TROUT STREAM IMPROVEMENT IN MICHIGAN

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Maintaining trout fishing at its former standard of excellence is proving to be a serious problem. Fish hatchery methods and fish culture are only two of the necessary steps leading to more and better trout fishing in our streams. Some thought must be given to the welfare of the fish after planting, and attention to improving the habitat. We can no longer depend merely on stocking because if conditions in the stream itself are not favorable, we cannot hope to be successful in producing large numbers of fish of suitable size. Conditions in the waters themselves must be bettered if the fish are to have adequate cover and food. It is possible to improve a stream considerably in counteracting the natural deficiencies by artificially improving upon what has been naturally provided or by restoring what man has destroyed.

Deforestation and lumbering practices have nearly ruined many of our streams, the former has removed shade and cover and has caused quick run-offs which are carrying immense quantities of ruinous sand into the streams every year, covering up the spawning beds and food producing areas. One of the methods of lumbering was directly in opposition to the production of trout. Dams flooded the spawning beds, and log drives scoured them out. Flooding for the drives widened the streams and washed into them non-productive sand which covered up the gravel. The rivers were cleared of all jams and cover before the drives and they were swept clear of any vestige of cover by the rush of logs. All these things—the destroying of spawning beds, the covering of great areas with sand, the excessive widening of the stream, and the removal of all cover, are now making themselves harmfully apparent. Perhaps the best way to regulate conditions already disturbed is to restore as nearly as possible original and normal conditions.

This problem is being attempted by the introduction of various types of barriers, hides, and covers. These devices are modeled after those made naturally. It is thought that they will accomplish several things toward restoring the streams to their former condition such as: digging pools, furnishing shade and cover, aiding in the production of more fish, stimulating food conditions, and improving fishing conditions as a sport.

Trout will not remain in a section that has no pools or cover. Pools are made by speeding up the current so that it will dig. This may be done, and has been done successfully, with a wingtype barrier made of log or stone slanted downstream from one bank at a 45 degree angle. This crowds the water to one side and so speeds it up with the result that the current digs a pool. A raft made of logs and wired to the bank can be placed over this pool for cover. By producing more pools we secure more fish in a section because one pool can support only a certain number of fish due to food competition. Many natural pools are so exposed that trout will not lie in them. By putting cover over them they can be made into suitable places for trout. Some of the natural pools have been filled with sand. Speeding up the current will remove this, also. A wing built from each side forcing the stream through a narrow channel in the center accelerates the current and causes it to dig in the sand a gravel bottom pool 100—300 feet long. The sand is piled up in a bar on each side behind the wings, thus the stream proper is narrowed and pools favorable for trout are produced. By means of a wing barrier the current can be thrown under a log so that it will dig a good pool under it. In gravel and stone sections, the wings increase the speed of the current and make a good riffle for a long distance down stream. The fish will stay in the pools and feed in the riffle so that a poor section can be transformed into good fishing.

The headwaters and small feeders coming in at the stream sides can also be much improved. The spawning beds in the headwaters can be changed by the introduction of wings to make the current faster and to keep the gravel beds clean of silt which, collecting on the trout eggs, would smother them. On hard bottoms in which the fish are unable to dig their nests, the wings, by means of the current produced, loosens the bottom material and sorts it so that it may be fit for spawning beds. The work already done on the Little Manistee River has shown that new spawning beds can be made by removing the sand covering from the gravel. As many as eight rainbow beds have been noted around one of these wings where before, the sand made it impossible to spawn. Increasing the spawning areas in this way is a great help because there is then more space for individual nests, and these nests are not so apt to be worked over by other spawners and the eggs destroyed.

