

DEPARTMENT OF NATURAL RESOURCES

# RESEARCH

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### ABSTRACT

The stocking of muskellunge fingerlings in Murphy Flowage for 10 years produced a limited sport fishery. Under liberalized regulations and a compulsory creel census 42 muskellunge averaging 27.1 inches in length were registered from 1956 through 1970. Angler harvest of stocked muskellunge from 11 releases ranged from 0 to 8.0% and averaged 1.4%. The low return was due to poor survival of stocked fingerlings and emigration.

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## INTRODUCTION

The muskellunge (*Esox masquinongy*) is managed in Wisconsin primarily for its value as a trophy fish; however, increasing harvest of muskellunge has created concern for providing and maintaining an adequate standing crop to meet the need for future angling opportunities (Wis. DNR 1979). Management strategies to meet the increased demand include muskellunge introductions into new waters (Wis. DNR 1979). The introduction of muskellunge into Murphy Flowage over a 10-year period allowed researchers an opportunity to evaluate a muskellunge stocking program under a compulsory creel census and liberalized fishing regulations.

## STUDY AREA

Murphy Flowage was\* located in northwestern Wisconsin in the headwaters region of the Red Cedar River, a tributary of the Chippewa and Mississippi Rivers. The flowage, which was formed in 1937 by impoundment of Hemlock Creek, a trout stream, had an elevation of 1,258 ft and was located within a hilly, rocky region known as the Barron Hills. Maximum depth of Murphy Flowage was 14 ft, and over 70% was less than 10 ft in depth. The 180-acre flowage had a volume of 874 acre-ft of water and approximately 7 miles of irregular shoreline. The average annual alkalinity was 37 ppm and the mean annual flow at the outlet was 18 cfs. Beard (1973) found 24 species of aquatic plants present in Murphy Flowage in 1967.

The bluegill (*Lepomis macrochirus* Rafinesque) comprised about 80% of the total biomass of panfish, while northern pike (*Esox lucius* Linnaeus) and largemouth bass (*Micropterus salmoides* Lacepede) accounted for about 65% and 35% of the game fish biomass, respectively (Snow 1978a).

## METHODS

In the summer of 1955, 1,000 muskellunge fingerlings (2.5 inch) were stocked in Murphy Flowage (5.6/acre), and each fall from 1955 through 1964 an average of 200 fingerlings (9-11 inch) were stocked (1.1/acre). All stocked fish, with the exception of the 1955 summer plant, were marked with a fin clip to identify the year class. All stocking was done at one location except in 1958 and 1964 when fingerlings were scatter planted.

Complete angling records were collected through a compulsory registration-type creel census operated throughout the entire study from 30 April 1955 through 31 May 1970. Information on the hours fished and number, length, and weight of fish caught were recorded for each angler at the end of the fishing trip. All fish were measured to the nearest 0.1 inch in total length and weighed to the nearest 0.1 lb. There was no closed fishing season and neither a bag limit nor size limit was in effect on Murphy Flowage at any time. Angling was

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\*The dam impounding Murphy Flowage on Hemlock Creek washed out on 31 May 1970, hence the use of past tense to describe the study area.

permitted from 4:00 a.m. to 10:00 p.m. in the summer and from 8:00 a.m. to 6:00 p.m. in the winter. No records were kept of fish caught and released. Further details of the procedures used may be found in Churchill and Snow (1964). Although a number of muskellunge were captured by angling, netting, and electrofishing in downstream waters, the harvest figures include only those fish taken in Murphy Flowage as recorded through the compulsory creek census.

Data on muskellunge abundance and growth were obtained from fyke netting (average of over 500 net days/year) and electrofishing (1958-1970) conducted throughout the entire study in conjunction with other ongoing studies.\* However, the low number of muskellunge captured by these methods (an average of 8 fish/year) precludes meaningful discussion of abundance. Age and growth of muskellunge were determined from spring scale samples and verified by fin clips. Where conflicts arose between the two methods, usually on older age fish, the age class from a specific fin clip was used.

