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GENERAL OBSERVATIONS ON THE CONDITION AND EFFECTS OF  
STREAM IMPROVEMENT DEVICES IN VARIOUS UPPER AND LOWER MICHIGAN RIVERS

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Between August 24 and September 9, 1938, an examination was made of certain sections of stream improvement in which the Institute has a particular interest.<sup>1</sup> Some of these structures were installed under the

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<sup>1</sup> Observations made at this time on the East Branch of the Black River have been recorded in Report No. 491.

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direct supervision of former Institute staff members: Drs. John Greeley and C. M. Tarzwell, and Mr. E. R. Kuhne. Others had been constructed by the M.E.C.W. following general outlines supplied by Dr. Tarzwell, and under the direct supervision of Messrs. Tom McClure and Herman Ottenhoff.

All of the Lower Peninsula work examined was described in detail at time of construction, and individual notes on each structure were made by Dr. Tarzwell and myself in October, 1934, and again from January 3 to 17, 1936. The work in the Upper Peninsula was described by Tarzwell shortly after its installation in the fall of 1933, and was re-examined by Tarzwell and myself December 16-23, 1935.<sup>2</sup>

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<sup>2</sup> Institute Report No. 362, May 29, 1936, by C. M. Tarzwell, contains a summarization of observations made during the winter of 1935-36.

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Repeated observations upon various improvement devices, and the keeping of individual records for each structure, afford valuable

information on the relative merits and permanency of different barrier types, construction materials, and installation methods; vegetational successions fostered by improvement; nature and degree of permanence of alteration of physical stream characteristics; normal expectancy of duration and efficiency; and maintenance requirements. While it would be desirable to make careful studies of the fish and fish-food supplies at the same time, such work is too time-consuming, and must be restricted to a few arbitrarily selected sample areas.

North Branch of West Branch of Escanaba River

The work in this stream was examined August 24, 1938. At 4:00 p.m. the air temperature was 65°, that of the water 63°F. The sky was clear, lowest temperature the previous night 36°F.

The structures installed by Mr. Ottenhoff in 1933 which were checked by Tarzwell and myself in December, 1935, begin in the SW quarter of Sec. 20, T. 44 N., R. 26 W., and continue to the junction with the West Branch of the Escanaba. The distance by stream is between one and one-half and two miles, the direct distance about one mile. Here the stream is roughly paralleled by the Kates Grade, which is now traversed by a road leading to the CCC camp of the same name. The country through which the stream flows is uniformly low and flat, grown with very hummocky clumps of marsh grass and with alder, the latter at times almost impenetrable. Along the stream side there is a profusion of goldenrod, joe-pye-weed, smooth aster, and white aster, which, when in bloom in late summer and fall, must attract large numbers of terrestrial insects, to the benefit of the fish food supply.

The stream itself is deep coffee color, and flows over a bottom uniformly composed of the dark, coarse, shifting sand encountered in so many Upper Peninsula streams. By common testimony, the streams in this

region were much higher than usual during the summer of 1938. It was necessary for me to leave the stream at many points, the entire channel being more than wader-top deep. The numerous bends are usually acute-angled, and at their inner apex a long, high sand bar generally juts into the stream, a hole five to nine feet in depth extending around the outer course of the bend. A majority of these holes are heavily shaded by undercut banks densely grown with alder. It might be stated as a generality that, despite the open character of the stream valley, the stream itself is partially shaded on one side or the other throughout the extent of this section.

Trampling of wide marsh grass areas in the vicinity of the stream side indicated the presence of a considerable number of deer. No predatory birds or reptiles were seen. Most of the sandbars bore numerous traces of muskrats, but no signs of beaver were detected, possibly because aspen is scarce and they would be restricted to a diet of alder.

The improvements exhibit a remarkable degree of uniformity, and have achieved very much the same results throughout the portion examined. In the opinion of the writer, the work might have been rendered more effective through application of certain fundamental differences in design. By far the greater number of structures are simple wing or reverse deflectors, constructed of logs and, where possible, sealed with stones along the upstream face. Not one of these extends above the surface. Many have been undercut wholly or partially, owing to failure of the seal, and in the case of many more the bank end has been cut around because it was not inset deeply enough. Holes from 30 to 48 or more inches in depth are frequently formed by the action of undercutting, and the barrier itself affords such holes a certain amount of desirable cover. Those which have cut around, however, are now increasing rather than decreasing the amount of bank erosion,

and so are doing more harm than good. Numerous deep holes have been formed, and an addition made to the cover naturally available, which is praiseworthy. It is the writer's conviction, however, that soft, sandy bottom streams such as this imperatively require improvement devices of a type which will assist in stabilizing the bottom. Gravel does not appear in this section until about 200 yards before its union with the West Branch. With gravel absent, the only hope for creating a bottom productive of food organisms lies in creating bars of sand and/or muck and organic debris, permanent enough in character to permit the establishment of aquatic vegetation, and to allow the existence of such burrowing forms as ephemerid mayfly nymphs, lumbriculid and tubificid worms, and sphaeriid clams. To attain this, deflectors much extend above the level attained by high water stages. Protruding structures are admittedly less natural in appearance, and a trifle more expensive to construct; but no real permanency of bottom in sandy stream sections can be secured with subsurface deflectors. It is significant that no vestige of aquatic vegetation was observed in the section examined. Below the surface, all sand bars and spits formed by the barriers were obviously in a continual state of change. No considerable accumulations of silt, muck, or organic debris were seen. As nearly as could be told, aquatic food organisms were exceedingly scarce except where occasional jams of drift wood offered harboring places. Doubtless some burrowing forms are present in large eddies and quiet-water areas adjoining the stream, but in general it is quite apparent that the food supply is extremely poor.

Judged from the standpoint of durability, the structures appeared to be holding up quite well, aside from the undercutting and bank washing already alluded to. Some of the stakes have been upheaved, apparently by ice action, but most of the devices are still well anchored. In the main,

simple wing deflectors appear to have fared better than V-type or reverse deflectors, possibly because the latter more frequently accumulate jams of driftwood so heavy and current-resisting as to tear loose the structure's moorings. Bundles of brush anchored to stakes were installed at frequent intervals, and have lasted surprisingly well. Although general weathering has thinned these by removing the smaller twigs, enough remains to provide a small amount of fish cover, and, more important, to afford harborage for certain clinging-type food organisms. A few square covers installed in midstream in this section have lasted better than most similar installations noted in other streams, largely because of the fact that those in the North Branch of the West Branch were fastened to their anchor stakes by heavy wires sufficiently long to permit them to rise and fall with floods and ice without exerting a direct upward pull on the stake.

Several wing deflectors have lost their effectiveness through being placed in locations where natural currents are stronger than currents produced by the structure, as a consequence of which the barrier is almost entirely embedded in sand and at best produces a slight riffle.

Detailed notes on individual structures may be found in the appendix to this report.

#### Work on Anna River Near Munising

The improvements in the Anna River were installed under the supervision of Mr. McClure in 1933. The work commences just above a small farm bridge crossing the stream in Section 16 of T. 46 N., R. 19 W., and extends almost to the city of Munising. The section cruised by Tarzwell and myself in 1935 begins at this bridge and extends to the next point where the stream adjoins the highway, about 1 1/2 miles by stream.

Here the bottom of the stream is predominantly soft, fine, white shifting sand, with some accumulations of silt, muck, and organic debris

in protected areas. Occasional narrow strikes of gravel and rubble run across the stream bed, and at such places the stream is very attractive.

At frequent intervals a less common type of bottom material appears-- fibrous, water-resisting peat. This may break up into large chunks or have deep, rough walled holes eroded in it. Aquatic mosses, and such plants as Chara and white water buttercup are able to root and become established on this material. Owing to its fibrous character, jagged, honeycombed surfaces are formed which offer excellent harborage to various fish food organisms.

The rate of flow is swift throughout. The banks average about two feet in height, and are sufficiently undercut to afford good cover. Heavy shade is provided by a mixed growth of white cedar and spruce--trees which frequently meet above the stream. At a few points the channel touches the grade of a railroad which follows the valley, and at such points the left side of the stream is devoid of shade. When inspected, the bottom sustained a rather heavy growth of moss, which, in turn, supported long streamers of algae, apparently Spirogyra. Other forms of aquatic vegetation were rare. The food supply appeared to be poor except in the gravel sections, among the moss, and in peat sections, although it is probable that some burrowing forms are present in the softer sections. Plant roots dangling from undercut sections of bank doubtless harbor some clinging-type food organisms. A few stoneflies of the genus Leuctra, clambering about over streamside shrubs, were the only adult aquatic insects observed.

Only one trout was seen--a brook trout about six inches long which rose to a grasshopper thrown on the water.

Where cedar and spruce are plentiful on the bank, numerous deadfalls have dropped into the stream. These now serve as natural deflectors, and afford considerable shade and cover as well. Frequently they completely bridge the stream, offering obstacles to wading and to fly fishing.

For the first quarter-mile considerable damage has been inflicted on the improvement barriers by a wooden bridge which was washed out somewhere upstream, and whose wreckage swept down the channel. This probably occurred during the spring floods of 1938. Timbers and planks have been left stranded on the bank above summer water levels, and in several instances have formed jams across the channel.

The principal types of barriers in the section examined are simple wing deflectors constructed of logs, and small clumps of brush anchored to a single stake in the stream bed. A greater part of the deflectors are extensively undercut. Owing to the fact that the stream is confined to a rather narrow channel, this is not a serious detriment, and is helpful in providing deep, narrow, well sheltered pools. It is almost certain, however, that unless the anchoring stakes are redriven soon a large number of structures will be lost through ice and flood action. The brush shelters have proved less permanent, many having been dislodged. Those which remain have been almost wholly embedded in sand, and so are of little value as fish cover at present. Enough persists, however, to support some clinging types of fish food organisms.

It is the feeling of the writer that this work is to be criticized more for its abundance than for its construction methods. The section examined in 1935 and 1938 is so plentifully endowed with holes and cover provided by natural stream obstructions, chiefly deadfalls and drift, that most of the artificial installations appear superfluous. Dense cedar and spruce shade comes from both sides of the stream except where the channel approaches the railroad grade. Nearer Munising, where some rather extensive swamp cuttings have been made, the need for shade and cover-providing improvements is greater.

Miners River East of Munising

The work installed in Miners River above and below the M-94 bridge was largely composed of stones and boulders, disposed with the hope of creating better pool conditions in a stream bed formed largely of gravel, rubble, and occasionally of bed rock. The fall is considerable, the water plunging over numerous small cascades and rapids. The river has eroded for itself a rather deep, narrow, ravine-like valley. In the section examined, excellent shade is afforded by a good beech-maple forest near the top of the banks, and by birch, mountain ash, and alder nearer the actual stream side.

Because so many of the structures originally placed here were found to have been washed away entirely or so leveled as to be unrecognizable, this section was not cruised in entirety, but examined only far enough to secure a general idea as to the fate of the barriers. It is apparent that the stones chosen for this work were not of sufficient mass to withstand the strong current, and that as a result the majority of the deflectors are represented only by two or three of the larger boulders used as foundations. These, however, together with the scattered smaller stones, create attractive riffles and small shelter areas and undoubtedly serve to increase the fish food supply. Pools and cover are still needed here.

Pigeon River

Experimental stream improvement devices were installed in the Pigeon River by Tarzwell in 1931. Five years later, it was found that only 10.6% of these were lost,<sup>3</sup> despite the extraordinarily heavy ice formation of

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<sup>3</sup> Tarzwell, C. M. 1937. Experimental evidence as to the value of stream\$ improvement in Michigan. Trans. Amer. Fish. Soc. 66:179

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1933-34. Individual observations were made on these structures at periodic intervals. This was one of the streams selected for intensive analysis of food supply. During the spring of 1936, a considerable amount of this work was torn out by enrollees of National Parks Camp Vanderbilt. It was argued that the original work was unsightly (a sentiment open to doubt), wherefore it was replaced by what this organization considered to be more attractive devices. The Park Service structures were placed in locations different from those of the State ECW, with the deplorable result that the alteration and stabilization of physical and biological conditions effected by the original work were destroyed. This is the more lamentable when it is realized that stream improvement devices seldom function at peak efficiency until they have been in place for two or more years, because modification and permanizing of physical conditions, and maximum occupancy by food organisms, is naturally a gradual and time-consuming process.

Not only were the original structures removed, but many were apparently cast adrift, with the result that unsightly jams of timbers have been thrown up on the banks for some distance downstream. Pressure from these jams has led to the wrecking of many more of Tarzwell's devices below the section where the actual substitution of structures was performed.

As may be seen from the appended photographs, the Park Service "structures" consist largely of trees felled into the stream at haphazard angles, and of stumps and flotsam cast promiscuously into the stream. As a result, bank erosion is increased as often as it is retarded; unmoored or insecurely fastened logs and stumps shift position so frequently as to obviate any likelihood of permanent environmental alteration; and desirable bank shade is chopped down to produce inadequate stream cover.

