

**RESEARCH
REPORT 44**

**SUMMARY OF NORTHERN PIKE STOCKING INVESTIGATIONS
IN WISCONSIN**

**By
David C. Krohn**

**Department
of
Natural
Resources**

Madison, Wis.

1969

ABSTRACT

Information on stockings of northern pike in 19 lakes in Wisconsin, Minnesota and Iowa in past years has been compiled and presented here to evaluate various kinds of stocking efforts and to present recommendations for future stocking and further evaluation.

The stocking of fingerlings and yearlings averaging 12-17 inches in total length into waters containing northern pike can result in a considerable return of the stocked fish and short-term improvement of fishing success and harvest. Generally, when northern pike populations were high, competition appeared to occur, as indicated by such factors as increased natural mortality and poor growth of stocked fish.

ACKNOWLEDGMENTS

The assembling of the information on northern pike stocking was aided by the cooperation of several Department of Natural Resources personnel. Stanton Kleinert developed the stocking survey questionnaire, assembled the surveys with the assistance of fish managers and gathered much of the other information on stocking. Biologists within the Fish Research Section permitted the use of unpublished data from annual reports and furnished other helpful information. -- Edited by Ruth L. Hine.

The author is a Fishery Biologist with the Bureau of Research, Delafield, Wisconsin.

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INTRODUCTION

Studies of survival, yield, and growth of hatchery-reared northern pike stocked in Wisconsin waters and native pike transplanted from winterkill lakes have been conducted in past years as part of Department programs. The objectives of this report are to (1) summarize the information on northern pike stocking from various investigations in Wisconsin, (2) present a limited literature review covering adjacent states, (3) evaluate the results on a generalized basis, and (4) present recommendations for stocking and further evaluation.

Information on the results of stocking northern pike was not plentiful and quite often was not complete. This made it impossible to examine in detail factors that could affect the outcome of stocking and in many cases, to thoroughly evaluate the stockings. As a result, conclusions in this report are presented in general terms and the degree of coverage varies widely for the various aspects of stocking. However, we felt that an analysis of the available material would serve to point out management techniques that could immediately be put to use, management practices that should be modified, and areas where further study is needed. A similar report, summarizing the information from Department files on stocking of hatchery-reared trout in Wisconsin, was prepared by Brynildson and Christenson (1961).

METHODS

Information on northern pike stockings in Wisconsin, Minnesota, and Iowa served as the basis for this report. In Wisconsin, results of stockings were obtained through a statewide questionnaire survey of all fish managers and from research reports. Information from the other states was obtained from the literature and through correspondence.

Individual stocking efforts were summarized by lake. The stocking summaries were categorized according to the stage of development of the northern pike at which most of the stockings in a particular body of water were made and according to location by state.

STOCKINGS OF NORTHERN PIKE FINGERLINGS AND OLDER FISH

Wisconsin

Murphy Flowage

Murphy Flowage, Rusk County, is 180 acres in size and has 6.5 miles of irregular shoreline. Most of the flowage is shallow with over 70 percent being less than 10 feet in depth. Maximum depth is 14 feet. Winterkills have not been a problem, for oxygen levels in portions of the flowage are adequate throughout the winter. Total alkalinity has ranged from a high of 58 ppm in November, 1965 to a low of 8 ppm in March, 1966. Compared with other waters in northwestern Wisconsin, the flowage is relatively productive.

Fish present include northern pike, muskellunge, largemouth bass, bluegill, yellow perch, pumpkinseed, black crappie, rock bass and brown bullhead.

A complete creel census and a compulsory permit system were initiated on the flowage in April, 1955. Since that time the flowage has been open to any legal method of fishing with no restrictions on size, bag, season or species.

In December 1963, a total of 8,534 northern pike (47.5/acre) weighing 7,253 pounds were placed in the flowage. The northern pike averaged 15.4 inches in total length, with a range of 10.4 to 22.8 inches, and 0.85 pounds in weight. Most of the fish were fingerlings. Based on weight the standing crop of northern pike was increased about 200 percent (20 lbs/acre before stocking to 60 lbs/acre immediately after stocking).

Although stocking greatly increased the standing crop of northern pike, and fishing pressure (for all species combined) was 22 percent higher, the catch during the 1963-64 ice fishing season was down by 23 percent when compared to that of the 1962-63 season (Table 1). The total number of northern pike caught was 127, the second smallest winter catch since the creel census began in 1955. Of these fish, 26 percent were stocked. The catch rate was 0.06, the lowest recorded at the flowage during the winter.

In contrast, fishing success and harvest in terms of numbers for the 1964 open-water season were much better than they were during the 1963 open-water season (Table 1). The catch rate, 0.07 fish per hour, was considerably higher than any recorded previously for an open-water season, as was the catch of 739 northern pike. Stocked fish comprised 61.8 percent of the catch. However, in terms of weight, fishing harvest was somewhat smaller than that of the previous open-water season. The total catch decreased 14 percent by weight. The catch of resident northern pike decreased 49 percent in numbers and 56 percent by weight.

TABLE I

Angling Statistics on Northern Pike from Murphy Flowage, 1955-1966

Year	No. Man Hours	Season*				Year					
		Fishing Pressure (Hrs./A.)	No. Northern Pike**			Catch Rate (Fish/Hr.)	Fishing Pressure (Hrs./A.)	No. Northern Pike			Catch Rate (Fish/Hr)
			N	S	T			N	S	T	
1955	10,201 1,101	56.7 6.1			268 94	0.02 0.09	62.8			362	0.032
1956	17,889 1,068	99.4 5.9			615 193	0.03 0.18	105.3			808	0.043
1957	16,532 2,475	91.8 13.8			351 297	0.02 0.12	105.6			648	0.034
1958	19,288 4,325	107.2 24.0			408 366	0.02 0.09	131.2			774	0.033
1959	17,984 2,069	99.9 11.5			326 179	0.02 0.09	111.4			505	0.025
1960	10,354 2,858	57.5 15.9			262 189	0.03 0.07	73.4			451	0.034
1961	10,038 1,951	55.8 10.8			487 238	0.05 0.12	66.6			725	0.060
1962	11,973 1,671	66.5 9.3			601 164	0.05 0.09	75.8			765	0.056
1963	11,298 2,047	62.8 11.4	94	33	551 127	0.05 0.06	74.1	645	33	678	0.051
1964	10,236 646	56.9 3.6	282 24	457 12	739 36	0.07 0.06	60.5	306	469	775	0.071
1965	8,126 434	45.1 2.4	195 20	33 2	228 22	0.03 0.05	47.6	217	33	250	0.029
1966	7,098 196	39.4 1.1	131 16	13 3	144 19	0.02 0.09	40.5	147	16	163	0.022

* Open-water statistics are given first and are followed by the statistics on ice fishing for each year.

** N = native fish, S = stocked fish, T = total fish.

After the 1964 open-water season, catch rates, fishing pressure and seasonal catches declined with the exception of catch rate during the 1966-67 ice fishing season. In the angling year 1966, fishing pressure and seasonal catches had reached record lows. The catch rate for the 1966 open-water season was one of the lowest ever recorded.

The return to the angler of stocked northern pike was low. Of the 8,534 fish stocked only 553 or 6.5 percent were caught. Stocked fish represented 42.1 percent of the total catch of 1,315 northern pike from the ice fishing season of 1963-64 through the angling year of 1966. However, 82.6 percent of the stocked fish were caught in the open-water season of 1964. In the other seasons stocked fish made up only 16.7 percent of the total catch.

The poor success of the stocking program was due in large part to the migration of stocked fish over the dam and losses from natural mortality caused by parasites. These factors caused marked declines in the population of resident and stocked northern pike (Table 2). Periodic surveys below the dam indicated continual downstream migration, especially in the spring. Additional losses of northern pike both resident and stocked occurred in June, 1964 and in May and June, 1965 when extensive kills of northern pike took place. Both kills were attributed to the parasite, Myxobolus sp. It appeared that the losses of northern pike by migration and parastic infection were brought about at least in part by the marked increase in the standing crop as a result of the stocking in 1963.