The headwaters and sidefeeders can in many cases be made more favorable for the fry and fingerlings. Where the water

is too shallow it can be brought to a suitable depth by placing a low dam of logs or stones across the stream. This will produce an area of still water above it and give a place for the young above the dam. The dark material which collects in the still water is the habitat of chironomids, midges and other small forms which constitute the natural food of young trout. Plants will grow in this quiet water and furnish protection from predators. By this means, food and cover can be given to the young, and they are prevented from dropping downstream where they would be devoured by the older fish. So by producing natural conditions here near the spawning areas, a larger production of young may be secured.

All barriers tend to increase the amount of food by creating a variety of conditions. While carrying on the active work of building, the barriers, I was able to make one hundred insect counts in varying types of bottom, depth, and current. Plant beds, especially chara, are very productive. Rubble produces more than gravel, and coarse gravel more than fine. The dark material along the stream sides is very rich in smaller forms of insects. The kind, however, of the insect is much larger in the plant beds. Sand is very barren of life,—in fact, I found absolutely nothing in it, in many cases.

As for the sand, itself, a thin layer of it is entirely as destructive as a thick bar. By cleaning the sand off the gravel and concentrating it in a heavy bar behind the barrier, a large area of gravel will be exposed. Dark, mucky material collects on the bars in the still water behind the barriers, as I have already noted, producing food habitats. Plants soon establish themselves in the muck on the bars, making the sandbar useful in place of ruinous. This quiet water behind the barrier is, literally, a rich, warm water nursery for young trout. When the bottom is already gravel the speed of the current sorts out the finer material so that more food will be produced in the coarser material that remains. I have also found that, up to a certain point, (not exactly determined), a swifter current produces a greater quantity of food.

The larger forms, such as stone flies, hellgramites, and certain caddis and may flies prefer a swift current. The still, shallow water behind the barriers make a suitable environment for the smaller forms of life, such as protozoa, and algae forms which are the food of trout stream insects. The wings concentrate all the drift food into one food channel and send it over the pool below, with the result that the trout can secure more of the drifting insects which may have fallen into the stream.

From information gleaned from fishermen this year and last, the barriers improve fishing conditions in general and fly-fishing in particular. Different types are constructed so that each pool is slightly different than the next and gives slight versatility in fishing. The food channels thrown along the hides and covers make excellent places for dry-fly fishing since the barriers localize the fish for the fishermen. Fish have been reported caught from under barriers that were not twenty-four hours old, and as many as six fish have been taken from under another. A sand section on the Little Manistee River, which fisherman invariably omitted, after improvement last year, has been fished with success this year.

There are at present 850 barriers under observation in the following rivers: Little Manistee, East Branch of the Black, Pigeon, Huron, Rifle, and Gamble. Data are taken on each barrier constructed so the original conditions are known and any change can be noted.

The cost of improvement in a stream averaging 30-40 feet in width is $100.00—$200.00 per mile, varying with the stream condition, the availability of material, and solidity of bottom. This year a flood test was carried on in the Pigeon River where 71 barriers built there were exposed with intention to a 22 inch flood slightly higher than a normal spring flood. None of the barriers were lost.

In conclusion, during the two years of field demonstration, this project of trout stream improvement has been successful on the whole. It is planned to continue the work next year in various streams in the State, with a check of those dams built this year, in the hope of further progress and success.

Discussion

DR. CARL HUBBS: Reference has frequently been made to the fact that a great many of our trout streams have been rendered poor for the trout by the operations of the lumbering days. Streams were cleared of their snags, logs and other obstructions, so that the logs could be floated down stream, with the result that habitats favorable to trout have changed into a shallow, sandy areas where trout are infrequently found. It has occurred to a good many of us that these trout streams could be improved and that we could get back to the so-called pristine conditions by the introduction of cover. The Department of Conservation in Michigan has undertaken on a fairly large scale experiments to determine whether or not this can be done. The experiments are being conducted by the Institute of Fisheries Research at the University of Michigan. Last year a considerable number of such barriers were put into one of