## RESULTS AND DISCUSSION

### Return to the Angler

Return of stocked muskellunge to the angler varied from 0 to 8.0% (Table 1). The first stocking of fall fingerlings in 1955 was the most successful in that 16 of 200 stocked were caught by anglers at an average length of 29.8 inches. Angler harvest of muskellunge stocked as large fall fingerlings (9-11 inch) totaled 1.8% (0.7% as legal; 30 inches or larger) compared to a return of only 0.4% of 2.5-inch fingerlings stocked in June 1955, none of which were harvested at a size of 30 inches or greater. Hoff and Serns (in press) reported returns of 4% and 1% for stocked fingerlings in Escanaba Lake where stocking was done to supplement a self-sustaining population.

The low return of muskellunge is attributed primarily to the presence of northern pike. Fingerling survival may have been low because of competition with an already established northern pike population; biomass of native northern pike over 14.0 inches averaged 8.3 fish/acre weighing 13.1 lb/acre, respectively, during the 15-year study (Snow 1978b). The northern pike is considered one of the biggest threats to muskellunge in waters where they occur together (Becker 1983). Serns and Andrews (1983) suggested that high densities of northern pike were an important factor in low survival of stocked muskellunge (less than 12 inches) in several lakes, and Johnson (1981) noticed an observed decline in a native muskellunge population to be related to the invasion of northern pike. Emigration, to be discussed later, also appears to have contributed to the low return of stocked fish.

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\*One net day = one fyke net set for 24 hr; the average number of muskellunge captured also includes fish captured from electrofishing (amount of effort not quantified).

Results of scatter plantings of muskellunge in 1958 and 1964 did not appear to show any advantage over stocking of all fingerlings at one location. The 1958 and 1964 scatter plants resulted in returns to the angler's creel of 0.5% and 1.5%, respectively, compared to an average of 2.0% for all other introductions of fall fingerlings.

### Harvest

Anglers harvested 42 muskellunge averaging 27.1 inches in length and 5.5 lb in weight from 1956 to 1970. Length and weight ranged from 13.0 to 44.5 inches and 0.4 to 19.5 lb, respectively. Harvest averaged 3 muskellunge annually and yield averaged 19 lb annually. Harvest and yield ranged annually from 0 to 6 fish and 0 to 35.1 lb, respectively. Muskellunge made up less than 0.5% of the average harvest and weight of all species taken by anglers from Murphy Flowage (Snow 1978a).

Sixteen of 42 (38.1%) muskellunge harvested were 30 inches or greater in length. However, because of the time required from initial stocking (1955) until a muskellunge could reach a legal size of 30 inches, no muskellunge 30 inches or greater were taken by anglers until 1959, four years after the initial stocking. Considering the period from 1959-69 when legal-sized muskellunge were available to the angler, 16 of 31 (51.6%) of the muskellunge harvested were 30 inches or greater in length. Hoff and Serns (in press) reported that 23% of the muskellunge harvested by anglers from Escanaba Lake, under similar liberalized regulations and compulsory creel, were 30 inches or greater in length.

Based on the number of total angler hours from 1955-69, it took an angler fishing Murphy Flowage 4,729 hours (0.0002 fish/hour; nonspecific catch rate) to harvest a muskellunge, and 7,867 hours (0.00013 fish/hour) from 1959-69 to harvest a 30-inch or larger muskellunge (typical legal size). Hoff and Serns (in press) estimated that a maximum of 5% of the total angler hours are by fishermen solely after muskellunge. Applying this value, anglers fishing Murphy Flowage harvested a legal-sized muskellunge every 393 hours (0.002 fish/hour) from 1959-69. This harvest rate is lower than the 152 hours (0.006 fish/hour) reported by Hoff and Serns (in press) for Escanaba Lake and the mean of 125 hours (0.008 fish/hour) reported by Hansen (in press) for 8 Wisconsin lakes.

