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RESULTS OF EXPERIMENTAL STOCKING OF WALLEYE FINGERLINGS, 1951-1963[1]

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Abstract

Walleye fingerlings were planted in 60 to 70 Michigan lakes between 1951 and 1963. They made a real contribution to the stock and fishery of 4 lakes; provided a limited amount of fishing in 20 lakes; contributed nothing to 17 lakes; and results were not evaluated at about 20 lakes. An intensive creel census was conducted at Bear and Fife lakes, two of the lakes which provided a limited amount of fishing. In addition, walleye population estimates were made at Fife Lake. At Bear Lake, it was projected that the catch from the three supplemented year classes would be 59% greater than the average catch from classes comprised only of native fish. At Fife Lake, one supplemented year class was six times stronger than the average natural year class but another was much weaker than average. Rates of return from walleye fingerlings planted in Bear Lake were 7.1%, 0.3%, and 2.3% for three consecutive annual plantings. Similar estimates at Fife Lake were

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[1] A contribution from (incidental to) Dingell-Johnson Project F-29-R.

1.0% and 0.1% for two consecutive plantings. The standing crop of walleyes in Fife Lake during the spring of 1964 was 2.3 fish per acre. Only 1.8 fish per acre remained the following year. Of the total mortality rate of 22.2%, 5.1% was due to angling. A simple model was developed to predict the number of fingerlings which should be stocked in a lake to produce a good, stable, walleye sport fishery.

Introduction

Artificial propagation of walleyes in Michigan began with the release of 1,120,000 fry in 1882.[2] Since then, billions of fry and fingerlings have been released in the state, in many waters, with varying degrees of success. Perhaps the greatest success was at Lake Gogebic where an outstanding fishery was created (Eschmeyer, 1950).

In 1927 a list of Michigan waters containing self-perpetuating walleye populations was compiled by the Fish Division from a questionnaire sent to all conservation officers. Presumably this inventory was used as a guide for subsequent stocking recommendations. By 1950, however, the need for a more careful evaluation of the stocking program was apparent. Questions of greatest concern were (1) how frequently, and at what rates should walleyes be stocked for optimum returns? and (2) how much do periodic plantings in lakes which have little or no natural reproduction (maintenance stocking) contribute to the walleye population and fishery of these lakes? Under the direction

[2] Fifth Biennial Report of the State Board of Fish Commissioners.

of Walter R. Crowe, a group of experimental lakes was selected and a stocking schedule prepared. This report presents the results of this program.

Procedures

Plants of walleye fingerlings have been made in 60-70 Michigan lakes since 1951. Some plants were introductory and others were for maintenance. Some lakes were stocked in consecutive years; others either on an alternate year, every third year, or a longer schedule. Unfortunately, irregular and often insufficient production of fingerlings by the hatcheries disrupted the experiment so that many lakes could not be planted either at the time or in the quantity scheduled.

Except for two lakes, Fish Division field personnel were to evaluate the establishment or increase of the walleye stock and the creation or improvement of the fishery by means of creel census and netting. At Bear Lake (Manistee County) and Fife Lake (Grand Traverse County) an intensive creel census was conducted by fish research personnel. The census on these two lakes was part of a study of experimental fishing regulations. Census procedures were outlined by Christensen (1953) and C. M. Taube.[3]

In these experiments fingerling walleyes were stocked at rates from less than 1 to over 40 per acre. Fife Lake received 37.2 per acre in 1961 and 40.5 in 1962. Bear Lake was stocked with 1.4, 5.1,

[3] Final Report of Dingell-Johnson Project F-27-R-2, Work Plan No. 2.

and 13.9 fingerlings per acre in 1960, 1961, and 1962, respectively. Fife Lake has an area of 575 acres; Bear Lake, 1,744 acres.

Creel census information from Fife Lake was augmented by mark-and-recapture population estimates in the spring of 1964 and 1965. Walleyes were captured in trap nets, scale sampled, and jaw tagged with #3 Monel strap tags. The census clerk and a cooperating boat-livery operator collected tags from marked fish caught by anglers. The abundance, survival, growth, and exploitation rates of walleyes were calculated for the 1961 and 1962 year classes. These classes were supplemented by stocking. It was not possible to distinguish between planted fish and those naturally produced at either Fife or Bear lakes. Consequently, the planting program was evaluated by comparing the catch from year classes supplemented with hatchery walleyes to the catch from year classes comprised of native fish.

Findings

Among the many lakes which received walleye fingerlings, the plantings made a real contribution to the stock and fishery of 4 lakes; they provided a limited amount of fishing in 20 lakes; and gave negative results in 17 lakes. There was no follow-up at the remaining (about 20) lakes. The four lakes where plantings were successful were Lake Charlevoix (Charlevoix County, T. 33N., R. 11W.), Eagle Lake (Cass County, T. 7S., R. 15W.), East Twin Lake (Montmorency County, T. 29N., R. 1E.), and Vineyard Lake (Jackson County, T. 4S., R. 2E.).

