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INSTITUTE FOR FISHERIES RESEARCH

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Report No. 116

EXPERIMENTAL TROUT-STREAM IMPROVEMENT WORK ON THE PIGEON RIVER IN 1931

In August, 1931, the Game Division of the Conservation Department made available the sum of $250.00 for experiments in improvement of a part of the Pigeon River, on the Pigeon River state forest. The planning, supervision, and testing of the work was to be done by the Fisheries Institute. A particular point in these experiments was to determine the resistance of the cover-control installations to flood and to ice. The general nature of the improvement was similar to that discussed in other reports.

Mr. Clarence Tarzwell made a preliminary investigation of the stream on July 31 and August 1, cruising a section of the stream in a rowboat in order to find parts at which improvement was needed and to locate supplies of logs and stones to be used. Due to the limited funds available, it was considered desirable to do the work at places which could easily be reached and near available materials, so other sections were left for later consideration.

Field work was started August 20 with the aid of 3 laborers hired in the vicinity. A teamster and two-horse team were added the following day and for a period of two weeks the installation of improvement devices was continued. These consisted of wing dams, V-types, Y-types, A-types and I-types built of logs or stones, or both, in such a way as to deflect the stream current and cause a trout pool to be formed. Also cover shelters were made to provide hiding places for trout. Log devices were anchored into place by cedar or tamarack stakes which were driven solidly into the hard stream bed or, in a few instances, were wired to the bank.

From August 20 to September 4, a total of 71 installations were made. Of these, 60 were constructed of logs and trees, 6 of stone, and 5 of logs and stone. Current-deflecting devices numbered 34, while 37 cover-shelters were put in. The improvements were put in three sections: near the Pigeon River ford, Section 17, Corwith Township (21); in sandy section about 3/4 mile below the Forest Headquarters, Section 9, Corwith Township (21), and just north of the south line of Cheboygan County (29). The total stream mileage covered by the work was approximately 2 miles. Most of this was in parts having a hard bottom, although a predominatly sandy area of about 1/2 mile was included.

Costs of the work were as follows:

Teamster and team 14 days at $6.00	$84.00
Laborers (46 days at $3.00)	138.00
Total labor cost	$222.00
Wire	8.75
Staples	1.75
Dynamite, caps, and fuse	1.76
Total materials cost	12.26
Total cost (labor and materials)	$234.26
Cost, per single installation	3.29

The costs given here do not include an item of $9.00 for labor used in the experimental flooding and recording of the flood stages at three points by men stationed there to make observations. Including this expense, omitted above because it was not an expense incurred in actual installation of work, the total expenditure from the fund which the Game Division made available for the Pigeon River project was $243.26.

Expenditures incurred by the Fisheries Institute are not included in the costs of the improvement work. The full time of one man (Mr. Tarzwell) for 15 days might properly be figured into the cost of installing the improvement work, as much of his time was spent in planning, supervising, and participating in the work. However, since a part of his time was devoted to the experimental phases of the project (Note-taking, etc.) his time has not been given in the labor costs. The expense of a small amount of use of a Ford car run by the Institute is also excluded from the cost of the work as given above. This expenditure was slight since the mileage run was very low. Tools (axes, picks, shovels, mauls, pliers, peavies) were loaned by the Institute. Expenditures incurred by the Institute for biological studies of the Pigeon River (Dr. Greeley and Mr. McCrimmon) as well as in the experimental flooding and testing of the work are, of course, not part of the costs of installation.

The cost of $3.29 per improvement device is higher than similar costs for work in certain other streams (Little Manistee, and Black Rivers). This fact was due to the very hard bottom of the Pigeon River, which made the driving of stakes difficult, and the difficulty of reaching the place of work. Since about six stakes are used for each wing dam or shelter of logs, the time spent in driving these is greater than that of gathering materials or any other operations concerned (unless materials are scarce). From the point of view of mileages improved, the sandy area was more expensive than the stony places, because the sluggish current made it necessary to space the devices closely in the sandy region to accomplish the desired result. The stony areas, with more rapid current, are more easily improved and the influence of a current deflector extends a much greater distance.