The work installed in 1931 was not examined in the stretches adjacent to the Tin Bridge or the Forest Headquarters. The section inspected, extending from the Vanderbilt Bridge to the third north-south fire line reaching the stream below this point, has been so greatly altered, as described above, that notes on individual structures were not taken. It was, in fact, difficult in all cases to determine with certainty whether a given device had gone out due to failure of construction or whether it had been removed by the Park Service. Such of the original barriers as remained in place seemed, with few exceptions, to be still effective. As would be expected in a stream subject to heavy ice formation and considerable fluctuation in level, stakes are frequently upheaved, and are in need of re-driving. Deflectors, especially those of the V type, are often wholly or partially undercut. In three instances, large and unsightly jams of drift material have lodged on barriers, and have completely bridged the stream. Deep holes and good cover result, but the immediate water areas are unfishable, and the angler must leave the stream to pass the obstruction.

One noteworthy piece of construction was an erosion control installation near the lower end of the section. Here an eroding sand bank about 20 feet high and 100 feet long has been faced with log terraces. The once exposed sand is now well secured by a good growth of grasses and shrubs, cherry being most abundant. A long, heavy, log wing breaks the strength of the current before it reaches the sea wall, which remains in good repair.

Here, as in a majority of streams inspected, the great need is for repair and maintenance of existing structures, rather than for installation of additional or substitute structures. Extensive repair could be carried out for less than the cost of new or substitute improvement of relatively small stretches.

The fact cannot be too strongly emphasized that permanency and stability are the most vital features of stream improvement. Depending upon the bottom type, a year or longer may be required before a given device completes its designed alteration of physical stream characters. Even longer periods--three or more years--may elapse before this altered section demonstrates its maximum potentialities as a fish food producing unit. This is but logical when one reflects on the time which elapses before a drastically altered land area supports a vegetational climax. It should be remembered that while insects and other invertebrates may be washed in and established from adjoining areas, populations increase solely through natural reproduction, and a number of insects require two or more years to complete their life cycle.

For these reasons it must appear obvious that, when once a stream improvement device has effected its designed changes, every effort should be exerted to preserve and stabilize these changes. A maximum of food production is never attained by a shifting stream bed.

#### The West Branch of the Sturgeon River

Stream improvement devices were installed in the West Branch of the Sturgeon November 3 to 20, 1933, the section involved being about two miles in length, beginning at the site of the former U.S. 27 highway bridge north of the village of Vanderbilt. When the work was constructed, the river was followed rather closely by the twistings of the highway. During 1935-36, the State Highway Department re-routed U.S. 27, straightening out many of its convolutions and at most points removing it some distance from the stream. In the long run, the results of this change may be beneficial to the stream, but certain immediate effects have proven deleterious. For example, during early May, 1935, the writer noticed that gravel washings were being poured directly into the stream, where the fine powder settled out on stones of the stream bed, encasing fish food organisms and in some

observed instances causing their death by suffocation. After complaint had been registered this practice was abandoned, but not before some permanent harm had been done. During the process of dredging out a new roadbed through heavy muck deposits adjoining the stream, large amounts of this substance washed through the channel. For some distance downstream from the point where U. S. 27 now first crosses the West Branch, the new highway grade rises directly from the water's edge. Here all stream improvement structures on the left bank were removed during grade construction. As a result, no shade or cover exists, since no trees were left standing. The grade has been protected against erosion--one of the designed functions of the improvements here--but cover is badly needed. Practically all of the physical modifications of stream profile, and the plant beds produced by the improvements, have been destroyed or greatly altered along the highway grade.

When considering the fate and the achievements of stream improvement installations in the West Branch of the Sturgeon, it is first of all expedient to consider briefly some of the more salient characteristics of this stream. Through the section involved, the stream width averages about 30 feet, the depth 10 inches; the current is uniformly fast. Although sand and limited amounts of muck, silt, and organic debris are present in restricted locations, by far the greater part of the stream bed is composed of gravel, ranging in size from that of a pea to as large as a man's head, the average size being about that of a hen's egg. In the main these stones are smooth and polished, with few surface irregularities, and only rarely are they coated with spongy marl. In consequence, food production is not as high as might be expected from gravel bottom. While the stream has a lake origin, it flows through many miles of thick cedar swamp which, through combination of spring water seepages and shade, keeps the temperature quite low, even in warm weather. Anchor ice has been observed forming on the

bottom of the West Branch when the air temperature was lower than  $-25^{\circ}\text{F}$ , but molar action of surface ice is normally not an important factor. Fluctuations in level are seldom extensive, and, a result of these conditions, structures may be built with tops near the water line without much danger of damage. Owing to lack of any considerable quantities of natural holes or cover, and to the fact that one side or the other is unshaded because of highway proximity, this section seemed especially in need of attention.

With few exceptions, the installations were of two major types: wing deflectors and pole bank and bend rafts. Deflectors were almost entirely built of pine logs sealed with gravel and stone; bank rafts were constructed chiefly of cedar poles. Tamarack stakes were commonly employed.

Installation of rafts along the bank and in bends was done with the idea of checking bank erosion, which in some cases was rather serious, and of offering cover and protection to trout in a section relatively free from natural cover in the usual form of deadfalls, submerged snags, large boulders, or undercut banks. Deflectors were designed not only to create holes in the uniform gravel bottom, but to concentrate and stabilize such silt as might be present in the stream and allow aquatic vegetation to become established.

Plant Succession.-- In naturally sheltered places, Chara (stonewort) and a fine-leaved Potamogeton of the filiformis group occurred before improvement devices were installed but, owing to the swift current and gravel bottom, beds of these plants were restricted to small and infrequent localities. The installation of barriers engendered a remarkable increase in the size and number of plant beds, by creating quiet water areas where silt and muck might accumulate and plants take root without disturbance.

Chara (musk-grass or stonewort) is obviously much more successful than any higher plant species in the West Branch of the Sturgeon. After its beds have been established for from one to two years, such plants as Potamogeton heterophyllus, Sagittaria, Ludvigia, Anacharis, watercress (Roripa nasturtium), and white water buttercup (Ranunculus aquatilis) appear and may become numerous, although never approaching Chara in abundance. Sagittaria, Ludvigia, and P. heterophyllus seldom appear until the Chara bed where they root has become so well established as to constitute practically an extension of shore. Anacharis, watercress and white water buttercup prefer quieter areas, but can withstand some current, especially the last-named. Once a bed becomes well grounded and occupied by Sagittaria and Ludvigia, the next invasion is by sedges (Carex species), followed by burr-reed (Sparganium). Then, when consolidation is well accomplished, the former aquatic plant bed is taken over by various mints, composites, and other terrestrial vegetation.

An attempt has been made to estimate the actual increase in area of plant beds directly attributable to barrier installation. As a result of an effort to give due consideration to previously-existing beds, it is believed the following figures err on the side of conservatism. Since computations for each year were made in similar fashion, however, it is felt that the ratio of annual increase is given with reasonable accuracy. By October, 1934 (eleven months after barriers were installed), the area of plant beds had been increased by 2,728 square feet. By December, 1935, the increase was 7,545 square feet, and in September, 1938, 10,930 square feet, over the original area as of November, 1933.

Durability of Structures.--When reporting on the condition of Michigan stream improvement as of 1936, Tarzwell<sup>4</sup> stated that from time of installation

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<sup>4</sup> Tarzwell, C. M. 1937. Trans. Amer. Fish. Soc. 66:179.

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to December, 1935, a period of two years, loss of structures from the West Branch of the Sturgeon totalled 2.0 per cent. At that time the work was viewed by the writer also, and was considered to be in uniformly fine condition, with every indication of continuing so for many years to come. In September, 1938, it was calculated that 20.9 per cent of the structures had gone out entirely while another 27.6 per cent were in need of repair. A strong probability exists that this sharp increase in loss and degree of damage is almost wholly attributable to a freakish cloudburst which, during May, 1938, struck the headwaters section of the West Branch and sent a high, turbulent wall of water, laden with drift logs and debris, tearing down the channel. Accurate measurements of the crest of this flood were not made, but local residents are unanimous in testifying it to be by far the highest level attained by the stream during their memory. Many bank rafts were either ripped away completely or thrown high and useless on the banks, while others opened up fan-wise owing to breakage of binding wires. Wing deflectors fared better, and while some were undercut and others damaged through tearing away of one or more logs, very few are beyond repair.

Alteration of Stream Profile.--Eleven months after installation, these barriers designed to form pools and holes had increased the depth of water for an average of nine inches. Twenty-five months after installation the average depth increase amounted to 17 inches. Fifty-eight months after installation, two-third of the barriers had increased the total average depth by 25 inches; but one-third of the structures had, through partial or complete damage, lost an average of three inches depth since the preceding check-up. This clearly emphasizes the need for an arrangement which would allow an agency, relief or otherwise, to devote some time and labor annually to the task of maintaining efficiency in previously installed structures.

It is felt that repair and replacement of the original devices is all the work that should be attempted on this particular section of the West Branch. If the holes and riffles already formed are perpetuated, greater benefit to the stream will accrue than from installation of additional or different devices.

#### Little Manistee River

Work carried out on the Little Manistee in 1930 was almost wholly of an experimental nature. Due to this fact it is not surprising that many devices have gone out or sustained serious damage, and that others have proven to be ineffective. Large stretches of this stream are particularly difficult to improve, because not only are banks and bottom overwhelmingly sandy, but the sand formation extends beyond depths ordinarily affected by accepted types of structures. Gravel cannot be uncovered in many sections, and continued digging by devices culminates in their loss through undermining of stakes.

Both bottom type and fluctuation in level contribute to the almost complete absence of aquatic vegetation in the upper sections. Not until the M-63 bridge is reached does vegetation become a common feature of the stream bed.

Throughout the greater part of the portion examined, especially from the "Box Car" downstream, many installations have been made by the CCC. Some of these appear to be well conceived and executed, notably some of the erosion control devices mentioned in the detailed notes in the appendix. Others are less desirable. Repeated installations of rectangular shelters made almost wholly of alder are of doubtful value since they cannot be expected to be durable. In not a few cases, even wing deflectors were seen to be anchored to alder stakes.



From the M-63 bridge downstream, the stream's greatest need is for improvements which will deepen and accelerate the flow through sections now broad and flat. This may be accomplished in various ways, probably most economically by construction of very long wing and Y deflectors and blunt V deflectors whose closed apices are pointed upstream, as exemplified by installations in the North Branch of the Au Sable near Lovells. The latter type of barrier will, if properly installed, eventually lead to the formation of an island in its lee which, through gradual growth, may effect the desired deepening of flow by partially splitting the stream into two channels. Island formation may be expedited if brush is piled behind the deflector at time of construction.

#### Summary

The following points represent the writer's views on Michigan stream improvement, based on repeated inspections, reduced to concise form:

1. Wooden materials, often forced upon the improvement crew by necessity, are the obviously logical choice for fish covers and erosion control. If securely wired and anchored to deeply driven stakes of some water-resisting wood such as oak or tamarack, and when the bank end is deeply inset, log deflectors are very effective and in a few years' time take on a natural weathered appearance; but they cannot match stone deflectors in permanence and naturalness of appearance.

2. Wherever available, large stones and boulders should be used for deflectors, for considerations of permanence and appearance. Such structures, however, are useless in soft bottom streams.

3. Once a stream improvement device is installed it should be maintained in good repair and in its original form and dimensions. At the present time it is much more desirable that existing improvements be

maintained than that new structures be installed in unimproved streams.

4. On new construction projects emphasis should be placed on careful and durable work rather than on covering a large stream mileage.

5. It would appear that the most successful types of barriers are: simple wing deflector; reverse deflector; V deflector with apex directed upstream; bank and bend rafts. Square or triangular "covers" placed at the surface in midstream soon fill, and are useless as covers but may form islands. Reverse deflectors and Y deflectors are oftentimes efficient, but frequently cause jams through lodgement of drift.

The need now is for perfection of placements and construction methods for proven barrier types rather than for further large-scale experimentation with new types.

North Branch of West Branch of Escanaba River

beginning in southeast corner of Sec. 20, T. 44 N.,

R. 26 W. and running to junction with West Branch Escanaba.

1. Large single log wing on left, estimated 40' long. Bottom sand. Large (est. 6') hole behind log which is now 8" below surface in 18-20" of water. Looks permanent.
2. Wing on right 50 yards down. Upper surface of log with several notches. Length est. at 40'. Shallow flow over top, undercut. Deep hole from outer end extending 10' back upstream. Permanent.
3. Brush shelter on left--still in place, but thin. Protects hole dug by (2), which extends about 100 feet. Bottom still 100% sand, scant shade.
4. Reverse deflector--doing little if any good--too far below surface to alter current.
5. Down from (4) 50 feet. Stump anchored in hole on right; of doubtful value as bank is undercut.
6. Gone out. Apparently a wing--three stakes caught on alder on right just below stump, (5).
7. Wing on right, 30' long, one log. Embedded in sand, top now 8" below surface of water. Doing very little good. Fine natural hole on left, overhung by alders.
8. Brush shelter on left--stake too obvious. Brush thin.
9. Wing on right, one log, 1 foot below surface. Big hole on either side chiefly due to natural constriction of stream banks.
10. I-deflector across stream leaving about 3' open stream at either end. Of questionable value--tending to increase erosion.

