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MANAGEMENT OF SPAWNING MARSHES FOR NORTHERN PIKE [1]

By John E. Williams and Buddy L. Jacob

Abstract

The northern pike is a favored game fish. Also it appears to serve as an important predator in keeping yellow perch populations under control, but it has little effect on bluegill populations. Pike populations are at low levels in most lakes because of heavy angling pressure and because of the loss of spawning marshes. Management of spawning marshes increases and stabilizes recruitment.

Marsh management gives better returns than natural spawning marshes by: (1) maintaining high water levels, (2) controlling stocking rate, (3) eliminating fish predators and competitors, and (4) getting better growth and survival through fertilization. However, production of fingerling pike, after 1-3 months in the marsh, is highly variable; for 12 marshes in Michigan it ranged from 1 to 13,000, but averaged 2,941 two-inch fingerlings per acre per year. Nevertheless, intensive marsh management on 25 lakes increased the populations of adult pike in the lakes from 1.1 to 5.3 per acre. Loss of pike spawners in marshes appears to be high; hence stocking pike fry in artificial marshes is being evaluated. Hatching pike fry in troughs appears to be another promising approach.

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[1] Contribution from Dingell-Johnson Project, F-29-R, Michigan.

This report is part of a symposium on management of northern pike, held at the Midwest Fish and Wildlife Conference, St. Paul, Minnesota, December 10, 1969. Other papers given at the same symposium, but not reproduced here, were: (1) Sex determination and sex ratio of northern pike, by John M. Casselman (Ontario). (2) Spawning marsh area requirements, by Duane Shodeen (Minnesota). (3) An evaluation of the effect and extent of habitat loss on northern pike populations and means of prevention of losses, by C. W. Threinen (Wisconsin).

Introduction to symposium

(Held at St. Paul, Minn., Dec. 10, 1969)

By John E. Williams

I'd like to welcome you to the 31st annual meeting of the Society for the Preservation and Encouragement of Aquatic Raptors (S. P. E. A. R.)!

As you can guess from the title of this Symposium, many of us in the Midwest are interested in increasing the number of our chief raptor, the northern pike, and consequently are concerned with what can be done to improve its recruitment.

Twenty years ago, our good friend Raymond E. Johnson declared that one would not expect to find an overabundance of stunted yellow perch in those (Minnesota) lakes where the combined catch of walleyes and pike in gill nets exceeded 40% by weight of the total catch of fish. In other words, a lake with 40% of its fish in the form of fish-eating predators would not develop stunted populations of the smaller species--to go one step further. We would have difficulty today in southern Michigan finding a lake that would satisfy this criterion.

The average warmwater lake in southern Michigan today has 50 to 100 pounds of panfish for each pound of northern pike; and we know it takes only 3 1/2 pounds of food to feed one pound of pike for a year. So, we apparently have 15 to 30 times as many panfish as

the pike can eat; or, to put it another way, we need 7 to 15 times as many pike as we have now, to eat one-half of the available panfish.

At Otsego Lake, Michigan, the pike population was declining fast prior to 1954. Only a few large, old pike were left, and a study of their last remaining spawning area revealed that, although spawning was carried out, hardly any fingerlings survived. This apparently was caused by swarms of yellow perch in the marsh which followed the spawning pike and ate their eggs. As many as 46 pike eggs were found in one perch stomach. Thus, one of the reasons why it is difficult to increase the numbers of predators such as pike and muskies is something that may be unique in the world of predation. These fish do not protect their young, in contrast to all higher animal predators. You never see mice eating baby foxes! If you did, I guess we'd all be knee-deep in mice! And our game farms would be furiously raising fox fingerlings and stocking them! But you surely do see perch eating baby pike; and bluegills, golden shiners, small bass, green sunfish and many other fish will do the same thing. After all, a newly hatched pike fry is about the size of a small mosquito larva.

A second factor contributing to low pike populations has been their dependence for spawning on flooded marshes in the spring. Because of varying lake levels, in many years the marshes do not flood at all, or, if they do and the pike spawn in them, the water level may drop too quickly before the eggs hatch or before the fry are ready to feed.