Most muskellunge were taken by anglers during the months of July (33.3%), June (26.2%), August (16.7%), and May (11.9%), while 7.1% were taken in September and 2.4% in April and October. Only 1 (2.0%) of the muskellunge harvested was taken out of the normal open season for muskellunge in Wisconsin (first Saturday in May to November 30). Hoff and Serns (in press) reported 13% of the muskellunge taken from Escanaba Lake were harvested outside these seasonal periods.

### Emigration

Several fin-clipped muskellunge stocked in Murphy flowage were later captured downstream in a portion of Hemlock Creek, Bolger Flowage, or Hemlock Lake, the next impoundments downstream from the Murphy Flowage dam. In November 1964 an

11.3-inch muskellunge stocked 30 September of the same year was netted a short distance below the Murphy Flowage dam and in 1967 a 30.0-inch marked muskellunge was captured in Bolger Flowage. In August 1977, a 51-inch muskellunge (1962 stocking) weighing 35 lb, 15 oz was caught by an angler in Hemlock Lake. This particular muskellunge was the largest taken by either DNR sampling or angling during the study period and either passed over the dams at Murphy and Bolger Flowages to reach Hemlock Lake, or moved downstream after the dams washed out on 31 May 1970. In addition to these marked muskellunge, a 10.2-inch unmarked muskellunge was captured in April 1966 in Bolger Flowage, indicating either downstream movement of naturally produced muskellunge in Murphy Flowage or natural reproduction in Bolger Flowage.

Snow (1974) reported extensive downstream movement of stocked northern pike in Murphy Flowage and estimated that 25% of the northern pike stocked in Murphy Flowage in December had gone over the dam downstream by May of the following year. Snow (1974) suggested that the introduced northern pike were "crowded" out by an established native northern pike population occurring at relatively high densities (15-yr mean of 8.3 pike/acre). Downstream movements also appear to hold true for stocked muskellunge; however, the magnitude of such movements do not seem to be as extreme based on the number of recaptures reported and may be a reflection of low short-term survival or low stocking densities.

#### Growth Rate

Growth rates of muskellunge in Murphy Flowage were above average in comparison with other selected muskellunge waters in Wisconsin (Table 2). Johnson (1971) characterized growth rates of muskellunge from Bone Lake as "fast", Lac Courte Oreilles as "average", and Big Spider Lake as "slow". Using this categorization, growth rates in Murphy Flowage would be considered better than average, with muskellunge reaching a length of 30 inches by age V, and 40 inches by age IX.

#### Natural Reproduction

Natural reproduction of muskellunge did occur as a result of 10 years of stocking in Murphy Flowage. With the exception of the 1955 plant of small fingerlings, all muskellunge stocked (1955-64) were marked with a fin clip so any natural reproduction which occurred would be determined by capture of unmarked muskellunge from an age class other than that of the 1955 plant. Such unmarked muskellunge accounted for 3.6% of the total number observed through creel census, netting, and electrofishing surveys (N=167); however, the possibility exists that a number of these could have been unclipped fish or fish on which fin regeneration was not detected (McNeil and Crossman 1979). Positive evidence of muskellunge reproduction came in April 1966 and May 1970 when a 10.2-inch and 10.7-inch muskellunge was captured in Bolger Flowage and Murphy Flowage, respectively. Since stocking was discontinued in 1964, the small muskellunge were undoubtedly from natural reproduction. Additional evidence of spawning attempts was provided in 1964 by the capture of a 17.9-inch fish thought to be a northern pike-muskellunge hybrid.

## SUMMARY AND MANAGEMENT IMPLICATIONS

Poor survival of stocked fingerlings was probably the most important factor involved in low abundance and low return to the angler. Interspecific competition with an established northern pike population may have provided a disadvantage too great for substantial survival of introduced muskellunge to occur. Introductions of muskellunge fingerlings into waters with an established northern pike population have had limited success in the past, and the same result appears to be true for Murphy Flowage. Migration of stocked fish over the dam also contributed to the relatively small numbers observed in netting and shocking operations and the creel census over the 15-year study period.