Appendix - 2

11. Wing just below on left. Fifteen feet long, 2 logs high. Large hole just below overhung by alders.

12. Fifty feet down, a natural subsurface jam of deadheads is supported by a row of stakes --



13. Reverse deflector 50' down. Below it a 75 square foot bar of 60% sand and 40% silt and debris, open growth of Vallisneria and white water buttercup on bar.

14. Wing on left, 15 feet, without value.

Unmoored deadheads at next bend cover hole wader-top deep. Still all sand. Deep hole all around bend with some more deadheads. At end of bend is a stake whose barrier is gone.

15. One hundred feet below about bend, an embedded and useless wing on left.

16. Embedded and functionless log raft in middle.

17. Three-log wing on left--in place but badly overshot.

18. One hundred feet down a 20' wing on left completely embedded and useless.

19. Opposite (18). A brush shelter, thin but holding well, covers a 5 foot hole.

20. Twelve-foot wing on left shoots water under thick alder. Good work. Hole 36-38" deep.

21. Thirty-foot wing on left, top log 12" under water. Good hole at end under alder at bend.


22. Forty-foot wing on right at foot of bend--overshot, deep hole behind, wing partially embedded.

23. Stream constricts just below No. 22, and there a large stump anchored in middle has dug hole est. 6' deep which runs into next bend.

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Appendix - 3

Below this bend about 150 yards the stream becomes too deep to wade. No barriers seen, but some were possibly obscured by the dark, reddish-brown water.

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24. Wing on right--12 feet long, embedded in sand.
  25. Wing on left--15 feet long--embedded.
  26. Wing on left 3 logs high, 20 feet long. Bank end washed away.
  27. A log raft in midstream, embedded.
  28. Around next bend, 100-150 yards, a 20-foot wing on left, embedded.
  29. An attempted gravel wing on left, 15 feet long. Composed of fist-size stones which have been leveled off and partly buried. A hole at its end is probably caused as much by natural channel configuration as by structure. Just below, 2 stakes persist where a log wing went out.
  30. On right a 50-foot wing backed with rock. Partially embedded and overflowing.
  31. On left, a similar wing, but largely embedded, and doing little.
  32. Stake on right, with no barrier. This point is just above island lying in recently cut-off oxbow . This island was obviously cut off by man. Channel through neck of land is over wader tops.
  33. Just below the above stake, a stump is anchored on right.
  34. Below island 100' an anchored stump, and a stake without a structure--latter (stake) has been upheaved.
- Then a long (330 yds.) bend with only one stake visible.
35. Below bend, a 25-foot wing on left, bottom conditions unchanged. Wing overflowing, in usual condition. Open meadow on right.
  36. Isolated stake on right--probably once held brush.
  37. Fifty feet down, a 20' wing on left, as usual.
  38. I-deflector lined with brush. In place. Stranded log from some deflector on bank just below.
  39. Reverse deflector, almost a  $\wedge$ . In place.

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40. Wing on left lined with brush, embedded.

41. Around next bend (200 yards) a reverse deflector of logs, bank ends reinforced with stone.

42. One hundred feet down a 20-foot wing on left, also a stake whose structure is gone.

43. Then a very sharp bend, with a wing on left whose inner end is cut around, bulk of flow going there. Gravel first appears in bottom here.

Hydropsyche and leptocerids common.

44. Two stakes, barrier gone.

45. Reverse deflector 100 feet below 44--embedded.

46. In next bend a stone wing makes a nice riffle--current not greatly deflected.

47. In bend above bridge, a stone-faced wing on right. Looks very good. Alder at end opposite.

48. Just above bridge, reverse deflector makes a good riffle.

Detailed notes taken on stream improvement devices in the Anna River near Munising, August 25, 1938. Cruising begun at a small bridge leading to a dairy farm in section 16 of T. 46 N., R. 19 W. Numbers assigned to structures arbitrarily.

1

Just below the bridge are remains of a log deflector on the left. Being badly broken up and overflowed, it affords cover only.

2

Deflector on left 12 feet long, undercut, top 6 inches out of water.

3

Remains of wing on right. Bottom composed almost entirely of soft, shifting sand. Alder shade on right, fairly dense. It is possible that (2) and (3) together once constituted a reverse deflector.

4

Wing on right throws current under alder. Many old deadheads lodged on left add to cover. Water around end of deflector 26-28 inches deep, current swift.

5

Wing on left 18 feet long, undercut, sand bar in lee destroyed but a waist-deep hole formed around outer end under overhanging alder on the right. Some wreckage, apparently from a washed-out bridge, is lodged here. Bottom still 100 per cent sand.

6

An old tree felled across the stream perpendicular to the current has dug a hole about 34 inches deep. Immediately below is a wing on the right, still holding but badly battered.

7

Fifty feet down a tree similarly felled. Difficult to determine certainly whether this is natural or artificial.

8

Log jam on right where stream bends near railroad grade, lodged on small island. Affords some protection from erosion.

9

A submerged brush cover now lying on bottom and largely embedded in sand, doing little good. A natural submerged log just above is giving better cover than the brush. Bottom still sand.

10

Seventy-five feet down a 20-foot wing on left. Deeply undercut but stakes still holding. Deadheads lodged against the structure add to cover.

11

Forty feet down a brush shelter on the left has come unmoored but has lodged against bank and become sanded in. Eroded peat appears here in deep water--sides of peat-walled holes steep and jagged, offering some cover and improving conditions for food organisms. Banks now very open; railroad grade running parallel to stream.

12 & 13

Stream narrows and becomes very swift, too deep to wade. Fifty paces down another brush shelter is loose from its stake, but fast to bank. Boulders appear in bottom.

14

Turbulent riffle running along a small natural island. Fall of riffle about 12 inches in 10 feet, at least a portion of boulders artificially placed.

15

Eight paces down a brush shelter held in midstream by a long wire which permits it to rise and fall with changes in water level. Bottom mixed sand and peat, very little shade. Shelter rests on bottom, top is at



Appendix - 7

at surface. The long wire, permitting the shelter to float free, is a good idea since it prevents embedding in sand.

16

Five paces down a transverse I-deflector, overflowed. Deadhead lodged over top at an angle across stream has aided in producing a waist-deep hole.

17

Fifty feet down, the river bends sharply away from the railroad. In the bend another brush shelter rests on the bottom. Bridge wreckage in bend is lodged in a good position to check erosion over a hole 5 feet deep.

18

Thirty feet below bend an 8-foot I-deflector is lodged in midstream at an angle of  $45^{\circ}$ . Considerable natural cover in and over stream here. Bottom conditions unchanged.

19

Twenty feet down a stump staked to the left bank opposes a 20-foot wing on the right. Immediately below, the stream vanishes under a huge jam--the remainder of the washed-out bridge. This is unfishable and rather unsightly. It is likely to cause increased erosion of the banks at this point.

20

A huge tree lodged across the stream--upper surface grass grown. This is just below the jam. Immediately below, a 10-foot wing on left is in good condition. By it a dislodged deflector log is caught in midstream on submerged natural deadheads.

21

Twenty feet down a 10-foot wing on right has dug a waist-deep hole and so gives cover. End and bottom undercut, also inner end. Thirty feet down another natural log jam.

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22

Just below jam a 20-foot wing on left. Undercut and with a deadhead wedged across channel to opposite bank. Undercut as usual. Bottom still shifting sand.

23

Fifty feet down a wrecked square brush raft in center--large deadfall here has produced a good hole.

24

Twenty feet down a wing on right is too nearly parallel to current to be effective.

25

Sixty feet down a 20-foot wing on left as usual. One hundred feet downstream again curves near railroad grade. Here deeply eroded peat again appears in bottom. Shade is lost.

26

Fifty feet below bend a 10-foot wing on left--undercut throughout.

27

A minute island with submerged brush in channel just below. Value questionable. A few boulders here, possibly from railroad grade.

28

Seventy-five feet down another centrally situated brush pile embedded in bottom.

29

Boulder deflector on left--does well as a riffle-producer.

30

Twenty feet down another brush shelter, as usual.

31

Another of same, as usual.

NOTE: At pole  $\frac{3}{27}$  on railroad a large spring run enters from left through culvert. Gravel and marl in bottom here.

32

Just below culvert a wing on left. Undercut. Some peat also appears in bottom. Fifty feet down another log jam, this one small.

33

Twenty feet down an I-deflector supports a dense stand of grass and one small cedar. Doing well.

34

Wing on left, undercut. Stumps and deadheads lodged just below.

35

Near the highway a large log (10 feet long x 24" diam.) is high and dry, stakes heaved up.

36

Twenty-foot wing on left, as usual.

37

Twenty feet down a thirty-foot wing on left, undercut, overflowing, sand bottom as usual.

38

Thirty feet down a large 3-log deflector on left, undercut as usual. Channel blocked from end to right bank by drift.

39

Bare stake on left. Much algae on bottom. Stream again nears railroad and narrows to constrict flow. Divided by long island.

40

Above run ends in stone riffle, probably natural. Fall of 12 inches in 8 feet.

41

High wing on left, 2 logs out of water, but still undercut for entire length and of practically no value.

42

A bare stake as stream bends away from railroad.

Stream then touches highway grade, ending section cruised by Tarzwell and myself in 1936.

West Branch of Sturgeon River

This work was installed November 3-21, 1933. The first structure is tagged No. 529. Notes were kept on the basis of serially numbering, beginning with one. (Series K-5-A.)

1

Cedar log wing deflector on right, just below old U. S. 27 bridge. Greatest depth 22".

1934: In good, solid condition. About 400 feet of mucky area in lee.

Channel at end 28" deep. Nice riffle, rubble in channel bottom.

1935: Average depth increased by about 4". Mucky area 600 sq. ft.,

50 sq. ft. of plant bed.

1938: Unchanged except undercut at both ends, which has reduced mucky area

to about 300 sq. ft., impermanent in character. Plant beds restricted

to 20 sq. ft. of cress next to bank.

2

Cedar shelter raft on left, submerged. Water 12" deep.

1934: In good condition. Depth now 24".

1935: Depth increased to 26-31".

1938: Unchanged except for small amount of lodged drift. Pool depth as

in 1935.

3

Pine log wing on left. Greatest channel depth 15".

1934: Pool at end 24" deep. 18 sq. ft. of Chara above. Chara and Potamogeton filiformis starting below. Muck bar in lee covers 300 sq. ft.

1935: 68 sq. ft. of Chara above. In lee, 450 sq. ft. muck bar with sparse

Chara. Riffle effect extends 1400 ft.

1938: Inner end slightly cut around, outer overflowing. Chara in former

location but very sparse. Mucky area about 800 sq. ft., unstable.

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4

Cedar pole shelter and erosion control on right.

1934: In place, 18" pool along and under raft.

1935: In place.

1938: In place, covering excellent, long, shaded pool.

5

Pine log deflector on right. Stream depth 8-16".

1934: Pool at end 22" deep. Cress starting in lee. Chara rooting along right bank.

1935: Pool at end 25" deep. Bar 100 sq. ft. with small patch of planted watercress.

1938: Unchanged, except all plants now gone.

6

Cedar pole shelter raft. Greatest depth of water 15".

1934: Some Chara-grown silt bars forming next to bank. Pools 18-20" deep.

1935: As above, deepest point now 24".

1938: Little change in physical conditions. Weathered to attractive natural appearance.

7

Cedar pole shelter on left.

1934: In place, harboring large numbers of caddis larvae (Hydropsyche).

1935: Conditions unchanged.

1938: Unchanged. Affords excellent cover to extensive pool area.

8 & 8a

Cedar pole bend raft on right, to check erosion and protect 38" hole.

1934: Bar, formed just above shelter by retarded current, supports 20 sq. ft. of Chara.

1935: In place; erosion being checked.

1938: Drift added to barrier; hole about 36" deep. Open stand of moss, watercress, white water buttercup, and P. filiformis covers about 800 sq. ft. just below.

Cedar pole shelter on left. No plants. Gravel and stone bottom, greatest depth 23".

1934: Current retarded above. Chara and white water buttercup under shelter, 24" pool along outer side. Excellent stand of these plants on 160 sq. ft. of muck bar formed below. Mud flat extends to next barrier, with such additional plants as Ludvigia and P. pectinatus.

1936: In fine condition. Bar and plant beds now cover about 300 sq. ft. Chara dense.

1938: Still in place. Hole about 20" deep. Muck bar and plant bed, including eel-grass, cress, and arrowhead extends to next structure, about 1200 sq. ft.

Cedar pole shelter on left. Gravel and rubble bottom; water under shelter 18" deep.

1934: Pool around structure 30" deep. Narrow Chara bed extends below cover for 20 feet.