our streams, the Little Manistee. Mr. Tarzwell later checked this work over and found that a very large percentage of the barriers remained in the streams over the winter. Unfortunately we did not have any very large floods in the spring—of course none of these trout streams in northern Michigan flood very much, but the flood water was less than usual—so that we do not know as yet how permanent these constructions in the stream will be. We were able to get a better idea of the permanence of these improvements through a test this year on another, the Pigeon River. Something like eighty of these barriers were put into the Pigeon River, and through the courtesy of one of the fishing clubs we were enabled to create a flood to our own liking by raising the flashboards in a dam. The stream was flooded to an increased height of twenty-two inches at the upper end of the series of barriers and seventeen inches at the lower end. Of course those of you in this section of the country, who think of flood waters in terms of ten, twenty and thirty feet, might not think much of such a flood; however, in a northern trout stream a two foot rise is larger than we would expect in the flood season in the spring when the snow is melting. In this test we did not lose one of these barriers; and it was evident, that this amount of flood water for a short time at least was insufficient to destroy any of the installed barriers.

Of course the method of installation of the barriers is a matter of considerable importance. They must be put in securely. Merely taking a log and tying it to the shore with a piece of wire is not sufficient. The barrier must be very well staked. The barriers that we put into the Little Manistee River accomplished everything we expected, such as deepening holes and furnishing shelter for trout. We also expected that vegetable beds would be established in the loose material which had been dug below the barrier. As anticipated there was an increase in the production of food on the barriers themselves, particularly the brush types. The insect food tends to gather on the barriers right where the trout can get at it. Insects, even the little black fly larva, will come from under the stones and congregate on the barriers sometimes within a day after the barriers are set up. By observation we know that the trout take to these holes; and the anglers catch trout in the immediate vicinity of these constructions.

We had anticipated a considerable improvement in the spawning conditions for the trout. This has gone beyond our anticipation. On the Little Manistee there was a stretch of about five miles, with a clean, sand bottom, where the sand had washed in from the sand banks, covering the bottom and producing a condition not suitable to the reproduction of trout. Mr. Tarzwell found that in that stretch of five miles on the Little Manistee the rainbow trout had utilized the gravel beds at practically every barrier. The barriers were put in such a way that the current which was diverted to one side of the stream, removed the sand

from the original gravel bottom which the trout could utilize for spawning.

It has been our custom to put in several types of barriers. The idea has been to build the barriers out of materials available near the banks of the stream, so as to reduce the expense. We have made a good many dams of boulders which have worked very well. If old deadhead logs from the lumbering days are abundant, we make use of them. We have made very satisfactory barriers out of snags and the old pine stumps. The average cost on a stream say thirty or forty feet wide of a single barrier which would produce a good pool, has been found in our experimental work to be in the neighborhood of two or three dollars.

A type of barrier which has been advocated, the Hewitt dam, is not suitable for Michigan, although it may be excellent for the swift streams of New York state. This barrier is made out of logs placed crosswise in the stream, and on top of these logs are placed lengthwise, which in turn are surmounted with heavy wire and brush, producing a cascade, and a pool below. On the narrow Michigan trout streams with low banks such a barrier will tend to flood a considerable area on the sides of the stream.

We are hoping to be able to publish before long a pamphlet describing the methods of construction which we have found suitable, economical and effective in our waters.

MR. TITCOMB: May we not have a description of your barriers.

DR. HUBBS: Many of our barriers are simple in construction. We place out two or three logs end to end, if the stream is wide enough, setting them at an angle from the bank. The most effective angle is about 60 degrees; which will divert the water satisfactorily to one side of the stream and furnish sufficient slope so that the barrier will not catch too much trash. A barrier straight across the stream is not as satisfactory as one set out at an angle of about 60 degrees downstream.

MR. TITCOMB: How do you anchor the logs?

