge in 1976-78 to 3.6 in 1979 and 2.6 in 1980 (Table 2). Also, 1979 was the first year since netting began that more mature females than males were taken and the first year since 1974 in which the mean length increased for spawned females (Table 2, Fig. 2). In 1979 pumpkinseeds and yellow perch dominated the net catch of native fishes. Black crappies and white suckers continued to be scarce (Fig. 1).

In 1982 the CPE for muskellunge was only 0.5, a reduction of 79% from that in 1980 (following 2 years of manual removal) and 93% from the mean CPE for the 3 years previous to manual removal (Table 2). Evidence of better growth was indicated from four muskellunge (30.8 to 35.0 in) tagged in May 1982 and recaptured in May 1983. They had grown an average of 1.8 in. This compared with a mean annual growth of 0.8 in for 33 female muskellunge (28.9 to 34.3 in) which had been tagged in May 1979 and recaptured in May 1980. Also in 1982, the mean length of female muskellunge increased to the levels of 1969-74 (Table 2).

The catch of black crappies increased gradually between 1980 and 1982, then sharply in 1983 (visual observation). Meanwhile, a considerable increase in the yellow perch

population was evident in 1979 (Fig. 2). By 1981 and continuing through 1983, the yellow perch was the dominant panfish in Iron Lake (visual observation), but average growth was not as high as Michigan state average (Laarman 1963).

A small population of northern pike existed in Iron Lake at least since 1968. In 1980, coincident with the reduction of muskellunge, the northern pike population began a gradual increase followed in 1982 by a sharp increase, when the CPE for pike (0.87) exceeded the CPE for muskellunge (0.46). No changes were noted in the populations of largemouth and smallmouth bass.

Population estimates

In 1970 the population of sexually mature muskellunge was estimated to be 871 fish (95% confidence limits, 655-1,299), consisting of 79% males and 21% females. Ages of these fish were not determined, but mean length of males was 27.7 in (range 22.0 to 38.0), of females 34.4 in (range 29.0 to 41.0). Only 23% of the males but 96% of the females were legal size (30 in or larger). The estimated population density of legal-size muskellunge was 0.84 fish per acre (0.40 males and 0.44 females).

In 1979, during the muskellunge egg collection operation, the population of mature females was estimated to be 732 fish (95% confidence limits, 433-2,367), or 1.85 females per acre.

Creel census

The first creel census in 1981, which included the months of January and February, estimated 2,485 (±113.0) hours of angler effort and a catch of 158 (±20) muskellunge (Table 3).

The second creel census period of 1981 ran from 15 May through July. During this period the estimated catch of

muskellunge was only 13 (±13) for 1,161 (±272) angler hours (Table 4).

Discussion

The 1966-67 nettings provided evidence that fingerling muskellunge from some of the earliest stockings in Iron Lake survived in significant numbers. Considering the small size of the fingerlings stocked from 1962 through 1965, the relatively high survival was considered unusual (Johnson 1974, 1982).

In 1970 the estimated population of legal-size muskellunge (30 in and larger) was 0.84 fish per acre, 2.5 times greater than the mean density (0.33 fish per acre) of 30-in and larger fish found in typical muskellunge lakes in Wisconsin (Hanson, in press).

One native fish species difficult to assess with nets was the golden shiner, and it may have been important in influencing the population densities of both black crappies and muskellunge. The reduction of the muskellunge population density by manual removal and liberalized fishing would have resulted in less predation on adult golden shiners and white suckers, plus increased potential for reproduction of golden shiners. Thus, it is possible the golden shiners, white suckers, and black crappies all may have benefited from the reduction in the population density of muskellunge. When the dominant suckers and black crappies were suppressed, a niche may have been provided for the yellow perch to become the dominant panfish in Iron Lake.

Annually, since 1974, a few yearling muskellunge were captured in survey nets, evidence that natural reproduction was occurring. In 1982 yearlings made up 26% of the total catch of muskellunge. The apparent increased survival of young muskellunge may have been one result of the decrease in numbers of larger individuals. The substantial increase

in northern pike numbers, following the 1981 reduction in the muskellunge population, further suggests that cannibalism may have been occurring in the muskie population.