1936: Unchanged, except Chara now covers 270 sq. ft.

1938: Unchanged. Weathered to attractive natural appearance. Pool about 34" deep.

Cedar pole shelter on left. Coarse gravel bottom.

1934: Good cover over 25" hole.

1936: Unchanged.

1938: Unchanged.

Pine log wing deflector on left. Coarse gravel bottom, greatest depth 23".

1934: Pool around outer end 30" deep. Bar of sand covered with muck occupies about 300 sq. ft. below deflector.

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1936: Greatest depth increased to 28". Bar now high out of water; 200 sq. ft. of muck.

1938: Still in place, but outer end undercut by a hole 32" deep. Will soon cut around bank end and increase erosion.

13

Cedar pole bend raft along right, protecting 21" hole.

1934: Pool under raft 27" deep, erosion effectively checked. Large amount of drift accumulated by device, about equal to one-fourth of raft. Bar being formed above.

1936: Still effective.

1938: All except lower end sanded in and supporting a dense Chara bed and one good patch of watercress. Pool at lower end almost 36" deep. Lodged drift still on structure.

14

Cedar pole shelter on left. Gravel bottom. Protects 30" hole.

1934: In good condition. Chara and P. filiformis beds forming along left bank and extending to next structure downstream.

1936: Plant bed about 120 feet long.

1938: Unchanged, except pool now 34" deep.

15

Deadhead underwater cover on right. Sand and gravel bottom, 17-31" deep.

1934: In place and holding well.

1936: Unchanged.

1938: Gone out.

16

Cedar pole shelter along left bank. Gravel bottom, 17-31" deep.

1934: In place.

1936: In place.

1938: Gone out.



17

Single hemlock pole wing on left. Gravel bottom, greatest depth 17".

1934: Plant bed along left bank continuous from 14 to 19.

1936: As above, greatest depth 26".

1938: Gone out. Plant beds still intact, probably well enough established to continue without protection of deflector.

18

Pine pole bank cover on right. Gravel bottom, greatest depth 21", in center.

No plants or muck bars.

1934: Pool along outer edge 30" deep.

1936: In good condition; pool 33" deep.

1938: In place. Subsequent workers have piled a dozen large stones in stream between here and next wing. Doing no harm, but so promiscuously placed as to be of little value.

19

Pine log wing on left. Gravel bottom, greatest depth 21". No plants or muck bars.

1934: Mucky area occupying 375 sq. ft. below wing. Watercress, Elodea, Chara and P. pectinatus coming in. Pool around end 20' x 10' x 28".

1936: Much the same, except depth increased to 36" near end. An excellent long pool around the end produces almost 1200 sq. ft. of riffle area.

1938: As above. A very successful and attractive installation.

20

Cedar and pine raft on right, joining No. 18. Gravel bottom, greatest depth 18".

1934: In good condition. Water along edge about 27" deep.

1936: Pool depth increased to 32".

1938: Pool depth increased to 36". An excellent cover.

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21

Cedar pole shelter on right. Gravel bottom, no plants. Greatest depth 18".

1934: In good condition. Pool 29" deep.

1936: Unchanged.

1938: Pool now 39" deep; structure still in good condition.

22

Cedar pole shelter on right. Gravel bottom. Greatest depth 21".

1934: Holding well. Pool now 39" deep.

1936: Unchanged.

1938: Unchanged.

23

Pine log wing and director on left. No plants or bars.

1934: Good 30" pool below barrier along bank. About 40 sq. ft. of plant beds on muck bar in lee occupying about 200 sq. ft.

1936: Not much change, although some other worker has placed a stone wing just below No. 23. The stone wing is all subsurface.

1938: As above, except inner end now being cut around. This should be repaired.

24

Cedar raft anchored to deadhead. Protects 30" pool.

1934: In fair shape. Structure not placed exactly right, pool now reduced to 22" depth.

1936: Little change.

1938: Still well anchored. Pool depth increased to 40".

25

Cedar pole shelter raft on right. Coarse gravel bottom, no plants or bars.

1934; 1936; 1938: Little change.

Brush shelter, birch, alder, aspen, on left. Coarse gravel bottom. No bars, trace of Chara.

1934: Quite effective. Plant bed enlarged to reach down to next barrier-- bed about 80 feet long, 3 to 4 feet wide. In addition to Chara, P. filiformis and white water buttercup are appearing.

1936: Little change. Chara still predominates in plant bed.

1938: Structure almost destroyed, but plant beds still intact. Another rock pile 20 paces above here--good for food organism harborage, but rather superfluous in a naturally rocky stream.

Submerged cedar pole shelter raft on right. Bottom unchanged, some Chara on left bank.

1934: In good condition.

1936: Unchanged.

1938: Now on bottom, embedded in sand and gravel.

Reverse wing deflector on left. Coarse gravel bottom, greatest depth 17".

1934: Chara and watercress appearing on bar below barrier. Sand and gravel bar forming below outer end. Pool around end 23" deep.

1936: Plant bed occupies about 60 sq. ft.

1938: Still in place, but outer end undercut. Appearance and efficiency would be improved by redriving stakes.

Pine log wing on right opposite No. 28.

1934: Some watercress and Chara appearing above barrier.

1936: Little change.

1938: Upper end loose from stake, but lodged on bank. This barrier now

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functions more as an I-deflector than one element of a reverse.

Chara bed above barrier is so well established as to be tantamount to an extension of the bank.

30

Cedar pole cover on right. Gravel bottom. Greatest depth 14". No bars or plants.

1934: In good condition. Hydropsyche larvae (caddis) clinging to logs in large numbers. Riffle improved by drift lodged on barrier.

1936: Little change.

1938: Still functioning efficiently. Fine weathered appearance.

31

Cedar and poplar pole shelter raft on right just below No. 30.

1934: In good condition.

1936: Unchanged.

1938: Intact but submerged almost to bottom. Will soon be embedded.

32

Cedar pole shelter along left bank.

1934: In good condition. 25 sq. ft. of Chara established above shelter.

1936: Much the same, extent of Chara doubled.

1938: Little further change.

33

Cedar pole shelter on left. Gravel bottom, no bars or plants.

1934: Chara starting below cover.

1936: Chara bed increased about fourfold.

1938: Plant bed well established, but cover opened somewhat, reducing shelter.

34

Cedar pole shelter on left. Gravel bottom, no bars or plants.

1934: Sparse growth of Chara starting long left bank.

1936: About 300 sq. ft. of Chara.

1938: Little change.

35

Cedar pole shelter raft with protection boom. Chara bed along bank.

1934: In good condition. Chara very dense above and below shelter.

1936: As before. Chara occupies 200 sq. ft.

1938: Little change. Chara beds well consolidated.

36

Cedar pole shelter raft on right.

1934; 1936; 1938: Still in place, working efficiently.

37

Y-deflector with spillway. Gravel bottom, no bars or plants.

1934: Muck bar below right wing sustains small watercress bed. Both wings undercut; sand bar being built up below.

1935: About 100 sq. ft. of plant bed have formed below each element.

1938: Channel of Y blocked by drift and logs. If not cleared, structure is likely to go out.

38

Double shelter raft, cedar. Gravel bottom, good Chara bed below.

1934: In good shape. Pool under cover now 24", an increase of 10".

1935: Giving excellent cover to long, attractive pool.

1938: Has been forced to bottom by weight of large deadhead log dropped on it by the flood of last spring. Still some cover at upper end.

Chara intact.

39

Submerged pine log, just left of center, making 45° angle with current.

1934: In place but doing little good--narrow hole under log.

1935: Producing about 800 sq. ft. of riffle area.

1938: Doing little good--overflowed and undercut.

40

Cedar pole shelter on left. No bars or plants; gravel bottom.

1934: In place.

1935: As before.

1938: Gone out.

41

Pine log and gravel wing deflector on right. Greatest depth 15".

1934: Hole around end now 25" deep. 300 sq. ft. of muck bar formed in lee and below, on which Chara and watercress are taking root--about 50 sq. ft. of plants.

1935: Depths unchanged. Muck bar now about 800 sq. ft., Chara bed 400 sq. ft.

1938: Sand bar built up above water level, area 800 sq. ft. Holding well, but stakes should be redriven.

42

Single cedar pole on left. No bars, small patch of Chara near bank. Gravel bottom.

1934: In place, little change in conditions.

1935: In good condition. 60 sq. ft. of Chara bed.

1938: Little further change.

43

Single pine log in center of stream, parallel with current.

1934: Anchorage for caddis larvae afforded, but doing little else.

1935: Good pool has been formed along one side due to drift lodgment.

1938: Embedded in sand, due to dislodgment of drift.

44

Submerged cedar pole shelter raft on left. Greatest depth 14".

1934: Giving good cover, water slightly deeper.

1935: Has formed 18" pool.

1938: Now shelters an excellent 40" pool. Some drift accumulated here, but raft still firmly anchored.

45

No barrier. Drift log tagged through error.

46

Poplar tree felled to give shelter and build bar.

1934: In place.

1935: 100 sq. ft. of plant bed formed, including Chara, white water buttercup and Ludvigia.

1938: Tree now washed away but plant beds remain. Deadheads have lodged at former site of barrier. No need for replacement.

47

Cedar pole shelter raft on left. No bars or plants.

1934: Plant beds, especially Chara, forming rather densely about raft.

1935: About 80 sq. ft. of Chara.

1938: The structure is completely embedded in vegetation-grown silt, and has become, to all intents, a part of the stream side.

48

Cedar pole shelter on left. Gravel bottom, greatest depth 16". No bars, trace of Chara near bank.

1934: Now shelters pool about 24" deep.

1935: Chara bed now occupies about 60 sq. ft.

1938: Still intact. Highway Department's new rustic bridge just below this point.

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49

Double cedar pole shelter on left. Gravel bottom, no mud bars, some plants.

1934: Very good shelter over pool 3 feet deep.

1935: As above. Fine, natural appearance.

1938: Gone out. Gravel bar built up here by State Highway Department.

50

Cedar pole raft on right. No bars or plants.

1934: Plant beds forming below. Silt and debris collecting in quiet water above.

1935: In good condition. Chara beds occupy about 100 sq. ft.

1938: Gone--see for No. 49.

51

Cedar pole shelter on right. No bars, trace of Chara. Greatest depth 24".

1934: Gravel cleaned off, exposing clay. Pools 30" deep. Pine stump wired in below is forming backwash with pool 42" deep.

1935: In good condition, little change from 1934.

1938: Gone--see for No. 49. Pools remain--sustained by natural eddy.

52

Cedar pole shelter on right, no plants or bars, greatest depth 18".

1934: In place.

1935: Ditto.

1938: Gone out.

53

Pine log and gravel wing on left. No plants or bars, greatest depth 18".

Gravel bottom.

1934: Pool around outer end 24" deep. About 150 sq. ft. of muck below, on which sparse growths of Chara are rooting.

1935: Same except for some drift which has lodged across channel and

excavated a pool 5 ft. deep.

1938: Somewhat undercut, but still has an attractive gravel bar and island in lee. Drift still present.



54

Cedar pole raft on left. Gravel and mud bottom, no plants. Greatest depth 15".

1934: In place. Plant beds forming below about 40 sq. ft.

1935: Partly embedded in muck deposits produced by No. 53.

1938: Gone out except for a few logs lodged on bottom. Chara beds well established along bank.

55

Cedar pole raft on right. No plant beds, mud flat on opposite side. Greatest depth 20".

1934: Offering good cover to 20" pool.

1935: Little change.

1938: Little change. Chara beds along bank, almost continuous here.

56

Cedar pole shelter on right.

1934: In place.

1935: In place.

1938: Gone out.

57

Pine log and gravel wing deflector on left. Gravel, and gravel-mud bottom. Greatest depth 24". No bars, trace of P. filiformis on mud.

1934: Good pool, 150 sq. ft. in area, 36" deep, below outer end. Muck area 70 sq. ft. in extent in lee, P. filiformis, Chara, and white water buttercup starting in.

1935: Pool depth increased to 42". Plant beds now occupy about 300 sq. ft.

1938: Lower stakes loosened. Water not diverted with original force, pool depth decreased to 34". Unless given attention soon, will go out.

58

Cedar pole shelter on right. No plants or bars.

1934: Shelters pool 18" deep. About 10 sq. ft. of plant beds starting below and under structure.

1935: Still holding. Little change except plant beds better consolidated.

1938: Gone out. Hole filling with sand and fine gravel.

59

Cedar pole shelter on left. No bars or plants.

1934: In good condition. 15 sq. ft. of Chara below structure.

1935: Still holding, but poles spreading owing to breakage of wires.

1938: In place, but submerged almost to bottom. Plant beds unchanged.

60

Cedar pole shelter on left. No bars, but some moss and algae on gravel.

1934: Condition good. 18 sq. ft. of white water buttercup below.

1935: Little change.

1938: Good cover at upper end. Lower end sunk to bottom. Lodged drift is aiding in pool formation and in affording cover.

