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Recommended Citation

Eddy, S. (1940). Minnesota Lake Surveys And Fish Management. *Journal of the Minnesota Academy of Science*, Vol. 8 No. 1, 9-14.

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Biological Science

MINNESOTA LAKE SURVEYS AND FISH MANAGEMENT * 1

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Lake surveys consist of quantitative inventories of the physical, chemical and biological conditions of lakes, determining the productivity and carrying capacity in terms of the elements of fertility and the resulting food and fishes. Such surveys have developed within the last fifteen years.

Surveys are necessary to solve the troubles of problem lakes where the fish are stunted and not thriving. Lake surveys show many cases where lake improvement is needed. Lake improvement has been somewhat neglected in Minnesota, and is difficult because of the vast number of lakes.

The public appears to believe that lake surveys are a cure-all for everything. Lake surveys are only the beginning and have been worthwhile, forming a background for the solution of many problems affecting Minnesota lakes. The lake surveys are the foundation for fish management.

Fish management means to manage a body of water and its contents in such a way as to produce a maximum sustained yield of fishes which are best suited to the conditions of the lake. This involves the improvement of the environment for fish life and necessitates maintaining the proper balance of size ratios in the population. Lake management for fish production is in an early stage of development and there is much which is not fully understood and worked out.

The first step in lake management is to determine the type of lake and the fishes best suited for this type, as the lake should be managed for the production of the kind of fishes for which it is naturally adapted. It is not practical to attempt to manage a pike lake for lake trout or a bass lake for pike. This is the first aim of the lake survey.

Surveys have indicated the suitability of various types of lakes for certain species of fishes. From these results, Minnesota lakes have been classified according to the fishes for which they are best suited. One type is suited for lake trout, another for brook, rainbow or brown trout. At least two different types, usually large lakes, are suited for wall-eyed pike. Small fertile lakes form a type suitable

* 1 Prepared with the assistance of Works Progress Administration, Official Project No. 665-71-3-69. Sub-project (69) No. 218, sponsored by University of Minnesota (1936-1940).

for bass, crappies and sunfishes. Shallow muddy lakes constitute a type suitable for bullheads and rough fishes. The characters distinguishing these various types have been described previously.*²

In order to manage a lake, the existing conditions of the fish population must be thoroughly understood. Surveys of populations are just as important as surveys of the environmental conditions. The ratio between the forage and predator fishes must be worked out as forage fishes are not usually great competitors of the predacious fishes which feed largely on the forage fishes. The ratio between the two year, three year, four year, and other age classes of the predominating fishes, must be determined. To evaluate these ratios, the proper ratio of age classes necessary to produce the well-balanced population must be worked out. This is one of our important future problems.

Studies on fish populations in Minnesota lakes have shown that frequently the lakes most heavily fished contain vast numbers of small and stunted game fish but very few large ones. Other lakes not so heavily fished contain more large fish and fewer small fish. Apparently there should be a balance in the population whereby all sizes should be well represented. Otherwise, lakes may be over-stocked with small game fish.

One of the important factors in maintaining the proper balance of size in a fish population is the presence of big fish which keep the numbers of small fish, even those of their own species, reduced. When a lake is over-stocked with small fish, increased fishing is not the remedy. Fishing is selective, most fishermen use tackle and methods specialized to catch only the big fish. Thus the natural control of the small fish is removed and the over-population results.

In lakes near the larger cities, the intensive fishing keeps the larger individuals of the game fish population reduced to a low degree. These lakes are usually very fertile and support a heavy fish population which, due partly to the heavy fishing, is composed mostly of large numbers of small fish. These lakes are usually either the bass-pike or the bass-sunfish type. It is probably impractical to manage these lakes for larger game fish but easier to manage them for smaller pan fish such as bluegills, pumpkinseed sunfish, and crappies.

Fishing regulations and hatchery operations are necessary for proper fish management but they should be correlated with the facts determined by lake surveys. Artificial stocking should only be done where actual surveys show a deficiency of young fish. The introduction of new species should not be made until it is fully proved that such species will not interfere with the production of desirable fishes already in the lake.