When comparing the 1970 and 1979 population estimates, the 1979 estimate of 1.85 females per acre seems inordinately high (0.44 females per acre in 1970). It is theorized that an overestimate occurred because the spawned (marked) females tended to leave the spawning area where the nets were set. This same phenomenon probably occurred during the 1970 population estimate but was much less a factor, because in 1970, 79% of the muskellunge captured (and marked) were males. Males would be more likely to remain in the spawning area after being marked and released.

Conclusions

The fisheries management experience at Iron Lake is worth examining. The original management goal was achieved with the successful introduction and subsequent development of a northern muskellunge population. However, the decision to make Iron Lake a muskellunge brood-stock lake, although a logical one for the DNR, turned out to be a problem. Because the DNR had relatively few dependable sources of northern muskellunge eggs, it was also logical to protect the potential new source of eggs with restrictive angling regulations. The adverse consequences of the resultant, and somewhat unexpected, expansion of the muskellunge population were not immediately obvious but occurred over a period of years.

Intensive annual surveys of the fish population, which would probably have revealed the changing population structure, were not made. As is often the case under these circumstances, increasing complaints of anglers became the stimulus to corrective action by the DNR.

With the advantage of hindsight, two lessons to be learned from this management experience are: carefully consider beforehand all the possible consequences of any major change imposed on a fish population, and intensely monitor any fish population being subjected to novel management techniques.