61

Cedar pole shelter on left. No bars, algae and moss on gravel. Greatest depth 18 inches.

1934: Holding well. Pool 22 inches deep under shelter.

1935: In place, little change.

1938: Gone out. Pool filling in with sand and fine gravel.

62

Pine log and gravel deflector on left. No bars or plant beds. Greatest depth 20 inches.

1934: Bed of Chara on upstream side. Channel depth increased to average of 24 inches. Mucky area starting to accumulate below wing--about 200 sq. ft. in extent with small patch of watercress starting to establish itself.

1935: Little change.

1938: Undercut in middle, which has led to destruction of mucky area and plant beds. Depths not greatly altered.

63

Cedar pole shelter on left. No bars, some sedge at shore and algae on bottom. Greatest depth 18 inches.

1934: In fair shape, covering hole 26 inches deep. About 6 sq. ft. of plants at upper end.

1935: In place, plant beds increased in area to 60 sq. ft.

1938: Stakes pulled up. Two logs left in place. Hole still persists, depth now about 34 inches. Damage probably very recent--hole likely to fill in within a year.

64

Cedar pole and gravel wing deflector on right. No bars or plants. Greatest depth 22 inches.

1934: Channel around end 27 inches deep. Somewhat undercut, preventing muck bar formation.

1935: Depth increased to 32 inches around end. Riffle area about 800 sq. ft.

1938: Wing undercut throughout but still deflects most of flow. Hole at outer end now 34 inches deep. A stump lodged in midstream just above has helped to preserve the hole under No. 53.

65

No barrier; tagged by mistake.

66

Submerged cedar pole shelter on left. No bar or plants.

1934: Holding well. Covers 26 inch pool.

1935: Gone out, lodged on bank just below, too high to be of much good.

1938: No sign--probably carried away by 1938 flood.

67

Cedar pole shelter on left. No bar or plants, greatest depth 15 inches.

1934: In good condition, covering pool 20 inches deep. Very good fish cover.

1935: As above, but little change.

1938: Gone out; pool filling in.

68

Cedar pole shelter on left. No bar or plants. Banks grassy and undercut.

1934: In poor condition, likely to go out soon.

1935: Gone before bottom conditions were significantly altered.

69

Cedar pole shelter on left. No bars or plants. Protects 4 foot undercut bank.

1934: In poor shape--anchorage insecure and inadequate.

1935: Gone out.

70

Cedar pole raft on right. No bar or plants, greatest depth 15 inches.

Shore low, grassy.

1934: Giving good cover.

1935: Appearance improved by weathering, still quite efficient.

1938: As above. Now shelters 28 inch pool.

71

Cedar pole shelter on left. No bars, but some Chara and P. filiformis on sand between raft and shore. Greatest depth 13 inches.

1934: Torn loose from original position, and lodged by a rough foot bridge just below, where it is giving good cover, and may remain.

1935: ?

1938: Gone out.

Pine log and gravel deflector on left bank, in bend. No bars or plant beds, gravel bottom as usual. Bank high, eroding. Greatest depth 14".

1934: Good bed of Chara and P. filiformis above upper end, area about 30 sq. ft. Channel around end about 22 " deep, flowing into very quiet water stretch below. Erosion well checked. About 70 sq. ft. of mixed plant beds on 125 sq. ft. bar.

1935: Chara bed above now occupies about 132 sq. ft. Bar below now holds about 144 sq. ft. of Chara and mixed plants. Riffle area 800 sq. ft.

1938: Outer half undercut, destroying muck area. Water cress has built out bank about 3 ft. on average for 50 feet downstream. Depth of channel about 26".

Fine log and boulder wing on left bank, in bend. No bar or plants. Greatest depth 20 inches.

1934: Water 3 feet deep above wing, erosion of bank checked. About 160 sq. ft. of Chara and P. filiformis have formed just below.

1935: Depth increased to 37" at deepest point. Plant bed increased to 360 sq. ft., Elodea and watercress added to original plants.

1938: Although deflector is slightly undercut the very heavy cress bed in lee and extending to next barrier is dense enough to resist current. Vallisneria and Sagittaria are appearing in bed, and it is likely that it will soon become a part of the bank. Stakes of wing should be redriven.

Cedar pole shelter on left. Trace of muck and plants. Depth near shore 19".

1934: In good condition. About 30 sq. ft. of plants along and under structure.

1935: Erosion checked. Structure in good condition.

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1938: Still performing efficiently. Outer edge upheaved somewhat, but covers excellent hole averaging 24" deep for entire length of cover.

75

Cedar pole shelter on left just below No. 74.

76

Cedar pole shelter just below No. 75. These three structures are almost continuous, and observations for No. 74 apply to 75 and 76. 76 needs some rewiring (1938).

77

Cedar pole shelter on right. No mud bars or higher plants.

1934: Covers hole 20" deep. Caddis larvae (Hydropsyche) numerous on logs.

1935: As above, little change.

1938: Tending to fill in with sand, on which F. filiformis and P. heterophyllus appear along with Chara and white water buttercup. 10 sq. ft. of watercress at lower end, total plant bed area about 400 sq. ft.

78

Dual bank raft of cedar poles on right. No bar, thin strip of Chara on opposite shore.

1934: At upper end a 30" pool is formed, while at lower end about 30 sq. ft. of plant beds extend down along bank.

1935: Little change.

1938: Hole now not over 20" deep,--poles spread apart at lower end of first element, and middle beginning to fill in with a gravel bar. Hole under second (lower) element not over 15" deep, filling in with watercress and Chara for entire length between raft and bank. Solid bed of Chara about 3' wide from here to No. 79 along bank.

Pine log and gravel wing on left. No plants or bars; greatest depth 14".

1934: Channel around outer end 33" deep. Sand bar below outer end almost reaches surface. About 100 sq. ft. of mucky area in lee with abundant growths of Chara and watercress. Plants extend far below along bank.

1935: Plant bed now occupies about 200 sq. ft. Little change otherwise.

1938: Still holding perfectly. Plants about the same except for addition of sparse growth of Ludwigia in lee. Hole at outer end now 36" deep.

Cedar pole raft on right. No bars or plants. Greatest depth 18".

1934: Very good cover over 27" hole. About 400 sq. ft. of plant-grown muck bar formed along bank below barrier.

1935: Plant beds (chiefly Chara) now about 550 sq. ft. in area.

1938: Still intact, but sunk almost to bottom. Lower end lodged against a large boulder which has produced a 40" hole.

Cedar pole shelter on right bank. No bars, small amount of Chara near bank.

1934: In good condition. Plant bed about doubled in area.

1935: Little change.

1938: Gone out. Narrow fringe of Chara persists along bank.

Cedar pole shelter on left bank. No bars, Chara and P. filiformis along shore just above.

1934: About 20 sq. ft. of plant beds along bank. Pool under raft about 24" deep.

1935: Unchanged.

1938: As before. Poles covered with Hydropsyche and Simulium.

83

Cedar pole shelter on left. No bars, small bed of Chara and Potamogeton below.

1934: Plant beds now about 3 feet wide extend down bank for 150 feet, connecting 80, 81, 82, and 83.

1935: Little change.

1938: No apparent change. Moss and grass now growing on logs of the rafts.

84

Cedar pole bank raft on left. Chara strip along shore below shelter.

1934: In good condition--pool depth increased from 18 to 20".

1935: No change.

1938: No change, except weed bed better consolidated.

85

Cedar pole shelter on left. No immediate plant beds.

1934: In good condition, sheltering pool 20" deep. Checking bank erosion successfully.

1935: As above.

1938: Still functioning, but lower end slightly upheaved--should be repaired.

86

Cedar pole shelter on left. No bars, sparse plant growth nearby.

1934: In good condition.

1935: As above.

1938: A small highway drain now enters here, and has partially embedded this structure in sand and mud. Chara and P. heterophyllus still abundant.



Pine log and gravel wing on right. <sup>No</sup> Plants in immediate vicinity. Greatest depth 19".

- 1934: Due to angle of deflector (almost perpendicular to current), a quiet water area has been formed above, and Carex (sedge) here occupies about 400 sq. ft. A 30" channel has formed around the outer end, and below, a gravel bar, in whose lee is about 100 sq. ft. of plant bed, on 170 sq. ft. of muck deposit.
- 1935: Carex driven out by flooding. Now 600 sq. ft. of Chara above wing and about 300 sq. ft. below.
- 1938: A perfect wing deflector functionally, although higher out of water than is consistent with attractive appearance. In lee, there are 800 sq. ft. of Chara, with minor admixtures of watercress, eel-grass and arrow head. Sedge has returned upstream on bank extension in eddy above wing.

Cedar pole raft on right. No bars or nearby plants. Bank high, overhanging, eroding.

- 1934: Pool under cover increased in depth from average of 13 to average of 24". Affords good cover and has checked erosion.
- 1935: Little change.
- 1938: Has broken partially loose from stakes, and should be rewired and anchored. Conditions have not yet had time to reflect this damage.

Cedar pole raft on right. No bar or plants. Protects 30" hole by eroding bank.

- 1934: Pool depth not increased, but erosion stopped and good shelter available.

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- 1935: Little change, except pool now 32" deep.
- 1938: Traces of erosion again showing, because logs have spread due to partial breaking loose of binding wires. Should be repaired.

90

Cedar pole shelter on a point on right bank. Bottom mixed gravel and sand. No plants, although sedges, algae, Chara and Potamogetons appear on opposite shore. Pool 30" deep.

- 1934: No change, except that erosion has been checked.
- 1935: No change noted.
- 1938: In place, but lower end opened up and spread fan-wise. Should be repaired.

91

Cedar pole shelter on left. Sand bottom. No nearby plants or bars. Greatest depth 22".

- 1934: In only fair condition.
- 1935: Better results now--drift lodgement has increased pool depth to 42", 10' x 20'.
- 1938: The same or a similar drift log has, by lodging on raft, made possible establishment of a dense bed of Chara and arrowhead on a sandbar which almost reaches the surface just above raft in bend.

92

Cedar pole shelter on left just below small natural drift jam. Pool just above raft 32" deep. Bottom gravel again. No bars, but sparse plant growth just below structure.

- 1934: Good cover given to 36" pool--quite attractive.
- 1935: Little changed, except plant beds enlarged somewhat.
- 1938: Hole under jam at upper end now 46" deep. Plants as before.

93

Cedar pole shelter on left. Sand and gravel bottom. Large, Chara-grown mud flat below structure. Depth under raft 20".

1934: Holding well, little change.

1935: Surrounded by bar, and plant beds. About 800 sq. ft. of Chara, partly due to jam above (see under No. 92).

1938 : Cover is now sanded in completely, while Chara and P. filiformis grow over and around it. Some arrowhead (Sagittaria) near shore line.

94

Cedar pole shelter on right. No bars or plants. Banks high, eroding. Greatest depth under raft 20". Gravel bottom.

1934: Pool depth now 22". Structure holding well.

1935: As before, but about 50 sq. ft. of Chara has taken root just below.

1938: Pool now 30" deep. Logs at lower end have spread owing to wire breaking. Otherwise in good condition.

95

Cedar pole shelter on right. Large bed of Chara and Potamogeton along shore near raft. Water under raft 16" deep. Bank undercut and eroding.

1934: Little change.

1935: As above; has added about 50 sq. ft. to Chara bed.

1938: Allmost entirely mudded in to bottom, this effectively checking erosion.

96

Cedar pole shelter on left. Plant beds near shore continue under eroding bank.

1934: Little change. Checking erosion.

1935: Unchanged except that plant beds have doubled in area.

1938: Has been cut around, with the result that part of current is being thrown against bank. Is increasing erosion, and should be drawn into bank and reanchored before further harm is done.

Cedar pole shelter on right. No plants or bars. Bank undercut. Water under raft about 12" deep.

1934: Giving good cover. Pool now 36" deep, and in a location where it will be particularly efficient.

1935: In excellent condition. 100 sq. ft. of Chara below raft.

1938: Unchanged, except that two large drift logs have lodged on top.

Cedar pole shelter on right. Conditions as for other bank rafts in this immediate series. Sparse Potamogeton near raft.

1934: Functioning as designed.

1935: Entire raft surmounts a fine two-foot pool. Chara bed below, about 50 sq. ft.

1938: No change.

Cedar pole/ shelter on right. Conditions as before. Greatest depth 24".

1934: In fair condition. Pool at both ends 36" deep.

1935: Pool depth increased to 42". Otherwise unchanged.

1938: Raft has pulled away from bank enough to cause erosion. Pools unchanged, but repairs are indicated if erosion is to be checked.

Cedar pole shelter on right. Conditions as before, except for narrow plant bed near shore which supports Chara, Potamogeton, and sedge (Carex). Greatest depth 22".

1934: About 30 sq. ft. of plant bed below raft. Pool depth unchanged.

1935: Plant bed increased to 200 sq. ft.

1938: This structure also is pulled away from bank. Pool depth decreased to 15". Plant area about the same, but with considerable admixture

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of watercress and P. filiformis. Needs repair to check erosion.

