Original: American Fisheries Society
cc: Institute for Fisheries Research
Fish Division

Revision of Report No. 1082 O. H. Clark
June 30, 1947

Report 1082A

Stream Improvements in Michigan

O. H. Clark

Fish Division

Michigan Department of Conservation

Lansing, Michigan

Abstract

When wartime curtailments of labor and material forced a retrenchment in Michigan's stream improvement program, greater attention was given to design and testing of new materials and methods applicable to specific improvement problems. In a uniform-bottomed artificial drain, fishing was improved by installation of 2-foot-square concrete blocks, cast at the site at a cost of $2.50 per block. In 5 years, there has been no maintenance cost. In a sand- and rubble-bottomed stream, deflectors were installed made of Wakefield sheet piling jetted in with a portable pump, and so designed as to escape damage from trash, floating ice or flooding. The cost was $23.05 per unit, and no maintenance has been required after 1 year of operation. High, eroding sand banks are being protected by planting vegetation and by construction of short wing jetties of Wakefield sheet piling. New fishing areas have been created by restoring flow through old oxbows and bayous by the use of diversion dams, and by creation of small ponds on minor spring-fed streams. For 200 earth-filled log crib deflectors, original cost was $17.45 per structure and maintenance cost, over a 4-year period was $1.38 per structure per year. Experiments are under way to determine

the feasibility of lowering stream temperatures by diverting dam overflows directly into the ground-water table.

Introduction

In Michigan during the wartime shortage of materials and labor, a considerable portion of available facilities were expended on development of stream improvement methods believed to be new, or at least significant modifications of existing methods, and on closer analysis of individual stream problems. Far too much stream improvement work has been done with little or no attempt to adapt or develop techniques for specific results. Although pools and riffles are generally the most needed physical features for trout stream improvement, a heavily sanded channel needs different treatment than a rubble- or rock-bottomed stream. The following things are most often lacking in trout streams: (1) pools and riffles; (2) bank erosion control; (3) temperature control; (4) prevention or control of sedimentation; (5) flood control; (6) uniformity of flow; (7) pollution control; (8) fish food; (9) shade and cover; and (10) spawning facilities. This report will discuss techniques developed to meet some of these problems.

Pool and Shelter Development

Lack of cover and rest areas for trout on a drainage ditch in southwestern Michigan was one problem encountered. This stream had temperatures sufficiently low to support trout but contained few pools and little shelter. To provide these features and overcome the difficulty of holding structures in place, 2-foot-square cement blocks were placed on the bottom in staggered rows (Figure 1). Each block weighed approximately 1,150 pounds and was cast at the site with an iron ring embedded in one face to facilitate handling. A gin pole with an extended arm was used for placement. In this particular water the conventional type of double wing deflector with a center unit placed midway between the two wings has been most effective because it increased the area of backwater and the amount of cover. Since the water was 2 to 4 feet, all but one of the structures required a second layer of blocks superimposed upon the foundation layer. Over a 5-year period there has been a gradual settling which was most rapid during the first few days after installation. Now it is planned to lift the blocks and readjust them at a higher elevation. The placement of these structures in the stream has resulted in concentration of the fishing at the devices and, according to the anglers, an improvement in catch. An average of 64 blocks was used for each deflector, and a total of 512 blocks were cast and placed at a cost of $1,312.56. This sum included form lumber and experimentation on the best method of handling. The cost per block of $2.50 can be reduced substantially on subsequent projects. To date there has been no maintenance cost.