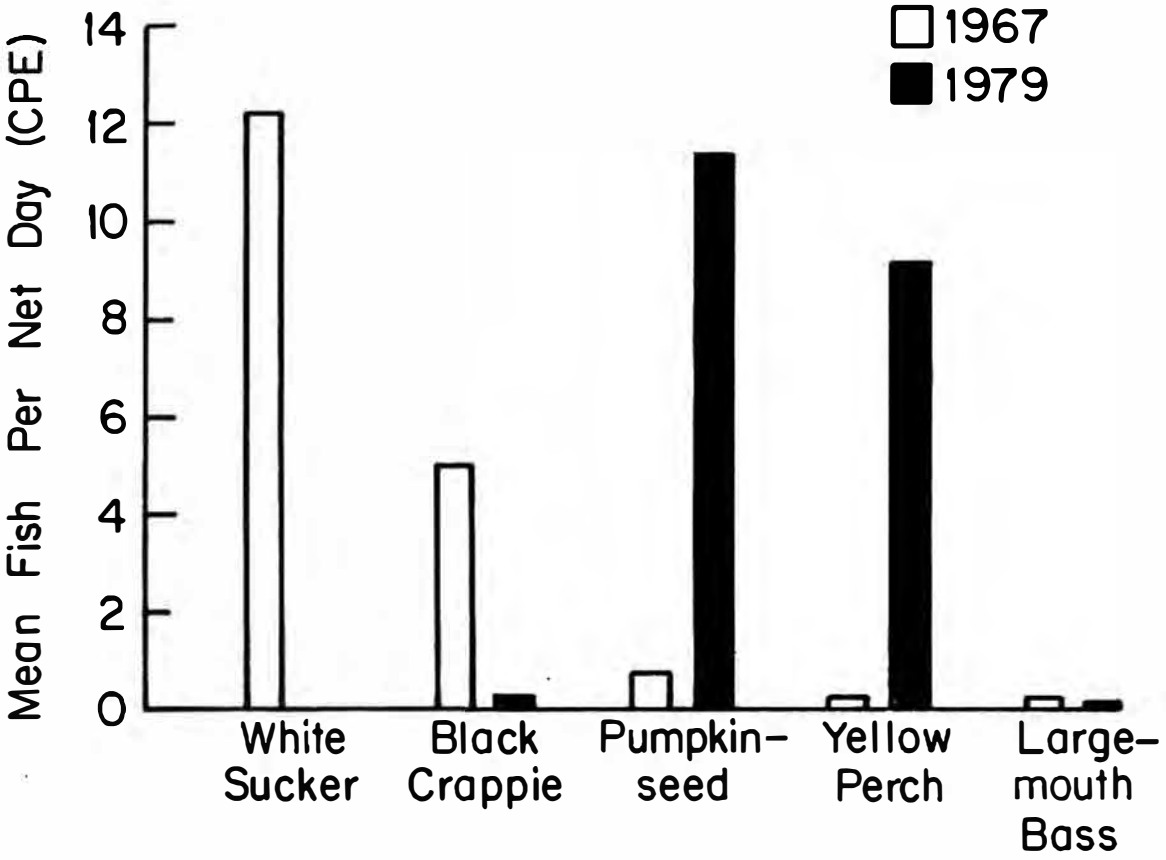

Figure 1. Net catches of native fishes in nets set in Iron Lake, Michigan, May 1967 and 1979.