101

Cedar log wing deflector on left. A few plants along shore. Greatest depth 22".

1934: Pool around end 30' long, 36" deep. 100 sq. ft. of fine dense Chara bed has formed below.

1935: Chara bed enlarged slightly, otherwise the same.

1938: Still serves as hole producer and as cover, but is badly undercut throughout. Chara extends all the way to next raft, about 2,500 sq. ft. Very dense bed reaching to surface.

102

Cedar pole shelter on left. No bars or plants. Greatest depth 18".

1934: Checking erosion. Plant beds starting to form along bank and under raft.

1935: Little change. Plant beds now occupy about 50 sq. ft.

1938: Water about 14" deep. Bank caving off along here. Chara very dense for four feet out from barrier--a natural bank raft, well rooted.

103

Cedar pole bank raft on left. Conditions as before. Greatest depth 18".

1934: Pool at lower end 28" deep.

1935: As before.

1938: Gone out.

104

Cedar pole raft on left. Conditions as before. Protects 36" pool.

1934: Unchanged.

1935: Unchanged.

1938: Dislodged and hanging to bend just below.

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105

Cedar pole shelter on right. Conditions as before; greatest depth 18".

1934: Erosion checked. Holding well.

1935: Pool depth increased to 24".

1938: Apparently unchanged. P. filiformis growing under raft near shore.

106

Cedar pole shelter on right. Conditions as before. Greatest depth 24".

1934: In fine condition. Erosion being arrested.

1935: As before, but pool only 22" deep.

1938: Lower end spread. Erosion beginning. Holes as yet unchanged.

107

Cedar pole triangular shelter along right bank. Good bar and plant beds on opposite side of stream. Bank 4' high, eroding. Greatest depth 21".

1934: Little change, but erosion is being checked.

1935: Pool depth greatly increased--maximum 52". 200 sq. ft. of Chara below.

1938: Cover has gone out, but a 36" pool still remains. Should be replaced.

108

Pine log boom shelter across stream. Traverses 36" pool.

1934: Pulled out, due to too heavy drift accumulations.

109

Cedar pole shelter on right. Covers 36" pool. No bars or weed beds on this side.

1934: Pool depth increased to 42". 50 sq. ft. of P. pectinatus below raft.

1935: Little change noted.

1938: Birch trees which once shaded this area have been cut, exposing stream. Cover still in place. A stone riffle has been artificially

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installed about 100 ft. lower. Of little value in a naturally rocky section, since stones used are too small to offer much cover.

110

Cedar pole shelter on right. No plants or bars. Bank eroding.

1934: Gives good cover to 18" pool.

1935: Little change.

1938: Now broken loose and lying at 30° angle to current, touching bottom.

Chara beds (about 300 sq. ft.) in immediate vicinity.

111

Cedar pole shelter on right. Protects 24" pool. Other conditions as above.

1934: Holding well.

1935: No change.

1938: No change except in weathered appearance.

112

Cedar pole shelter on left. Conditions as before.

1934: In place.

1935: Pool depth slightly decreased due to filling next to bank. Erosion checked.

1938: Still effective as erosion control, some cover under outer edge.

113

Aspen pole shelter on right.

1934: Checks erosion.

1935: Still effective.

1938: No change.

114

Aspen pole shelter on left. Gravel and mud bottom. Chara and Potamogeton along shore.

1934: Condition satisfactory.

1935: Little change except for a slight increase in size of Chara beds.

1938: Bank shade cut off. Wires of raft broken, allowing it to sink to bottom, where it will shortly be embedded.

115

Pine log and gravel wing on left. No plants or bars, gravel bottom. Eroding bank. Greatest depth 13".

1934: In good condition. Channel around outer end 29" deep. Watercress rooting in lee. Erosion checked.

1935: Pool now about 27" deep, 60 sq. ft. in area. Chara and watercress in lee occupy about 150 sq. ft.

1938: Deflector still in good shape. Drift logs have accumulated in lee, where an island, thickly grown with sedge, has formed.

116

Trash and deadhead jam on left, designed to check erosion and, until silted in, to provide fish cover. No plants or bars, greatest depth 12".

1934: Still in place.

1935: Holding well, somewhat increased by drift lodgement.

1938: This structure, in conjunction with 115, has produced a huge eddy (20' x 36"). Erosion checked.

117

Cedar pole cover on left. No plants or bars; bank 5' high, undercut. Shelters pool 23" deep.

1934: In good condition. Watercress starting to establish between raft and bank. Pool at lower end now 28" deep.



1935: Little change.

1938: Pool now only 14" deep. Raft surrounded with about 50 sq. ft. of Chara. Cress scarce now. Raft will probably become embedded and form bank extension. Erosion effectively checked.

118

Cedar pole cover on left. No bar or plants, conditions as for 117. Greatest depth under raft 17".

1934: Pool depth increased to 28".

1935: Little change.

1938: Still intact. About 15 sq. ft. of watercress between raft and bank. Erosion stopped.

119

Cedar pole shelter on left. Conditions as before. Overhung by aspen on bank.

1934: In good condition.

1935: Erosion checked.

1938: Covers 24" hole. Aspen on bank so undercut as to be in danger of caving off into stream with the fall rains.

120

Cedar pole shelter on left. Conditions as before.

1934: Intact and checking erosion.

1935: Chara now occupies about 100 sq. ft. below raft.

1938: Unchanged, except Chara not so thick. Probably damaged by drift during flood.

121

Cedar pole shelter on right. Conditions as before.

1934,35, 38: In place; little change noted except for gradual weathering of appearance.

122

Cedar pole shelter on right. Some Chara and Potamogeton. Covers pool 36-42" deep.

1934: Little change.

1935: Still providing cover and arresting erosion.

1938: Gone out, but weed beds firm enough to probably remain.

123

Cedar pole shelter on right. No bars or plants, bank eroding.

1934: Intact. Some beaver cuttings here.

1935: Checking erosion, pool 18" deep under raft.

1938: Little change. This stretch adjoins site of one of Highway Department's rustic pergolas.

124

Cedar pole shelter on right. Conditions as before. Covers 26-28" pool.

1934, 35, 38: In place, although so located as to be of little value save as erosion control. Stream has good natural cover here.

125

Pine log and gravel wing on left. Some Chara present. Bank low and marshy. Greatest depth 17".

1934: In good repair. Now surrounded by 30" pool, while a quiet-water area in lee contains about 20 sq. ft. of plant beds.

1935: Little change. Riffle area produced by wing equals about 500 sq. ft.

1938: Still holding, although a natural log jam just below tends to negate its effect in erosion control.

126

Pine log deflector in center of stream, based against small natural island.

Chief function is to preserve this island from current accelerated by 125.

No plants or bars here, bank shade and cover absent. Greatest depth 20".

1934: Functioning according to design.

1935: Bar formed parallel to island has some plants starting.

1938: A large amount of drift material has lodged on head of island, but effect is unaltered.

127

Cedar pole shelter on left. No plants or bars. Gravel bottom.

1934: Gone out, lodged on next raft downstream.

128

Pine log and gravel wing on right. Conditions as before. Greatest depth 26".

1934: Has enabled about 40 sq. ft. of plant beds to form in lee. Pool and channel around end about 20' long, 36" deep.

1935: Still holding.

1938: In place. Appearance quite pleasing due to effects of weathering.

129

Cedar pole shelter on left. Conditions as above.

1934: In good condition.

1935: About 100 sq. ft. of Chara beds have formed just below.

1938: Little further change.

130

Cedar pole shelter on left. Conditions as above.

1934: In place.

1935: About 50 sq. ft. of Chara have formed just below.

1938: Excellent cover. A thick bed of watercress at lower end.

131

Cedar pole shelter on left bank. Conditions as before. Bank 5' high, undercut, eroding.

1934: Little change except for erosion being arrested.

1935: As above.

1938: Immediately below raft is a bed of watercress, merging into a very dense Chara bed occupying about 50 sq. ft.

132

Cedar pole shelter on left. Conditions as before. Greatest depth under raft, 20".

1934: Erosion being checked.

1935: Pool depth increased to 24".

1938: Structure mostly pulled up and piled on bank, probably by 1938 flood. Hole is now filling with sand and gravel on which Chara is rooting.

133

Cedar pole shelter and deflection boom on left. Conditions as above.

1934: Has increased depth under raft from 26 to 42".

1935: Little change.

1938: Hole depth decreased to 30". Structure damaged, but still efficient save at lower end, where erosion is not completely stopped.

134

Cedar pole shelter on right. Conditions as before.

1934: Covers 22" pool.

1935: Little change.

1938: Still in place, although probably unnecessary owing to abundance of natural shade and cover. Another rustic bridge (by Highway Dept.) just below here.

135

Pine log and gravel wing on left. Conditions as before. Greatest depth 14".

1934: 160 sq. ft. of plant beds above wing. Pool around end 30" deep.

In lee, 300 sq. ft. of mucky area, one-third of which bears plants.

1935: Above wing, 200 sq. ft. of Chara; below, 400 sq. ft. of mixed Chara and cress.

1938: Site of former Chara bed now occupied by an island grown with burr-reed (Sparganium). Other conditions about the same.

136

Cedar pole shelter on left. Other conditions as before.

1934: In good condition.

1935: As above.

1938: Broken up and sunk to bottom; grown up with Chara.

137

Cedar pole shelter on left. Conditions as before.

1934: Covers pool 20" deep.

1935: Little change.

1938: Little change. Erosion controlled.

138

Cedar pole raft on left. Gravel bottom, no plants or bars. High grassy banks. No bank shade.

1934: Holding well. Plant beds just below occupy about 50 sq. ft.

1935: Little change. Plant beds unchanged in extent, but some watercress has come in.

1938: Crushed to bottom by huge drift log. Plant beds will probably remain, but cover is lost.

139

Cedar pole shelter on left bank, in bend. High, eroding bank, other conditions as before.

1934: In good condition. Plants starting in along shore line.

1935: Plant beds now occupy about 50 sq. ft.

1938: Structure has gone out. Should be replaced to halt erosion.

140

Cedar pole shelter on left. Conditions as before.

1934: In position; arresting erosion.

1935: About 60 sq. ft. of Chara beds are now established below the raft.

1938: Crushed down by large drift log. This probably recent, since fresh caddis cases are still adhering to log.

141

Cedar pole shelter on left. Conditions as before.

1934: In fair condition. About 40 sq. ft. of plant bed started along bank.

1935: Still holding. Chara bed increased to about 180 sq. ft.

1938: Little further change apparent.

142

Cedar pole shelter on left. Conditions as before.

1934: Plants coming in below structure, 20 sq. ft. in area.

1935: Plant beds have grown to 80 sq. ft. in area.

1938: Lower end of raft has opened up fan-wise. Otherwise, little change has occurred.

143

Cedar pole shelter on left. Conditions as before.

1934: 20 sq. ft. of Chara below raft.

1935: Covers pool 20" deep. Chara now occupies about 60 sq. ft.

1938: Little further change.

144

Cedar pole cover on left.

1934: In fair condition. 15 sq. ft. of plant beds have formed below.

1935: In original location, but sunk to bottom.

1938: Partially embedded.

145, 146 & 147

These three structures were removed by the highway department during construction of the new U. S. 27 bridge. A number of structures from here down as far as the road parallels the stream have been either removed or altered as to effect by this road grade construction.

148

Cedar pole shelter on right. No plants or bars, gravel bottom, high, eroding bank.

1934: In position. Plants starting in just above raft.

1935: Little further change.

1938: Badly damaged, but still shelters 39" pool. Bank is caving off in bend.

149

Cedar pole boom shelter along right bank. Conditions as before.

1934: In place, checking erosion.

1935: As before.

1938: Shelters hole too deep to wade--estimated depth 6 feet.

150-153

Removed for road construction.

154

Cedar pole shelter on left.

1934: Checking bank erosion.

1935: About 100 sq. ft. of Chara have formed around and below raft.

1938: Thrown on bank. Conditions altered by road. Plant beds destroyed.

155, 156

Removed for road construction.

157

Pine log and gravel wing deflector on left. No bars or plants; gravel bottom. Greatest depth across channel 21".

1934: Above wing about 50 sq. ft. of plants beds are established. Around end of wing, channel is 30" deep. Mucky area below occupies about 200 sq. ft., half of which supports weed beds.

1935: Depths about the same, but Chara beds increased to 400 sq. ft.

1938: Wing is now undercut, but where part of the Chara bed was formerly, there now exists a rush- and reed-grown island, which extends downstream to 158.

158

Cedar pole cover on left. Conditions as before. Bank 6' high, eroding.

1934: In good condition, checking erosion.

1935: Chara bed covers about 80 sq. ft. below raft.

1938: Little further change. One stake needs to be redriven. Some watercress is appearing among the Chara.

159

Cedar pole raft on left. Conditions as before.

1934: In position. Erosion slowing up.

1935: As before.

1938: A dense bed of plants, including Ludvigia, Chara, P. filiformis, eel-grass and watercress has formed just below the raft.

