1
8
7
5

Survival, Growth, and Vulnerability to Angling of Walleyes Stocked as Fingerlings in a Small Lake with Yellow Perch and Minnows

James C. Schneider

Fisheries Research Report No. 1875

December 27, 1979

MICHIGAN DEPARTMENT OF NATURAL RESOURCES
FISHERIES DIVISION

Fisheries Research Report No. 1875

December 27, 1979

SURVIVAL, GROWTH, AND VULNERABILITY TO ANGLING OF WALLEYES STOCKED AS FINGERLINGS IN A SMALL LAKE WITH YELLOW PERCH AND MINNOWS[1]

By James C. Schneider

Abstract

An experimental fish community comprised of fathead minnows, yellow perch, and walleyes was established in Jewett Lake. Fingerling walleyes about 150 mm long were stocked at the rate of 62 per hectare each fall for three consecutive years once the other species were established. Abundance, survival, growth, and food habits were monitored up through the fourth year.

The fish community developed about as predicted from earlier studies. A large population of minnows was replaced by large, balanced populations of yellow perch and walleye. By the fourth year, survival of the three walleye plantings ranged from 0.071 to 0.708, depending at planting time on length of planted fingerling, abundance of food of the appropriate size, and density of older walleyes in the lake. Walleye mortality was highest during the first year in the lake (especially in the first month), and low in subsequent years.

Test anglers found the walleyes and yellow perch fairly easy to catch. This type of fish community has good potential for fisheries management.

---

[1] Contribution from Dingell-Johnson Project F-35-R-5, Michigan.

Introduction

Past attempts to create walleye fisheries by stocking hatchery-reared fingerlings into fish communities have given unpredictable results (Laarman 1978; Schneider 1969). In the early 1970's, a series of research studies was begun in Michigan to develop guidelines for walleye stocking which would improve the rate of success. Key questions were how walleye survival and growth related to food size and type, and could satisfactory walleye populations and fisheries be created in large lakes and in small, intensively managed lakes. Field experiments were set up in ponds (Schneider 1975), a large lake (a study by P. W. Laarman which is nearly completed), and in three small lakes (Beyerle 1976, 1977; and this report).

The experiment which is the subject of this report is the third, and last, of the small-lake experiments relating walleye growth and survival to different types of prey fishes. In the first experiment, the only prey fish present was the bluegill (*Lepomis macrochirus*); in the second, the golden shiner (*Notemigonus crysoleucas*) and the fathead minnow (*Pimephales promelas*); and in the third, the yellow perch (*Perca flavescens*), the fathead minnow, and the bluntnose minnow (*Pimephales notatus*). In each of these experiments large fingerling walleyes (average lengths of 98 to 179 mm) were stocked for three consecutive years and a final evaluation of success was made in the fourth year.

The site of this experiment was Jewett Lake, in the Rifle River Recreation Area, Ogemaw County, Michigan. The lake appears to be ill-suited for walleyes, nevertheless, the stocked fingerlings thrived there. Area is only 5.2 ha and maximum depth about 5 m. Nearly all the substrate is composed of soft silt and peat. Dissolved oxygen approaches--but never reaches--critically low levels in winter. The light brown water has a methyl orange alkalinity of 34 ppm.

Jewett Lake has been used for fish population studies since 1945. In recent years, the dynamics of yellow perch in simple fish communities of one or two species were examined (Schneider 1972). It was predicted that a highly piscivorous species, such as walleye, should be added to these communities to regulate recruitment of yellow perch and stabilize the yellow perch population.

The objectives of this experiment were two-fold: (1) to determine the survival and growth of stocked walleyes in a habitat where yellow perch were the primary forage fish and, closely related, the feasibility of managing small lakes for walleye, and (2) to determine the effect of walleye on the dynamics of yellow perch.