A third reason for the decline of northern pike has been their exceptionally high vulnerability to angling. No other warmwater game fish can be caught so easily even under low population densities. We've all read the figures: 62 to 64% of the adult pike caught at Cox Hollow in Wisconsin in the first year it was opened to fishing--40% of the population in the first month; Escanaba Lake--50 to 64% per year; Murphy Flowage--32 to 54% per year; Grove Lake, Minnesota--32 to 49% per year. When you then add 30-40% natural mortality, it is easy to understand why few pike survive past 3 years of age.

At three small Michigan lakes which had been closed to angling for 3 years, fantastic catches of pike were made in a short time after the lakes were re-opened to fishing. In one 5-acre lake having a population of 68 adult pike, 11 hours of fishing caught 22 (or 31%) of them. In other words, only 2 hours of angling per acre in one day caught 31% of the pike present. Some of our lakes are subjected to 500 hours of fishing per acre per year. Can it be understood then why the average southern Michigan lake has only one pike per acre?

So, to encourage "Sir Lucius," we in our individual states have tried the following: (1) greater restrictions on the catch, (2) protection of marshes from filling or dredging, (3) elimination of winter spearing, (4) winter rescue and transfer operations, (5) raising pike in hatcheries and stocking them, and (6) artificial management of pike spawning marshes.

In management of a marsh the usual procedure is to build a low-head dam between the lake and the marsh, and then transfer adult

pike over the dam. The dam provides high water on the spawning grounds every year, and maintains the water level for a desired period of time. Plankton pulses develop in the flooded marsh, and the pike fry can grow to 3 inches or more before going to the lake. The dam also prevents the movement into the marsh of other fish which might eat the pike eggs and fry.

Although in Michigan we were able to increase the pike population of a lake considerably by marsh management, it was difficult to keep the pike population high enough to control bluegills. In fact, the only places we were able to do this was at two lakes closed to pike fishing. Obviously the bluegill is not a preferred food of the pike. We found that when pike had only bluegills to eat, their growth rate was very slow--only to about 16 to 18 inches in 3 years.

Eventually we may find that pike can best be managed in lakes where they have just their preferred food such as perch or even rainbow trout. (In this case we would need to look for some other biological control for stunted bluegills.) Maybe the answer is to reestablish a broad spectrum of fish and game predators such as were probably present in Michigan lakes before the white man arrived. Or perhaps it may require very restrictive fishing regulations on the predator fish combined with intensive marsh management.

As many people have decided when studying predation, it seems that the deeper you get into the subject, the more puzzling

it becomes. Things such as availability, vulnerability, preference, and buffering, always crop up to confuse the issue.

The inter-relationships between warmwater predator and prey species are very complicated. It's easy to confuse the fact of predation with the effect of predation, as the late Paul Errington warned. It reminds one of the way Dr. Edward Condon described his study of flying saucers. He felt it was like "searching for an extra-terrestrial needle in a terrestrial haystack, without knowing what an extra-terrestrial needle looked like!" At least we know where the haystack is--it's been spread over a pond bottom for a pike-spawning substrate!

But let's get on to some of the practical problems!

Natural Marshes vs Managed Marshes

by

J. E. Williams and B. L. Jacob

Nearly all of the northern pike in Michigan are the result of spawning in natural marshes. From a general inventory we estimate that there are excessive populations of northern pike in 23 lakes, adequate populations in perhaps 1,000 lakes, and inadequate populations in the remaining 6,000 or so lakes in the state. We are pleased that there still is considerable pike reproduction in natural marshes, but we are not satisfied with the extent of it.

The shortcomings of natural marshes are familiar to most fishery personnel. The production from year to year is erratic; good production is associated with high water which occurs about 1 year out of 5. Natural marshes typically produce small fingerlings that have poor survival. Other fishes gain access, to prey on pike eggs and fry and compete with the fingerlings for food. The small size of pike presents a special problem in those waters with stunted panfish populations where the pike are most needed as predators. Finally, natural marshes are diminishing in number and size under the pressure of the relentless encroachment of cottage development.