The two weeks of work on the Pigeon River was not sufficient to improve a very large percentage of the area that is in need of trout-pool improvement. However, some very good trout pools were produced and the amount of good fishing water has been considerably extended. It was found that the effect of a wing dam device on the Pigeon River differed from that of a similar apparatus on the Little Manistee River, due to differences in the bottom of the two streams. The former has a much harder bottom than the latter where deep holes quickly developed on the Little Manistee, wherever the current was greatly accelerated, this was less true on the Pigeon, where an increase in current velocity often failed to scour out a hole, due to the compact bottom, of lime-encrusted stones. At places in the third part of the work the current (surface reading) was accelerated from 2 up to 4 feet per second without an immediate result of digging by the swift water. The results of a longer period of current action are awaited, however, and it is probable that holes will develop in a few months, at points of swift current. Experiments with 40% dynamite were made, charges of from one to two sticks being exploded at places just off the ends of wing dams. Due to impracticability of seating the dynamite deeply enough, only shallow holes could be blasted and the use of explosive in starting the digging of a hole was not very successful. It is difficult to seat dynamite deeply into a stony bottom, when working in a swift current, and it was considered that the use of picks and shovels was more efficient in starting such holes. Some time was spent in this type of labor at a few places. If holes do not develop in the course of a few months, it may be advisable to spend several days of labor in improving the holes by use of pick and shovel.

Mr. H. F. Harper offered the use of the Lansing Club dam on the Pigeon River for the purpose of giving the improvement work an experimental flooding, to determine how successfully the devices would withstand high water. Tests were made on September 8. Although the flood was of short duration, as compared to a normal flood, a rise of water somewhat greater than a normal spring flood was produced and maintained for several hours. Driftwood which had not been moved by the water in the spring of 1930 was moved by the experimental flood. (This driftwood had been piled above reach of the stream by flood waters when the dam here went out).

Observers were posted at each of the three points at which work had been done.

Each man was supplied with a gauge so placed as to show the rise in the stream level. Readings were made at each point at ten-minute intervals. (See attached graph of water rise at each point). The greatest rise of water varied from 22 inches to 14 inches above normal at the three points. The lower most station (D in graph) showed the least rise. However, due to the speed of the stream here (surface velocity 7 ft. per second) the stress of the flood waters against the improvement devices was probably greater here than elsewhere. At all points it was noted that the flood water poured over the tops of the wing-dams and other devices, and so it is probable that the force against them is not proportional to the height of the flood water since any water above a certain height spills over them. Although flooding increased current velocity, it is not probable that a higher flood than was given could materially increase the velocity over what it was during this flood, for a higher flood would allow water to extend its channel over the stream banks.

Readings on velocity increase at several points are as follows:

Section A. (immediately below Lansing Club dam, in stream channel below the large pool). Normal water velocity 1.7 ft. per sec. Velocity at 20 inches of flood 3 ft. per sec.

Section B (at first section of improvements). Normal water velocity 1.4 ft. per sec. Velocity at 17 inches of flood 3.5 ft. per sec. Velocity at 22 inches of flood 4.2 ft. per sec.

Section C (at second section of improvements, sand area). Normal water velocity 1.0 ft. per sec. Velocity at 21 inches of flood 1.2 ft. per sec.

Section D (at third section of improvements). Normal water velocity 3 ft. per sec. Velocity at 9 inches of flood 5.2 ft. per sec. Velocity at 14 in. of flood 7 ft. per sec.

Velocities were measured at the surface, by method of timing a float over a given distance. Due to friction, bottom velocities would be less than surface ones.

The flooding was continued approximately six hours and during this time the pond level was lowered two feet. The spillway of the dam was pouring over water at a depth of 10.25 inches at normal low-water. Taking the spillway width as 11 feet the calculated discharge of the river was 30 cubic feet per second (calculated from formula for discharge over sharp-crested weir). At the height of the flood, the discharge (crest of 41 inches over the spillway) was calculated as 240 cubic feet per second (same formula).