The introduction of fingerlings at rates of 1.4-2 per acre into Lake Charlevoix in 1955, 1957, and 1958 resulted in the establishment of a population with spawning runs up the Jordan River. A small fishery has developed. In Eagle Lake, East Twin Lake, and Vineyard Lake, maintenance plantings provided good returns to the anglers but did not establish reproducing populations. These three lakes range from 375 to 974 acres and are relatively shallow, with maximum depths of 25 to 42 feet. Stocking rates varied from 4 to 32 per acre.

The remainder of this report is devoted to the results at Bear and Fife lakes where more thorough evaluations were conducted.

In these lakes walleye fingerlings were stocked to supplement the natural populations. Catch estimates for 1946-1965, obtained from the creel census, are given in Table 1. These estimates are minimal because some walleyes were caught after dark when there was no census. However, assuming this error to be constant from year to year, annual changes in fishing quality are reflected in the catch-effort index.

The walleye sport fishery in both lakes was not impressive. At Bear Lake the best catch was in 1952, when 1,333 walleyes were taken or less than 1 per acre. At Fife Lake the highest catch was 308 in 1946, or about 1 per 3 acres.

Bear Lake

Walleye fishing at Bear Lake has varied considerably through the years (Table 1). From a high level in 1952, the catch and catch per hour gradually declined to a low in 1960 but returned to the level of 1955 by 1964. Most of this increase during the early 1960's was due to the strong natural year classes of 1958 and 1959. Walleyes in the supplemented year classes of 1960, 1961, and 1962 grew rapidly and began entering the sport fishery during their third summer of life (Table 2).[4] The 1960 year class first appeared in the catch during 1962 when it made up 9% of the total number caught. By 1964, the three augmented year classes made up 77% of the catch.

The contribution of hatchery walleyes to the catch was evaluated by comparing the virtual population of native and supplemented year classes. Presumably, broods augmented with hatchery fingerlings would be larger than those comprised entirely of native fish. The virtual population of each native year class (1949 through 1959) was derived from estimates of the number caught and the age structure of the catch. For each calendar year, the total catch was multiplied by the fraction contributed by each year class to give the annual catch from each class. The annual catches were then summed throughout the life span of each brood. An average of 528 (range, 148-942) native walleyes were caught out of each of the 1949 through 1959 year classes.

Because more fish from the planted year classes would be caught after the census was terminated in 1965, the virtual populations of these groups were predicted from creel census information about the 1953 and 1959 year classes. These classes were selected because

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[4] A 13.0-inch minimum size limit was in effect throughout the creel census.

they also entered the fishery at Age II. Of the total number eventually caught, an average of 90.6% of these two classes were caught before Age VI, 72.5% before Age V, and 54.4% before Age IV. Using these percentages and the sums of the catch estimates in Table 2, the projected virtual population estimates for the 1960, 1961, and 1962 classes were 706 (640 ÷ 0.906), 556 (403 ÷ 0.725), and 1,259 (685 ÷ 0.544), respectively. The average for these classes supplemented by stocking was 840, or 312 more than the average native year class of 528. The difference is statistically significant at the 10% probability level.

Rates of return of hatchery walleye fingerlings were calculated by subtracting the average catch of native walleyes from the projected catch of each planted year class and dividing by the number of fingerlings stocked. Estimated returns are 7.1%, 0.3%, and 2.3% for the 1960, 1961, and 1962 plants, respectively. Depending on the actual number of native walleyes produced in these years, hatchery returns could be as low as 0% and as high as 28.2%, 6.2% and 5.2% for the respective plants.

Fife Lake

The walleye fishery of Fife Lake also fluctuated through the years (Table 1). The relatively large number caught between 1946 and 1948 is correlated with stocking of walleye fry which was done until 1942. Thereafter, a small population produced a harvest of about 50 fish per year. A substantial increase occurred in 1963 but the catch returned to the average level in 1964 and 1965.

As at Bear Lake, walleyes in the planted year classes of 1961 and 1962 grew fast, averaging over 16.0 inches at age III (Table 3). The fastest growing fish entered the sport fishery during their second growing season (Table 4). The 1961 year class first entered the catch in 1963 and dominated the catch in 1964 and 1965. The 1962 year class contributed little to the catch in 1964 and 1965. Therefore, it was mainly native, not hatchery, walleyes which made up the large catch in 1963.