Methods

The earlier studies at Jewett Lake had indicated that the fish community had to be carefully constructed to prevent the establishment of an excessively large, dominant, slow-growing year class of yellow perch the first year and weak year classes in subsequent years. The basic plan was to (1) eliminate all fish from the lake, (2) stock planktivorous minnows until they had established a large population, (3) stock yellow perch eggs until natural reproduction was established, and (4) stock fingerling walleyes each fall for 3 years after the first year class of perch had been established. The rationale was that the minnows would depress the abundance and growth of young perch until adult perch and walleyes were established, and that walleyes should not be stocked until there was a supply of small perch available for them to eat. For 150-mm walleye fingerlings, it was judged that young perch less than 65 mm long would be excellent prey (Schneider 1975).

The fish in Jewett Lake were eradicated with rotenone in May 1972. Adult fathead and bluntnose minnows were stocked shortly after and, as no natural reproduction had taken place by September, again in May 1973. About 3 million (30 liters) fertilized yellow perch eggs, collected from other lakes, were stocked in Jewett Lake each spring, 1974-76. None of the perch planted in 1974 survived in the presence of a very large population of fathead minnows. A year class of yellow perch was produced the next year and in all subsequent years. Fingerling walleyes, averaging 137 to 179 mm in length, were stocked each September, 1975 to 1977, at the rate of about

62 per hectare. Fins clipped at planting were as follows: 1975--right pelvic; 1976--none; and 1977--left pectoral. No natural reproduction of walleyes occurred during the study.

The fish populations were sampled in spring (May) and fall (September-October) with electrofishing gear and with two types of trap nets. The electrofishing gear consisted of a boat fitted with two booms, five electrodes, and a 3-phase, 220-volt a-c generator which supplied about 3 amps. The trap nets had a single pot, 1.5 m × 2.5 m × 0.8 m, of either 38-mm stretch mesh or 19-mm stretch mesh.

The mark-and-recapture procedure was used to estimate the size of the fish populations each fall, 1975-78, and in spring 1978. The estimates were stratified by 25-mm size groups for perch and by age groups (planting clips) for walleye, to eliminate bias caused by size selectivity of the fishing gear. With the aid of scale samples and length-frequency measurements, estimates of each species were made by both size and age.

In fall 1975, the fish were very small, so samples of perch and minnows were captured over a 2-day period and marked by dyeing with Bismark Brown Y (1 part water to 25,000 parts of 53% dye, for 1 hour). The estimates were computed by means of the Schumacher-Eschmeyer formula (Ricker 1975). In 1976-78, a different procedure was used. Samples of fish were captured, marked by clipping a caudal fin, and released. A week was allowed for the fish to resume normal behavior before the recapture samples were taken. The numbers of fish in the populations were estimated by means of the Chapman modification of the Petersen formula (Ricker 1975).

Despite intensive sampling, the estimates of the walleye population in spring 1978 were later found to be unreliable and have not been used. The 1976 year class of walleyes was estimated at 127; however, 161 different fish of that year class were actually handled in subsequent months. The cause of the error is not known.

Average lengths of walleyes and young perch were calculated directly from empirical measurements. Average lengths of older age groups of perch were obtained indirectly by weighting the empirical measurements with the population estimates, to compensate for size selectivity of the fishing gear.

Estimates of the standing crops of fish were calculated from estimates of numbers of fish, average lengths, and length-weight regressions.

Samples of fish were collected for analysis of food habits on four occasions and preserved in 10% formalin. Later, the food organisms found in the stomachs were counted and their lengths were measured, when possible.

Jewett Lake was closed to angling except on two occasions. In May 1978, research personnel caught samples for the population estimates. All these fish were released. On July 26 and 27, 1978, public fishing was allowed so that the fish populations could be reduced to levels commensurate with the lake's productivity. For computations of walleye and perch survival, it is assumed that the fish removed in July 1978 would have been alive that fall (2 months later).