TABLE 2

Population Estimates of
Resident and Stocked Northern Pike in Murphy Flowage*

	May 15, 1962	May 15, 1963	May 15, 1964	Oct. 15, 1964	May 15, 1965	May 15, 1966
Native	2,050	1,376	2,644	1,045	1,601	1,117
Stocked	Dec. 1963 8,534 fish stocked		7,519**	1,693	758	91***

* Population estimates for resident northern pike are for fish over 13.9 inches and are based on estimates for 2-inch size groups. Population estimates for stocked fish are based on 2 to 3-inch size groups. Data were obtained from netting, shocking and angler returns.

** Population estimate based on combined data is 7,467 fish.

*** Population estimate based on combined data is 141 fish.

Nebish Lake

Nebish Lake, Vilas County, covers about 94 acres and has a maximum depth of 45 feet. The bottom of the lake drops off rapidly from shore leaving only a small littoral area for the growth of rooted aquatic plants. The lake is of low fertility with a conductivity of 34 mmhos and a total alkalinity of 17 ppm.

Nebish Lake is one of the 5 lakes included in the Northern Highland Research Project where a complete creel census and a compulsory permit system have existed since 1946. Since that time, except for isolated instances, the lakes have been open to any legal method of fishing with no restrictions on size, bag, season or species. Spear fishing was allowed on Nebish Lake for all species from 1964-66. The lake was renovated with rotenone on October 3, 1966.

Fish present before renovation included yellow perch, smallmouth bass, rock bass, northern pike, walleye, largemouth bass, bluegill, pumpkinseed, green sunfish, and bullhead. The three most abundant fish species in the total catch from 1964-66 in order of decreasing abundance were yellow perch, smallmouth bass and rock bass.

Northern pike were probably first introduced into Nebish Lake in 1939. This stocking of 100,000 fry (1063.8/acre) established a northern pike population. The number of fish caught from the stocking however, is not known. Since 1939 two additional stockings of northern pike have been made. The lake was stocked with 525 fingerlings (5.6/acre) in January, 1962 and 502 fingerlings (5.3/acre) in January, 1963 ranging in length from 10.0 to 16.0 inches and 6.8 to 17.2 inches, respectively.

The return to the angler of northern pike stocked in January 1962 and 1963 was low, but the stocked fish made up a significant segment of the total catch. Of the 1,027 northern pike stocked, 25 fish or 2.4 percent were caught by anglers from 1962-66 (Table 3). The stocked fish made up 24 percent of the total catch of northern pike over this period. Eight northern pike were speared over the three-year period, 1964-66, when spearfishing was allowed. None of these speared fish were from the 1962 and 1963 stockings.

The northern pike fingerlings exhibited good survival their first 4 months in the lake based on net catches but suffered considerable mortality during the following year. Of the 1962 and 1963 stockings, 12 and 24 percent respectively, were captured in fyke nets the first spring following stocking. During the second and succeeding springs, few stocked northern pike were captured in the nets (Table 3). Mortality of stocked northern pike during their first year or so in the lake was due almost entirely to natural causes for the catch by anglers was insignificant. When the lake was renovated in 1966, only one stocked northern pike out of a total of 108 northern pike was found.

TABLE 3

Fyke Net Catch, Return by Angling, and Growth of Stocked Fingerling Northern Pike in Nebish Lake, 1962-66

Date	1962 Stocking					1963 Stocking				
	Age	Fyke Nets	Angling	Total Lgth.(in.)		Age	Fyke Nets	Angling	Total Lgth.(in.)	
				Range	Avg.				Range	Avg.
At Stocking				10.0-16.0						
Spring, 1962	I	61								
Open-water, 1962			5	10.0-18.2	15.4					
At Stocking									6.8-17.2	12.7
Spring, 1963	II	3				I	119			
Open-water, 1963			3	19.2-21.7	20.6			1	17.9	
Spring, 1964	III	7		17.7-21.2	20.2	II	10		15.4-21.5	18.9
Open-water, 1964			3	21.9-25.4	23.6			4	19.0-23.7	21.1
Spring, 1965	IV	5		18.4-22.8	21.4	III	6		16.2-24.0	20.1
Open-water, 1965			3	20.5-24.2	22.5			5	19.5-23.9	21.8
Spring, 1966	V	2		20.7-26.6	23.7	IV	9		17.5-25.8	21.1
Open-water, 1966			1	21.8				0		

Nebish Lake does not appear to have the potential to support a good northern pike fishery. Based on recent population estimates (Table 4) and creel census data from 1946, northern pike of sizes desirable by fishermen have not been abundant in the lake. From 1946-66 the annual catch rate and harvest of northern pike averaged 0.01 fish per hour and 20 fish, respectively. Fishing pressure (for all species combined) averaged 20.1 hours per acre. Growth of northern pike has also been slow (Table 3). Low fertility and lack of spawning areas are probably two important reasons why northern pike have not been very successful in the lake.

TABLE 4

Population Estimates of Northern Pike in Nebish Lake

Date	Categories of Northern Pike	Size of Northern Pike (Inches)	Population Size
Spring, 1963	Resident + 1962 Stocking	17+	122
Spring, 1964	Resident + 1962 & 1963 Stockings	17+	153
Spring, 1965	Resident + 1962 & 1963 Stockings	17+	110
	1962 & 1963 Stockings	17+	32
Spring, 1966	Resident + 1962 & 1963 Stockings	17+	141
Fall, 1966	Resident + 1962 & 1963 Stockings	All size groups	621

Lake Poygan and Big Lake Butte des Morts

The waters involved in a study of northern pike in these lakes by Priegel (1968) are located in Winnebago, Calumet, Outagamie, Waushara and Fond du Lac Counties and include Lake Winnebago and Big Lake Butte des Morts on the Fox River and Lakes Poygan and Winneconne on the Wolf River (Fig. 1).

All four lakes are shallow, eutrophic lakes. Lake Winnebago covers 137,708 acres and has a maximum depth of 21 feet. The smaller upriver lakes (Poygan, Winneconne and Butte des Morts) have areas of 14,102, 4,507 and 8,857 acres, respectively and are actually widenings of the Wolf and Fox Rivers. The maximum depth of these upriver lakes does not exceed 11 feet.

The purpose of Priegel's investigation was to determine the movement and harvest of northern pike stocked into waters containing an excellent northern pike population. The fish were obtained from Rush Lake during winter rescue operations and were stocked through the ice into Lake Poygan and Big Lake Butte des Morts (Table 5). The northern pike were tagged in the lower jaw with a monel tag and recaptures of tagged fish were reported voluntarily by anglers. There was no size limit or seasons to curtail the harvest.