In the artificial management of marshes, many of the shortcomings disappear. One obtains a regular and dependable production

of fingerlings, in desired numbers and sizes. A managed marsh is typically a flood plain with a dike and water level control structure at its outlet end. The control structure ordinarily serves as a barrier to the upstream movement of panfish and minnows. Ideally, the area to be inundated has a good stand of grass or fragile non-woody annual plants, is capable of being completely drained, and has a watershed just large enough to keep the marsh filled, with a minimum of overflow. Such an area provides ideal spawning substrate, in the event that broodstock are introduced. The grass infusion nourishes an abundance of food for the young pike, there is good protection from predation by other fish, and there is minimum competition by panfish and minnows.

Managed marshes have one major disadvantage, namely high cost. Land is expensive in highly developed areas where marshes are needed most. Generally the cost of development and operation is high.

We have 30 active managed spawning marshes in Michigan (as of 1969), ranging in size from 1 to 390 acres. These occur primarily on the larger lakes which are most in need of additional pike. Management of some marshes is intensive, including fertilization with sheep manure. In others, management consists solely of introduction of broodstock, and drawdown at the appropriate time. As you would expect, production varies widely, ranging from as low as one fingerling per acre to 13,000 per acre. Production from 12 marshes,

carefully evaluated for several years, averaged 2,941 two-inch fingerlings per acre per year.

To what extent has our pike-marsh management benefitted the angler? One indication of extent of benefit is seen in the following. A total of 25 lakes, with low pike populations, were seined prior to any management activity; they were found to contain an average of 1.1 adult northern pike per acre. After various management activities, which included management of pike marshes, these lakes were seined annually for several years and we found an average of 5.3 adult pike per acre. Sorting out the influence of the various management activities (separate management categories in Table 1), we find that in lakes with intensive bluegill reduction, a 400% increase in the pike population can be attributed to the marsh operation. In those lakes with slight (40%) bluegill reduction, and in those with no bluegill reduction, the increases in the pike population which could be attributed to marsh operation were 208 and 107%, respectively.

Another indication of the extent of benefit from marsh operation comes from the number of adult pike trapped as they enter the marsh each spring, once the marsh-management project is started. At Townline Lake, Montcalm County, in the first 2 years the marsh was operated, an average of 42 pike per year were trapped at the marsh. After several years of marsh management, 474 were trapped annually, for an eleven-fold increase. At Otsego Lake, Otsego County, an average of 28 adult pike per year were trapped

before management; this increased to 320 per year after marsh management, again an eleven-fold increase.

In 1966, we made a startling discovery at our largest pike marsh which is located at Houghton Lake. Prior to this we had assumed that the brood fish which are transferred to a marsh in the spring simply return to the lake after spawning. But in 1966, we installed a two-way trap in the outlet channel from the marsh to count broodstock returning to the lake. We discovered that only about 15% returned to the lake from the marsh; furthermore, after drawdown we did not find them in the marsh, and we still cannot account for their disappearance. In 1967, there was some improvement in return of broodfish at the Houghton Lake marsh, but the majority of them again disappeared.

We now realize that the loss of adult pike in spawning marshes may be a common occurrence, so a new approach is being tested. Adult pike are stripped, the eggs hatched in a hatchery, and the swim-up fry are planted in the managed pike marsh. Advantages from this approach, in addition to preventing broodstock loss, are: (1) control of the number of fry in the marsh, (2) producing fingerlings of uniform size, which reduces cannibalism, (3) elimination of predation from broodstock, and (4) a reduction in cost of catching and transporting broodstock. Results from 2 years of trial with fry plants are inconclusive, but nevertheless encouraging. Excluding one poor marsh, the average production per acre from five trials was 1, 173 fingerlings between 3 and 4 inches in length. The cost of these fingerlings was

$83 per thousand, excluding the capital investment in the marsh itself. Unfortunately, we do not have good comparative data on the cost of pike fingerlings from marshes that were stocked with adult pike. However, inasmuch as the fry costs were $1.50 per thousand and stocking rates averaged 20 thousand per acre, we suspect that fry planting would compare favorably.

Again (though without precise supporting data) we are convinced that the 1,173 three-inch fingerlings per acre were worth more to the angler than were the 2,941 two-inch fingerlings (cited earlier) produced in marshes stocked with brood fish. The additional one inch of length would give a big advantage for survival.

We have reviewed much of the literature on rearing of northern pike, to profit by experience in other states and areas. This review is summarized in Tables 2, 3 and 4; the related references are grouped in the appendix under various management categories.

