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# THE TECHNIQUE OF IMPROVING OUR FISHING WATERS

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The upbuilding of the game-fish resource is a complex problem involving three primary factors: (1) the crop harvested by the sportsman; (2) the stock of the fish species concerned, and (3) the enivronment of the fish.

Each of these three main factors involved in fish increase is subject to control by man, and has been subjected to a greater or lesser degree of control.

(1) The harvest or total sport catch can be regulated by various restrictive laws. These measures and their enforcement have usually been necessary and helpful. But unlimited extension of regulatory measures is manifestly insufficient. Restrictions are essentially means of saving, rather than of producing.

(2) The stock of the given species of game fish can be directly increased by fish culture. Efforts to build up the fish population by the establishment of exotic species, and by the continued propagation of both foreign and native species, have been in general well repaid. Fish culture however has usually proven insufficient in maintaining the stock, not to mention increasing it. Even a great expansion of propagation can not be expected to meet successfully the increasing drain on the fish supply. The effectiveness of an unlimited increase in fish culture must encounter the limitation set by the carrying capacity of the environment. When this limit is reached, we can not expect more fish production to result from doubling the stocking, any more than we can expect more corn production to follow the planting of twice the normal amount of seed per acre. Even though the carrying capacity of a body of water has not been reached, greatly increased stocking faces the law of diminishing returns. We can have little doubt that the

nearer the carrying capacity is approached, other factors remaining equal, the smaller will be the advantage gained from each additional increase in the number of fish planted.

The stock of fish can be added to by increasing natural reproduction as well as by expanding artificial propagation. This is one of the fundamental means by which the improving of our fishing waters can be expected to help increase the fish supply and the fish crop. Natural reproduction can be increased by many forms of environmental control, among which we may mention:

(a) Allowing fish access to natural spawning grounds.—This can be accomplished by constructing really usable fishways over dams; by regulating pond levels so fish may reach and utilize such spawning areas as marshes, or strips of gravel along the shore; by cleaning out feeders too choked for fish to readily pass through on their spawning runs; by opening up channels into adjacent lagoons or swales suitable for spawning. (b) Increasing the spawning facilities. This can be accomplished by exposing original gravel bottoms in trout streams, as has been done by the current-accelerating deflectors described in our Bulletin on The Methods of Improvement for Michigan Trout Streams; by preventing the burying of more gravel bottom through erosion control; by adding gravel to stream or lake bottoms for the use of species which prefer to place their eggs in gravel; by installing gravel-filled spawning boxes on bottoms too soft to hold up gravel otherwise; by adding lighter debris on very soft bottoms for the use of species, like bluegills and large-mouth bass, which readily utilize such material; by establishing bullrushes or other plants whose stems or roots serve to support the eggs of certain species. (c) Finally, the natural reproduction of game-fish can be increased by providing effective cover in the form of brush shelters or otherwise, for the young fish after they have hatched.

Increasing the natural reproduction has of course the same limitations as has the expanding of artificial propagation. Merely adding to the stock of fish in any given water will not increase the fish production beyond the capacity of this environ-

ment to produce fish. And the nearer this producing capacity is approached, the less effective will be each addition of another lot of young fish.

(3) Obviously the course to follow, wherever and whenever practicable, is the improvement of our fishing waters so that they will carry more game fish, producing a larger crop for the angler to catch. The conditions holding down the fish production should be first determined by a lake or stream survey. Then these conditions should be rectified. This is the essence of the new idea of environmental control, as applied to the fish supply.

The improving of our lakes and streams is being shown to be a really successful method for the increase in our supply of game fishes. The fish yield has been very much increased in sections of trout streams which have been improved. Good catches of lake fish have been made about brush shelters, immediately following their construction. So marked has been the increased catch of fish about the new constructions, that many have questioned whether this new method is not merely adding to the depletion of the fish supply. We regard this legitimate criticism as unsound for the following reasons:

Unimproved sections of a lake or stream, which are unquestionably at first depleted because the fish take quickly to the improved areas, remain capable of holding as many fish as before, and should hold them, after the improved sections have become crowded.

There is some evidence that a large proportion of the fish crop of most species is not harvested by man. If this is true, it follows that attracting and concentrating the adult fish to make their capture more certain, increases the percentage which the angler catches and decreases the percentage going to the natural enemies. It must not be forgotten that an increase in the catch, up to the point of not endangering the future supply, is our prime objective.

It is possible to construct the improvements so that some of them will serve as refugees, insuring the survival of a brood stock.

A reduction in the number of adult fish, when the population of large fish is anywhere near the saturation limit (carrying capacity) adds to the growth of the young replacement crop.

~~Rapidly~~, the improvements if intelligently installed increase the reproduction, survival and growth of the fish, through the bettering of conditions. The replacement rate may thus be accelerated, so as to balance the increased depletion by the anglers.