160

Cedar pole raft on left. Conditions as before.

1934: In fine condition, and functioning as designed.

1935: Little change, except for addition of about 25 sq. ft. of Chara.

1938: No further changes noted.



161

Cedar pole shelter on left. Conditions as before.

1934: In good condition.

1935: Erosion appears to have been stopped.

1938: Raft has now sunk to bottom. Some watercress and P. heterophyllus remain around it.

162

Cedar pole shelter on right in bend. Conditions as before.

1934: Some plants are starting to root just below the raft.

1935: Plant beds now occupy about 60 sq. ft.

1938: Raft has been damaged. Bank is eroding; plants have washed out.  
Should be replaced.

163

Bank raft composed of boards from old foot bridge, along right bank.

Conditions as before. Greatest depth about 20".

1934: In very good condition. Checking erosion.

1935: Now covers a nice pool about 24" deep.

1938: Still in excellent condition. Considerable drift material has lodged on the raft, but it is still solidly anchored.

164

Cedar pole shelter on right. Conditions as before.

1934: In fair shape. Chara coming in under and below raft.

1935: Chara area increased to 45 sq. ft.

1938: Raft has opened up owing to wire breakage. Plants have disappeared.  
Useless.

165

Cedar pole shelter on left. Conditions as before.

1934: About 20 sq. ft. of plant beds have come in below.

1935: Plant bed area has increased to 110 sq. ft.

1938: Raft is now entirely embedded in Chara. As a result it no longer gives cover, but functions very efficiently as an erosion control device. It is believed the Chara will soon be so firmly consolidated as to form an actual extension of the bank at this point. A thick bed of watercress averaging four feet in width extends from here to No. 166.

166

Cedar log and gravel wing on left. Gravel bottom. No bars or plants.

Bank 4' high, eroding. Greatest depth across channel 21". Deadheads piled in lee to stabilize bar formation.

1934: Above wing about 20 sq. ft. of plant beds have established themselves. Around the outer end is a 34"-deep channel. A large muck flat has formed below, on which there is about 100 sq. ft. of plant bed.

1935: Little change in depth. Plant beds now occupy about 250 sq. ft., bar about 400.

1938: Hole unchanged. In lee, P. pectinatus has replaced Chara.

167

Cedar pole shelter on left. Conditions as before. Greatest depth 18".

1934: In excellent condition.

1935: Now covers pool 30" deep.

1938: Lower end of raft is grounded on stream bed. No plants present except a small clump of watercress at upper end.

168

Cedar pole cover on left. Conditions as before.

1934: Still in place.

1935: About 55 sq. ft. of Chara have come in below the raft.

1938: Raft is almost grounded on stream bed, but plants persist.

169

Cedar pole bank raft on left. Conditions as before.

1934: In fair shape.

1935: 100 sq. ft. of Chara bed just below raft along shore.

1938: Raft has opened up, as a result of which erosion of the bank has resumed. A drift log wedged on raft extends across channel at surface here.

170

Cedar pole shelter on left. Conditions as before. Greatest depth 26".

1934: Covers attractive 30"-deep pool. Plant beds 20 sq. ft. in area have formed below the cover.

1935: Chara beds now cover about 75 sq. ft.

1938: Little further change.

171

Cedar pole raft on left. Conditions as before.

1934: In good conditions; covers attractive 25" pool.

1935: About 150 sq. ft. of Chara have come in just below.

1938: No further change apparent. There is a 20 sq. ft. cress bed between this and 170.

172

Cedar pole shelter on left. Conditions as before.

1934: 200 sq. ft. of plant beds under and below raft.

1935: Chara beds now occupy about 500 sq. ft.

1938: As above, except the raft itself has been forced to the bottom by drift logs.

173

Pine log and gravel wing on left. Conditions as before. Greatest depth 23".

1934: Holding well; plants beginning to appear in quiet water in lee of wing.

1935: Depths unchanged. Riffle area of 600 sq. ft.

1938: Wing torn loose from stake, now thrown up against bank, thickly embedded in Chara. Hole largely filled in. (This structure opposite abandoned house on right.)

174

Cedar pole shelter on left. Conditions as before.

1934: Raft tending to become embedded in Chara.

1935: As before.

1938: Raft almost entirely embedded, having been forced down by drift logs.

Some P. heterophyllus occurs here.

175

Cedar pole shelter on left. Conditions as before.

1934: Pool depth has decreased from 24 to 20", but about 120 sq. ft. of Chara occurs just below raft.

1935: Little further change.

1938: General conditions about the same, but the outer half of the raft has been ripped away.

176

Cedar and poplar pole shelter on right in bend. Gravel bottom, no bars or plants, bank 4' high, eroding. Protects hole four feet deep, at lower end of 176 and extending under 177.

1934: In good condition.

1935: As before.

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1938: Still functioning efficiently. Erosion checked. A rough foot bridge has been built across the stream at this point.

177

Cedar pole shelter on right. Conditions as before. Shelters excellent, long pool, 4'.

1934: In good shape.

1935: Pool sheltered well--one of the most attractive pools in this 2-mile section.

1938: Broken out, but hole little altered, since produced largely by natural stream eddy. Needs cover.

178

Cedar pole shelter on right. Conditions as before. Covers lower end of pool mentioned under 177.

1934, 35, 38: Little change. Continuing to function as designed.

179

Cedar pole bank protector on left. Conditions as before.

1934: In good condition.

1935: Shelters 24" pool.

1938: Raft has gone out, but its place has been largely filled by lodged drift material.

180

Cedar pole shelter on left. Conditions as before.

1934: In poor condition.

1935: Weakened, but still holding.

1938: Gone out. This structure never was anchored securely enough to produce any permanent alteration of stream, and afforded indifferent cover.

181

Cedar pole shelter on left. Conditions as before.

1934: In good condition.

1935: In place, covering 14" pool.

1938: Gone out. No bank shade here, making replacement of raft desirable.

182

Cedar pole shelter on left. Conditions as before.

1934: In good condition.

1935: Giving cover to 24" pool.

1938 : Gone out. Pool exposed.

183

Cedar pole shelter on left. Conditions as before. Greatest depth 24".

1934: In good condition.

1935: Giving shelter to 27" pool.

1938: Gone out. Pool exposed, save for light aspen bank shade in afternoon.

184

Pine log and gravel wing deflector on right. Conditions as before. Greatest depth of water 26".

1934: In poor condition and likely to go out.

1935: Still in place. Has produced about 400 sq. ft. of riffle. 200 sq. ft. of Chara has rooted in lee.

1938: Gone out. Although never very efficient, the plant beds formed in its protection are probably consolidated firmly enough to maintain themselves.

185

Pine log and gravel I-deflector just right of stream center. Conditions as before.

1934: Hole under log 28" deep, bar with 20 sq. ft. of plants forming behind.

1935: Pool area about 100 sq. ft., depth unchanged. Chara bed occupies about 250 sq. ft. One side is plugged with jammed drift logs.

1938: Stake only remains. Hole persists, but slowly filling in. Plant beds still intact, which helps to preserve hole.

186

Pine log wing on right. Bottom gravel and rubble; no bars or plants; banks low, marshy. Greatest depth of water 18".

1934: In place.

1935: Depths have been increased by about 4 inches. 1200 sq. ft. of riffle area have been formed, as well as 60 sq. ft. of Chara beds.

1938: Deflector thrown up on bank, channel depths back to normal.

187-189

Torn out.

190

Pine log and gravel wing on left. Conditions as before, except bank now 5' high. Greatest depth 15".

1934: Channel around outer end 24" deep; 50 sq. ft. of plant beds have formed below.

1935: Channel now 26-28" deep. Plant beds occupy 100 sq. ft.; riffle area 400 sq. ft.

1938: Outer section of wing torn away; muck bars and plants destroyed.

191

Pine log I-deflector, or submerged weir. Conditions as before. Depth 14".

1934: Producing an attractive riffle. Depth increased to 26".

1935: As before.

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1938: One end loose, allowing log to lie parallel with current. Now ineffective.

192

Cedar pole shelter on left. Conditions as before.

1934: In place, covering 18" run.

1935: Little change.

1938: Gone out. Depths unaltered, but destitute of cover.

193

Deadhead shelter along left bank. Conditions as before.

1934: In place.

1935: Giving shelter to deepened channel.

1938: Still holding. Some plants here but probably not because of raft.

194

Cedar pole shelter on left. Conditions as before.

1934: In position.

1935: As before.

1938: No change observed.

195

Pine log and gravel wing on left. Banks low and marshy, no plants or bars. Gravel bottom. Greatest depth 19".

1934: Channel around end now about 27" deep. An extensive bed of Chara, occupying about 250 sq. ft., has formed just below. Merging with the bank, sedges are encroaching.

1935: Little further change.

1938: Although somewhat undercut, with end stakes in need of re-driving, depths and plant beds remain about the same as before. If the structure is repaired, shore-inhabiting sedges will probably build an island in the lee.



196

Pole and plank shelter along left bank, which has been walled with plank, probably by Highway Department. Other conditions as for 195.

1934: In good condition.

1935: Still functioning efficiently as a cover.

1938: Gone out. Little change in bottom, except for exposure.

197

Cedar pole shelter on right. Conditions as before. Shelters 34" pool.

1934: Pool depth increased to 36".

1935: No apparent change.

1938: Continuing to give good shelter. Appearance attractive, due to weathering.

198

Cedar pole shelter on left. Conditions as before.

1934: In good condition.

1935: As before.

1938: Gone out. Stream exposed.

199

Cedar pole shelter on right. No plants or bars. Gravel bottom. Bank 3' high, undercut.

1934: In good condition.

1935: As before.

1938: Has gone out, but is lodged under alder clump about 60' downstream, and now has about 10 sq. ft. of watercress growing at its upper end.

200

Cedar pole shelter on right. Conditions as before.

1934: In place.

1935: Covering rather shallow run. Not digging any deeper.

1938: Still in place. 199 has lodged here, deepening channel somewhat.

201

Pine log I-deflector (submerged). Conditions as before. Greatest depth 18".

1934: Is producing a fine riffle at lower end of 36" pool.

1935: Little change.

1938: Only one stake remains; hole is filled in. Someone has placed some ineffective and poorly conceived stonework in here--stones too small to resist current, and angles so placed as to increase, rather than check, erosion.

202

Cedar pole raft on right. Conditions as before.

1934: In place.

1935: Covering shallow pool, about 15" deep on average. Still no plants.

1938: Gone out, without trace.

203

Pine log I-deflector to right of center. Greatest depth 18". Conditions as before.

1934: A 30" pool has been formed in front of deflector. Over this pool someone has built a cover which may collect drift and endanger entire structure.

1935: Greatest depth decreased to 26". On a bar about 200 sq. ft. in area and largely impermanent, 50 sq. ft. of plants have appeared.

1938: Structure has gone out. Plants destroyed.

204

Cedar pole shelter on right. Conditions as before.

1934: In good condition.

1935: Little change.

1938: Gone out.

205

Cedar pole shelter on left. Conditions as before.

1934: In good condition.

1935: About 90 sq. ft. of Chara established just below cover.

1938: Little further change, except erosion of bank checked by Highway Department stonework.

206

Cedar pole shelter on right. Conditions as before.

1934: Holding.

1935: Still in place, but has affected little change.

1938: Gone out.

207

Cedar pole shelter on left. Conditions as before.

1934: In place.

1935: Chara bed about 125 sq. ft. in extent just below raft.

1938: Gone, but considerable drift material lodged in bend on right gives good cover.

208

Cedar pole shelter on right, just below bridge on old U. S. 27. Conditions as before.

1934: In place.

1935: Still holding.

1938: Now almost entirely submerged; bank caving badly. Cattle trampling obviously responsible.

This is the last of the 1933 installations on this stream.

Little Manistee

First 6 barriers -- 1 stump, 2 drift logs, 3 wings, gone out.

7

Beech and basswood felled into stream from opposite sides. Stream 12' wide; greatest depth 7", sand bottom.

1938: In place, but tops broken away. Hole in middle 20" deep.

8

Basswood felled parallel to current on right. Sand bottom; greatest depth under stump 22".

1938: Stump cut around. Trunk embedded. Hole and eddy under stump now 20"; bottom of hole still sand.

9

Natural jam tagged for continued observation.

1938: Unchanged.

10

Cedar log laid across stream from left side, designed to catch drift.

1938: Still in place but serving no purpose, no drift having lodged.

11

Cedar log naturally wedged across stream.

1938: In place but has caught no drift.

12

Dead tree fell completely across tree from left. Sand bottom; greatest depth 15".

1938: This tree is a hornbeam, and from its stump end young shoots 15 feet high have arisen and provide good shade. Pool averages 20" in depth for length of log. An island 5' x 15' has formed in lee on right. Bottom still sand.

13

Cedar log wedged from small island to basswood on right. Makes angle of 45° with current.

1938: No change noted in depths. Basswood has decayed and broken up.