Results and discussion

Food habits

The roles of walleye, yellow perch, and fathead minnow in the Jewett Lake fish community were reflected in the foods they ate. The feeding habits of these species in 1975-78 (Table 1) were consistent with earlier studies at Jewett Lake and elsewhere (Schneider 1972; Colby et al. 1979; Thorpe 1977; Scott and Crossman 1973). Fatheads ate mostly zooplankton and small benthic animals, plus some terrestrial insects and plants. In addition, one minnow out of a sample of 44 had eaten two newly hatched perch fry. The failure of the 1974 perch year class in Jewett Lake was apparently due to fathead predation and competition. Young yellow perch of similar size ate foods of the same basic types and sizes, except that terrestrial items and plant materials were rarely taken. As yellow perch grew they progressed to larger items, principally midge larva, insect nymphs, and small fish. Walleyes of fingerling size and larger selected fish and the largest benthic animals.

Population trends

The fish community developed about as expected. The fathead minnow population expanded to 26.3 kg per hectare (180,000 fish) by fall 1975 (Table 2). In the following 12 months, predation by walleye and yellow perch reduced them to 2.1 kg per hectare (3,500 fish) and, subsequently, they were reduced to an insignificant level. However, the minnows served the intended objective of tempering the survival and growth of young yellow perch until walleyes were established (Tables 3 and 4).

The yellow perch population expanded and stabilized quickly. By fall 1976 (two year classes present), it had achieved its highest biomass, 29.1 kg per hectare, and all sizes were well represented (Tables 2 and 5). Recruitment was fairly even and growth was good (Tables 3 and 4). Unfortunately, growth of young perch increased as the minnow population declined. As a result, many young perch became too large for the fingerling walleyes to eat in later years.

The walleye population also expanded and stabilized quickly. By fall 1977 (three year classes present), a biomass of 16.0 kg per hectare had been reached and there was a fairly broad range in size of fish (Tables 2 and 5). Growth of the larger and older walleyes slowed then, but growth of smaller and younger walleyes remained good (Table 4). Consequently, anglers were allowed to remove 29 walleyes of the 1975 year class and 46 of the 1976 year class in July 1978.

Walleye survival

Estimates of walleye natural mortality indicate that most deaths occurred within 1 year of stocking (probably in the first month), and that the third plant (1977) experienced a much higher death rate than the first two plants (Table 6). Natural mortality during the first year in the lake, fall age 0 to fall age I, ranged from 0.276 (second plant) to 0.929 (third plant), and averaged 0.550. For the third plant, a mark-and-recapture estimate in early October 1977, indicated that only 147 fingerlings had survived the first month in the lake--a mortality of 0.568. In the second and third years in the lake walleye natural mortality was very low, approaching zero. By the fourth year of the experiment, fall 1978, survival would have been about 0.360 for the 1975 plant, 0.708 for the 1976 plant, and 0.071 for the 1977 plant if angling mortality had not been allowed (Table 7).

The relatively high survival of the 1976 plant was probably due to a larger size when stocked (179 mm as compared to 137-141 mm) and, perhaps, to better health. That plant was comprised of fast-growing walleyes which had not been subjected to fin clipping. The poor survival of the 1977 plant was probably due to predation by the dense population of older walleyes and to a relatively sparse food supply. In the fall of 1977 the minnow population was very low, and young-of-the-year yellow perch were relatively scarce and large.

The walleyes planted in Jewett Lake experienced about the same overall survival as the walleyes planted in the small experimental lakes containing either minnows or bluegills (Table 7). An exception was that the second plant experienced a high--rather than intermediate--rate of survival, for the reasons cited above. For the conditions in these experiments--small lakes, simple fish communities without large piscivors other than walleyes, planting rates of 62 to 111 fingerling walleyes per hectare per year, and fingerling sizes of 98 to 141 mm--typical survival rates in the fourth year of the tests were about 40% for the first planting, 30% for the second planting, and 5% for the third planting.

Angling

Since the fish in Jewett Lake were protected from public fishing, the population was in a unique, unexploited state. Test anglers found fishing quality to be extremely good and significantly large portions of the populations were readily captured.