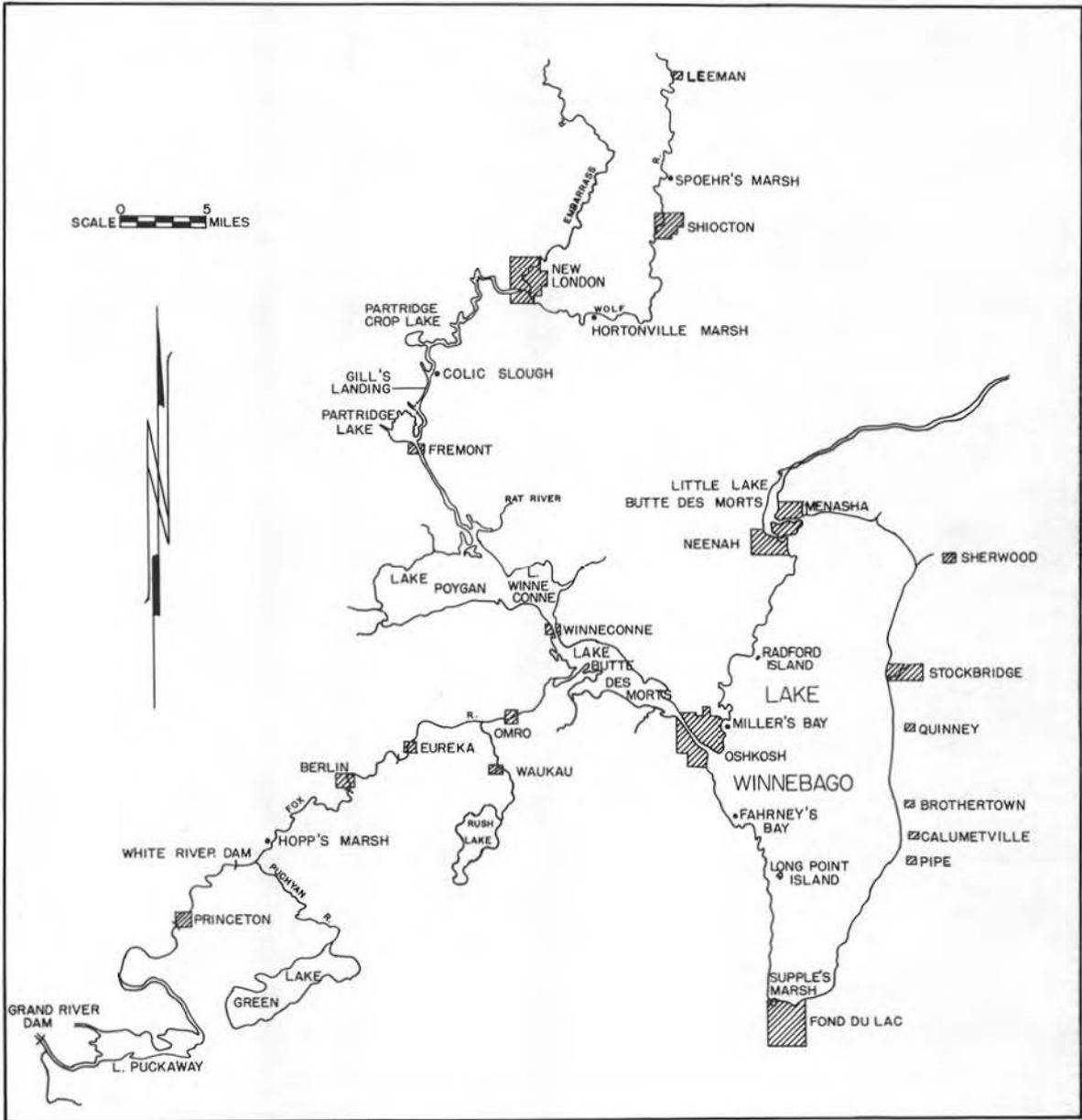


Figure 1. Map of Lake Poygan and Big Lake Butte des Morts and the surrounding area.

TABLE 5

Stocking of Northern Pike in Lake Poygan and Big Lake Butte des Morts,
Return to Anglers, and Location of Harvest

	Lake Poygan	Big Lake Butte des Morts
Stocking date	January 21, 1965	February 8, 1966
Number stocked	965	1,689
Number per acre	0.1	0.2
Total length (Inches)		
Range	11.2 - 26.2	8.1 - 23.6
Average	17.7	13.9
Harvest: 1965	38	-
(No. tags		
returned) 1966	45	48
1967	<u>1</u>	<u>24</u>
Total	84	72
	8.7 %	4.3%
Location of harvest		
L. Poygan	52.4%	4.1%
L. Winneconne	29.8%	16.6%
Big L. Butte des Morts	3.5%	34.7%
L. Winnebago (or below Neenah- Menasha dams)	4.7%	44.7%
	*	

* Also 5 fish in Wolf River above Lake Poygan; and 1 in the Fox River.

The return of stocked fish from both stockings was low (Table 5). Over a period of 3 years, anglers returned 84 tags from the Lake Poygan release for a minimum harvest of 8.7 percent. Anglers returned 72 tags from the Big Lake Butte des Morts release over a two year period for a minimum harvest of 4.3 percent.

There were significant differences in the location of harvest of the stocked fish. Most of the returns from the Lake Poygan stocking came from Lake Poygan and adjacent Lake Winneconne (Table 5). Returns from the Big Lake Butte des Morts stocking indicated considerable downstream migration of stocked fish into Lake Winnebago.

It appeared that the low return of stocked fish may have been due to the high density of the resident northern pike populations, fishing pressure and to migration. Both lakes have excellent northern pike populations and competition between the resident and stocked fish may have adversely affected the stocked fish. Both lakes are not believed to be heavily fished for northern pike and exploitation rates were probably low. Many stocked northern pike from Big Lake Butte des Morts also moved downstream into areas that were known to be lightly fished for northern pike. The difference in percentage return between the two lakes suggests that stocking larger fish increased the return.

Pleasant Lake

Pleasant Lake, Walworth County, covers 138 acres and has a maximum depth of 29 feet. The lake is fertile with a total alkalinity of 152 ppm and a conductivity of 336 mmhos. Pleasant Lake contains a northern pike population; however, reproduction has been poor in the lake and northern pike are not abundant.

The lake has been stocked frequently with northern pike in the past. No information was available on stockings conducted from 1958 to January, 1960. The stockings from August, 1960 through September, 1964 (Table 6) were investigated.

TABLE 6

Stocking of Northern Pike in Pleasant Lake

Stocking Date	No. Stocked (No./Acre)	Total Length (Inches)	
		Range	Average
Aug. 25, 1960	140 (1.0)	Fingerlings	
June 8, 1962	555 (4.0)	3.5 - 6.5	4.7
Sept. 5, 1963	493 (3.6)	5.1 - 10.2	7.3
Sept. 3, 1964	507 (3.7)	4.3 - 14.7	6.4

TABLE 7

Percentage of Stocked Northern Pike Caught in Pleasant Lake in
Relation to Resident Northern Pike

Date of Capture	No. Resident Fish	Percentage of Stocked Northern Pike*				
		1960 Stocking	1962 Stocking	1963 Stocking	1964 Stocking	Combined Stockings
Fall, 1962	19	5.0(1)	47.2(17)			48.6
Spring, 1963	6	14.3(1)	25.0(2)			33.3
Fall, 1963	10	0	50.0(10)	70.0(23)		76.7
Spring, 1964	8	11.1(1)	46.7(7)	52.9(9)		68.0
Fall, 1964	2		71.4(5)	88.2(15)	87.5(14)	94.4
Spring, 1965	10		16.7(2)	60.0(15)	0	63.0
Fall, 1965	2		0	83.3(10)	84.6(11)	91.3
Spring, 1966	4		20.0(1)	63.6(7)	85.2(23)	88.6
Fall, 1966	0		0	0	0	0

* The number of stocked fish captured is given in parentheses.

TABLE 8

Growth of Stocked Northern Pike in Pleasant Lake
(All Stocking Combined)

Age	Season	Sex	Total Length (Inches)	
			Range	Average
I	Spring	Unknown	10.1 - 13.9	11.5
I	Fall	Unknown	15.9 - 23.6	18.9
II	Spring	Male	12.1 - 23.2	18.9
		Female	14.7 - 25.2	20.7
		Combined	12.1 - 25.2	19.7
II	Fall	Unknown	21.5 - 30.2	26.0
III	Spring	Male	21.8 - 23.2	22.7
		Female	22.0 - 30.3	29.1
		Combined	21.8 - 34.0	27.2

The fish stocked from 1962 through 1964 evidently suffered substantial initial mortality. Population estimates in mid-October averaged only 10 percent of the number stocked the preceding summer. No population estimates of the 1960 stocking were made.

Although survival was poor, stocked fish comprised a large percentage of the northern pike population based on netting and shocking surveys (Table 7). A check of angler catches during the winter of 1964-65 indicated the same trend. A total of 34 angler-caught northern pike was noted, 21 of which were stocked fish. However, in spite of the contribution of the stocked fish to the population and the frequent stockings, northern pike were not very plentiful in the lake.

The growth of the stocked fish was very good (Table 8). Northern pike males and females averaged 18.9 and 20.7 inches at Age II and 22.7 and 29.1 inches at Age III, respectively.

Observations on the dispersal of the stocked fish indicated rapid movement of the fish. Stockings were generally made at one release site. Stocked fish were found in the shallows of all parts of the lake within one week after stocking.

Silver Lake

Silver Lake, Kenosha County, covers 499 acres and has a maximum depth of 43 feet. The lake is fertile with a total alkalinity of 175 ppm. Silver Lake contains a northern pike population, but natural reproduction of northern pike generally has been poor and they are not abundant. The lake has been stocked frequently with northern pike since 1960 (Table 9).

TABLE 9

Stocking of Northern Pike in Silver Lake

Stocking Date	No. Stocked (No./Acre)	Total Length (Inches)	
		Range	Average
Oct. 4-13, 1960	5,234 (10.5)	6 - 18	9
June 7, 1962	453 (0.9)	5 - 9	7
Jan. 22, 1963	440 (0.9)	10 - 17	14
April 13, 1965	848 (1.7)	18 - 25	
Feb. 2, 1966	1,164 (2.3)	12 - 14	13
Jan. 16, 1967	90 (0.2)		25.1*

* Average size of six fish captured during spring netting in 1967.