That the reproduction, survival and growth of game fishes in lakes and streams is subject to increase through human control is rapidly passing from a theory to a demonstration. Trout have repeatedly been observed spawning in gravel uncovered by current deflectors, and in gravel which has been hauled into streams with sand or marl bottom, and lake fish have utilized gravel spawning areas which have been added to the shoals. Nearly 7000 young and half-grown fish by actual count, almost all game and pan fish, have been seined about a single small brush shelter. Observations and study have shown that the food for fishes can be and has been increased, by such means as improving the conditions for insect larvae and providing spawning facilities for forage fish.

Finally, the ideal method is to improve a whole lake or stream, so as to make all sections habitable, to make all food producing areas available to the fish and to avoid any undue crowding of either fish or fishermen.

The success resulting from the improvement of our fishing waters is likely to install over-confidence in its possibilities. Some enthusiasts are already beginning to claim that fish hatcheries may now be abandoned or greatly curtailed. This view is no more justified in our opinion than was the baseless hope of some early fish culturists that artificial propagation would render unnecessary all fish laws. The upbuilding of our game fish supply requires every possible means: laws and regulations wisely made and thoroughly enforced; extended and improved fish culture, and the improvement of our fishing waters.

The improvement of fishing waters involves the restoration of natural conditions where these have been destroyed. This is to be accomplished by such fundamental changes as the alleviation of the silt and pollution nuisances, the re-meandering of unnecessarily ditched streams, the restoration of unwisely drained lakes, and the construction of artificial lakes. Perhaps no other factor has been more important in the depletion of the fish supply, in agricultural and sandy regions, than the silting. This has resulted in the filling of holes, reducing the general depth and smothering the natural food-producing bottom with a blanket of sand or mud, to change it into a valuable aquatic desert. The control of soil erosion, the cause of the silting, is demanded from all conservation viewpoints. The evil of pollution is too well known to need any restatement. It is not so generally recognized that thoroughly treated sewage may be a great boon to fish life, for its solid matter is removed and its excess oxygen-demand destroyed, while its fertilizing elements (phosphates, nitrates, potassium, etc.) are retained. These increase the aquatic life, just as the same elements in ordinary fertilizers increase land crops. The draining of lakes, marshes and bayous, and the ditching of streams, has been seriously detrimental to fish life. It is becoming realized that such drainage has often been carried beyond the needs of agriculture. Conservation of fishing requires prevention of unwise drainage practices and restoration of high water levels when compatible with agriculture. The construction of artificial lakes is of course an especially important means of increasing the fish supply.

These are big-scale, fundamental methods for the increase of fish life, indispensable to the attainment of our goal of going beyond the mere conserving of the dwindling fish supply. These methods deal with streams or lakes as a whole. In general they require state action, and involve other wild-life interests. We are more particularly concerned in this paper with those methods of improving fish conditions which are usable by individuals, and which are designed for the direct and

immediate benefit of fishing in the part of the stream which has been improved.

A technique for the improvement of American fishing waters is rapidly being developed, since this method for building up the fish supply has been appreciated in many parts of the country. Like many other latent ideas, this one has sprung up independently and simultaneously in many places.

Without meaning to underestimate the importance of improvement methods developed elsewhere, we shall briefly discuss the technique of improving fishing waters as this is being developed in Michigan. In this state, the improvement of public trout streams has been practiced since 1927, when the Department of Conservation inaugurated the work. During the past three years (1930 to 1932), this activity has been expanded, and the checking of the results and the related investigations have been carried on by the Institute for Fisheries Research. The first bulletin of this Institute deals with "Methods for the Improvement of Michigan Trout Streams". This publication goes farther into detail than is possible in this brief report. It may be purchased from the Institute for Fisheries Research, University of Michigan, Ann Arbor, Michigan. Lake improvement work has been developed in a similar fashion, during the last two years, following and in conjunction with the lake surveys conducted by the Institute under the support of the Michigan Division, Izaak Walton League of America.

## Stream improvement devices

Improvement devices for streams may be roughly classified as dams, deflectors and covers.

Dams are designed to make pools, varying in size from those only a few inches deeper than the original stream, up to large artificial lakes. They increase the available water volume for fish life and create a fast water pool below, provide holding basins over periods of low flow, and increase the food supply. Dams in streams with low banks may overwarm the water and kill the brush where flooded. On such waters they are not desirable. Dams may be built of boulders, using care to

chink stones in between the boulders, and finally using gravel on the upper side to prevent leakage. Alternate layers of brush and stones may be built up into a sturdy and watertight dam. Log dams are good if made nearly or quite leak-proof, and if very securely staked down. The Hewitt Dam has been described and figured so often, and so many of them have been built, that a description is not necessary. Several other types of dams for trout streams have been devised.