Table 2 is a summary of literature data on survival from eggs, and on production of fingerlings by various rearing practices, including records from unmanaged marshes. The figures are averages, so in most instances the results from individual studies cannot be recognized in this table. Intensive culture (practiced by Pennsylvania) was by far the most efficient method of production; when production is related to surface area of troughs, it amounted to nearly 2 million large fingerlings per acre, and there was the excellent survival of 93% from the egg stage. The next most productive method was stocking hatchery ponds with fry. North Dakota's Federal Fish Hatchery reported

an average production of 35,000 small fingerlings per acre, from 100,000 fry stocked. In hatchery ponds, stocking fry has usually done better than stocking either eyed eggs, or starting with broodstock. This is apparently also true of managed marshes, where fry stocking (Long Lake, Barry County) averaged 7% survival to 3-inch size, compared with most other marshes where broodstock were used and survival averaged 1.6% from egg to 2-inch fingerling. Natural marshes have shown tremendous range in production. Many of the higher figures in Table 2 were from studies on Swedish lakes; American studies have generally shown low natural production. It must be remembered that figures given are usually for high-water years, whereas production is often nil in low-water years. Not only is survival low in natural marshes (0.26%, average), but because of early emigration the average size of fingerlings produced is only about 1 inch.

For Table 3 we have calculated, for each management method, the hypothetical survival to fry and fingerling stages, and finally to II-year-old fish which are of legal size for angling. Natural hatch in marshes averaged 64%, against 75% for hatchery eggs under the best conditions. Survival from fry to fingerling size varied from less than 1% to 92% (from Table 2). To estimate survival from fingerling to II-year-olds, we used data given for muskies by Buss at the "musky workshop" held at Higgins Lake, Michigan, in September, 1967. These survival figures for muskellunge (which are the best available for pike) were from muskies in Union City Reservoir, Pennsylvania;

they are: 2.4% at 2 inches, 3.6 at 5 inches, 9.6 at 6 inches, 13.2 at 7 inches, and 69.9% at 9 inches. What survival figures are available for pike from Michigan are from Daggett and Emerald lakes, where survival amounted to 0.8, 2.7, and 35.6% in three tests of stocking 3.3-inch fingerlings. Additional information, on the survival to Age II from fingerlings of various sizes, is badly needed for cost-benefit analyses. Duane Shodeen (personal communication) reports 20% survival in managed marshes in Minnesota for pike stocked at 1.5-2.5 inches. If Shodeen's figures were applied to Michigan marshes, there would be a much greater survival of II-year-olds from managed pike marshes than is shown in Table 3. Even using the original information from Buss, it can be seen that a managed pike marsh contributes many times more pike fingerlings to a lake than does a natural marsh; the differential is 12 times as many when the marsh is stocked with broodfish, to 100 times as many when the marsh is stocked with fry.

Table 4 carries the above calculations one step further and shows the estimated cost per pike creeled, from 1 million fingerlings produced by various artificial methods. The cost per fish varies considerably and is quite directly related to size of program. For instance, Minnesota obtains over 1 million 12-inch fingerlings by winter rescue each year, at a cost of only 10 cents each. Also in Minnesota they do well in the management of marshes stocked with adult spawners; the cost for 2-inch fingerlings is 1.3 cents each. Michigan's cost on raising fingerlings, prorated over a 25-year life of the marsh and dam, ranged from 4.0 cents each for a 5-acre

marsh to 1.6 cents each for a 50-acre marsh; in both cases the marshes were stocked with fry.

Minnesota biologists estimate that it costs 25 cents each to raise 7-inch fingerlings in outlying ponds, which is the same cost computed by Wisconsin for their large production of musky fingerlings.

Although it costs more per fish to raise the large fingerlings in troughs, the much higher rate of survival of these to catchable pike keeps the cost of this program per pike creeled about equal to the cost of pike from outlying ponds, managed marshes, or hatchery ponds.

In conclusion, the natural marshes in Michigan produce many northern pike, and they deserve protection. They produce most of Michigan's northern pike at essentially no cost. On the other hand, these natural marshes are inadequate on many waters, they should be supplemented by large-scale management of artificial marshes and artificial planting from hatchery stock.