In May 1978, 31.7 hours of fishing with artificial lures, mainly directed at walleyes, yielded 61 walleyes (1.92 per hour) and 27 yellow perch (0.85 per hour). All were fin clipped and released, and five of the walleyes were soon caught again. On July 26, 1978, in 103.3 hours of fishing by a mixture of anglers using a variety of methods, 74 walleyes (0.72 per hour) and 139 yellow perch (1.35 per hour) were captured and removed.

For the walleye, approximately 345 fish of the 1975 and 1976 year classes combined were present in the lake in those months, thus, about 18% of those available were caught in May and 21% in July. For the yellow perch, roughly 450 fish of these two year classes were available to anglers in July, thus, about 30% were actually harvested.

Beyerle (1976 and 1977) observed that walleyes in the other two small experimental lakes were also fairly easy to catch. Fishing results for the three lakes--Emerald, Daggett, and Jewett (July 26 data only)--were as follows, respectively: 13, 22, and 20 hours of fishing per hectare; 3.1, 15.1, and 14.2 walleyes caught per hectare; 0.23, 0.70, and 0.72 walleyes caught per hour; and 5, 17, and 21% exploitation rates.

Observations on injuries due to capturing fish with artificial lures were made at Jewett Lake in May. Only one walleye (1.6%) was judged to have been severely injured, and it was found dead later. None of the yellow perch appeared to be severely injured and no mortality was observed.

Implications for walleye management

The results of the experiments at Jewett Lake and the other two small lakes demonstrated the potential for managing small lakes for walleyes. Planted fingerling walleyes survived in the small lake environment and grew satisfactorily in three diverse types of fish communities (Table 7). Pond studies (Schneider 1975) also have shown that small- to medium-sized walleyes can adapt to a wide range of environments and food types, including invertebrate-only diets. The key to success appears to be having food of the right size available when the walleyes are stocked. For walleyes 125-mm long the food should be no larger than 50 mm.

Survival of the first plant of fingerling walleyes was high for all three experimental lakes--0.352-0.421 after 36 months--but fell to near zero by the third plant as the walleye population built up. A similar pattern has been observed in large lakes (Schneider 1969). This could be countered by reducing the stocking rate, allowing fishing mortality to increase turnover rate, and by stocking larger fingerlings in later years. Survival during the first month after stocking is critical to success for survival is quite good after that period. It is suspected that much of the early mortality is a delayed result of stresses caused by handling.

The experimental lake containing minnows developed the highest biomass of walleyes, 31.8 kg per hectare, as compared to the lake with yellow perch and minnows, 16.0 kg per hectare, and the lake with bluegills, 13.5 kg per hectare. The walleyes grew most rapidly in the lake with minnows, but growth was satisfactory in the other lakes as well. The combination of fathead minnows plus golden shiners would seem to be the best for walleyes because prey of suitably small size would be available in all seasons. By contrast, the availability of small bluegills and perch varies seasonally and, in populations dominated by slow-growing fish, from year to year.

On the other hand, minnow populations can be virtually eliminated from lakes (e.g., Jewett) and ponds (Schneider 1975) which afford little cover for escapement from walleye and perch predation. Furthermore, a significant advantage of the combination of walleye and yellow perch is that it would probably provide stable fisheries for both species. The combination of walleye and bluegill offers less potential for management because bluegills were not effectively controlled by walleye predation. The bluegills were slow growing and would not have supported an attractive fishery. All aspects considered, the combination of yellow perch, fathead minnow, and golden shiner would seem to have the best potential for walleye management in most small lakes.

Knowledgeable anglers found the walleyes in the three small unfished lakes surprisingly easy to catch. Thus it seems possible that unrestricted fishing could prevent these lakes from achieving their full management potential. For a follow-up study at Jewett Lake, fishing restrictions in effect should prevent overfishing and distribute the catch equitably.