There were an estimated 1,397 walleyes in Fife Lake in the spring of 1964 (2.3 per acre). This figure is an average of two estimates. Marking (jaw tagging) was done during spring trap netting. One estimate was based on recaptures by anglers during the summer and fall of 1964; the other on recapture of fish marked in 1964 during netting in 1965. The smallest fish retained by the nets was 14.5 inches and all members of the 1961 and older classes were large enough to be taken (Table 3).

In the spring of 1965, 1,087 walleyes (1.8 per acre) were estimated to be present in Fife Lake. Trap nets were used both to capture fish for marking and for recapture. All members of the 1962 year class should have been large enough to be vulnerable to the nets but none were taken.

Since no recruitment occurred in 1965, the difference between the estimate in 1964 and the estimate in 1965 is a direct measure of annual total mortality. The loss was 310 fish or 22.2% of the population present in the spring of 1964. This rate applies, essentially, to the fourth year of life since the 1961 brood dominated the population. Angling mortality accounted for 5.1% of the total mortality. This estimate is based on tag returns by fishermen and is probably somewhat low. The rest of the loss (17.1%) was from natural causes. Although some tagged walleyes were found dead, tagging and handling probably was not a major cause of death. Nineteen tagged walleyes recaptured in 1965 had grown as much as the unmarked siblings.

Walleyes of the 1961 year class comprised 93% of those taken in nets but only 64% of those caught by anglers in 1964 and 1965 (Table 5). The proportion of older fish in the anglers' catch was greater than expected (chi square = 80 with 2 d.f.), suggesting that vulnerability to angling increases with age. This is likely because some walleyes are caught incidentally by pike fishermen using large minnows.

Survival of walleyes from fingerling to Age III was determined from the number of fingerlings stocked in 1961 and 1962 and the population estimates in 1964 and 1965. Survival of the 1961 plant was between 0 and 6.1%, and less than 1% for the 1962 plant. A range of 0 to 6.1% is given for the 1961 plant because the number of natural recruits of that year class which survived until 1964 is unknown. If natural recruitment in 1961 was average, then only about 2% of the hatchery fingerlings reached Age III.

The total number of walleyes which might be harvested from the 1961 year class (hatchery and native fish) was estimated by predicting the number of survivors at the end of each year of life, multiplying by an exploitation rate of 5.1% per year to obtain an estimate of the annual catch, and summing the annual catch estimates for those years when the class was vulnerable to the fishery. Two methods of estimating annual survivors were used. In the first method a constant mortality rate of 22.2% per year (determined for Age III-IV) was applied, consecutively, to the annual survivors of the 1961 year class beginning with the 1,035 estimated at Age IV. At the end of 9 years, however, the number of survivors would still be large, and since 9 years is thought to be the maximum life span of the walleye in Fife Lake, a second method of estimating survivors was devised in which survival was not constant but decreased beyond Age IV. A free-hand curve was drawn based on number of fingerlings stocked at Age 0, population estimates in 1964 and 1965, and a maximum life span of 9 years (Fig. 1). The number of survivors each year was read from the graph and an estimated catch computed using an exploitation rate of 5.1% per year (Table 6). It was estimated that 301 walleyes would be caught from the 1961 year class. This is six times larger than the average natural year class of 50 walleyes. However, the 1961 class was not strong enough to create even fair fishing and only about 1% of the hatchery fish were ever caught.

Netting and creel census data indicated that the 1962 class had virtually disappeared by 1965. Only six walleyes were caught from this year class, a maximum return of less than 0.1%.

Evaluation of the creel census

Creel census estimates of the walleye harvest from Bear and Fife lakes were thought to be low because there was not a census of night fishing. Some confirmation of a systematic bias was found in the Fife Lake estimates for 1964. In that year the catch estimate was only 54 and a minimal estimate of 74 was derived from tag returns. This difference is not statistically significant, however.

Appraisal of walleye stocking

After these many years of walleye propagation, undoubtedly there is not one potentially suitable body of water in the state which has not been stocked. If suitable spawning sites were available, walleyes probably were established. Conversely, failure to find the species in a particular lake nowadays suggests that additional introductory plants have very little chance of establishing a self-perpetuating population. It is recommended, therefore, that introductory plants be made only in new impoundments or in those waters in which the physical environment has been altered or the fish populations have been manipulated.

Results from the maintenance walleye-stocking program in Michigan are similar to those in other states. Namely, a fishery can be supplemented in some lakes but only at high stocking densities (Rose, 1955; Threinen, 1955; Carlander et al., 1960; Mayhew, 1960; Scidmore, 1957; Bailey and Oliver, 1959; Olson and Wesloh, 1962).

Stocking rates in the order of 15 to 68 fingerlings per acre or 5-10 thousand fry per acre were required to make a measurable improvement in the catchable population or the harvest.