At Hunt Creek, where the Michigan Conservation Department maintains a research laboratory, two sections of the creek have been improved on an experimental basis. One section was improved in 1943 by installing conventional single- and double-wing deflectors constructed of earth-filled log cribs with sodded tops (Figure 2). These structures have functioned well but have required annual maintenance to keep them at maximum efficiency. Periodically, high water has overridden them and caused some washing. Sod and soil thus removed has had to be replaced, but to a lesser extent each year as the vegetation has become more fully rooted. The other section was improved in the fall of 1945 by using single and double wing deflectors constructed of sheet piling. Ten of the 13 structures placed were constructed with triple Wakefield sheeting built of salvaged 1- by 10-inch pine lumber. Three boards are required for a single piling. The center one is placed between two parallel outer planks so that a 2-inch tongue and groove are formed on opposite edges. The three planks are then fastened together with nails sufficiently long to permit clinching. One end is then cut off at a 45-degree angle with the point on the tongue side. Individual pilings for this particular section were cut 5 feet long and jetted in by means of a portable high pressure pump. A guide and support was installed by jetting in 8-foot cedar posts at approximately 5-foot intervals. On the upstream side of the posts, a log stringer was placed. This member was squared on its upstream face, and notched and spiked at its junction with the posts. Posts and stringers were placed far enough below the water surface so that they would be continually submerged. Sheet piling was then started at the end toward the center of the stream. The first pile, which had been sharpened symetrically, was driven with great care to keep it vertical and then was spiked to the stringer as a guide for subsequent piling. The tongue of each pile fitted into the groove of the previous one, and the 45-degree angle point tended to wedge them all tightly together to form a watertight seal. At its outer end the top of the structure was cut off at the water line and gradually tapered upward until at the bank line it was 4 inches above the water. The cut was made low to permit flood water to override the device and so give pressure relief and clearance for any floating trash that otherwise might collect on the structure. The deflector was built well into the bank to reduce the possibility of cut-around. Additional submerged planks or logs to

Figure ___ Re-usuable wooden forms for casting cement blocks.

Figure ___ Arrangement of cement blocks in the Dowagiac River.

Figure ___ Earth-filled log-crib wing deflectors in the experimental section of Hunt Creek.

Figure __ Single wing deflector in the Clam River with the terminal end protected by sheet piling. Note the formation of bar behind the wing.

act as cross current diggers were placed slightly downstream from the end of the wing and spiked to posts jetted in to a depth of 7 feet (Figure 3). Others were placed as a submerged downstream extension to the wing parallel with the current. Between the wings of several structures a plank or log was placed below the low-water level and parallel with the current. This particular construction has proved most efficient. After being in place a year the structure required no maintenance and none is anticipated for some time to come. The other three structures in the second improved section were built similarly except that 2- by 6-inch matched sheeting was substituted for the triple Wakefield sheeting. Matched sheeting reduced by two-thirds the amount of lumber necessary per structure, and appeared to function equally well. Deep holes have been cut below most of the structures and after one year those with the additional submerged construction at the midstream end of the wings have cut the deeper holes.

The 13 structures cost $306.00, or $23.54 per unit. Ten of the structures were of salvaged material which has not been evaluated in the above figure. Had new lumber at the rate of $85.00 per 1,000 board feet been used throughout, the cost would have been approximately doubled. Posts and stringers were cut from adjacent wood lots and represent only labor costs. The particular advantages of this type of construction are water-tight seals, long life, the ability under flood conditions to pass floating trash and ice, and the relief of flood pressure by overtopping. Such overtopping would have little or no detrimental effect on the device. This structure has proven very satisfactory where heavily sanded conditions are encountered.

Control of Bank Erosion

There are a number of streams in Michigan, particularly in the northern zone, that have become badly sanded by bank erosion. Attempts to control this condition are being made on portions of the Pere Marquette in the Lower Peninsula and the East Branch of the Two Hearted River in the Upper Peninsula. Considerable work was done in the 1930's by the Civilian Conservation Corps on several of the worst stretches in the Pere Marquette River. This work included terracing, tree planting, and the protection of the water line by log booms. Much of the work failed, especially at the water line. It was believed that some of the old construction could be salvaged by installing a series of short wing jetties to deflect the current from the raw bank. A protective cover could then be reestablished naturally with some help in the form of grassing or tree and shrub planting. To carry out this plan jetties were constructed like the wing deflectors at Hunt Creek described above, with the exception that the terminal ends extend about a foot above low water line. They maintain this height to within about 6 feet of the bank, and then angle upward until at the bank end they are 3 to 6 feet above low water (Figure 4). All of the wood parts extending above the water line were creosoted. The terminal ends were braced to the bank downstream with a submerged log held in place by posts jetted in, to a depth of 12 feet. It is necessary to construct two or more of these wings in series at each of the major bends where erosion is taking place. The angle at which the jetties are placed varies from approximately 30 to 45 degrees and depends in general on the way the main current strikes the bank. Cost figures on this work are not yet available, since construction is still in progress. However, they will approximate figures given for Hunt Creek plus the additional cost of longer sheet piling and driving to a greater depth.