TABLE 10

Percentage of Stocked Northern Pike Caught in Silver Lake in Relation to Resident Northern Pike

Date of Capture	No. Resident Fish	Percentage of Stocked Northern Pike *				
		1960 Stocking	1962, 1963 and 1965 Stockings**	1966 Stocking	1967 Stocking	Combined Stockings
Spring, 1961	66	12.0 (9)				12.0
Spring, 1962	7	66.7 (14)				66.7
Winter, 1962	48	29.4 (20)	0			29.4
Spring, 1963	10	37.5 (6)	33.3 (5)			52.4
Winter, 1964	13	18.8 (3)	27.8 (5)			38.1
Spring, 1965	4	20.0 (1)	92.6 (50)			92.7
Spring, 1966	6	0	60.0 (9)	75.0 (18)		81.8
Spring, 1967	2	33.3 (1)	60.0 (3)	91.7 (22)	75.0 (6)	94.1

* The number of stocked fish captured is given in parentheses.

** Fish from these stockings could not be separated with any degree of certainty.

TABLE 11

Growth of Stocked Northern Pike in Silver Lake

Age	Season	1960 Stocking			1966 Stocking		
		No. Fish	Total Lgth.(in.) Range	Avg.	No. Fish	Total Lgth.(in.) Range	Avg.
	At Stocking	5,234	6 - 18	9	1,164	12 - 14	13
I	Spring				18	12.0-13.9	12.8
II	Spring	12	16.5-26.1	20.7	22	15.0-22.5	18.8
II	Winter	20	21.0-27.5	24.2			
III	Spring	6	17.2-31.8	22.7			
IV	Winter	3	28.5-32.0	29.9			
V	Spring	1		38.0			
VII	Spring	1		32.0			

No estimates of total return to the angler or survival of the stocked fish were obtained by spring netting data and some observations of anglers catch during the winter indicated that stocking provided most of the northern pike in Silver Lake (Table 10). However, in spite of the contribution of the stocked fish to the population and the frequent stockings, northern pike were not very plentiful in the lake. The growth of stocked fish is given in Table 11.

The stocked fish dispersed rapidly after stocking. Within 17 hours after the April, 1965 stocking, 25 stocked fish were taken in a fyke net one-half mile from the release site. There was also some evidence of migration of stocked fish. Seventy-three northern pike from the stocking in February, 1966 were found below the outlet of the lake in May, 1966.

Golden Lake

Golden Lake, Waukesha County, is a fertile body of water which covers 258 acres and has a maximum depth of 46 feet. An extensive marsh composed mainly of rushes is present on its northwest end. Because of the position and dimensions of the marsh, the lake is difficult to net effectively during the spring. Golden Lake contains a northern pike population and has been stocked several times with northern pike from 1964 to 1966 (Table 12).

TABLE 12

Stocking of Northern Pike in Golden Lake

Stocking Date	No. Stocked (No./Acre)	Total Length (Inches)	
		Range	Average
Sept. 10, 1964	174 (0.7)	5.9 - 10.6	9.0
Sept. 15, 1965	150 (0.6)	6.1 - 12.0	8.7
Sept. 16, 1966	371 (1.4)	5.9 - 13.9	8.4

Netting and shocking surveys indicated that generally the percentage of stocked fish in the catch was low (Table 13). However, sample sizes were usually quite small. No estimate of return to the angler or survival were obtained, but it appeared that survival of at least the 1965 stocking was very low. The growth of stocked fish is given in Table 14.

TABLE 13

Percentage of Stocked Northern Pike Caught in Golden Lake in
Relation to Resident Northern Pike

Date of Capture	No. Resident Fish	Percentage of Stocked Northern Pike*			
		1964 Stocking	1965 Stocking	1966 Stocking	Combined Stockings
Fall, 1964	13	23.5(4)			23.5
Spring, 1965	36	10.0(4)			10.0
Fall, 1965	1	0	0		0
Spring, 1966	1	75.0(3)	0		75.0
Fall, 1966	0	0	0	0	0
Spring, 1967	25	3.8(1)	0	0	3.8
Fall, 1967	2	0	0	33.3(1)	33.3

* The number of stocked fish captured is given in parentheses.

TABLE 14

Growth of Stocked Northern Pike in Golden Lake

Age	Season	No. Fish	1964 Stocking	
			Range	Average
	At Stocking	174		
0	Fall	4	5.9 - 10.6	9.0
I	Spring	4	9.6 - 10.6	10.2
II	Spring	4	11.4 - 12.4	11.9
III	Spring	3	19.5 - 20.1	19.9
	Spring	1		20.9

Potters Lake

Potters Lake, Walworth County, has an area of 157 acres and a maximum depth of 26 feet. The lake is fertile with a total alkalinity of 148 ppm and a conductivity of 318 mmhos. The lake contains a population of northern pike.

Potters Lake was stocked with 250 male and 250 female northern pike (total of 3.2/acre) in April, 1965. The males averaged 16.2 inches in total length (length range, 14.0 - 18.6 inches) and the females averaged 18.5 inches (length range, 16.0 - 20.0 inches).

From August 14-23, 1965, a fish kill specific to northern pike occurred. A total of 894 northern pike or nearly 6 fish per acre were removed from the lake. One fish in 20 was a stocked fish. Dying fish that were examined had gills that were damaged. Gill filaments were eroded and fungus and algae covered much of the gill surface. The kill was not a complete one. During the 1966 spring netting, 178 resident and 25 stocked northern pike were captured. The ratio of stocked to resident northern pike was 1:8 during spring netting indicating that the resident fish suffered a greater mortality than the stocked fish during the August, 1965 fish kill.

It was not possible to determine if disease or environmental conditions in the lake were directly responsible for the kill. However, environmental conditions in the lake were probably involved. The abrupt beginning of the kill tended to support this hypothesis. The onset of the kill coincided with 3 hot sunny days when air temperatures exceeded 90° F. Water temperatures of 90° F at the surface and 75° at 12 feet were noted. Dissolved oxygen was almost zero below 12 feet. The lake was also very turbid due to algae and zooplankton blooms, high dissolved solids and the natural muddy character of the water.

Based on the ratios of stocked to resident fish obtained in August, 1965 and the following spring, population estimates of 64.5 and 25.5 fish per acre at the time of stocking were calculated. Both estimates were biased because of differential mortality but they indicated that Potters Lake was carrying a high population of northern pike. Nine stocked males and 16 stocked females captured during spring netting averaged 18.6 and 22.5 inches in total length for average increases of 2.4 and 4.0 inches, respectively, over average lengths at stocking.

It was not known if the high density of resident northern pike and the subsequent stocking of additional fish were factors influencing mortality in Potters Lake. However, the possibility exists that the high density of northern pike could have influenced the condition of the fish making them more susceptible to disease and adverse environmental conditions. If disease was a factor, it could have been passed to some of the stocked fish.

There was some evidence from nearby lakes that suggested that density of northern pike may influence mortality. Fish kills specific to northern pike have occurred in recent years in other Walworth County lakes similar to that observed in Potters Lake. In some of these lakes information on the size of the northern pike population was available and it indicated that northern pike were very abundant. These kills all occurred during the warmest part of the summer and dead fish from one of the lakes showed symptoms similar to the fish from Potters Lake.

Fish Lake

Fish Lake, Waushara County, has an area of 289 acres and a maximum depth of 5 feet. The lake has a history of winterkills. Natural reproduction of northern pike has been excellent.

A partial winterkill occurred in the lake in early spring of 1965. Some fish of the following species were known to have survived the kill: northern pike, yellow perch, pumpkinseed, rock bass and bullhead. After the kill the lake was stocked in 1965 with fry, fingerlings and adult northern pike, adult bluegills and fingerling largemouth bass. The stockings of northern pike included a plant of 500 fish (1.7/acre) in the spring of 1965 and another plant of 400 fish (1.4/acre) in the spring of 1967. These fish were obtained from Rush Lake, Winnebago County during winter rescue operations. The fish ranged in total length from 12 to 26 inches.

