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PROVIDING SHELTER, FOOD AND SPAWNING FACILITIES FOR THE GAME

FISHES OF OUR INLAND LAKES

by

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Lake improvement, as we propose this term, signifies the creation and maintenance in our inland lakes of conditions which favor an abundant crop of game fish. The premise of lake improvement is based on three premises: (1) lake fishes require more than pure water in which to survive, grow and multiply; (2) such essential conditions as shelter, food and spawning facilities are often so deficient as to limit the production of lake fish; (3) it is practicable to increase the yield of lake fish by building up the deficient factors.

Lake improvement is environmental control applied to the increased production of lake fish. It rests on the same biological bases as the better known and more thoroughly tested activity of stream improvement, which is the environmental control of stream fishes, particularly the trout (Hubbs, Greeley and Tarzwell, 1932). Lake and stream improvement together comprise a main branch of fish management, just as another type of environmental control is a fundamental part of game management (Leopold, 1933). Lake and stream improvement are main divisions also of aquiculture, or aquatic farming. They are the approximate counterparts of silviculture in forestry.

It follows that lake improvement is an important and integral field of wildlife management, and therefore of conservation in general.

When it first became evident that the supply of our game fishes was becoming depleted, laws were passed to limit and regulate the catch, in the expectation that the enforcement of these measures would stop the depletion. As depletion nevertheless continued, chief faith was transferred onto the introduction of species not native to the waters being stocked, and onto the artificial propagation of a few desired fishes. Despite partial or temporary successes, and some spectacular results, fish culture did not justify the faith of its more ardent advocates, that it would build up the stock to the extent that restrictive laws might be mitigated or repealed. On the contrary, the natural stock of game fish generally further reduced. In recent years, the strain on the supply has become continually greater, as the number of fishermen has increased and as the means for transportation have been perfected and made generally available. There has consequently developed an acute need for a new means to be used by state and federal authorities, and by private groups and individuals (assuming that some occasion may remain for individual action), in their efforts to maintain the stock of game fish. To meet this need a new method for conserving and upbuilding the game-fish supply has recently been proposed, and is now being brought into action. This new method is lake and stream improvement.

A few enthusiasts think that lake and stream improvement should replace fish culture; that all the money now being spent in hatching and rearing fish could more effectively be spent in making our lakes and streams more fit for the natural production of game fish. We oppose this extreme view, but believe on the basis of present evidence that improvement work promises to become an increasingly important supplement to fish culture, much as fish culture has helpfully supplemented restrictive legislation. We think it safe to conclude that much benefit will be derived from lake and stream

improvement, but there is little evidence to indicate that this new activity will quickly bring on an angler's millenium. It may even be anticipated that money and effort will be unwisely spent, at times and in places, in the improvement work; in other words, that history will repeat itself. Unwise fish laws have often been passed; good laws have failed of enforcement; some species have been unwisely introduced; others have been stocked at considerable expense in waters unfit for them; hatcheries have been built where the water supply is inadequate; diseases have been introduced and spread through hatcheries. Despite these commonly recognized blunders, fishing regulations and fish culture have enormously helped to conserve the fish supply. Similarly we may anticipate that lake improvement, despite false moves, will serve effectively as an aid not only in conserving, but also in further building up the game-fish population. To avoid false moves, with their financial losses and their retarding of progress, it is of vital importance: (1) that research on the methods and results of lake improvement be very materially expanded and intensified; (2) that more men be trained to carry on this research and to install the lake improvements; (3) that demonstrations of lake improvement methods be set up as soon as the methods are adequately studied and tested, and (4), of course, that adequate funds be provided to support this research, training of men and demonstrations as well as the routine activity of lake improvement.

Increased fishing is a main reason why this new aid in conserving and increasing the fish supply of our lakes is needed. Other reasons, fundamental and important, also exist. Deforestation and the cultivation of the land, and especially the drainage of the soil and of marshes and lakes by tiling and ditching, have, singly or in combination, lowered the water table, thus reducing the size of many lakes, and converting some of them into marshes or much flats. In the West, these factors, along with overgrazing and irrigation, have converted fine lakes and marshes into alkali flats.

These activities of man have also increased soil erosion, causing smothering silt to accumulate on formerly productive lake shoals, and causing the lakes to become roily and therefore less productive of the green plant life which serves as pasturage for the aquatic animals. The organic content of some lakes has been increased by sanitary sewage and by rich material leached out of the soil, so much so in certain regions as to cause an excessive growth of noxious algae in the summer and the winter-kill of fish beneath the ice.