The amount of fish which can be removed from a lake without

*² Eddy, Samuel, 1938. Classification of Minnesota Lakes for Fish Propagation. Progressive Fish Culturist, 41:9-13.

disturbing the general production has never been worked out. Fish managers anticipate that there is, however, a yield limit just as there is a limit to the amount of game which can be taken from land areas without depleting the original supply. It is important to proper fish management that this yield should be determined and it will probably be necessary to limit the amount of fish taken from a lake to conform with this yield. This, however, is a problem which will take some years to solve.

Preliminary studies on sunfish and crappies have shown that only a very small number of fry, varying from 1% to 3%, survive to become fingerlings. From 10% to 75% of the fingerlings or 1 year-old fish survive to become 2 year-olds and from 10 to 40 per cent of the 2-year-olds survive at the end of the third year, when most of these fish reach what might be called adult size. Tagging studies of wall-eyed pike carried on in several Minnesota lakes by the U. S. Forest Service and the University, show that about 12% of the three and four year old fish die a natural death each year and that from 6% to 25% of these age classes are caught annually by fishermen.

These studies are but the beginning in determining the fate of the fish populations and have shown that the survival rate is not constant but varies in different lakes and also varies from year to year in the same lake. The results clearly indicate that a large number of fry must be produced annually, as only a small fraction will survive to become adults and that only a relatively small number of the adults can be taken without upsetting the sustained yield.

The improvement of lakes for the purpose of increasing the desirable fishes is one of the fundamental phases of fish management and consists of improving conditions for spawning, carrying capacity, and the specific needs of the fishes for which the lake is managed. It is possible to improve certain conditions for fish life which will increase the yield or productivity. All lake improvements should be based on previous surveys. The existing conditions in the lake for fish life must first be measured in order to determine those needing improvement. In all cases, the cost of the improvement must be considered to determine if results will justify the expenditures. In many Minnesota lakes the expense of many improvements would be so great that it would be impractical to attempt to remedy certain unfavorable conditions known to exist.

One of the major needs for lake improvement in Minnesota is the restoration of lake levels. Hundreds of lakes have had their levels reduced by drainage and drought until they no longer can carry fishes through the winter. Through lowered levels, other lakes which were once good game fish lakes have become suitable only for rough fish. The restoration of these levels will tax all the ingenuities of the water engineers.

It is possible to increase the fertility of many of the lakes by

adding commercial fertilizer or even ordinary barnyard manure. The proper use of these substances increases the productivity of the lake in food and consequently in more pounds of fish. In Wisconsin, and other states, it has been demonstrated that by fertilizing a small experimental lake, the size and number of fishes can be increased. Experiments with lakes and ponds in many other states have definitely indicated that fish production can be increased by fertilizing. A few Minnesota lakes have been fertilized but no checks have been made to determine the results.

However, many Minnesota lakes are too far from the source of fertilizers to justify the expense of fertilizing. Also, the extent and number of Minnesota lakes which could be profitably fertilized is so great that the expense would be prohibitive. This is a case where the results may not justify the expenditure. There is some consolation in the fact that fertility increases the depletion of oxygen in winter and in a region of severe winters too much fertility is undesirable.

One of the most practical improvements for our lakes is to increase the available food by either introducing the proper food organisms or by maintaining the proper kind and amount of vegetation for food production and shelter for young fish. In some cases, food may be increased by introducing forage fishes which do not compete with those already there and will not disturb the balance. This has already been done in some of the northern lake trout lakes where tullibee were absent. Lake Superior herring, which feed on material which was not greatly utilized in these lakes, have been introduced to provide additional food for the trout. Although this was done only a few years ago, in some lakes they have multiplied to a great extent. This is only the first step and the results seem to be successful. The next step will be to increase the lake trout population and eventually trout fishing should be greatly improved.

Proper vegetation in a lake is important for successful maintenance of fish. Vegetation forms not only shelter for smaller fish but produces much of the basic food for fishes. It is an important agent in oxygen production. Many of the lakes have their shore waters cleaned of all types of vegetation, particularly in front of cottages and around bathing beaches. These clean sand bottoms may be ideal for bathing but they are deserts as far as fish food and fish production are concerned.

Some lakes may be just the opposite and have too much vegetation. This is possible when the vegetation becomes so thick as to choke the open waters and prevent free movement of the fish. Likewise, too much vegetation may result in an accumulation of decaying plant waste during the winter to use up the oxygen and cause winter "kills." In many of the lakes, improvement may consist of restoring and increasing areas of vegetation, while in other lakes, improvement may consist of removing and restricting the growth of vegetation.

