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SOME COMMENTS ON STREAM IMPROVEMENT IN MICHIGAN

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It is generally agreed that the major requirements of trout include pure, cool water seldom if ever becoming warmer than 70° F.; deep, protected pools where the trout may rest and find shelter from their natural enemies; an adequate food supply; and suitable facilities for spawning.

To meet the first of these requirements, copious supplies of spring water are necessary. The stream flow should be sufficiently deep and swift to preclude undue warming of the water by the summer sun. Shade afforded by streamside trees and shrubs, and by aquatic plants in the water itself, help greatly in keeping water temperatures within the range favorable to trout.

The second requirement, pools, is met in nature by the physical character of the stream bed, by mats of aquatic plants, and by the effects of fallen trees and the accumulation of drift.

It has been demonstrated repeatedly that of all types of stream bottom material, gravel is the most productive of food organisms available to trout (although certain types of silt bars may contain more organisms per unit of area, stomach investigations indicate that many of these are not directly available to trout). Gravel is also required for spawning purposes by brook, brown and rainbow trout. Maximum food production usually occurs in shallow water. Spawning, especially by brook trout, is generally carried out in water less than a foot deep.

The ideal trout stream, then, would be one liberally supplied with spring water, shaded by vegetation on the bank and in the water, and flowing over a bottom where gravel riffles alternate with deep pools. A great majority of Michigan's northern streams, and not a few in the southern part of the state, once fitted this characterization quite closely. Unfortunately, deforestation and agriculture greatly increased erosion and lowered the water table, with the result that many springs dried up or were choked with sand. Pools disappeared when loggers cleared natural obstructions from the stream channel in preparation for the spring log drives. Eroding sand covered gravel riffles and filled pools, until many once-productive streams became broad, flat, and uniformly shallow, their bottoms covered with shifting sand in which few food organisms could exist, and in which spawning could not be carried out successfully. Exposure of increasing amounts of water to the direct rays of the sun, coupled with the failure of springs, produced higher water temperatures, with deleterious effects to the trout. And some of the factors which made for warmer water in the summer, notably the failure of springs, allowed the water to become colder in the winter, with increased ice formation as the result. In the spring, large slabs of ice swept along by flood waters scoured the stream bed and destroyed much of the aquatic vegetation and the multitude of food organisms harbored there. So it came about that when the building of good motor roads and the institution of shorter working hours in industry began to be reflected in ever-increasing numbers of anglers, the trout streams themselves were rapidly declining in production and in carrying capacity. When it became apparent that restocking alone would not be sufficient to keep fishing at the desired level, fisheries workers began to give serious thought to plans and methods for improving the physical character of the streams with the objective of restoring or duplicating, so far as possible, the conditions which had prevailed before man's activities began to wreak their havoc.

Within the past decade, the practice of installing so-called stream improvement structures has grown from the occasional haphazard efforts of a few enthusiastic private individuals to a large-scale organized program supported by several federal bureaus and by the conservation agencies of many states. Hundreds of miles of streams have been "improved". Some of the earlier structures have been in place for nearly ten years; and by observing the success with which these older devices have met the onslaught of ice and flood, drift and debris, valuable knowledge may be gained as to the types of construction best suited to various situations, -- knowledge the application of which should lead to more efficient structures in the future.

The first work of this nature performed in Michigan, under the auspices of the Fish Division's technical branch, the Institute for Fisheries Research, was largely experimental in character: many different types of structures composed of a wide variety of materials were installed during the first few years of the Thirties. The types of devices most frequently installed were: single wing deflectors (Figs. 1 & 2); double wing deflectors; double wing deflectors with diverters, sometimes called Y-deflectors (Fig. 3); reverse deflectors, made by staggering the opposed wings of a double wing to produce a rapid swirl in the stream; bank rafts (Figs. 1 & 2); bend rafts; boom covers (Fig. 4); submerged transverse digging logs sometimes called I-deflectors; and center covers, either rectangular or triangular.

Materials employed in construction depended to a considerable extent upon what was readily available. For example, deflectors were generally formed of waterlogged logs, but if boulders were at hand, these were employed (Fig. 5). Rafts and staked covers were generally made of dead saplings and small trees, especially cedar; boom covers were filled in with floating drift material. Waterlogged logs and deadheads were considered to be the best material for wooden deflectors since their weight would tend to hold them in position and place less strain on the supporting stakes than when dry dead or green logs were used, as was sometimes necessary. Stakes were made from tamarack, cedar or oak by preference although other and less satisfactory woods were occasionally employed by necessity.

The function of wing deflectors, either single or double, is to accelerate stream flow and by so doing to scour sand from the bottom and expose gravel in its place, and to deposit the dislodged sand in the form of a stable bar in the lee of the deflector, thus removing it from detrimental circulation in the stream. In a year or so the bar is likely to emerge as an island, and to be further stabilized by the advent of rooted vegetation. When a bank cover is placed opposite and just below a single wing, a deep, protected pool is formed under the cover. The function of the I-deflector is simply to create a hole or depression in the stream bed just beneath itself. Bank rafts, bend rafts and boom covers are designed to check bank erosion and, depending on the method of installation, to create protected pools or, by silting in, to restrict and deepen the adjacent stream channel.