Anglers harvested 42 muskellunge averaging 27.1 inches in length from 1956-70. This harvest represented 1.4% of 3,002 stocked fish which were returned to the creel (1.8% of larger fall fingerlings, 0.4% from 1955 plant of smaller summer fingerlings). It took an angler fishing for muskellunge an estimated 393 hours to harvest a muskellunge 30 inches or greater. July and June were the most productive months in terms of success, accounting for almost 60% of the total harvest. Under liberalized regulations allowed at Murphy Flowage, 51.6% of the muskellunge harvested were 30 inches or greater in length during the period 1959 to 1970. Therefore, over 48% of the muskellunge harvested would have been of sublegal size with an imposed 30-inch size limit. Only 2% of the harvest was creeled outside the normal open season for muskellunge in Wisconsin. Under the present 32-inch minimum size limit effective in most Wisconsin waters, 61.3% of the harvest would have been of sublegal size. In the case of Murphy flowage the 2-inch increase in size limit would have theoretically reduced harvest by approximately 13% compared to the 30-inch size limit. A 34-inch minimum size limit could have reduced harvest by 32.3% over the 30-inch limit and 19.4% over the 32-inch limit.

Growth rates of muskellunge stocked in Murphy Flowage were good in comparison with other selected muskellunge waters in Wisconsin; however, abundance remained low for the duration of the study. Natural reproduction occurred as a result of stocking fingerlings in the 180-acre flowage but was not sufficient to maintain the muskellunge population.

The compulsory creel census permitted a very precise determination of the contribution to the creel of individual lots of stocked muskellunge fingerlings -- only the second study in Wisconsin able to do so.

TABLE 1. Number and percent of stocked muskellunge harvested by anglers from Murphy Flowage, 1955-70.

Year Stocked	No. Stocked	Avg. Size Stocked (inches)	No. Harvested <sup>a</sup>	Percent Harvested
1955 (June)	1,000	2.5	4	0.4
1955 (Sept)	200	11.0	16	8.0
1956	200	9.6	4	2.0
1957	200	8.7	3	1.5
1958*	200	9.5**	1	0.5
1959	198	9.5**	3	1.5
1960	195	9.0	0	0.0
1961	203	9.5**	5	2.5
1962	200	9.5	0	0.0
1963	200	9.0	1	0.5
1964*	206	11.4	3	1.5

\*Scatter plants.

\*\*Average of 7-12 inch fish stocked; no record of fish being individually measured.

<sup>a</sup>Of total muskellunge harvested, one was unclipped and one was of uncertain origin and are not included.

TABLE 2. Mean total length for various muskellunge age classes from selected Wisconsin waters.

Location and Reference	Sample Size	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	
Escanaba Lake (Hoff and Serns in press)	258	14.2	21.0	25.4	29.0	32.6	34.8	35.8	38.8	41.5	43.3	44.9	--	--	
Bone Lake (Johnson 1971)	246	--	19.0	26.1	29.8	33.4	35.7	39.2	39.5	--	43.5	--	--	--	
Lac Courte Oreilles (Johnson 1971)	552	11.2	16.2	22.5	25.9	28.4	30.0	31.1	32.6	33.0	33.6	37.0	--	--	
Big Spider Lake (Johnson 1971)	71	11.4	15.3	22.6	24.8	26.2	28.1	29.4	33.1	30.6	27.0	--	--	--	
8 Wisconsin Lakes* (Hanson in press)	Males	1,531	--	--	22.4	25.9	28.3	30.3	32.1	33.3	35.1	36.1	37.4	38.2	38.7
	Females	548	--	--	--	26.7	29.9	32.3	34.9	36.6	38.8	40.2	43.4	44.7	45.6
Murphy Flowage (Present study)	100	9.9	17.0	22.1	28.7	31.7	35.1	37.2	37.8	40.9					

\*Lakes included Winter, Sissabagama, Little Arbor Vitae, Big McKenzie, Sand, Day, Big, Big Arbor Vitae.

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