On May 23, 1967 a seine survey was conducted on the lake. About 9 acres of the lake was seined including some of the deepest water in the lake.

It appeared that the northern pike sampled during the survey were from natural reproduction. A total of 49 northern pike were collected ranging in total length from 10.0 to 26.9 inches. Only one fish was over 20.4 inches. None of the stocked fish obtained from Rush Lake were captured. The fish that were captured appeared to be mainly from the 1966 year class indicating that the fry and fingerling stockings in 1965 were probably not very successful.

No definite explanation could be given for the absence of northern pike obtained from Rush Lake. As far as the 1965 stocking is concerned, mortality and exploitation by fishermen could have reduced the number of northern pike from this stocking considerably over the period of two years preceding the survey; however, no data is available.

Lawrence Lake

Lawrence Lake, Marquette County, covers 231 acres and has a maximum depth of 12 feet. The lake is fertile with a total alkalinity of 145 ppm and a conductivity of 267 mmhos. The lake contains a population of northern pike, but natural reproduction has not been good.

Lawrence Lake was stocked with a combination of fingerlings and yearlings in March, 1965 and 1966. Five hundred fish (2.2/acre) were stocked each year. The fish averaged 15 inches in total length and ranged from 12 to 22 inches for each stocking.

The lake was netted during late March and early April 1966 and a significant proportion of the catch was stocked fish (Table 15). Fish from the 1965 stocking averaged 19.3 inches in total length for an increase in average length of 4.3 inches since stocking.

TABLE 15

Percentage of Stocked Northern Pike Caught in Lawrence Lake in Relation to Resident Northern Pike

Date of Capture	No. Resident Fish	Percentage of Stocked Northern Pike		
		1965 Stocking	1966 Stocking	Combined Stockings
Spring, 1966	70	25.5	14.6	34.0

Stocked fish were released at one point and appeared to disperse rapidly. One fish stocked in 1966 was captured about one-half mile from the release site 3 weeks after stocking. No stocked fish were captured in a net located near the point of release.

Cox Hollow Lake

Cox Hollow Lake is a fertile, 96-acre impoundment located in Governor Dodge State Park, Iowa County. The lake was stocked with 16 pair of adult largemouth bass and 22 pair of adult northern pike in 1958. The lake was first opened to fishing on June 1, 1960. All fishermen were required to obtain a permit and to show their catch at a checking station.

The population of northern pike and largemouth bass available to the angler on opening day was estimated at 3,600 northern pike and 2,030 largemouth bass.

The catch on opening day was spectacular. A total of 844 northern pike and 61 largemouth bass were taken. For the month of June more than 2,230 fish were caught by over 5,000 anglers. Over 40 percent of these fish were caught on opening day.

Growth was above average. Two year old northern pike averaged 26 inches in total length and yearlings averaged 17.5 inches. Two year old largemouth bass averaged 13.0 inches in total length and yearlings averaged 6.0 inches.

Lake Puckaway

Lake Puckaway, in Green Lake and Marquette Counties, is a fertile body of water with an area of 5,433 acres and a maximum depth of 5 feet. The lake contains a northern pike population.

Lake Puckaway was stocked with 500 tagged yearlings and older fish (0.1/acre) in April, 1965. The fish averaged 17 inches in total length and ranged from 13.2 to 25.2 inches.

Very few of the stocked fish were captured based on voluntary tag returns. Anglers reported the capture of 3 stocked fish in the summer of 1965 and 2 stocked fish in the summer of 1966. One stocked fish was captured during a shocking survey in the summer of 1966.

Most of the stocked fish caught by anglers were captured in the general area of the release site. The farthest distance from the point of release that a stocked fish was captured was about 1.5 miles.

Minnesota

Grace Lake (Wesloh and Olson, 1962; Scidmore, 1964):

Grace Lake, in Beltrami and Hubbard Counties, covers 885 acres and has a maximum depth of 45 feet. It is moderately fertile with a total alkalinity of 150 ppm. Prior to stocking of northern pike in December, 1958, the lake had a better than average walleye population, a dense yellow perch population and small populations of northern pike, pumpkinseed, crappies, rock bass, white suckers and brown bullheads.

Grace Lake lacks northern pike spawning habitat and no northern pike representing the 1957 through 1961 year classes were present in the anglers' catch. Because of little or no recruitment from natural reproduction, the catch of northern pike dropped from 1,033 fish in 1957 to 405 fish in 1958. The resident northern pike population was estimated to be about 950 fish at the beginning of the 1959 open-water season.

In December, 1958, Grace Lake was stocked with 5,133 yearling northern pike (5.8/acre) ranging in total length from 12 to 17 inches. The stocked fish were marked and the lake was creel censused the following two summers and winters.

Stocked fish represented a major portion of the catch (Table 16). In the following two seasons after stocking, 1959-60 and 1960-61, stocked fish made up 81 and 82 percent of the total annual harvest in numbers, respectively.

The return of stocked fish was large. By the end of two fishing seasons it was estimated that 2,265 marked northern pike were taken for a return of 44.1 percent of the number stocked. The stocking resulted in a substantial increase in fishing success (Table 16). Fishing pressure also increased somewhat following stocking.

TABLE 16

Harvest of Resident and Stocked Northern Pike in Grace Lake

	1957-58	1958-59	1959-60	1960-61	1959-61
Total harvested	1,033	405	1,419	1,359	2,778
No. stocked fish harvested			1,149	1,116	2,265
Percent of total harvest stocked fish:					
By number			81	82.1	81.5
By weight			63.9	73.5	68.9
Catch rate (fish/hr)		0.02	0.07	0.11	
Fishing pressure (hrs/acre)		21.8	23.4	27.0	

The stocked fish grew rapidly from an average of 14.8 inches and 0.8 pounds at the time of stocking to 24.8 inches and 3.8 pounds during the winter season of 1960-61.

The abundant yellow perch population was thought to have been heavily utilized by the northern pike and as a result, responsible for the good growth of the stocked fish. Gill net sampling of yellow perch showed a decline in the yellow perch population and suggested that predation by the 1958 stocking of northern pike and subsequent stockings were responsible for it.

The northern pike from the 1958 stocking apparently adjusted very well to their new surroundings. The low density of resident northern pike in the lake at the time of stocking was thought to be a factor responsible for the successful integration of the stocked fish.

Fish Lake (Scidmore, 1964):

Fish Lake is a fertile body of water 78 acres in size, with a maximum depth of 58 feet.

The lake was heavily stocked in late April and early May, 1961 with 1,377 yearling pike (17.7/acre) ranging in total length from 14 to 24 inches. At the time of stocking, the lake had a large population of slow-growing bluegills and pumpkinseeds, a fair population of largemouth bass and crappies and a small northern pike population composed mainly of yearling fish.

During the first summer and fall after stocking, an estimated 1,136 northern pike weighing 1,329 pounds were taken in 7,138 man-hours of fishing. On an acre basis this was equivalent to 14.6 fish weighing 17.0 pounds harvested under a fishing pressure of 91.5 hours. The catch rate was 0.16 fish per hour.

The return of stocked fish was quite large. Of the 1,136 fish caught, 882 were estimated to be stocked fish, giving a return of 64.1 percent in numbers and 76.5 percent in weight of the original stocking. During the first 15 days of fishing, 70.3 percent of the stocked fish were returned and by the end of the first month and one-half of fishing, 91 percent of the stocked fish were taken.

There was a marked difference in the growth of the stocked and resident fish. The resident fish grew rapidly during the summer and fall. The stocked fish grew very slowly. The average increment of growth of resident and stocked fish by August, calculated from the last annulus, was 5.0 and 1.8 inches, respectively. The average length of the resident and stocked fish at the last annulus was 13 and 17 inches, respectively. The high density of northern pike did not seem to depress the growth rate of the resident fish for it was comparable to that in similar lakes. The slow growth of the stocked fish suggests that they were unable to adapt to their new surroundings apparently because the resident fish occupied most of the suitable habitat. As a result they found it difficult to obtain food and became quite vulnerable to fishing.

Poor weather and ice conditions limited winter angling and spearing. Thus no data were gathered during this period. Netting during the following spring spawning season resulted in a catch of 2 marked and 16 resident fish. From the opening of the season until June 1962, spot checks of the anglers indicated that no stocked fish and only a few resident fish were caught. Evidently most of the stocked fish had disappeared.