Lakes containing populations limited by inadequate reproduction may give better returns from stocked fish than lakes with large populations of walleyes or none at all. For example, the walleye populations of Spirit and Clear lakes, Iowa, have been increased by stocking (Rose, 1955; Carlander et al., 1960). The lakes reported on here, Bear and Fife, and Ripley (Threinen, 1955) gave some returns. Olson and Wesloh (1962) concluded that returns from walleye stocking in Many Point Lake, Minnesota, which contains a good population of native walleyes, were not commensurate with the stocking effort. On the other hand, good returns were obtained from Escanaba Lake, Wisconsin, which has yielded up to 22 pounds per acre of native walleyes in one year (Churchill, 1957a). However to my knowledge only one lake has produced exceptional walleye fishing because of maintenance stocking. Groebner (1960) reported the walleye catch from Lake Francis, Minnesota, increased to 4.7 pounds per acre following several years of stocking at rates of 2.7 to 30 fingerlings per acre. Natural reproduction is not known to occur in this lake. Plants of larger fingerlings (25 per pound) gave the best returns.

Ideally, hatchery walleyes should be used to supplement weak natural year classes. However, it is difficult to maintain a uniform age distribution by stocking. Data from Bear and Fife lakes and other studies (Threinen, 1955; Olson and Wesloh, 1962) indicate survival of the second of two consecutive annual plants is poorer than the initial plant. At Lake Ripley, Wisconsin, survival of the second plant was one-third that of the first (Threinen, 1955). The difference was 6-fold at Fife Lake. Census data from Bear Lake suggest an even greater difference. Plants every 4 years in Eagle and East Twin lakes, Michigan, maintained satisfactory fishing and seemed to result in better survival of fingerlings than plants made in consecutive years. Carlander et al. (1960) reported stronger year classes in even numbered years were correlated with fry stocking in those years. These data suggest survival, probably during the first year, is in part, inversely related to the density of older fish. However, my attempt to correlate strength of year classes in Bear Lake with abundance of adult walleyes (as reflected in the catch-effort index) was unsuccessful. Similarly, Smith and Krefting (1954) could not correlate class strength with number of adults, abundance of competitors, or number of hatchery fry planted (38-450 per acre) in the Red Lakes, Minnesota.

The number of walleyes which must be stocked to produce a fishery of a given quality will vary considerably from lake to lake--not only because of differences in survival attributable to the environments but also because of differences in fishing pressure. However, certain generalizations about survival, exploitation, and rate of return may be made based on data in the literature. These observations pertain to those situations where stocking has been somewhat successful.

The annual rate of natural mortality of adult walleyes is low but variable. The 17% rate for Fife Lake (between Ages III and IV) agrees well with the estimates of 17-27% given for walleyes Age IV and older in Clear Lake, Iowa (Whitney, 1958). Ryder (1968) reported a natural mortality rate as high as 50% and a 3-year average of 41% in Nipigon Bay, Lake Superior. Niemuth et al. (1959) reported a natural mortality of 10-15% at Escanaba Lake, Wisconsin. The average rate of 4.6% (annual variation 1 to 7%) at Oneida Lake, New York (Forney, 1967), agrees very well with the figure of 4% for Many Point Lake, Minnesota (Olson, 1957). Both estimates apply to mature (Age IV plus) walleyes. Escanaba, Oneida, and Many Point lakes have denser walleye populations and are better walleye waters than Fife and Clear lakes. Tag returns from Lake Gogebic, Michigan, suggest a very low rate of mortality. One tag applied in 1947 was returned by an angler in 1965. This walleye was at least 20 years old--considerably older than the typical life span of 7 years estimated by Niemuth et al. (1959). Although mortality during the prime age of 3-4 years apparently is low, it probably increases thereafter in the manner shown in Figure 1. If mortality did not increase with age, the walleye would live even longer.

Up to 15% of the walleye fingerlings planted may survive to adulthood (Niemuth et al., 1959). At Lake Ripley, Wisconsin (Threinen, 1955) about 7.5% of a plant of 15.4 fingerlings per acre survived to Age IV. At Fife Lake, Michigan, I estimated survival to Age III from a plant of 37.2 fingerlings per acre was, at best, 6.1%. In both studies survival was slightly better than these figures indicate because anglers took some fish before they reached these ages. Perhaps 10% of the number stocked reached a catchable size of 13 inches. From the data given by Churchill (1957b) for Escanaba Lake, Wisconsin, I calculated that even at stocking densities of 165 fingerlings per acre survival to Age III would have been about 13% if no fishing had been allowed. In this calculation it is assumed that the rate of natural mortality would be the same when no fishing mortality occurred as when fishing mortality took place. Since natural mortality would probably increase to compensate for a lack of fishing mortality (Ryder, 1968), 13% is probably high. In summary, the maximum survival rate of planted walleye fingerlings to catchable size appears to be about 10% between the stocking rates of 15 and 165 fingerlings per acre. Information at hand does not indicate that survival decreases as stocking density approaches the carrying capacity of the lake.