Study of the effect of flooding was made immediately after the water had dropped in the various sections sufficiently to permit accurate observation. Each of the improvement devices was examined (by Mr. Tarzwell) and tested for loose stakes or other defects. It was found that the work had resisted the high water well and that losses were confined to one trout cover on which two stakes had pulled loose, allowing some shifting of the logs (but not a destruction of the cover). These two stakes were ones which had been cut too short (about 3 feet, instead of 7 or 8 feet) and evidently there was not sufficient length imbedded in the stream bottom. A total of 207 stakes were used and all others held firmly. As the high water had carried down a great amount of loose driftwood, the first two of the obstructions caught this to form a large log jam. The second device was bearing the greater part of the jam and it is possible that the stakes may not hold all this material and it would not be surprising if this improvement may be torn loose. The strength of the barrier shown in holding the large jam even for the time-being is worthy of note.

The short periods of high water during the experimental flooding did no appreciable damage to the improvement work (with the exception noted above). The effect of longer periods of natural high water and of ice will be studied. The number of different types of devices which were installed will make it possible to find out what types are most effective for use in this or similar streams. (The work was again inspected December 20 and an account of findings at this date is appended to the present report).

In connection with the improvement project, a general survey of trout-stream conditions was carried on by the writers, assisted by Mr. G. L. McCrimmon. The purpose of this work was to obtain knowledge of the general conditions and productivity of the waters where improvement was to be done. Such information is essential in planning this work and in evaluating its results.

The survey cards which accompany this report include most of the data gathered in the few days of survey work (August 20-23 and September 2-7). Temperatures taken by the caretaker at the Lansing Club have been discussed in a previous report (No. 107). That report also discussed the general condition of the brook and rainbow trout, and the black spot parasite of the brook trout.

The brief survey has disclosed a number of points which should be considered in their bearing on the problem of improvement of the stream. These may be summarized as follows: (1) The Pigeon River on the Forest Reserve becomes dangerously high in temperature during very hot weather (refer to report No. 107). (2) The brook trout are heavily infected with a Trematode parasite (Family Strigaeidae) which causes black spots in the flesh. The parasite goes through one of its life-history stages in snails (refer to report No. 107). (3) The brook trout are mostly thin and small for their age and most of the second year group (in August) are below legal size. The cause of the poor condition is not known (refer to report No. 107). The rainbow trout in the same waters are in excellent condition and most of the second year group (in August) are above legal size. (4) The stream supports a heavy population of minnows, suckers, and other non-game fish. The ratio of trout to other fish, as determined from 4 seining examinations on the Forest Reserve was low, the trout being less in number than the others (ratios were 1:2.2, 1:4.8, 1:5.8, and 1:7.5). This means an intense competition for food, since the smaller sizes of trout eat much the same food as these other species. The trout population could not be accurately determined but a conservative estimate (based on seining) would be above 1800 per mile. (5) The stream is rather heavily fished, particularly at regions where there are good pools.

It is desirable to consider the probable effect of the stream improvement work in relation to these points of consideration that have been listed: (1) Temperature conditions will be improved to some degree by the current-deflecting devices which make the stream more narrow and concentrate the current toward the more shaded side. Wherever it was possible to do so, improvements were planned with this in mind. By concentrating the current into a rather narrow channel, the water will be less easily warmed than it is when flowing in a wide, shallow channel. The total result of the improvements, in their effect on temperature, will depend on the amount of stream that is improved. At present, with 71 devices installed, the ratio between improved and unimproved waters on the Pigeon State Forest is low and a great improvement in temperature conditions cannot be expected. (2) The effect of the improvement work on the black parasite of the trout will probably not be noticeable. However, by construction of trout pools of a deep type and cutting down of the amount of shallow, warm, marginal flats, it is probable that favorable habitats for snails will be decreased, and the parasitism may thus be lessened. (3) The effect of pool-improvement work on the poor condition of the brook trout cannot be predicted, with any certainty, as the cause of the poor health of the trout is not understood. If the trout are suffering from some disease it is possible that this may last for only a few years or less. If the brook trout were otherwise healthy, it would be very probable that the construction of favorable pool habitats would result in the production of more large trout. Considering both rainbow and brook trout, we can predict with confidence that the pools which have been improved will be inhabited by trout of one or both species of larger sizes than could be found at areas without pools. (4) By changing wide, shallow areas to swift, deep pools it is expected that the proportion of minnows, suckers and other fish to trout will be decreased by reason of a decrease of their more favorable habitats and increase of more favorable trout habitats. If an appreciable decrease in temperature is caused by the improvements, this should also result in increasing the ratio of trout to other fish. (5) By improving areas unfavorable for trout because of poor pools, it is expected that the improvement work will increase the capacity of the stream to carry legal-size trout and will spread the fishing over a larger area than is utilized at present. Study of the Little Manistee work done in 1930 has shown that angling was extended over some areas formerly neglected because of being non-productive.