Creation of Additional Fishing Water

A simple method of providing more fishing is to create new water. This plan has been tried on the Little Manistee River in Michigan by the construction of a diversion dam which directs the water through an old oxbow and adds 1,700 feet of new trout water. To divert the water it was necessary to build a dam that would provide a head of not less than 2 feet. This dam was constructed of two rows of triple Wakefield sheeting 6 feet apart, braced by 4- by 6-inch oak wale shores and tied together by 3/4-inch steel rods. The space between the sheet piling was filled with earth and the top seeded to grass and rye (Figure 5). Additional earth,for added strength, was placed on the downstream side, completely covering the sheet piling and providing 2 feet more free-board. The slope was sodded to the water line and the approaches grassed and planted to jack pine. Most of the heavy deposit of silt and muck which accumulated during the many years since the oxbow had been cut off from the main stream, was flushed out in the first 2 days of operation. During the construction of the dam a box-type spillway was used to prevent formation of appreciable head. After completion of the dam the spillway was filled with earth to strengthen the structure. The dam has an overall length of 110 feet and extends well into the banks at each end. Its total cost was $1,538.07.

The success of trout planting in several old rearing ponds in southern Michigan stimulated interest in developing similar ponds on waters formerly considered too small to warrant much attention. In the autumn of 1945 a dam was constructed in the Waterloo State Park Area on a stream whose flow was approximately 120 gallons per minute. This dam forms a pond of about 2 acres which was stocked with legal-sized trout in the winter of 1945-1946 and enjoyed considerable public use during the summer of 1946. Two additional ponds will be constructed during the fall of 1946, one of 6-1/2 acres, the other of 5 acres. The possibilities of expanding this program are great and will provide trout fishing in a section of the state most deficient in this type of sport.

TEMPERATURE REDUCTION BY CHANNEL AND BANK DEVELOPMENT

The Clam River whose source is Lakes Mitchell and Cadillac near the city of Cadillac lies in the north-central part of the lower Peninsula and flows southeastward into the Muskegon River. It is considered marginal for trout because relatively high water temperatures may occur during warm weather. There are at least two causes for this condition. One is the warm water from the source lakes, and the other is the widening and the shoaling of a considerable portion of the stream. Seepage runs conducted with the cooperation of the U. S. Geological Survey in the summer of 1946 during a period when no water was spilling over the dam from Lake Mitchell into the river indicated a pick-up of 22 second-feet of water between the source and a point approximately 20 miles downstream. Most of the time this large volume of spring and seepage water maintains a stream temperature sufficiently low to support trout. Because conditions in the stream are marginal, it was considered desirable to attempt temperature reduction by narrowing the channel and planting the banks. With the cooperation of the Cadillac Rod and Gun Club easements permitting public access and the right to construct and maintain improvements were obtained along the greater portion of the

Figure ____ Single-wing deflector of triple Wakefield sheeting with submerged log tailing downstream from the end of the wing (Hunt Creek).

Figure ___ A double-wing, sheet-piling deflector in Hunt Creek.

Figure ___ Two wing-jetties in the Pere Marquette River designed to prevent bank erosion. Note the height differential between the stream and bank ends.

Figure ___ Earth-filled sheet piling dam on a tributary of the Fox River. A series of these dams have been placed on this stream to form trout ponds.

20-mile stretch. To date 200 devices, mostly single wing deflectors, have been installed. Narrowing the channel has been accomplished by placing the structures so that bars could form behind them. In the 5-year period since the first deflectors were installed, portions of the stream have been narrowed by two-thirds of their former width. By careful maintenance and the addition of auxiliary devices where needed, it has been possible in some instances to extend the bar formation from one structure to the next. All but 12 of the structures were made of materials taken from the adjacent stream banks and consist of earth-filled log cribs with sodded tops. The terminal ends of 20 wings have been protected against cutting by 6 to 8 feet of sheet piling and in many cases the banks opposite the single wing deflectors have been protected either by boom logs or sheet piling. Treeless banks have been planted with white cedar, spruce, pine, and mixed hardwoods. The total cost of these 200 structures has been $3,490.00 or $17.45 each. Their maintenance for the 4-year period cost $1,092.00 or $1.38 per structure each year.