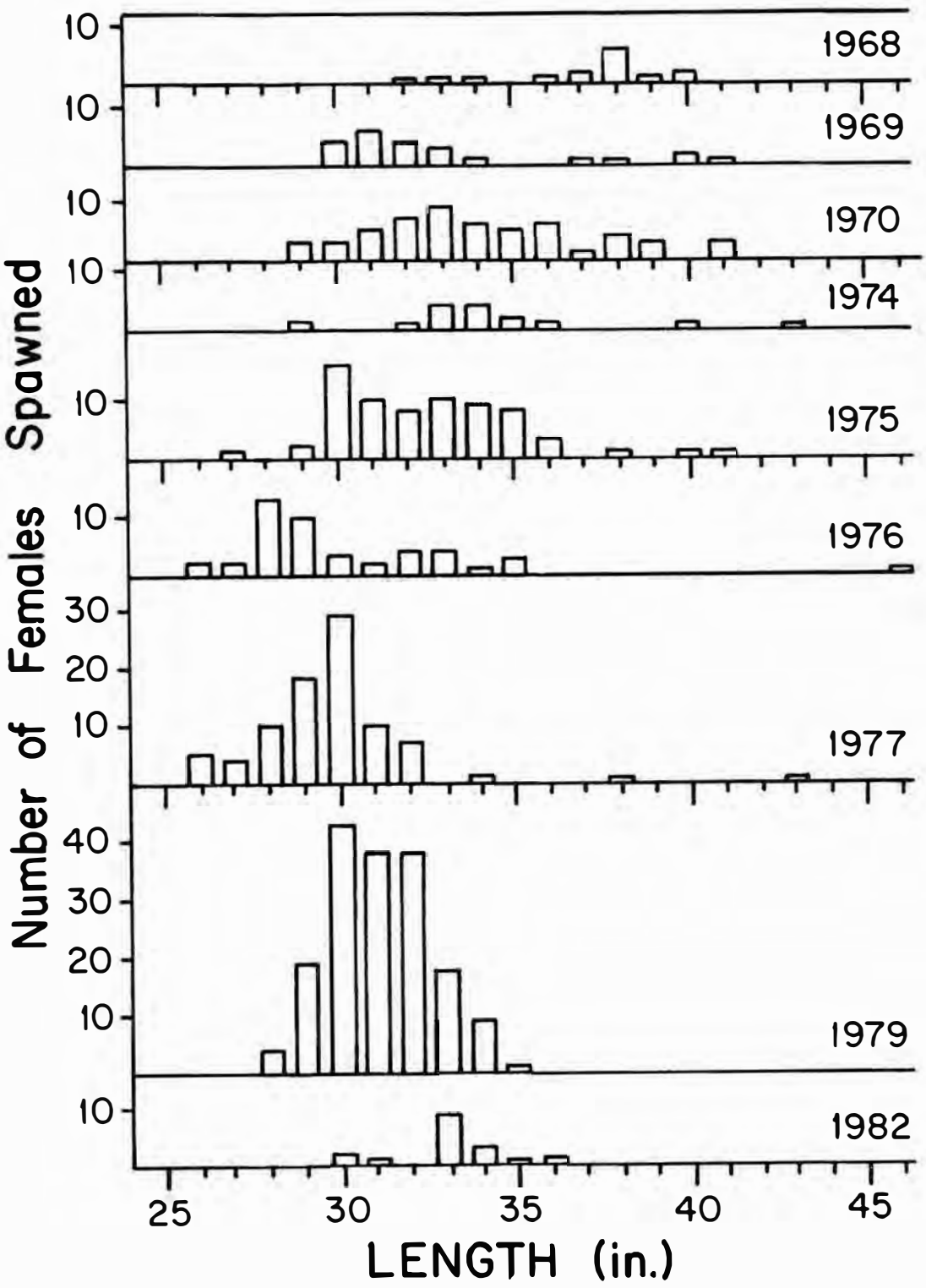

Figure 2. Variations in number and mean length of spawned female northern muskellunge from Iron Lake, Michigan, 1968-1982.

Table 1. Northern muskellunge fingerlings stocked in Iron Lake, Michigan, 1962-72. Mean length calculated from U. S. Department of Interior, Fish and Wildlife Service, Manual of Fish Culture.

Year	Number of fingerlings stocked		Size of fish	
	Total	Per acre	Number per pound	Mean length (inches)
1962	1,500	3.8	214	3.1
1963	1,750	4.4	97	4.1
1964	3,300	8.3	329	2.7
1965	3,000	7.6	86	4.3
1966	1,833	4.6	4	11.9
1967	3,000	7.6	27	6.3
1969	214	0.5	4	11.0
1970	850	2.1	---	---
1971	1,985	5.0	14	7.8
1972	1,600	4.0	13	8.0
Mean per year	1,903	4.8	88	6.7

Table 2. Summary of netting operations for muskellunge on Iron Lake, Michigan, 1966-82. Number of fish spawned in parentheses.

Year	Netting date	Effort (net days)	Fish caught	Total CPE	Mean length of muskellunge spawned (inches)	
					Male	Female
1966	8/25-26	10	8	0.8	---	---
1967	5/10-12	9	33	3.7	---	---
1968	4/10-15	---	212	---	28.9 (-)	37.1 (15)
1969	4/20-5/1	33	293	8.9	27.9 (33)	33.4 (23)
1970	4/27-5/2	36	276	7.7	27.7 (208)	34.4 (55)
1971	4/26-5/11	157	405	2.5	27.1 (34)	33.4 (23)
1972	5/8-14	75	252	3.4	---	---
1974	4/29-30	6	62	10.3	29.1 (47)	34.5 (15)
1975	5/4-13	104	412	4.0	---	32.9 (70)
1976	4/9-25	30	231	7.7	---	30.6 (45)
1977	4/17-23	74	586	7.9	---	30.2 (86)
1978	5/1-11	28	201	7.2	---	---
1979	4/30-5/9	87	314	3.6	30.3 (125)	31.6 (170)
1980	4/27-5/4	58	148	2.6	---	---
1982	5/2-8	90	41	0.5	29.2 (24)	33.4 (17)

Table 3. Summary of a creel census of muskellunge spearers on Iron Lake, Michigan, January-February 1981.

	Effort		Catch		
Month	Number of anglers	Hours fished	Number of fish	Fish per hour	Percent of anglers interviewed
January	559	2,067.5	148	0.0716	37.39
95% C.L.	±13	±61.0	±11	±0.0056	±0.84
February	130	417.5	10	0.0240	16.92
95% C.L.	±20	±95.0	±17	±0.0409	±2.55
Total	689	2,485.0	158	0.0636	33.53
95% C.L.	±23	±113.0	±20	±0.0086	±1.13

Table 4. Summary of a creel census of muskellunge anglers on Iron Lake, Michigan, May-July 1981.

	Effort		Catch		
Month	Number of anglers	Hours fished	Number of fish	Fish per hour	Percent of anglers interviewed
May	21	165	3	0.0182	47.62
95% C.L.	±16	±68	±7	±0.0426	±36.28
June	229	609	7	0.0115	26.20
95% C.L.	±80	±200	±10	±0.0369	±9.15
July	117	387	3	0.0078	26.50
95% C.L.	±55	±171	±6	±0.0159	±12.46
Total	368	1,161	13	0.0112	27.45
95% C.L.	±98	±272	±13	±0.0118	±7.31

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