Table 1. --Population density of adult northern pike in lakes before and after management of spawning marshes and under different degrees of bluegill control. Figures are pike per acre, determined by seining.

Management plan	Number of lakes	Pike per acre (average)		Increase due to marsh mgt.	
		Before mgt.	After mgt.	Pike per acre	Percentage
90% bluegill control only	5	-	3.0		
90% bluegill control plus marsh mgt.	5	1.3	8.2	5.2 *	400*
40% bluegill control only	7	-	1.7		
40% bluegill control plus marsh mgt.	2	2.5	6.9	5.2	208
Marsh management only	2	3.2	6.6	3.4	107
Total lakes, before and after marsh management	25	1.1	5.3	4.2	382
Average (weighted)	9	-	-	-	292

* The rationale here is that these lakes normally would "produce" 1.3 pike per seine-acre; 1.7 was added by bluegill control, giving the value 3.0; and an additional 5.2 was the result of marsh management, raising the final figure to 8.2. The addition of 5.2 to 1.3 is an increase of 400%.

Table 2. --Pike fingerling production, average length, and survival from various practices compared with natural marshes

Methods	Number of tests	Days: rearing period	Fingerling pike: Per acre (thousands) Ave.	Per acre (thousands) Range	Fingerling pike: Ave. length, inches	Per cent survival Ave.	Per cent survival Range
Intensive							
Hatchery troughs Fry stocked	1	30-180	1,891*	-	5.6	93	-
Extensive							
Hatchery ponds Fry stocked	6	81	9.4	0.1-90	4.4	26	0.2-76
Marshes, managed Fry stocked	2	50	2.9	2.8-3.0	2.8	7	7.0-7.5
Marshes, managed Adult brood stock							
Short term	18	49	2.4	.003-29	1.8	1.6	0.03-6.6
Long term	1	210	0.05	-	13.2	0.8	-
Hatchery ponds Eggs stocked							
Short term	2	34	2.5	.002-6	1.8	8	0.04-16
Long term	1	200	0.06	-	11.0	0.04	-
Hatchery ponds Adult brood stock	8	60	1.7	0.08-3.4	2.7	1.5	0.1-3.4
Natural marshes At emigration	5	20	35	0.5-125	1.0	0.3	0-0.6
Survival to first fall	1	200	-	-	13.0	0.002	-

* Number of hatched fry per acre of trough surface; from Pennsylvania hatchery production for one year.

Table 3.--Hypothetical survival of northern pike from egg to fry, to fingerling, to II-year-old, for rearing in hatchery trough, hatchery ponds, managed marsh, or natural marsh, stocked with fry or brood stock

Method	Per cent survival			Survival per 1,000 eggs [1]			Fry survival: ratio to natural marsh
				To fingerlings		To II-yr olds	
	Egg to fry	Fry to fgl	Fgl to II-yr	Length (inches)	Number		
Hatchery trough, fry	75	92.6	2	2	324	7	16,610
			70	9	370	259	
					694	266	
Hatchery ponds, fry	75	26	4	4.4	195	7.8	488
Managed marsh, fry	75	7.25	3	2.8	54	1.6	102
Hatchery ponds, brood stock	64	1.5	3	2.7	9.5	0.3	18
Managed marsh, brood stock	64	1.55	2	1.8	9.9	0.2	12
Natural marsh[2]	64	0.26	1	1.0	1.7	0.016	1

[1] For survival from egg to fry per 1,000 eggs, use percentage figures in the first column.

[2] Under most favorable conditions. Production in natural marsh may be nil most years.

Table 4.--Anglers' catch of pike in the creel per 1,000,000 fingerlings, cost per fingerling, and cost of pike in the creel from different methods of pike management. Based on angler exploitation estimated at 50% of available II-year-old fish

Method	Fingerlings planted		Survival per cent, fgl to II-yr-old	Angler catch (thousands)	Cost per pike in creel
	Length, inches	Cost per fingerling			
Managed marsh	3	$0.02	3	15	$1.33
Hatchery ponds	4	0.03	4	20	1.50
Outlying ponds	7	0.25	40	200	1.25
Intensive trough	9	0.50	60	300	1.67
Winter rescue	12	0.10	70	350	0.29

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of northern pike

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