Exploitation rates of walleyes reported in the literature range from 6 to 47%. Rose (1947, 1955) reported exploitation rates of 15-28% at Spirit Lake, Iowa; Patterson (1953) and Niemuth et al. (1959), 20-40% at Escanaba Lake, Wisconsin; Olson (1957), a 3-year average of 27% at Many Point Lake, Minnesota; Whitney (1958), 6.3 and 15.7% at Clear Lake, Iowa; Forney (1967), 10, 14, and 47% for Age IV and older walleyes at Oneida Lake, New York; and Ryder

(1968), 10, 17, 29% in Nipigon Bay, Lake Superior. These rates are high compared to the 5% rate at Fife Lake. However, Michigan and New York are the only states among those mentioned with a minimum size limit of 13.0" and 12.0", respectively.[5] Considerable numbers of juvenile walleyes are taken elsewhere. Churchill (1957a) estimated that a 13.0-inch size limit at Escanaba Lake would have reduced the catch by 39%. Under this size restriction, an exploitation rate of 20% is probably about par for a good walleye fishery (Crowe, 1957).

A "good" walleye lake should yield about 2-4 lb. per acre per year (Groebner, 1960; Johnson, 1964). Furthermore, it has been estimated that 14-20 fish per acre are required for good fishing (Threinen, 1955; Mayhew, 1960). These latter estimates must include juvenile walleyes because, at an exploitation rate of 20% and an average weight of 1 1/2 lb. per fish (equivalent to a length of 16 inches) only 10 adults per acre are required to produce good fishing.

A simple model was developed to predict the number of fingerlings which should be stocked in a lake to produce a good, stable, walleye fishery (Table 7). This model is based on these assumptions: (1) average weight of fish caught is 1.5 lb.; (2) this average weight is attained in 3 years; (3) recruitment into the fishery occurs at Age III; (4) survival rate is 10% up to Age III and then follows the rate in Table 6 thereafter up to a maximum age of 9 years; and (5) exploitation rate is 20%. Although the assumptions for this model are based on data from both this study and others, many of

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[5] New York removed the size limit on walleyes in 1960.

the rates, especially growth and survival, may not apply at the higher population densities in the model.

The model was constructed by starting with a catch in Year 3 of 3 pounds or 2 fish per acre. At an exploitation rate of 20%, a population of 10 adults per acre was required. Assuming a survival of 10% from fingerling to Age III, 100 fingerlings per acre were stocked the first year (Year 0). The number of survivors in Year 4 at Age IV was obtained by subtracting the Year 3 catch (2) from the Year 3 population (10) and multiplying by the survival rate for this age group which would prevail without angling mortality (0.847). This latter statistic was obtained by adding 0.050 to the survival rate of 0.797 in Table 6 to adjust for the 5% rate of angling mortality which occurred at Fife Lake. Twenty per cent of the 6.8 survivors in Year 4 (or 1.4) will be harvested. Calculations were done in like manner for each year of life for this age class. In order to maintain a constant angling harvest of 2 walleyes per acre in Year 4, 0.6 fish per acre would have to be contributed by a second planting made in Year 1. With a harvest rate of 20%, a population of 3.0 fish of Age III would be required in Year 4. The history of the second year class, and all subsequent classes, was filled out in the same manner as the initial class.

The model predicts that 100 fingerlings per acre should be planted the first year and only about 30 the following year. About 40 fingerlings are required in the fifth plant and each year thereafter when the population has stabilized. The goal of the manager would be to adjust the stocking rate so that 3.5 to 4.0 Age-III walleyes are recruited annually.

The model also predicts the age distribution of the catch. A little less than one-half will be from Age-group III. Most of the rest will come from Ages IV and V. A total of 5.0 will be caught out of the first plant of 100 fingerlings for a return of 5%. Returns from subsequent stocking will be about the same. At an average cost of 3 cents per fingerling (Niemuth et al., 1959) each walleye in the creel would cost about 60 cents.

However, at high population densities, the assumptions concerning growth, survival and mortality, and longevity may not apply. Carlander and Whitney (1961) have shown that growth rate is density dependent. It is likely that mortality and longevity are also. An anticipated decrease in growth rate, increase in natural mortality rate, and shortening of the life span would further tend to reduce yield and increase cost of the maintenance stocking model. If, for example, the return from hatchery fingerlings was not 5%, but only 2.5%, as it was for the third planting at Bear Lake, then the cost of each walleye caught would be $1.20 instead of $0.60. Threinen (1955) estimated that each stocked walleye creeled at Lake Ripley cost $1.38.