Various types of deflectors, described in the bulletin on "Methods for the Improvement of Michigan Trout Streams", are especially well adapted to sandy low-banked streams. Deflectors are designed to put the current to work: to force the stream to improve itself. By careful planning, the current (unless very sluggish) can be made to create and enlarge pools in soft-bottomed streams to almost any degree desired, with the expectation that the sheltered pools so constructed will increase the carrying capacity of the stream for large trout. The principle of the deflectors is the blocking of only part of the stream, thus concentrating and accelerating the current where not blocked. Where properly slanted (30° to 60° downstream), this type of barrier does not greatly spread out the water above, although it deepens the water several inches by offering a partial resistance to the natural flow. Silting of the bottom is avoided. The deepened water above, the crevices about the stone or log construction and the deepened riffle below are all attractive to fish. Exposed and washed gravel increases the food production and provides spawning grounds. Weed beds produced in the lee of the deflectors and in the quiet water below furnish shelter as well as food. The construction methods for deflectors are in general similar to those for dams. The different types of deflectors include: wing deflectors, slanted downstream from one shore; V-deflectors, confining the water to form a midstream riffle below the opening in the V; Y-deflectors, similar to the V's but with parallel directors below; I-deflectors, cross-bars in mid-current; A-deflectors, splitting the current against either banks; underpass deflectors, designed to gouge out a hole below. All these types are effective and useful in the proper situation.

Digging holes, uncovering gravel, producing riffles and establishing weed beds, by means of deflectors, are all to the good but do not complete the improvement of a stream for trout. A small shallow pool with good cover is usually more acceptable to trout than a large open pool. And the large open pool can be greatly benefited by adding hiding places. Some streams or sections of streams already 3 feet or more deep may need only shelter to build up their carrying capacity. It is generally sound policy to combine deflectors with covers, directing the accelerated current against a cover. Especially when the shelter devices are made with a front digging log, the strong current is forced down to gouge out a hole below. Thus the finest sort of trout holes are produced. Cover types described in the bulletin already referred to include the boom cover, bend raft, bank cover, triangle cover, X-cover, tepee cover, stumps, bridge covers, "fish house" or slab covers and stepping stones.

The boom covers and bend rafts are designed to serve a double purpose—providing shelter for trout, and retarding erosion on the outer swing of the bends. Controlling stream erosion is one of the most fundamental and important means of improving streams, as already pointed out. The planting of shrubs and trees along eroding banks to prevent bank erosion, as well as to yield shade, and the planting of trees, grass or other suitable vegetation on high banks, to bind down the surface soil, will no doubt become important methods of bettering stream conditions. The Institute for Fisheries Research now has a graduate student tackling these problems.

To counteract the tendency of stream improvement to concentrate the fish and to increase the catch, care should be taken to balance the conditions so that all stages in the life cycle will be benefited. The first step, where practicable, is to better spawning conditions. The next is to provide adequate shelter for the young trout. Brush shelters or weed beds can be established and little side channels or spring runs can be cleaned out for fry nurseries. Other methods for the improvement of trout streams are also available.

It has already been demonstrated:

(1) That barriers (dams, deflectors and covers) can be installed cheaply and soundly.

(2) That the life-conditions for trout (shelter, spawning and food) can by these means be markedly bettered.

(3) That trout quickly respond to and take advantage of the bettered conditions.

(4) That long stretches of heretofore troutless or almost troutless water can thus be made to yield good catches of adult trout within a few months after the installation of well-designed improvements.

Environmental control in lakes has also shown great promise. The improvement of lake conditions, for the basses and other game fishes, promises to take a place along side of stream improvement.

Progress has especially been made along the line of increasing shelter for the young fish. That young fish take readily to brush shelters has been clearly observed. As mentioned before, one small shelter was found to be harboring nearly 7000 young game fish. The shelters also serve to attract large fish, and have thus increased the fish catch. Methods for the construction and installation of brush shelters are being developed.

Experiments have been undertaken to increase the supply of forage fish: the minnows on which the bass grow big. The blunt-nosed minnows is an especially valuable forage fish, since it is non-predaceous, and subsists upon bottom materials, with the small plant and animal life contained therein, thus providing a direct link between such food and the game fish which feed upon the minnow. The eggs of this minnow and of a few other forage fishes are desposited on the under side of the stones, boards or other flat objects. Boards built into "minnow slabs" are bound to be utilized as spawning places. Experiments in ponds have shown that the reproduction of these species of minnow can be greatly increased by providing them with an adequate quantity of spawning surface. The principle is being applied to lakes, to increase the growth and the numbers of bass and other species of game fish, which feed upon minnows.

Methods for the increase of weed beds in lakes are being studied with the expectation that practical means for increasing weeds where they are needed will result.

The establishment of gravel beds in suitable places has been accomplished as part of the lake improvement program. The absence of gravel beds suitable for spawning is considered to be one reason for the failure of small-mouthed bass to reproduce in certain waters which seem otherwise well suited. Gravel added to lakes is also used by some of the pan fishes.

Adjoining lagoons which are rich and well suited to supporting fish life are being connected by ditching to the lake, so that fish may utilize the favorable area for feeding or spawning.

Many things may be done to make our aquatic environments more productive of fish life. The work which has been done in Michigan may be considered a mere start. Many years of effort, by a great number of individuals, will be required before fish environments can be made to yield their maximum productivity. But the promise of the work already accomplished leads us to predict that it will prove possible to increase our supply of game fish to an abundance well beyond the present level.