DR. HUBBS: The log type of barrier is anchored by an oak stake, preferably seven feet long, driven down to the water's edge. The logs are attached to the stake, and to the shore, with heavy No. 9 galvanized wire. Many of our barriers are made out of boulders, particularly in wide, shallow streams without any holes. This type of construction has proved successful not only in trout streams but also in bass streams. A V-shaped type of barrier extends out well towards the middle of the stream, leaving enough room for a boat to go down and for the current to go through. That will produce quite a large hole if the bottom is of the type which will permit excavation. The simple cover type is perhaps the most desirable in streams with a solid rock bottom, with firmly cemented gravel, where it is almost impossible to dig holes.

There are several other types of barriers. The type will depend on the judgment of the man who is installing the barrier and the construction

will depend again upon the material which is available on the stream bank and the nature of the stream at that particular point. These conditions, of course, vary a great deal. In a number of places in Michigan the owners of the stream, have put in barriers independently. Sometimes they have done well, and in other instances no favorable results have followed. One thing that must be avoided is the placing of the barriers too close together. The distance between them will depend on the nature of the stream, the amount of current, the amount of soft material on the bottom, and many other factors. It is very difficult to give a general explanation of the various types of barriers. One would have to know the type of stream, the particular conditions, and the barrier which would be suitable for the situation.

MR. TITCOMB: This is a very important subject. Mr. W. Carter Plattz has written what is perhaps the best book on the improvement of trout streams. The methods he describes would be more suitable for the sluggish type of stream, but it is an interesting work. The idea Mr. Hewitt brings out is to apply in each stretch some remedy which the natural environment and the conditions prevailing in the stream seem to call for. I have just returned from Mr. Hewitt's place in the Catskills, and I am much impressed by what he has accomplished on about two miles of the Neversink River, on stretches which are perhaps from one hundred to two hundred feet wide. It is a torrential stream, very rocky. First he runs some logs up and down the stream, about eight or ten feet apart. These logs are cut nearby. Then he lays across the stream a line of logs at the foot of the horizontal logs, notched and spiked into the others; then he lays on these logs heavy woven wire, about four feet wide.

PRESIDENT LECOMPTE: What mesh?

MR. TITCOMB: I should say about six inch, maybe four or five. He lays the wire over a string of logs across the stream at the lower edge and tacks it on to the logs running up and down stream. In that way he has anchored the whole thing together very securely. Then he lays on brush, hemlock principally, to cover the wire, and on top of that he piles stones. He lays another stretch of logs across the stream above the first layer, and anchors these with logs running up and down the stream also, notched and spiked into the others. The whole thing is filled with stones, which are available both above and below these barriers. The result is that in high water the water runs over the whole barrier, but in low water a large portion of it goes through the barriers.

A pool is created not only below the barrier, from four to eight feet deep, but also under the barrier, and in some places the trout have three or four feet under the barrier where they can hide. In the pools thus created there were many large trout. The area which he has changed in this way was originally what the angler calls a "walking area," a wide stretch of water probably a few inches deep. For a small,

narrow stream of course that might not apply, but all the various ideas that have been referred to can be worked out to accomplish the same thing, having regard to the local conditions. I feel that in a great many places we can at least treble the productivity of trout streams by using these barriers.

DR. EMMELINE MOORE (New York): I should like to ask Dr. Hubbs how many snags he put in the five mile stretch on the Little Manistee.

DR. HUBBS: I have not that information at hand. While we have put in close to a thousand barriers, we have placed them primarily as a matter of experiment. We do know they can not be placed too close together. If a stream has a rather rapid current, the barriers may be placed within perhaps 150 to 200 feet from each other. In such streams as Mr. Titcomb has described, where the water is shallow and the bottom smooth, the barriers may be placed so that the pools will be perhaps, in some streams, 50 feet apart. In some trout streams they may be placed closer together than in others. One of the great dangers of the Hewitt barrier is the spreading of the stream over the banks above the dam. Some of our better Michigan trout streams have gone up to 81° and 82° F. this year, and any damming of these streams, even with the Hewitt barrier, which will spread the water only for a short distance over the bank, may ruin them by bringing the temperature in certain years above or beyond the danger point for trout. Mr. Hewitt, in one of his articles, has estimated the cost of installation of that type of barrier at one dollar per foot of width of stream; our barriers have cost only two or three dollars apiece. That matter, of course, is not so important for Mr. Hewitt, who, I understand, is a man of considerable means, but in state work, where the operations are carried on a wide scale, the element of cost cannot very well be overlooked. I do not wish to condemn that particular type of barrier, but there is no doubt that it is not suited to certain conditions of Michigan.