Log now lying at 5° angle. Island supports good stand of Nine-bark.

14

Natural jam of cedar logs below island in No. 13. Covers a good pool.

1938: Little if any change. Bottom sand and muck with a trace of fine gravel.

15

Stone reverse deflector. Bottom gravel and rubble. Stream width 20'; greatest depth 6".

1938: In excellent condition, unchanged except greatest depth now 10".

Probable reason this is no deeper lies in scant flow in this section.

16

Stone reverse deflector. Conditions as for No. 15, except depth 9".

1938: Gone. Bank extension, which may have started as an island in lee, remains. Depth unchanged.

17

Natural barrier formed by tree falling across stream from right. Has dug 22" hole.

1938: Still in place. Pool now only 14" deep, but a good riffle is being created.

18

Natural barrier ~~formed~~ <sup>provided</sup> by a fallen cedar tree extending from right to left bank. Has formed a 33" hole just below log.

1938: Almost no change, except a hole of similar depth above log.

19

Log tagged for drift.

1938: Gone.

20

Natural barrier formed by log fallen across stream. Has dug a 14" hole.

1938: Pool now 18". About 50 sq. ft. of shallow gravel riffle just below.

Some moss on hardened sand hummocks.

21

Natural barrier of drift materials wedged from a central island to the left bank. Has produced a 24" pool.

1938: No detectable change.

22

Drift log.

1938: Gone.

23

Stone wing on right perpendicular to current. Sand bottom. Greatest depth 11".

1938: Almost completely gone--partially embedded, and leveled off. An aspen caved off from bank at this point has produced a pool 6' x 10' x 30" in sand. Gravel on right.

24

Natural jam formed by fallen aspens. Greatest depth 19". Sand bottom.

1938: Has formed an island 5' x 10' on right and a hole 10' x 30' x 36" on left.

25

Stone dam extending across stream perpendicular to current.

1938: Completely vanished--stones apparently embedded in sand.

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26

Stone dam similar to No. 25.

1938: Gone.

27-32

Not located. 3 drift logs, 2 wings, 1 natural jam.

33

Natural log jam on left. Covers a 25" pool.

1938: Little change, except that a grass-grown island 3' x 19' has been built up below jam.

34

Log reverse deflector and protecting log. Sand bottom; greatest depth 11".

1938: In place. Depths from 14" at upper end to 24" at lower.

35

Natural log jam on right has produced 28" hole.

1938: Reduced to a single log. Channel 20" deep, sand bottom.

36

Drift log embedded on left.

1938: Still in place.

Quite a lot of poor improvement by someone along here.

37

Log reverse deflector. Central channel 18" deep.

1938: In place but both inner ends cut around, reducing depth of central channel to 14".

38

Unstaked pine log deflector on right (natural). Hole at end 28" deep.

1938: Still in place. This section seriously damaged by later amateur work.



39

One of Metzelaar's old jams formed by felling two trees into stream to collect drift. Has dug 30" hole.

1938: Gone out.

40

Stone dam across stream, with lower central spillway. Sand bottom. Greatest depth 11".

1938: In place, has produced an attractive fine gravel riffle and 24" hole.

41

Natural log jam entirely across stream. Has produced a 30" hole.

1938: Only one log left. Hole 28" deep; its bottom 90% sand, 10% fine gravel.

42

Natural log jam across stream. Covers a 35" hole.

1938: Hole partly filled by sunken drift; conditions otherwise unchanged. Bottom chiefly sand with some muck.

43

Stone reverse deflector. Sand bottom. Greatest depth 14".

1938: General conditions unchanged, except that a 48" pool has been produced below barrier under alder shade. Sand persists.

44

Stone dam across stream, with spillway left of center. Sand bottom. Greatest depth 12".

1938: Has produced a 24" gravel bottom hole ending in a very attractive gravel riffle.

45

Waterlogged drift log in stream parallel to current. Tagged to test further drifting.

1938: Someone has anchored this with a stake. Still lying parallel to current, it is valueless.

46

Naturally formed wing on right. Sand bottom with trace of rock. Greatest depth 18".

1938: Unchanged. Boundary of Ke-Che-Mun-Do Club crosses stream here.

80

Cruising resumed at point known as the "Box Car," Section 13 of Peacock Township. No. 80, a jam built by Metzelaar, is gone. CCC workers have attempted some erosion control, which is inefficient.

81-89

Not found. May have been removed by workers from Camp Sauble.

90

Pine log wing on right. Flat, sand bottom. Greatest depth 20".

1938: Inner end is cut around and log embedded, now functioning as submerged I-deflector. Has produced a 24" pool just below.

91

Birch tree felled to form wing deflector on right.

1938: Removed, and an open-pole square cover of alder (!) substituted. Will go out soon, in all likelihood.

92

Elm tree felled across stream from left to catch drift. Greatest depth 12 ". Sand bottom.

1938: No drift present. Depths and bottom unchanged. Good shade from alders which meet over stream. Would have to be opened up before fly fishing would be possible.

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93

Log wing on right. Sand bottom. Greatest depth 18".

1938: Outer end embedded. Has produced a hole 6' x 10' x 30" just below.

Bottom still sand.

94

Elm tree felled across stream from left. Stump at water's edge. Bottom flat, sand. Greatest depth 26".

1938: In place. Stump now in stream 3' out from present bank. Has caught one drift log. Hole across channel 20" deep. Still 100% sand bottom.

95

This barrier is 234 paces below 94. It consists of a birch tree felled across stream from left with the thought that the fine twigs and branches of the top would offer good cover.

1938: In place--has produced 28" hole.

Between 94 and 95 are many structures installed after the original work.

They are listed as follows, measured from No. 94:

- 32 paces below 94 a square raft on left covers hole 5' x 10' x 36".
- 51 " " " " " " " right " " 8' x 15' x 30".
- 108 " " " " " " " " " " 5' x 7' x 28".
- 131 " " " " " " " left " " 4' x 8' x 26".
- 145 " " " " spring seep enters river from left.
- 168 " " " " square raft on left. Bank side silted in, water along outer edge 12" - 14" deep.
- 174 paces below 94 a square raft on right has settled and become embedded. It is now covered with 8"-10" of grass- and sedge-grown mud.
- 218 paces below 94 a structure on left has gone out--only thin alder(!) stakes remain.

96

Natural barrier formed by cedar log lying athwart stream. Bottom sandy. Log has produced hole 54" deep.

1938: Apparently unchanged. Good shade is provided by alder, ash, elm and basswood. The hole is in the form of a gentle eddy about 18 feet in diameter.

97

Aspen felled across stream from right to left.

1938: Gone out.

98

Birch tree felled across stream from right.

1938: Gone.

99

Log in stream tagged to measure drift.

1938: Gone.

100

Birch tree felled into stream from right to provide cover. Sand bottom. Greatest depth 25".

1938: In place but sanded in. Small hole under part of log 14" deep. Bottom unchanged.

101

Natural log jam on right. High, eroding sand bank here as river bends to left.

1938: Still holding, and covering a 36" hole. Just above, the CCC has installed some erosion control work consisting chiefly of log sea wall and terraces planted with honey locust. Appears to be succeeding.

102

Log extending across stream. May catch and accumulate drift.

1938: Log now 8"-10" above water. Useless.

103

Remains of an old railroad bridge on whose pilings drift has accumulated.

Greatest depth 17". Sand bottom.

1938: Most of drift material dislodged, but hole is now 20" deep. About 6 sq. ft. of fine gravel have been exposed, and 10 sq. ft. of dense white water buttercup beds are established just below. Then a hole 36"-40" deep begins and extends down midstream 50' to head of a bend where erosion control work, better than that near 101, is in place. More beds of white water buttercup and eel grass are scattered over sand shallows inside bend.

104

Drift log.

1938: Gone.

105

Log wing deflector on right. Sand bottom. Greatest depth 22".

1938: Badly broken, inner end gone, remainder overflowing; but a sand bar grown with white water buttercup has formed in lee, and a hole opposite outer end under alder shade is about 6' x 20' x 24". Sand bottom persists.

106

Pine log wing on right. Sand bottom. Greatest depth 24".

1938: Log embedded in sand except for extreme outer end, where water is 20" deep.

107

Elm log wing on right. Sand bottom; greatest depth 15".

1938: Stakes badly heaved; inner end cut around, outer 3/4 overflowed, but a shallow muck bar supporting sparse white water buttercup built up in lee. Hole at outer end 18" with trace of fine gravel appearing at bottom.

108

Natural drift jam shelters 40" pool.

1938: No change discernible.

109

Drift log.

1938: Gone.

Cruising recommenced at M-63 bridge, Section 11, Peacock Township.

138

Top of beech tree staked down in center of channel to provide cover.

1938: Gone.

139

Triangular wing deflector on right composed of cedar and birch logs. Sand bottom. Greatest depth 26".

1938: Gone. Hole largely filled with shifting sand.

140

Natural log jam on left.

1938: Gone.

141

Pine stump staked in midstream.

1938: Has drifted downstream and lodged about 10 paces below original location. Has dug 36" hole in sand.

142

Pine log deflector (single log) on right.

1938: Gone.

143

A-deflector in midstream. Sand bottom. Greatest depth 18".

1938: 142 has lodged in this barrier. A muck bed sparsely grown with eel grass under structure and next left bank. Greatest depth now 14".

144

One of Metzelaar's jams--made of logs and drift, extending across stream. Sand bottom.

1938: Jam now thrown to either side, probably by CCC. Central channel 22" deep, uniformly composed of shifting sand. Scattered dense beds of P. filiformis near banks. In shallow, mucky backwaters Sagittaria, Sparganium and Carex come in.

145

Wing deflector of 2 split logs, on right.

1938: Wrecked; stakes heaved up, logs broken loose and partly buried. Useless.

146

Wing deflector at right angle to current. Sand bottom. High, eroding sand bank on right.

1938: Inner end out, outer end overflowing and half embedded. Dense P. filiformis with sparse white water buttercup all around bend. Bottom still 100% sand. Erosion control (by CCC) ~~and~~ on high bank is effective for first 100 feet, where it is well grown with grass. Remaining 60 feet not effective; sea wall broken, bank caving.

147

Pine log wing on left. Greatest depth 18". Sand bottom.

1938: One stake only remains. Bottom in immediate environs is uniform with other adjacent areas: P. filiformis is dense on each side for 6-8' out from banks, central channel 10-15' wide, bottom 90% sand, 10% fine gravel.

148

Pine log I-deflector in midstream. Greatest depth 18". Gravel bottom.

1938: At this point there is a similar structure, but obviously installed some years after the original. Little change from original condition was apparent.

149

Natural jam on left.

1938: Gone.

150

Log jam and single cedar log, the latter running entirely across stream. Greatest depth 30". Sand bottom.

1938: In place. Little change in depth. Some pockets of fine gravel exposed.

151

Pine log wing anchored with large boulder on left. Sand and gravel bottom; greatest depth 12".

1938: Log gone, but boulder still produces nice riffle and pool 18" deep.

152

Another of Metzelaar's jams on right.

1938: Thrown up on right bank. Stream shallow and flat. Some P. filiformis and white water buttercup on former site, where muck is 12" deep.



153

Two piles of stone with pine log between, in center, parallel to current. Sand and gravel bottom. Greatest depth 17".

1938: Only stones left. Channel 18" deep, bottom sand with trace of fine gravel, supporting scattered growth of P. filiformis.

154

Natural jam on left covering deep hole. Sand bottom.

1938: In place. Hole too deep to wade, estimated 55"-60". Sand bottom with trace of gravel at upper end.

155

One of Metzelaar's old jams.

1938: Gone.

156

Natural jam lodged on remains of an old bridge on left. Covers hole 48" deep.

1938: In place. Hole depth varies from 10" to 36". Bottom sand with a trace of fine gravel. Since it completely traverses stream the spot is unsightly and unfishable.

INSTITUTE FOR FISHERIES RESEARCH

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United States Park Service work in Pigeon River, "Hay field" section. Such installations cannot operate efficiently, or fulfill definite purposes, because of their lack of coordination in design, and lack of adequate moorings, which allows them to change position.



United States Park Service work in Pigeon River just below the "Vanderbilt Bridge." Such agglomerations of drift materials may be expected to partially check bank erosion and provide fish cover. These ends could be obtained, however, without blocking the channel and so impeding the fisherman and offering dangerous resistance to ice and floods.



United States Park Service work in Pigeon River. Such barriers cannot be expected to withstand ice action. They make needless obstructions for the fly-caster. In this stream and others similar to it, where periodic floods and ice action are to be expected, the channel should never be completely bridged across by barriers.



United States Park Service work in Pigeon River. A high-face dam of this type is likely to silt in and be damaged by ice action.



United States Park Service work in the Pigeon River. Where the water is seen to be knee deep it was formerly hip deep, due to an efficient wing deflector. The hole produced by it is filled in since the deflector was removed by the U.S.P.S. The log jam seen across the stream will cause fishermen much annoyance since it interferes with fly fishing.

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