Inspection of Improvement Work, December 20, 1931

Following the experimental flooding of September 8, several additional floods were sent down from the Lansing Club dam. In order to observe the effect of all such floods, and to note all changes in the improvement devices that had occured in the four months period. Mr. Tarzwell checked over the work on December 20. It was also essential to know the condition of the barriers before ice action has begun so that it will be possible to note the effects of the ice next spring.

Each of the devices was examined and notes of its condition were made. The first one has collected a large amount of logs and stumps brought down by the flood waters and is now an excellent cover. The second has also collected many drifting logs and has been converted into a jam. The digging effect that it has caused is remarkable. There is now a four foot hole where before there was onlya few inches of water. This is all the more notable since the bottom is extremely hard, being made up of gravel and stones. In fact, the bottom is so firm that rainbow trout would find great difficulty in digging their nests and in most places would probably be unable to do so. The large, clean gravel bar extending 50 feet below and formed from the material scooped out by the current should furnish an excellent place for rainbows to spawn as the gravel is water-sorted, loose and clean. Similar bars have been formed by many others of the barriers and spawning areas for rainbow trout have been much increased.

Many of the barriers are piled three or four feet high with logs, and this is particularly true of the first section of improvements. The logs will cause the ice to exert a powerful force upon them. With the exception of number 3, every device in this section was in perfect condition. This latter one had been injured by the first flood but it is now in stable condition and looks as though it will remain so. It forms a very good hide for trout. Pools are being formed by every barrier and clean gravel is exposed. In the sheltered areas, deposits of dark, mucky material are forming and these will be richer in food-producing effect than areas of sand. Holes up to four feet deep have been formed, and a great amount of digging has taken place in the first section. On the wing-dam type of barrier, the high water has spilled over the top and caused a hole similar to those made by the Hewitt dams (which extend entirely across and cause ponding of the water). The wing-dams have made excellent holes without causing ponding, which would be detrimental in this stream. Large areas of sand have been removed from the gravel by current action near the barriers.

In the second section, the stream is wide and slow, with a bottom of shifting sand. It is here that the greatest improvement has taken place. Large areas of sand have been removed to expose the gravel, a far more productive type of bottom. The area had been filling up with sand for years and deposits were 2 to 3 feet thick. This sand has been removed to a depth of 2 1/2 feet over areas of 2500 to 3000 square feet behind the barriers. Pools 4 to 5 feet deep have been formed under the cover devices. These pools and gravel areas completely transform the area which before was a uniformly flat, sandy stretch. All of the barriers here are made of "dead-heads" and all are in perfect condition.

The third section is narrow, swift and stony. Good pools have been made here but changes are not so evident as in the sand region. Two of the barriers have been damaged. One large, wing-type device swung in to the bank as the end stakes were dug out by the current, and in the other case, the flood lifted a log over a large boulder which was holding it. With the exception of these two, all installations were in good condition.

Of the 71 improvement devices, only three have been damaged. The damage to these has not completely destroyed their usefulness as shelters to trout. The extent of digging caused by the work has been very great, more than had been expected in view of the hard bottom of the stream. Many good trout pools have been formed, areas of good food-producing bottom have been greatly increased, and spawning beds for rainbow trout have been greatly incrased. We consider the improvement work on the Pigeon River the best that we have done.

INSTITUTE FOR FISHERIES RESEARCH

signed:
John R. Greeley, Ass't. to Director,

and
Clarence M. Tarzwell, Fellow.

cc - Game Division, Department of Conservation
cc - H, F. Harper