Reports in the literature indicate stocking of fry instead of fingerlings will not appreciably reduce the cost of a maintenance fishery. Fry stocking in several Iowa lakes has supplemented the stocks to some degree (Carlander et al., 1960; Rose, 1955). However, rates of 3,000 to 10,000 per acre were required.

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Literature cited

Bailey, L. R., and J. A. Oliver. 1939. The fishes of the Connecticut. Biological survey of the Connecticut Watershed. New Hampshire Fish Game Dep., Surv. Rep. 4: 150-189.

Carlander, K. D., R. R. Whitney, E. B. Speaker, and K. Madden. 1960. Evaluation of walleye fry stocking in Clear Lake, Iowa, by alternate-year planting. Trans. Amer. Fish. Soc., 89: 249-254.

Carlander, Kenneth D., and Richard Whitney. 1961. Age and growth of walleyes in Clear Lake, Iowa, 1935-1957. Trans. Amer. Fish. Soc., 90: 130-138.

Christensen, K. E. 1953. Fishing in twelve Michigan lakes under experimental regulations. Mich. Dep. Cons., Inst. Fish. Res. Misc. Publ. 7, 46 p.

Churchill, W. S. 1957a. Conclusions from a ten-year creel census on a lake with no angling restrictions. J. Wildl. Manage., 21: 182-188.

Churchill, W. S. 1957b. Report given at the 13th annual Tri-State Fisheries Conference, Superior, Wisconsin, Jan. 21-22, 1957. (mimeo.)

Crowe, W. R. 1957. Report at 13th annual Tri-State Fisheries Conference, Superior, Wisconsin, Jan. 21-22, 1957. (mimeo.)

Eschmeyer, P. H. 1950. The life history of the walleye, Stizostedion vitreum vitreum (Mitchill) in Michigan. Bull. Inst. Fish. Res., No. 3, 99 p.

Forney, J. L. 1967. Estimates of biomass and mortality rates in a walleye population. N. Y. Fish Game J., 14(2): 176-192.

Groebner, J. F. 1960. Appraisal of the sport fishery catch in a bass-panfish lake of southern Minnesota, Lake Francis, Le Sueur County, 1952-1957. Minnesota Dep. Cons. Invest. Rep. 225, 17 p. (mimeo.)

Johnson, M. W. 1964. A five year study of the sport fishery of Mille Lacs Lake, Minnesota, 1958-1962. Minnesota Dep. Cons. Invest. Rep. 273, 16 p. (mimeo.)

Mayhew, J. 1960. Report on Green Valley Lake, Iowa. In Sport Fishing Inst. Bull. 107, Oct. 1960. Original article in Iowa Conservationist, Sept. 1960.

Niemuth, W., W. Churchill, and T. Wirth. 1959. The walleye, its life history, ecology, and management. Wisc. Cons. Dep. Publ. 227, 14 p.

Olson, D. E. 1957. Statistics of a walleye sport fishery in a Minnesota Lake. Trans. Amer. Fish. Soc., 87: 52-72.

Olson, D. E., and M. Wesloh. 1962. A record of six years of angling on Many Point Lake, Becker County, Minnesota with special reference to the effect of walleye fingerling stocking. Minnesota Dep. Cons. Invest. Rep. 247, 7 p. (mimeo.)

Patterson, D. L. 1953. The walleye population in Escanaba Lake, Vilas County, Wisconsin. Trans. Amer. Fish. Soc., 82: 34-41.

Rose, E. T. 1947. The population of yellow pikeperch (*Stizostedion v. vitreum*) in Spirit Lake, Iowa. Trans. Amer. Fish. Soc., 77: 32-42.

Rose, E. T. 1955. The fluctuations in abundance of walleyes in Spirit Lake, Iowa. Proc. Iowa Acad. Sci., 62: 567-575.

Ryder, R. A. 1968. Dynamics and exploitation of mature walleyes, *Stizostedion vitreum vitreum*, in the Nipigon Bay region of Lake Superior. J. Fish. Res. Bd. Canada, 25(7): 1347-1376.

Scidmore, J. 1957. Report at 13th annual Tri-State Fisheries Conference, Superior, Wisconsin, Jan. 21-22, 1957. (mimeo.)

Smith, L. L., Jr., and L. W. Krefting. 1954. Fluctuations in production and abundance of commercial species in the Red Lakes, Minnesota, with special reference to changes in the walleye population. Trans. Amer. Fish. Soc., 83(1953): 131-160.

Threinen, C. W. 1955. What about walleye stocking? Wisc. Cons. Bull., 20(11): 21-22.

Whitney, R. R. 1958. Numbers of mature walleyes in Clear Lake, Iowa, 1952-3, as estimated by tagging. Iowa St. J. Sci., 33(1): 55-79.