Implications for perch management

The addition of walleyes to the fish community of Jewett Lake brought about a significant improvement in the yellow perch population. In earlier experiments at Jewett Lake, perch growth was slow, recruitment irregular, and the potential for a fishery was poor (Schneider 1972). In the present experiment, the abundance and the composition of the perch population were brought into balance with the food resources of the habitat, perch growth was stimulated, many larger perch were produced, and the potential for a fishery was good. These changes are mostly attributed to walleye predation on small perch.

In the earlier report (Schneider 1972) I predicted the characteristics of a hypothetical perch population which would produce an optimal number of perch larger than 178 mm. This prediction was based on the natural mortality rates prevailing when yellow perch were the only fish species present, and on the food resources available for satisfactory growth of larger perch. In Table 8 these steady-state predictions are compared with the near-steady-state statistics observed in the walleye-perch-minnow experiment (population estimates for spring 1978 and average mortality rates in Table 6).

The predicted and observed growth rates were very close but, unexpectedly, more age-I perch were recruited and fewer age-II and age-III perch survived. The net result was that the biomass of age-I to age-III perch was lower than predicted, 10.2 kg per hectare instead of 13.2 kg per hectare. These comparisons suggest that walleye predation on young-of-the-year perch was not as severe as had been deemed necessary to maintain good growth of perch, and that walleyes caused an increase in mortality of older perch through predation (principally on age-I perch, judging from the size of prey-size of walleye relationship given by Schneider 1975) and competition for larger invertebrates (Table 1). The net result was a balanced perch population with different characteristics than predicted.

On a community level, the "loss" in potential perch biomass of 3 kg per hectare was more than offset by walleye production. Walleye standing crops as high as 16 kg per hectare were observed, and this ecosystem could probably support 10 kg per hectare of walleyes and 10 kg per hectare of yellow perch on a sustained basis.

The ability of walleyes to control yellow perch recruitment in Jewett Lake suggests that balance could be restored to lakes already containing a preponderance of slow-growing perch by planting walleyes. The successfulness of the technique appears, again, to be keyed to matching size of walleye stocked to size of prey and availability of food to assure good survival of the walleyes during the critical first year. Typically in these lakes, most perch are 100-150 mm long, recruitment is very irregular, alternate foods (such as benthos) are sparse, and young perch reach 75 mm by their first fall of life (Schneider 1972). Perch 75 mm long are suitable prey for only relatively large (>175 mm) fingerling walleyes, and only adult walleyes can eat the larger perch. Consequently, each lake must be surveyed in the summer prior to a planned fall stocking to confirm the availability of small food items suitable for the fingerling walleyes.

Table 1.--Frequency of occurrence (percent of all fish examined) of food items in the stomachs of walleyes, yellow perch, and fathead minnows of various size groups, 1975-78.

Food type	Walleye		Yellow perch			Fathead minnow
	125-250 mm	251-405 mm	8-9 mm	36-125 mm	160-245 mm	30-63 mm
Walleye		2				
Yellow perch	11	5			1	1
Fathead minnow				2		
Unidentified fish	44	16		5	1	
All fish	55	24		7	2	1
Crayfish		9				
Leech					5	
Chironomid	33	2		42	30	21
Other insects[a]	22	20		34	38	7
Amphipod		2		5	10	
Zooplankton			100	62		32
Plant		20[b]		12[b]		17[c]
Unidentified		2		25	3	40[c]
Number of fish	9	55	21	59	79	84
Number empty	2	24	0	14	27	16

[a] Primarily dragonfly nymphs.

[b] Probably taken accidentally while ingesting food animals.

[c] Closer examination, under a compound microscope, of subsamples of the unidentified stomach contents of fathead minnows revealed significant amounts of various types of algae and higher plants.

Table 2.--Estimated standing crops (kilograms per hectare) of walleyes, yellow perch, and fathead minnows in Jewett Lake, 1975-78.