Increase of Groundwater Flow

In addition to the control of temperature by narrowing the stream channel and planting the banks, data are being obtained on the feasibility of augmenting spring flow. This objective would be attained by introducing all or a portion of the stream flow near the source of the Clam River directly into the ground-water reservoir which it is believed feeds the springs that now contribute most of the cold water to the stream. It is presumed that the greater volume of spring flow would reduce the water temperature materially in the warm summer months.

Introduction of surface water into the ground-water reservoir would be accomplished by installation of a low-head dam to divert a portion of the flow through distribution ditches, or to flood an area large enough to absorb the diverted water. The stream flows through a large glacial outwash plain of highly pervious sand and gravel of considerable depth.

In March 1945, fourteen test wells were jetted 2 to 5 feet below the level of the ground-water table in the area that may be flooded. The water level in these wells was checked at bi-monthly intervals up to June 1, 1946. After June 1 weekly checks have been made and will be continued for an indefinite period. These data indicate fluctuations in the level of the ground-water table, and to a degree, the speed of percolation through the aquifer. Variations in the water level between wells indicates the ground-water gradient, and the direction of flow of subsurface waters. The level of the ground-water table in the test area has remained consistently below the level of the stream, with the difference increasing in proportion to the distance of the well from the stream. These data show a flow from the stream to the underground waters and also the ability of the ground-water reservoir to absorb additional waters. An effluent flow is indicated further by the above-mentioned seepage runs wherein the section under discussion lost one second-foot of water in a distance of 1-1/2 miles. Three miles below the site of the proposed spreading operation is the first tributary. This spring-fed stream is believed to be the first outcropping, other than the Clam River itself, of the water table that would be augmented by the spreading operation. If the foregoing assumptions are correct, a rather simple method of temperature reduction for many streams of similar character has been found. So far as the author can determine, the proposed plan will be the first application of this principle to improve trout streams by temperature reduction.

The principle of recharging ground-water reservoirs is not new. It has been used for many years in California and other western states for irrigation purposes. Many places in the eastern states of Ohio, New Jersey, New York, West Virginia and others are using this method to maintain underground reservoirs for cooling water in air conditioning plants, and for industrial areas where heavy pumping has depleted the ground water supply. Meinzer (1946) states that "The plan involves recharging the water from the public supply in winter when the surface water is cold, thus increasing the supply of cool ground water in summer when the surface water is too warm to be satisfactory for cooling purposes." The success of artificial recharging has been demonstrated many times both in Europe and the United States and its application to the improvement of trout streams is merely a new use for a proven method.

The high internal friction of even the most permeable aquifers assures a considerable time lag between recharging operation and discharge through seepage and spring flow into the stream. This time lag is determined by the distance through which the ground water percolates, porosity and permeability of the aquifer, and the ground-water gradient. Time lag is of great value from a stream improvement standpoint for generally the period of greatest recharge would be at the time of the spring break-up. The water thus stored would be released gradually at low temperature during the critical period in July and August.

A recording thermograph was placed 4 miles downstream from the site of the projected spreading operation and has been running continuously since June 3, 1946. The maximum water temperature recorded in the summer of 1946 was 81° F. on July 19; it remained at that figure for a 3-hour period. The air temperature on that day remained above 88° F. for 5 hours and reached a maximum of 91° F. Comparisons will be made between the average air and water temperatures for a considerable period both before and after the spreading operation. In cooperation with the U. S. Geological Survey a stream gage was installed near the site of the thermograph and 5-day-a-week recordings indicating the volume of flow have been made since June 3, 1946.

All data collected since 1945 will be analyzed and the resulting conclusions will determine the nature of the spreading operation and the time of its initiation.

SUMMARY

During the war period of material and labor curtailment Michigan's stream improvement program has confined itself largely to the following developments:

1. Cement block installation for cover and rest areas.

2. Single and double wing deflectors of earth-filled log cribs and sheet piling.

3. Bank control by jetties and vegetation cover.

4. Creation of new water by a diversion dam.

5. Construction of ponds to provide trout fishing in the southern part of the state.

6. Reduction of water temperatures by means of channel narrowing and bank planting.

7. Collection of data on which to base a proposed project for augmenting ground-water flow to improve trout stream temperatures.

LITERATURE CITED

Meinzer, Oscar E.

1946. General principles of artificial ground-water recharge. Economic Geology, May, 1946.