INSTITUTE FOR FISHERIES RESEARCH

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Table 1.--Creel census estimates of walleye harvest and catch per hour of walleyes from Bear and Fife lakes, 1946-1965

Year	Bear Lake Catch	Bear Lake Catch per hour[a]	Fife Lake Catch	Fife Lake Catch per hour[a]	Fife Lake Catch per hour[b]
1946			308	-	.008
1947			195	-	.004
1948			165	-	.003
1949			96	-	.002
1950			79	-	.002
1951[c]			26	-	.001
1952	1,333	.035	16	.001	.000
1953	942	.023	16	.001	.000
1954	880	.020	50	.003	.001
1955	1,101	.024	76	.004	.002
1956	490	.012	30	.002	.001
1957	594	.014	52	.002	.001
1958	322	.008	49	.002	.001
1959	158	.004	48	.002	.001
1960	124	.003	0	0	0
1961	582	.014	100	.004	.003
1962	572	.011	33	.002	.001
1963	979	.022	235	.013	.007
1964	1,240	.025	54	.003	.002
1965[d]	664	.019	51	.004	.002

[a] Equal to the estimated catch divided by the estimated hours spent fishing for game fish (i.e., walleye, bass, pike). The estimated hours spent fishing for game fish was obtained from angler interviews and estimates of total fishing pressure.

[b] Obtained by dividing the estimated catch of walleyes by the estimated hours spent fishing for all species.

[c] Excludes the spring catch which is usually insignificant.

[d] Excludes the fall catch which is usually insignificant.

Table 2.--Estimated number of walleyes from the 1960, 1961, and 1962 year classes caught annually in Bear Lake, 1961-1965. The percentage of the total catch of walleyes contributed by each year class is shown in parentheses.

Year caught	Year class		
	1960	1961	1962
1961	0	0	0
1962	52 (9.1)	0	0
1963	81 (8.3)	163 (16.7)	0
1964	317 (25.6)	193 (15.6)	448 (36.1)
1965[a]	190 (28.6)	47 (7.1)	237 (35.7)
Totals	640	403	685

[a] Excludes the fall catch which is usually insignificant.

Table 3.--Average length (inches) of Fife Lake walleyes taken either in trap nets or by anglers in 1964 and 1965. Number of fish in parentheses.

Year caught	Year class 1960	1961	1962
1964	21.9 (9)	16.8 (146)	14.9 (13)
1965	20.2 (4)	18.1 (79)	17.4 (2)

Table 4.--Estimated number of walleyes from the 1960, 1961, and 1962 year classes caught annually in Fife Lake, 1963-1965. The percentage of the total catch of walleyes contributed by each year class is shown in parentheses.

Year caught	Year class		
	1960[a]	1961	1962
1963	102 (43.3)	63 (26.7)	0
1964	11 (20.0)	34 (63.3)	4 (6.67)
1965[b]	11 (21.4)	33 (64.2)	7 (14.2)

[a] A naturally produced year class.

[b] Excludes the fall catch.

Table 5.--Number of walleyes from the 1960 or older, 1961, and 1962 year classes caught from Fife Lake during 1964 and 1965 by anglers and by trap netting. The percentage of the total catch by each method is in parentheses.

Method of capture	Year class		
	1960 and older	1961	1962
Angling	12 (27.2)	28 (63.6)	4 (9.0)
Trap netting	13 (3.3)	367 (93.3)	13 (3.3)

Table 6.--Estimated number of survivors (derived from Fig. 1) and estimated harvest from the 1961 year class of Fife Lake walleyes at successive ages

	Age									
	0	I	II	III	IV	V	VI	VII	VIII	IX
Survivors	22,950[a]	4,266	1,950	1,298[b]	1,035[b]	832	552	263	55	1
Survival rate		.186	.457	.666	.797	.804	.663	.476	.209	.018
Harvest	0	0	98	65	52	42	28	13	3	0

[a] Number of fingerlings stocked.

[b] Mark-and-recapture estimates.

Table 7.--Model of a walleye fishery with a constant harvest of two adults (3 lb.) per acre per year which estimates the number per acre of survivors and catch of each year class until stable recruitment is achieved

	Year following first plant													Total catch
	0	1	2	3	4	5	6	7	8	9	10	11	12	
1st plant														
Number survivors	100[a]	-	-	10.0	6.8	4.6	2.6	1.1	0.2	0.0	-	-	-	-
Number caught	-	-	-	2	1.4	0.9	0.5	0.2	0.0	0.0	-	-	--	5.0
2nd plant														
Number survivors	-	30[a]	-	-	3.0	2.0	1.4	0.8	0.3	0.0	-	-	-	-
Number caught	-	-	-	-	0.6	0.4	0.3	0.2	0.1	0.0	-	-	-	1.6
3rd plant														
Number survivors	-	-	35[a]	-	-	3.5	2.4	1.6	0.9	0.4	0.1	0.0	-	-
Number caught	-	-	-	-	-	0.7	0.5	0.3	0.2	0.1	0.0	0.0	-	1.8
4th plant														
Number survivors	-	-	-	35[a]	-	-	3.5	2.4	1.6	0.9	0.4	0.1	0.0	-
Number caught	-	-	-	-	-	-	0.7	0.5	0.3	0.2	0.1	0.0	0.0	1.8
5th plant														
Number survivors	-	-	-	-	40[a]	-	-	4.0	2.7	1.9	1.1	0.5	0.1	-
Number caught	-	-	-	-	-	-	-	0.8	0.5	0.4	0.2	0.1	0.0	2.0
Total catch	-	-	-	2	2	2	2	2	-	-	-	-	-	-