Even under the name of "improvement", lakes have been made less favorable for fish life. Productive marshes and shoals have been filled in to provide cottage sites and roadways, and to control mosquitoes. Needed fish shelter, in the form of brush, logs, weed beds, etc., has been removed or sanded over to provide bathing beaches, to facilitate boating, or merely to "beautify" the lakes. Plant growths have been torn up, the bottom disturbed and spawning grounds ruined by bathing and boating, especially by motor boating.

Most of these activities of man have harmfully affected fishing in our lakes, by making the environment less favorable for the fish. These harmful effects can for the most part be corrected by lake improvement methods, which are designed to make the environment more favorable to fish life. Thus lake improvement can serve to restore desirable conditions which have been destroyed or damaged.

Lake improvement can serve not only as an agent of restoration, but also as an agent of prevention. Understanding the basis of lake improvement should help to avoid the practices which, as outlined above, are harmful to the fish life of lakes.

By effective improvement methods it may be feasible not only to conserve, but also to increase the fish supply. Many of the deficiencies in the environment are not the work of man, but of nature. Correcting these natural

deficiencies may often be expected to materially increase the fish crop in our lakes, even beyond the limits of primeval abundance.

One more important reason for the improvement of the fish environment in lakes is that much of this work is simultaneously effective in bettering the conditions for waterfowl. This is notably true of increasing weed-beds and flooding the adjacent marshes.

The effective improvement of lake waters rests on two fundamentals. One is to know the environmental requirements for a good crop of lake fish of each species. The other essential is to learn how these requirements may be met. The basic idea is to determine what factors are limiting the abundance of the desirable game fish, and then, within the limits of practicability, to overcome or remedy the natural deficiencies.

In addition to suitable water conditions, which although often subject to lake improvement are not included in the definite topic of this talk, the essential requirements for a large yield of fish in an inland lake are: (1) sufficient shelter to allow the growing fish to escape their ever-present enemies, since a continuous new supply of growing and maturing fish is needed to replace the game fish which are being caught off; (2) enough food, since the growth of the replacement stock is obviously dependent upon the amount of available food; (3) adequate spawning facilities, since these are required for the natural restocking of the lake. It is possible of course to replace natural spawning with artificial propagation, but it seems far more economical in many waters to provide means for natural spawning. Whether the replacement stock is natural or artificial, it certainly needs be sheltered and fed in nature. It is surely far beyond any reasonable limit to expect that a sufficient supply of game fish for all of the many thousands of lakes in our country can be artificially bred and reared and fed until they reach a size fit for fishing. The artificial propagation of lake fish may provide the seed for stocking, but even if the output of

the hatcheries and rearing stations were increased many fold, there would still be need for the conditioning<sup>n</sup> of the environment in lakes. In fact, the heavier the natural stocking, the greater will be the need of shelter and food for the planted fish. Otherwise the stock may largely be consumed by predators or may over-run the lake with runt fish. These are not merely possibilities; they are matters of frequent observation.

The ideal in lake improvement is to modify each factor of natural fish production, so that it will make a most effective contribution to a larger and more dependable crop of fish for the angler to catch, remembering always that for each requirement there is an optimum from the standpoint of fish production. An excess of shelter interferes with fishing, and with normal fish existence, whereas too little shelter allows the growing stock of fish to be destroyed. Water pure beyond the optimum lacks the fertility absolutely necessary for the production of sufficient natural food, but water too rich in organic matter produces obnoxious plant growths and winter killings of fish; too much natural food makes it difficult to catch the fish. Spawning conditions when too satisfactory, or excessive plantings, lead to the over-population of the lake with stunted fish, just as truly as an understocking with naturally or artificially bred fish leads to depletion.

To obtain a maximum crop of lake fish, all conditions in the lake should be adjusted so far as practicable, so as to make the lake a self-sustaining biological unit. All the essential requirements for a large fish yield should be provided; none may be omitted, because the lack of any one is sufficient to hold down production. Plenty of good water alone does not make a fish lake. Good water, sufficient food, and adequate spawning facilities together will not produce many adult game fish, unless shelter for the developing fish is provided. The low fish population of many lakes is no doubt traceable to the inadequate development of only one or two of the essential requirements. That is the circumstance which makes it

practicable to remedy the deficiency through lake improvement. Relatively slight modifications in limiting factors--whether of shelter, food, spawning or other essentials--may greatly increase the carrying capacity of the lake.