MR. TITCOMB: Without these barriers you may have water stretching over a width of say 100 feet, with rocks protruding all through, catching the sun and heating the water. If you flood these rocks and create a depth of a foot or so of water I do not think you will get the high temperature which results from evaporation around the exposed rocks all through the channel of the stream.

DR. HUBBS: You are quite right so far as a trout stream of that type is concerned, but we have few of them in Michigan. Most of our streams have sandy bottoms and if we flood them the water goes over the banks to form a considerable area of shallow back water. Your statement is almost certainly true for the type of trout stream you get in New York state and throughout a good deal of New England, but it does not apply to our Michigan streams.

MR. TITCOMB: I am discussing the subject from a general point of

view. You cannot, of course, put in a barrier which will flood the banks; you have to select a spot where the banks are sufficiently high to prevent that. Any good angler who has been fishing a trout stream knows where to find the trout; he knows where the good pools are, and it should not be difficult to select stretches of water which have sufficiently high banks to permit the putting in of an obstruction. The idea would seem to be to create in the stretches which are unsuitable for trout the same conditions that you have in the sections inhabited by trout.

MR. LAIRD (Long Island): On Long Island we have the same condition that Dr. Hubbs speaks of as prevailing in Michigan. We have no boulders or logs. In putting in barriers we use two-by-fours and matched boards, drive the stakes in and run the barrier at an angle of 50 to 60 degrees down the stream. We do not have any material readily available with which to make the barriers.

MR. TITCOMB: When you spend $100 for 100 feet of barrier you have something that will last you about twenty years. A pool is created very much like that created by the old log dams of the early days. Mr. Hewitt can afford it, not only because he is well to do but because he proposes to sell the rod privileges on that two mile stretch to forty people next summer at $250 per rod.

MR. E. L. WICKLIFF (Ohio): Would the same principle apply to bass streams?

DR. HUBBS: Recently we put in a few test barriers in bass streams near Ann Arbor. These streams have a firmly cemented bottom which is difficult to handle as the water is heavily charged with lime. The barriers are of the V-shaped type which forces a tremendous amount of current into a small outlet, and holes about three or four feet deep were dug in a bottom which previously was about twelve inches deep. With a tremendous current we were able to dig into the cemented bottom, and produce fishing in stretches where fishing did not exist before. I doubt whether this type of construction can be used in a large percentage of bass streams because of the amount of flooding that will result. Possibly the Hewitt barrier would be better for such a stream or some type of construction which will be down near the bottom and will allow the flood waters to go over its top. In a trout stream, for instance, where the water is shallow and is subject to flood, I think the type of barrier must be some bottom-hugging type which will allow the excess current to go over the top, leaving the bottom unharmed. The current at the bottom of a stream, even in flood, is very slight; the velocity increasing rapidly as you approach the surface of the stream.

MR. BURR (Texas): We have some mountain ranges in Texas and we have succeeded in populating one of the mountain streams with rainbow trout. By the use of suitable barriers we could perhaps create a great many more places that would be suitable for rainbow trout, a situation

which would apply not only to Texas, but to any other southern state which has mountain ranges.

MR. LAIRD: There is one feature in connection with these barriers which has not yet been mentioned. Not only does the construction of barriers provide a place in which the fish may lay their eggs, but it affords them protection from birds and other enemies. In these holes the fish are protected from birds, whereas in shallow waters they are helpless.