It was not possible to evaluate the effect of the stocked fish on the pumpkinseed population because of their rapid decline and their inability to find food. The few stomachs from resident and stocked fish that were examined did not contain appreciable numbers of pumpkinseed.

Iowa

Clear Lake (Ridenhour, 1957)

Clear Lake is a shallow, eutrophic lake located in north central Iowa. It covers about 3,600 acres and has a maximum depth of 20 feet. Ventura Marsh, approximately 600 acres in size, lies adjacent to the lake and is an important spawning area for northern pike.

In October 1953, 15,192 fingerlings (4.2/acre) ranging in size from about 10.5 to 16.0 inches in total length were harvested from Ventura Marsh and stocked in the lake at eight locations. Of these fish 2,630 or 17 percent were individually marked in the upper jaw with a monel tag.

During the fishing season of 1954, a considerable number of the tagged fish were caught and the total harvest of northern pike was greater than in any previous year. Based on the voluntary return of tags, anglers caught 30.8 percent of the tagged fish. Total harvest of northern pike was estimated to be 7,372 fish based on the above tag returns and on other tagging studies that were being conducted. Almost two-thirds of these fish were probably from the stocking in October, 1953.

Movement studies based on tag returns indicated that movement of stocked fish was general and extensive. Stocked fish moved to all areas of Clear Lake within 6 months even if stocked at one end. There were only slight differences in the distribution of stocked fish (Carlander and Ridenhour, 1955).

Although many of the stocked fish of the 1953 year class were harvested, they generally were in poor condition. Fish of the same year class remaining in the marsh were in better condition as were fish of other year classes in the lake. In fact the mean condition factor of all fish captured in the lake except the stocked fish was almost identical to that of all the fish captured in the marsh.

Heavy natural mortalities were observed in Clear Lake on two occasions and they appeared to be mainly associated with stocked fish from the 1953 year class. The first mortality occurred in the summer of 1954. The largest number of dead northern pike was found along the shore in August. Most of the dead fish seemed to be from the 1953 year class as judged by their size. Another mortality occurred in May, 1955 and lasted for about 4 weeks. Again most of the dead fish were judged to be from the 1953 year class. It appeared that the stocked fish were unable to adjust to their new surroundings, perhaps because of competition from the resident northern pike.

STOCKINGS OF NORTHERN PIKE FRY

Wisconsin

The first three lakes mentioned under this category are part of the Northern Highland Research Project located in Vilas County northeastern Wisconsin. Information about methods used on the research project are reported earlier under Nebish Lake.

Spruce and Mystery Lakes

Spruce and Mystery Lakes are small bog lakes each covering 16.5 acres with maximum depths of 13 and 4 feet, respectively. Spruce Lake is of very low fertility. A conductivity of 22 mmhos and a total alkalinity of 3 ppm have been recorded in this lake. Mystery Lake is somewhat more fertile. A conductivity of 76 mmhos and a total alkalinity of 21 ppm have been recorded here.

The first introduction of northern pike into both lakes probably occurred in the 1930's. Since then a number of additional stockings have been made (Table 17).

TABLE 17

Stocking of Northern Pike in Spruce and Mystery Lakes

Stocking Date	Total Length (Inches)	Spruce Lake	Mystery Lake	Stocking Rate (No/Acre)
1949	-	7,000 fry	7,000 fry	424.2
1950	-	3,000 fry	3,000 fry	181.8
Mar. 1961	14.7-29.7	16 adults	16 adults	1.0
June 1961	0.75-1.25	7,500 fingerlings	7,500 fingerlings	454.5

Regulations in effect following the fry stockings in 1949 and 1950 were not the same on both lakes and this influenced the evaluation of these stockings. Spruce Lake was closed to fishing for 3 years after the 1950 stocking. When the lake was opened to fishing, catch rates generally were higher than before the lake was closed, even though fishing pressure was considerably greater (Table 18). However, it was not possible to determine if the higher catch rates in the face of increased fishing pressure were a result of the fry stockings or the closed season of 3 years. Mystery Lake had no closed season. Data on fishing pressure and catch rates in this lake several years after stocking suggest that the stockings improved fishing slightly for northern pike (Table 18). The return to the angler was probably much less than 1 percent.

TABLE 18

Angling Statistics on Northern Pike from
Spruce and Mystery Lakes, 1946-67

Year	Spruce Lake				Mystery Lake			
	No. Man Hours	Fishing Pressure (Hr/Acre)	No. Northern Pike	Catch Rate (Fish/Hr)	No. Man Hours	Fishing Pressure (Hr/Acre)	No. Northern Pike	Catch Rate (Fish/Hr)
1946	180	10.9	23	0.13	339	20.5	96	0.28
1947	54	3.3	1	0.02	231	14.0	49	0.21
1948	51	3.1	1	0.02	149	9.0	35	0.24
1949	111	6.7	1	0.01	52	3.2	1	0.02
1950	31	1.9	1	0.03	34	2.1	5	0.15
1951	Closed to Fishing				216	13.1	56	0.26
1952	Closed to Fishing				68	4.1	8	0.12
1953	Closed to Fishing				38	2.3	12	0.32
1954	614	37.2	28	0.05	232	14.1	87	0.38
1955	137	8.3	4	0.03	403	24.4	74	0.18
1956	283	17.2	13	0.05	117	7.1	7	0.06
1957	407	24.7	13	0.03	53	3.2	1	0.02
1958	232	14.1	4	0.02	No Fishing			
1959	165	10.0	6	0.04	8	0.5	1	0.13
1960	Chemical Treatment				Chemical Treatment			
1961	9	0.5	1	0.11	No Fishing			
1962	72	4.4	5	0.07	8	0.5	0	0
1963	45	2.7	8	0.18	18	1.1	2	0.11
1964	133	8.1	9	0.07	2	0.1	0	0
1965	360	21.8	5	0.01	No Fishing			
1966	412	25.0	0	0	No Fishing			
1967	331	20.1	0	0	No Fishing			

The northern pike stockings in 1961 were part of a reclamation project which also included stocking of largemouth bass. The project was initiated in July, 1960 when both lakes were treated with rotenone to eradicate the fish populations. Prior to treatment, the fish populations consisted of largemouth bass, northern pike, pumpkinseed, black bullhead, mudminnows and large numbers of small, slow-growing yellow perch. Eradication was not complete. Sampling in 1961 indicated that black bullheads and mudminnows survived in Spruce Lake and yellow perch and pumpkinseed in Mystery Lake.

The stocking of northern pike in Mystery Lake in 1961 was a failure because of frequent winterkills the following years. Only 2 northern pike were caught in a 3-year period following stocking. Both of these fish were stocked as adults. In the past Mystery Lake produced fair numbers of northern pike, however, it was deeper than it is now and was not as subject to winterkills. The reduction in water level occurred when a beaver dam in the drainage system of which Mystery Lake is a part, was removed and a lower head dam was constructed.

From the standpoint of return to the angler, the stocking of northern pike in Spruce Lake in 1961 was not very successful. Anglers caught 28 northern pike over a 7-year period, some of which may have been from natural reproduction. Four fish, however, were from the stocking of 16 adults.

The small return to the angler was partially due to low fishing pressure for several years following stocking (Table 18). Catch rates were markedly higher than in previous years. However, it is possible that if fishing pressure would have been about the same as before stocking, catch rates would have shown little or no improvement, resulting in no real benefits from the stocking.

Spruce Lake does not appear to be well suited for northern pike. A comparison of angling statistics on northern pike from Spruce and Mystery Lakes indicates that Spruce Lake has rarely provided the quality of fishing that has been recorded for Mystery Lake. Northern pike reproduction has been poor and growth slow (Table 19) in Spruce Lake. Probably one important reason for the contrast between the two lakes is that Mystery Lake is more fertile than Spruce Lake.

TABLE 19

Growth of Northern Pike in Spruce Lake

Year	Age Group	Sample Size	Average Total Length (Inches)
1962	I	4	14.5
1963	II	7	18.2
1964	III	9	20.3

Escanaba Lake

Escanaba Lake covers 288 acres and has a maximum depth of 25 feet. It is of rather low fertility with a conductivity of 50 mmhos and a total alkalinity of 25 ppm.