In many lakes, surveys may indicate that spawning conditions may be improved. Conditions for reproduction or natural propagation should be maintained at the highest possible levels in order to keep up the natural supply of fish. This is the natural way and is much cheaper than artificial propagation and stocking. For nesting species, sand and gravel beds should be constructed in lakes with muddy shores. In lakes with very soft mud bottoms, boxes of sand may be placed for bass nests. The production of blunt-nosed minnows, one of our most valuable forage fishes, may be greatly increased by placing boards and other structures under which fishes will deposit their eggs. The closing and protection of spawning areas is the cheapest and easiest way to insure sufficient reproduction.

The control of undesirable fish is one of the important steps in lake improvement. Destructive fishes such as carp, dogfish, and others, may compete with the game fish or may destroy conditions necessary for game fishes. The destructiveness of carp in Minnesota lakes has long been proven by the devastation of vegetation and the feeding and spawning beds for the game fishes. There are lakes in which the carp has practically eliminated all other fishes. The only sure way of exterminating the carp would be to kill every fish in a body of water by dynamite or a poison such as rotenone. This method is impractical for most Minnesota lakes because of the vast areas concerned and the enormous expense involved. Furthermore, it does not insure against the reintroduction of carp, which may occur through the use of young carp as bait in a fisherman's minnow pail. The most practical method at present for the management of carp is to control them by seining, by trapping on their favorite spawning beds, and by screening inlets and outlets where they may gain access from other waters.

The effect of attempts at fish management in the past without a thorough knowledge or study of conditions is well demonstrated by the planting of certain fish. Over fifty years ago, certain people thought they wanted carp and so they were introduced. These people got their carp and we are still getting results from this successful planting.

In Minnesota, all kinds of fishes have been introduced into hundreds of lakes without much thought of the consequences. Fortunately, in some cases these introductions were satisfactory. Many people would like to have every kind of a game fish in their particular lake. This desire is largely responsible for much of the indiscriminate planting which has occurred. It seems a shame to destroy a fine bass lake by introducing wall-eyed pike but this has been frequently done.

Shallow muddy lakes with a maximum depth of twenty feet or less may be subject to "winter kills." Stocking such lakes with game fish is a definite risk. Such lakes are usually best suited for bullheads and rough fishes, and if any other fishes are introduced, in most cases they should be limited to crappies and bluegill sunfishes.

Fishes, such as our game fishes, trout, pike, and bass, all feed on about the same kind of food and are, therefore, competitors of each other. It should be kept in mind that a lake provides support for only a limited amount of fish and when a competitive fish is introduced, it is only reasonable to assume that the maintenance of the native species will be reduced. The introduction of a new species into any lake should be studied carefully. It is sometimes much harder to remove it than it was to introduce it. It is seldom that bass lakes can be found in which trout will live, but thousands of dollars worth of fry of various species of trout have been wasted in attempts to establish these fish in all kinds of lakes. This type of planting is not good management and is not based on careful surveys. Lakes should be managed for lake trout only in rocky lakes where surveys show sufficient oxygen in the cold water below thermocline during the hot summer months.

All introductions have not been mistakes. There are many cases of small lakes without fish or with only perch which have been successfully stocked with bass and in some cases with rainbow trout. Many large lakes in the northeastern part of the state, until fifteen years ago, contained only pickerel or great northern pike and a few rough fish. The conditions of these lakes were considered carefully by Mr. Thaddeus Surber of the Division of Game and Fish and wall-eyed pike were introduced. The result of these introductions has been one of the most valuable and successful phases of management of Minnesota fishes before it was called management.

It is essential that all fish management must be based on common sense. Fish management is the method by which the reputation of Minnesota fishing will be maintained. No business could be run the way our fish resources have been managed for the past seventy-five years. No information was available of the extent of the fisheries resources or the rate at which they are renewed. Fish management based on lake surveys and population studies will improve the environment and will maintain the proper fish balance.

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THE EFFECT OF ENVIRONMENTAL FACTORS UPON THE GROWTH RATES OF MINNESOTA FISHES *¹

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The effects of certain environmental conditions upon the rate of growth have been investigated for a few species of fishes, but little has been done toward a general solution of the problem. Under nat-