Species, and year class	Season and year				
	Fall 1975	Fall 1976	Fall 1977	Spring 1978	Fall 1978
Walleye					
1975	1.4	9.3	7.7	--	5.9
1976		2.8	7.9	--	7.0
1977			1.4	--	0.8
1978					1.3
All	1.4	12.1	16.0	--	15.0
Yellow perch					
1975	1.5	8.2	7.0	4.2	2.2
1976		20.9	13.0	3.9	4.1
1977			7.0	2.1	4.4
1978					8.6
All	1.5	29.1	27.0	10.2	19.3
Fathead minnow					
All	26.3	2.1	trace	trace	trace
Total	29.2	43.3	43.0	--	34.3

Table 3.--Estimated numbers of walleye (in parentheses are the actual number of different walleyes examined) and yellow perch in Jewett Lake, spring 1975 to fall 1978.

Species, and year class	Season and year							
	Spring 1975	Fall 1975	Spring 1976	Fall 1976	Spring 1977	Fall 1977	Spring 1978	Fall 1978[a]
Walleye								
1975		325[b]		180 (88)		115 (82)		88 (68)
1976				325[b]		235 (128)		184 (115)
1977						340[b]		24 (17)
1978								325[b]
Yellow perch								
1975	3 million eggs[c]	6369		768		609	358	99
1976			3 million eggs[c]	22,766		2822	599	277
1977					2.4 million eggs	5366	1615	681
1978							4 million eggs	8019

[a] Prior to this estimate, in July 1978, the following fish were removed by anglers: 75 walleyes--29 of the 1975 year class and 46 of the 1976 year class; 165 yellow perch--approximately 107 of the 1975 year class and 58 of the 1976 year class.

[b] Actual number of walleyes stocked.

[c] Estimated number of fertilized yellow perch eggs stocked.

Table 4.--Average total length (mm) of walleyes and yellow perch in Jewett Lake, fall 1975 to fall 1978

Species, and year class	Season and year					
	Fall 1975	Fall 1976	Spring 1977	Fall 1977	Spring 1978	Fall 1978
Walleye						
1975	141[a]	324	325	351	345	360
1976		179[a]	203	279	277	291
1977				137[a]	168	277
1978						135[a]
Yellow perch						
1975	48	171		176	183	207
1976		74	72	124	143	190
1977				83	82	147
1978						83

[a] Size at planting.

Table 5.--Estimated number per hectare of walleye and yellow perch by size groups in Jewett Lake, 1975-78.

Species, and size group (mm)	Season and year				
	Fall 1975	Fall 1976	Fall 1977	Spring 1978	Fall 1978
Walleye					
0-199	62	60	65	--	62
200-249		2	10	--	2
250-299			25	--	29
300-349		35	23	--	17
350-399			8	--	8
400-470			1	--	2
Yellow perch					
0-99	1219	4359	1027	309	1535
100-174		78	584	107	147
175-280		66	73	76	57

Table 6.--Natural mortality rates, based on population estimates in Table 3, for walleye and yellow perch in Jewett Lake, 1975-78.

Species, and year class	Age interval: Egg to Fall, 0	Fall, 0 to Fall, I	Fall, I to Fall, II	Fall, II to Fall, III
Walleye				
1975		0.446	0.361	0.0[a]
1976		0.276	0.021[a]	
1977		0.929		
Average		0.550	0.191	0.0
Yellow perch				
1975	0.9979	0.879	0.207	0.661[a]
1976	0.9924	0.876	0.881[a]	
1977	0.9978	0.873		
1978	0.9980			
Average	0.9965	0.876	0.544	0.661

[a] For the calculation, the numbers of fish removed by anglers in July 1978 were added to the fall 1978 estimates.

Table 7.--Survival and average length (mm) in the fourth year, of three successive plants of fingerling walleyes in small lakes containing either minnows, bluegills, or yellow perch plus minnows.