Regarding the lake as a complex biological unit, it becomes apparent that the correct balancing of conditions is of utmost importance. As indicated above, an excessive development of any one factor in fish production, whether of food, shelter or spawning, should be avoided. Little benefit can be anticipated from making shelter more than sufficient for all the fish the lake will produce or feed. The fish population of the lake will be thrown out of balance, in relation to the food supply, by an unlimited increase in the spawning facilities (as also by excessive stocking). Overcrowding allows each fish only a small amount of food and results in decreased growth rate, often in a dwarfed stock. Over-crowding also tends to harm the fish by increasing disease, and perhaps by other means. The greatest annual production of fish suitable for the angler results when there are just enough, neither too few nor many individuals in relation to the food supply.

Under the present condition of ignorance, it can hardly be expected that an exact balance can be struck in improving a lake. Or if by chance or good judgment an approximate balance has been attained, it is unlikely that the balance can be maintained. Biological adjustments are delicate, subject to natural fluctuations which are often unaccountable or at least beyond control. A poor spawning season, for instance, may greatly reduce the replacement stock of fish. An increased fish production will tend to attract a disproportionate amount of fishing, thus overthrowing the balance.

Under continuous fish management (the only logical kind), it is perhaps undesirable that an exact balance of the biological conditions be struck, for the objective should be an approximate balance of factors, on successive

levels of an increasing fish production. An effort should be made to build up first the weakest element in the fish-producing environment, so as to provide for the maximum fish population which can be maintained by the other environmental conditions. When the least developed or most limiting factor has been built up and has increased the fish production, some other factor may then become under-developed in terms of the increased population. Thus an increase in spawning induced by adding spawning beds may render inadequate the shelter for young fish, even though fully enough shelter had previously been available. The increased numbers of growing fish may then consume what previously may have been a surplus of natural food. In this way the balance would tend to be successively overthrown. Each attempt at restoring the balance should lead in a cumulative way to greater fish production. This process should be continued to the practicable limit, which will depend on the intensity of fishing and on the economic values involved. As fishing is bettered this limit will tend in itself to rise. This is one reason why the need for lake improvement is extensive and permanent.

In planning the improvement of a lake it is highly desirable and efficient first to conduct an intensive survey of the aquatic conditions which may control the fish production, and to have this survey conducted by men competently trained not only in freshwater biology and fisheries science, but also in lake improvement work. The actual operations of lake improvement, following the program developed by the survey, should be conducted by men experienced in this work. Even in other than test lakes, some check-up should be maintained on the permanence and effectiveness of the improvements, to allow for the maintenance and modification of the installations. Particularly in this early stage of lake improvement work, it will often if not usually be difficult or even impossible to provide for a thoroughly scientific survey, for skilled workmen and for an adequate follow-up. The whole field of operation needs be enormously developed and improved, through research, training of men and demonstrations. The development of lake



improvement technique is most likely to accompany an expansion of the improvement work.

Our several years of experience in developing the idea of lake improvement, in making experimental installations, in supervising and planning for large scale operations by the E.C.W., and in checking our work and observing that of others, have led us to believe that the work has been well worthwhile even when conducted with little experience or technical competence, but that far greater returns can be anticipated as experience grows; as research is carried on, in the fundamental problems of limnology and ichthyology as well as in the methods of environmental control; as men are trained to competence for this research and for the practice of lake improvement, and as the perfected methods of improvement are made known through demonstrations and publications.

We should not lose heart because these ideals have not yet been realized. The field of lake improvement is still very young, for it was the outgrowth of the lake surveys conducted from 1930 to 1932 by the Institute for Fisheries Research under the auspices of the Michigan Division of the Izaak Walton League and the Michigan Department of Conservation. This survey soon indicated an obviously deficient production of game fish in many lakes, and definitely suggested deficiencies in the environment that seemed responsible for the small supply of fish. Applying to this situation the invaluable conservation query, "What can be done about it?", led us into our initial experiments in lake improvement.

As a contribution to the development of lake improvement we have prepared a fairly comprehensive bulletin, treating not only the need for environmental control, as briefly outlined here, but going into far more detail than is possible in this paper in regard to the specific requirements of the different species of lake fishes, the value of survey work in determining deficiencies in these requirements, the planning and carrying out of

the improvements, and the many methods of improving conditions for the various lake fishes; further treating, also, the practicability and value of lake improvement. It is hoped that this bulletin, after long delays, will soon be off the press, and that it will play a part, as did our bulletin on Methods for the Improvement of Michigan Trout Streams, in transforming thought and action on the fish side of wildlife affairs,--helping to replace the mere protection of fish by the restoration of the supply, through a purposeful increase in the carrying capacity and productivity of our inland waters.