When, on the basis of the first experimental installations, the Institute passed tentative approval on some of the types of structures tested, their construction was undertaken on a large scale by the CCC. Some additional types were conceived and introduced by various members of that agency. The subsequent fate of the structures which have been in place for periods of from two to ten years serves to re-focus our attention on the fundamental aim of stream improvement which is, in brief, to alter the physical and biological conditions of a stream in such a manner as to favor the production of trout.

Too much emphasis cannot be placed upon the fact that permanence is the keynote to success in attaining this aim. The aquatic insects which compose the bulk of the natural food of trout inhabit various ecological situations in the stream bed. Some cling to gravel and stones, others clamber about over submerged vegetation, still others burrow among dead leaves and similar organic debris, while a very few are able to exist in sand. Almost all of these organisms require at least a year to complete their development. A few may require two or more years. It follows, therefore, that once a stream improvement installation has been made, and has effected the desired physical alterations in the stream bed, some time, probably several years, must elapse before the bottom can be expected to harbor food organisms to the fullest extent of its capacity. It is equally obvious that should the structure become damaged, or become so loosened as to change position from time to time, maximum food production will never be attained, because the section of bottom influenced by the structure would be in constant state of flux. Also, since an important function of certain types of structures, especially deflectors, is to trap out and stabilize shifting sand, it is essential that every provision be made to prevent cutting around the inner end by water, and that the upstream face be sealed securely to prevent undercutting or leakage, and the upper portion kept high enough to avoid frequent washing over. This need for stability and permanence offers the chief objection to "improvement" achieved by mere "re-snagging", or by felling of streamside trees to lie at an angle to the current. Such partial barriers are at the mercy of ice and flood and, while offering cover to trout, cannot be relied upon to materially increase the natural food supply, or to stabilize shifting sand and create permanent silt bars and weed beds.

Errors in the installation of improvements are not infrequent. The commonest source of trouble lies in the employment of inadequate materials, and in failure to make everything secure. However, one may see not a few instances of overimprovement, either by placing of structures too close to each other, or by installing devices in a section already amply endowed with natural advantages for trout.

On the basis of frequent observations on stream improvement in all parts of the state from 1934 to the present, the writer has concluded that apart from the problems of erosion control, a great majority of stream improvement matters may be dealt with by the judicious use of two types of devices and modifications of them. These are the single wing deflector and the bank cover, the latter in the form of bank raft, bend raft or boom cover, whichever best fits the individual site.

The I-deflector, even when functioning at its best, creates but a small pool; and since it is generally installed so as to rest just beneath the surface it constitutes a hazard to boat and canoe travel on the larger streams, and a nuisance to anglers, because hooks are readily fouled in it. Double wing deflectors, with or without diverters, are likely to be bridged across by a log or similar large piece of floating debris. Soon a heavy load of drift will accumulate, with the result that the first large flood is likely to demolish or seriously damage the entire device. The same fate is apt to befall reverse deflectors. Covers in midstream, whether rectangular or triangular, almost invariably silt in, forming a shallow bar or island instead of a sheltered pool; and if placed near to but not in absolute contact with the bank, they frequently bring about increased bank erosion. Structures completely damming a stream, even those which maintain a head of only six to twelve inches of water, seem to be generally undesirable. On exceptionally cold streams they may produce a desirable warming of the water, and in many instances they produce a temporary increase in the food supply. These benefits, however, are usually of only a few years' duration. The fate of such ponds generally parallels that of beaver ponds, which often produce improved fishing for a few years and then slump to a low yield level which is seldom if ever restored so long as the pond exists.

Whatever the types of devices installed, rigidity of original construction should be supplemented by regular maintenance. It is almost a surety that greater benefits will accrue, over a period of years, from a limited number of barriers adequately maintained than from a much larger number of installations allowed to fall into a state of disrepair.

The chief difficulty in appraising the value of stream improvement generally, and that of the various types of structures, lies in the absence of accurate information as to the production of trout in areas prior to the installation of devices. Physical changes in the environment wrought by barriers can be checked closely, and changes in the bottom fauna can be determined with reasonable accuracy; but the ultimate effect of these changes on trout production cannot be measured with certainty when figures are lacking as to the resident population of an area before improvement. The acquisition of such information is an important phase of the work program at the Fish Division's newly established experiment station on Hunt Creek. It is planned that for two or three years data will be taken, incidental to other projects, on the existing status of trout and trout food organisms, and on the detailed ecological character of the situation. Then, when various types of improvement are installed for trial, these facts will serve as a yardstick for the measurement of results obtained.

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Text for Figures

Fig. 1. Log wing deflector, its outer end reinforced with boulders. Bank raft below deflector on opposite side of stream.

Fig. 2. Wing deflector made of logs and coarse gravel. Bend raft below deflector on same side of stream.

Fig. 3. Y-deflector.

Fig. 4. Boom cover.

Fig. 5. Stone and boulder deflector. Note how vegetation improves appearance.