In 1939 and 1940, the lake was stocked with 90,000 (312.5/acre) and 50,000 (173.6/acre) northern pike fry, respectively. The return from these stockings was not estimated but it is known that the fry did not establish a sustaining population. Only 11 northern pike were caught from 1946 to 1956. The first natural reproduction of any significance was noted in 1956. Adult northern pike were probably migrating from Mystery Lake and were responsible for this year class.

Fox Lake

Fox Lake, Dodge County, covers about 2,600 acres and has a maximum depth of 19 feet. The lake is fertile, with a total alkalinity of 185 ppm and a conductivity of 382 mmhos.

Until the winter of 1958-59 when the first recorded winterkill occurred, the lake had a reliable supply of oxygenated water throughout the winter and was one of the better fishing lakes in Wisconsin. Fish present in the lake prior to the kill included northern pike, walleye, largemouth bass, white bass, yellow perch, bluegill, black crappie, pumpkinseed, brown bullhead, carp, white sucker, bowfin, and longnose gar. The kill in the winter of 1958-59 eliminated most of the bluegills, walleyes, largemouth bass and longnose gar. After the kill the bullhead and carp populations expanded at a rapid rate.

In 1959 and for several years thereafter the lake was heavily stocked with northern pike, walleyes, largemouth bass and bluegills in an attempt to replace the fish lost during the winterkill. Some of the fish survived and supplied some fishing. However, because of the large bullhead and carp populations and the high level of fertility, the lake deteriorated. Desirable fish populations declined, turbidity increased greatly and huge algae blooms occurred. Rooted and nonrooted aquatic plants almost disappeared.

During the winter of 1964-65, another winterkill occurred. Most of the desirable fish were eliminated with the remaining species being predominantly carp, bullheads and crappies. Northern pike and bluegills were stocked after the winterkill but did not establish good populations.

It became apparent that stocking by itself would not restore a desirable fish population. After consultations with Fox Lake residents, the decision was made to treat the lake with a fish toxicant to kill the entire fish population. The lake was drawn down about 3 feet and in July and August, 1966, the lake was chemically treated with toxaphene. After treatment the dead fish were removed. The total weight of fish in the lake was estimated at 625 pounds per acre. Of this figure 77 percent were carp, 17 percent bullheads, 5 percent crappies and 1 percent other fish species. There was no way to tell if the kill was complete but no live fish were seen between September, 1966 and the first date of stocking in 1967.

Fox Lake was first stocked with northern pike after chemical treatment in January, 1967. A total of 11,908 adult northern pike (4.6/acre) ranging in total length from 12 to 35 inches were stocked during the first year after chemical treatment. Most of these fish were released April 5 - 11. Fifteen million northern pike fry (5,769.2/acre) were also stocked in the spring. The other fish species stocked in 1967 were walleye pike, largemouth bass, bluegills, yellow perch, muskellunge and fathead minnows.

The adult northern pike appeared to have suffered considerable mortality soon after stocking. Many dead northern pike were observed all over the lake in April. This mortality was thought to be due to handling and the poor condition of the fish at the time of stocking. Most of the fish were held for a considerable period of time in hatchery ponds before release. Very few adult northern pike were caught by anglers. In a netting survey conducted in the spring of 1968, no northern pike from the stocking of adults were captured; however, northern pike from the fry stockings were abundant in the nets.

The northern pike fry that were stocked appeared to show good survival during their first summer. Shortly after stocking it was possible to return to stocking sites and observe fry. Many cottages owners in the summer reported that they saw fingerling northern pike off their piers. In late August, fishermen were catching fingerling northern pike and some fishermen felt that the fingerlings were actually a nuisance. Some northerns up to 16 inches were harvested through October. The average total length of northern pike stocked as fry that were captured during four surveys was as follows: 5.8 inches, July 6; 5.9 inches, August 3; 12.6 inches, October 16; and 10.9 inches, November 16, 1967.

Beginning in early October, 1967 reports were received of dead northern pike being sighted. These dead fish appeared to be primarily from the fry stockings. Dead fish continued to be sighted right up to ice formation and as late as December 1, a dead northern pike was observed on the bottom through the ice. Samples of the dead fish were analyzed at the University of Wisconsin but no explanation for the mortality could be determined from the analysis. One possible explanation could be that the population of northern pike was too abundant and some thinning had to occur. The mortality appeared to have no serious effect on the population for approximately 2,500 northern pike, all from the 1967 year class, were captured in nets set the following spring (1968).

Person's Lake

Person's Lake, Douglas County, covers 170 acres and has a maximum depth of 8 feet. The lake is of very low fertility with a total alkalinity of 3 ppm.

The lake winterkilled during the winter of 1964-65. A subsequent shocking survey indicated that the kill was probably complete. In May, 1965, the lake was stocked with 2 million fry (1,176.5/acre) to establish a population. The fry were all released at one site.

Based on a shocking survey in May, 1966, the stocking appeared to have established a good northern pike population. A total of 74 yearlings were captured in 1.5 hours of shocking. The yearlings averaged 11.9 inches in total length and were found around the entire shoreline. The absence of other fish because of the winterkill may have been a factor influencing the survival of the stocked fry.

PROPAGATION AND STOCKING COSTS IN WISCONSIN

The annual yield of northern pike fry and fingerlings from hatcheries and rearing ponds in Wisconsin varies considerably (Tables 20 & 21). The number of spawners available and the success of hatching and rearing operations are two important factors influencing yield. A large proportion of the hatchery fry are stocked into public waters. The rest are transferred to rearing ponds or federal hatcheries. In 1965, a total of 11,660,700 fry were hatched. Over 9,600,000 were stocked in public waters.

The costs of stocking fry and fingerlings also show great variation (Tables 20 & 21). This variation is largely a result of changes in the success of hatching and rearing operations and changes in distribution costs.

Cost and yield figures were obtained from the cost report of the Bureau of Fish Management for the calendar year 1965.

TABLE 20

Statistics on the Propagation and Distribution of Northern Pike Fry in Wisconsin, 1961-65

Statistics	1961	1962	1963	1964	1965
No. embryos hatched*	4,630,500	8,989,800	6,888,100	26,512,200	11,660,700
Total hatching costs	\$7,376.34	\$14,320.73	\$7,666.43	\$12,778.88	\$11,336.01
Cost per thousand embryos hatched*	\$ 1.593	\$ 1.593	\$ 1.113	\$ 0.482	\$ 0.972
No. fry transferred to rearing ponds**	2,776,300	4,425,800	2,322,300	2,322,300	\$ 1,193,800

* All figures except those of 1965, were calculated indirectly from other yield and cost data.

** Fry that were not transferred to rearing ponds were stocked in public waters, transferred to federal hatcheries and lost before distribution.

TABLE 21

Statistics on the Rearing and Distribution of Northern Pike Fingerlings
in Wisconsin, 1961-65*

Statistics	1961	1962	1963	1964	1965
No. fry stocked in rearing ponds	2,776,300	4,425,800	2,431,000	2,322,300	1,193,800
Cost of fry	\$ 4,422.33	\$ 7,049.89	\$ 2,704.54	\$ 1,118.29	\$ 1,160.37
No. fingerlings reared	39,651	1,341	2,588	30,745	82,817
Pounds of fingerlings reared	1,283	162	372	9,975	53,999
Avg. weight of fingerlings (lb.)	0.032	0.123	0.144	0.324	0.652
Total rearing costs	\$12,378.68	\$15,897.84	\$28,215.84	\$19,012.99	\$19,686.91
Rearing cost per fingerling	\$ 0.312	\$ 12.098	\$ 10.900	\$ 0.618	\$ 0.238
Rearing cost per pound	\$ 9.65	\$ 98.13	\$ 75.85	\$ 1.91	\$ 0.32
Total distribution costs	\$ 9,671.36	\$ 6,067.15	\$11,525.09	\$ 8,489.52	\$13,477.72
Distribution cost per fingerling	\$ 0.244	\$ 4.617	\$ 4.453	\$ 0.276	\$ 0.162
Distribution cost per pound	\$ 7.54	\$ 37.45	\$ 30.98	\$ 0.85	\$ 0.25
Total cost of fingerling stocking	\$22,050.04	\$21,964.99	\$39,740.93	\$27,502.51	\$33,164.63
Total cost per fingerling stocked	\$ 0.556	\$ 16.716	\$ 15.356	\$ 0.895	\$ 0.400
Total cost per pound stocked	\$ 17.19	\$ 135.59	\$ 106.83	\$ 2.76	\$ 0.61

* Cost and yield of northern pike from winter rescue operation are included in the statistics.