[a] Number per acre of stocked fingerlings.

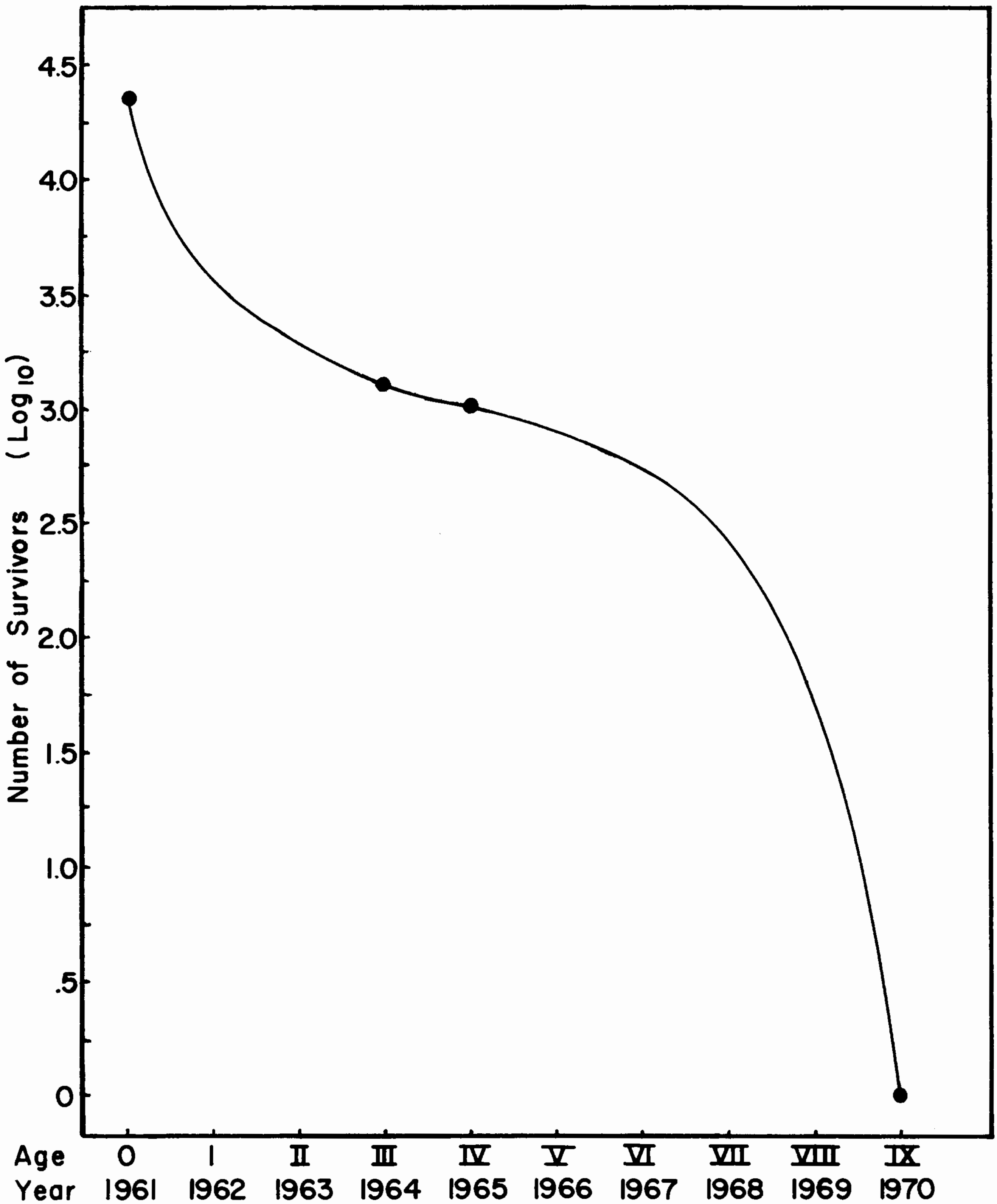

Figure 1.--Survivorship curve for the 1961 year class at Fife Lake.