Year of planting	Food type and lake					
	Minnow Daggett Lake[a]		Bluegill Emerald Lake[a]		Perch + minnow Jewett Lake[b]	
	Survival	Length	Survival	Length	Survival	Length
First	0.421	394	0.352	353	0.360	360
Second	0.293	366	0.212	277	0.708	291
Third	0.076	310	0.000	...	0.071	277

[a] Daggett Lake data from Beyerle (1977); Emerald Lake data from Beyerle (1976). For both lakes, survival was calculated from the number of fish planted and the actual number recovered when the lake was treated with rotenone in the fourth year. Planting rate was 111 fingerling walleyes per hectare per year.

[b] Jewett Lake data from this report. Survival was calculated from the number of fish planted, and the estimated numbers surviving in fall 1978, plus those removed by anglers in July 1978. Planting rate was 62 fingerling walleyes per hectare per year.

Table 8.--Predicted (P) structure of an optimal yellow perch population based on studies of yellow perch-only fish communities (Schneider 1972), as compared to the observed (O) structure of a yellow perch population in a walleye-yellow perch community (this study, mostly spring 1978 data).

Age	Natural mortality[a]		Yellow perch per hectare: Number		Yellow perch per hectare: Kilograms		Average length (mm)	
	P	O	P	O	P	O	P	O
I		0.88	247	309	1.2	2.1	83	82
	0.15							
II		0.54	210	115	5.8	3.9	147	143
	0.41							
III		0.66	124	69	6.2	4.2	178	183
	0.41							
IV		..	37[b]	..	2.7[b]	..	203	

[a] The predicted rates of natural mortality were computed from intervals of spring age I to spring age II, spring age II to spring age III, and spring age III to spring age IV; whereas the observed rates were computed from fall age 0 to fall age I, fall age I to fall age II, and fall age II to fall age III (Table 6).

[b] Predictions based on a fishing mortality of 0.5 between age III and age IV.

Literature cited

Beyerle, George B. 1976. Survival, growth and vulnerability to angling of walleyes stocked as fingerlings in a small lake with bluegills. Mich. Dep. Nat. Resour., Fish. Res. Rep. 1837, 11 pp.

Beyerle, George B. 1977. Survival, growth, and vulnerability to angling of walleyes stocked as fingerlings in a small lake with minnows. Mich. Dep. Nat. Resour., Fish. Res. Rep. 1853, 12 pp.

Colby, Peter J., Richard E. McNicol, and Richard A. Ryder. 1979. Synopsis of biological data on the walleye, Stizostedion v. vitreum (Mitchill 1818). Food Agr. Org. United Nations, Fish. Synopsis 119, 139 pp.

Laarman, Percy W. 1978. Case histories of stocking walleyes in inland lakes, impoundments, and the Great Lakes--100 years with walleyes. Am. Fish. Soc. Spec. Publ. 11: 254-260.

Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish populations. Fish. Res. Board Can. Bull 191, 382 pp.

Schneider, James C. 1969. Results of experimental stocking of walleye fingerlings, 1951-1963. Mich. Dep. Nat. Resour., Res. Develop. Rep. 161, 31 pp.

Schneider, James C. 1972. Dynamics of yellow perch in single-species lakes. Mich. Dep. Nat. Resour., Res. Develop. Rep. 184, 47 pp.

Schneider, James C. 1975. Survival, growth and food of 4-inch walleyes in ponds with invertebrates, sunfishes or minnows. Mich. Dep. Nat. Resour., Fish. Res. Rep. 1833, 18 pp.

Scott, W. B., and E. J. Crossman. 1973. Freshwater fishes of Canada. Fish. Res. Board Can. Bull. 184, 966 pp.

Thorpe, John. 1977. Synopsis of biological data on the perch, Perca fluviatilis Linnaeus, 1758 and Perca flavescens Mitchill, 1814. Food Agr. Org. United Nations, Fish. Synopsis 113, 138 pp.

Report approved by W. C. Latta

Typed by M. S. McClure