SUMMARY AND CONCLUSIONS

The stocking of large fingerlings and yearlings in waters containing northern pike can result in a considerable return of the stocked fish and short-term improvement of fishing success and harvest. Returns of 64.1 percent for the first fishing season following stocking and 44.1 percent for the first two fishing seasons were obtained in Fish and Grace Lakes, Minnesota, respectively. In Grace Lake, the catch rate increased from 0.02 fish per hour before stocking to 0.11 after stocking under an average fishing pressure of about 25 man hours per acre. Fishing pressure in Fish Lake was over three times as great as in Grace Lake and was probably one reason why the return of stocked fish was highest in Fish Lake. In northwestern Wisconsin, Murphy Flowage responded to a heavy stocking of large fingerlings with a record high harvest (in terms of numbers) and catch rate during the open-water season following stocking. Of the harvest 61.8 percent were stocked fish. However, in later seasons fishing success and harvest declined rapidly for reasons that will be mentioned later. Stocking of Clear Lake, Iowa, resulted in a return of 30.8 percent of the original stocking for the first fishing season following stocking. The total harvest of northern pike was greater than in any previous year. The northern pike stocked in the studies mentioned above ranged in total length from 10.4 to 24.0 inches. The range in average lengths was from about 12 to 17 inches.

Studies of fingerling stocking in fertile Wisconsin lakes where natural reproduction was poor indicated that stocked fish can represent a considerable percentage of the total population of northern pike. In Silver and Pleasant Lakes stocked fish generally made up more than half of the population of northern pike based on netting and shocking surveys. In Lawrence Lake stocked fish made up more than one third of the population.

However, in Silver and Pleasant Lakes at least, the rates and sizes of fingerlings stocked and the frequency of stockings did not produce good populations of northern pike. In Pleasant Lake, stocking rates generally were higher than in Silver Lake but the fingerlings were smaller. The survival of these fingerlings (ranging in average length from 4.7 to 7.3 inches) was very low, averaging about 10 percent 6 weeks after stocking. There were no estimates of survival available from the Silver Lake stockings so the effect of size on survival could not be studied. However, the results from both lakes suggest that heavier stocking rates are in order when stocking fingerlings of such sizes in this type of lake to obtain desired levels of fishing success and harvest. The data are limited though and more study is needed in this area.

Little information on the results of stocking fry into waters containing established northern pike populations was available. As a result it was not possible to evaluate this type of stocking.

Evidence obtained in several studies appears to indicate that waters have a certain capacity in terms of such characteristics as available food and space to support northern pike. These studies suggested that when this capacity is exceeded by stocking or otherwise, competition develops and is manifested through events that tend to restore a more suitable density of northern pike. In Murphy Flowage, after a very high density of large fingerlings was stocked, large numbers of the stocked fish moved out of the flowage. This movement continued during later years. Heavy natural mortalities of both stocked and native northern pike also occurred during the two fishing seasons following stocking. The migration and low return of stocked fish in the Lake Poygan and Big Lake Butte des Morts studies may have been due to some extent to the influence of the abundant resident population of northern pike. In Fox Lake after chemical treatment, a heavy stocking of fry coupled with high survival resulted in a high density of fingerlings the following fall. That fall and winter a mortality of the fingerlings occurred and it was thought that the mortality was related to the high density of the fingerlings. In Fish and Clear Lakes the condition of stocked northern pike declined, and in Clear Lake, two natural mortalities occurred that affected primarily the stocked fish. It appeared that these fish were unable to adjust to their new surroundings, apparently because the resident population occupied most of the available habitat. Similar events that appeared to be related to density occurred in George Lake (Groebner, 1964). The greatest natural mortality, 78 percent, occurred when the population was highest. Dead northern pike and many in poor condition were observed at that time. In contrast, yearlings stocked in Grace Lake adapted very well to their new surroundings as evidenced by their excellent rate of growth and good survival. The successful integration of the stocked fish was thought to be due to the very low density of the resident population and the resulting lack of competition between stocked and resident fish for food and suitable habitat.

Generally, northern pike appear to disperse rapidly soon after stocking. In Clear Lake 6 months after stocking, the movement of the stocked fish was found to be general and extensive. Other studies indicated the same trend. The movement in some of the studies may have been in response to competition between members of the population. Tagging studies of northern pike have shown that they naturally are active fish and that they move considerable distances.

It is well known that the fertility of a body of water directly influences its capacity to support fish populations. This would suggest that low stocking rates should be used when stocking lakes of low fertility when fishing pressure is not high. Nebish Lake, an infertile lake with a resident northern pike population, was moderately stocked with large fingerlings in the winter. The stocked fish showed good survival their first winter but during the following year suffered considerable natural mortality. The return from the stockings was low. The poor success of the stockings may have been related to stocking densities and the low capacity of the lake to support northern pike.

Stockings of brood fish or fry in new bodies of water or waters where the fish populations have been removed or drastically reduced generally are successful. In such waters northern pike show good initial survival, grow well, and increase in abundance. This was illustrated by the success of stockings in Fox Lake, Cox Hollow and Person's Lake.

Although general in nature, some recommendations regarding stocking procedures can be made. To obtain maximum return, fish of sizes as large as practical should be stocked, stockings should be made in areas where fishing pressure is moderate to high, and opportunities for stocked fish to escape should be limited. The stocking rate should be based on the density of the native northern pike population and the capacity of the body of water to support the species. In some cases it may be desirable to stock a high density of fish to achieve a substantial short-term increase in fishing success and harvest, but the possibility of a decline in the condition of the stocked fish and an increase in natural mortality must be accepted. Little information was available on when to stock fish, but fish stocked in the winter through the ice showed good initial survival.

Much more study is needed to thoroughly evaluate northern pike stocking for our knowledge is incomplete in every facet of stocking. As one approach to improve our knowledge, future stockings should be planned in such a way that an evaluation of numerous releases is possible. Stockings to be evaluated should be limited to lakes of a size that can readily be worked. A systematic schedule of various stocking rates of northern pike from fry through yearlings should be set up for lakes of similar types and having similar densities of resident northern pike. Estimates of survival, growth, representation in the population and, if possible, harvest or exploitation of the stocked fish should be made on a systematic basis.

To complete an evaluation of stocking, a rather precise breakdown of stocking costs is necessary. Stocking costs should be determined for various sizes of fingerlings obtained from rearing ponds, for fish obtained from salvage operations and for stock obtained from other sources.

Release of northern pike in controlled spawning and rearing areas is an adjunct of the stocking program not reviewed in this report because of the scarcity of data concerning effectiveness of such a program. However, experience in Minnesota and Michigan suggests that this management procedure offers considerable promise, and research is now in progress in Wisconsin.

If further study proves that it is satisfactory, it would then appear that this type of stocking would offer a basic long-term solution to the problem of low northern pike populations that would be more desirable than a direct stocking program.

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APPENDIX A

Scientific Names of Fish Cited in the Text

Northern pike	<u>Esox lucius</u>
Muskellunge	<u>Esox masquinongy</u>
Largemouth bass	<u>Micropterus salmoides</u>
Smallmouth bass	<u>Micropterus dolomieu</u>
Bluegill	<u>Lepomis macrochirus</u>
Yellow perch	<u>Perca flavescens</u>
Pumpkinseed	<u>Lepomis gibbosus</u>
Black crappie	<u>Pomoxis nigromaculatus</u>
Rock bass	<u>Ambloplites rupestris</u>
Brown bullhead	<u>Ictalurus nebulosus</u>
Black bullhead	<u>Ictalurus melas</u>
Walleye	<u>Stizostedion vitreum</u>
Green sunfish	<u>Lepomis cyanellus</u>
White suckers	<u>Catostomus commersoni</u>
Mudminnow	<u>Umbra limi</u>
White bass	<u>Roccus chrysops</u>
Carp	<u>Cyprinus carpio</u>
Bowfin	<u>Amia calva</u>
Longnose gar	<u>Lepisosteus osseus</u>
Fathead minnow	<u>Pimephales promelas</u>

