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A CHECK ON THE CONDITION AND EFFECTIVENESS
OF EXPERIMENTAL STREAM IMPROVEMENT STRUCTURES ON THE
EAST BRANCH OF BLACK RIVER, BLACK RIVER RANCH

Installation of stream improvement devices in the East Branch of the Black River on the holdings of the Black River Ranch, Montmorency County, was carried out under the direct supervision of C. M. Farzwell during 1930 and 1931. The structures, which are among the oldest in Michigan, include a few experimental types, construction of which has since been abandoned. The age of these structures makes their present condition a matter of great interest when considering questions of durability, appearance, and functional permanence of stream improvement devices.

Two major classes of materials are employed in these structures. Those occupying the section from the Upper Dam to the Lower Dam (about two miles of stream) are constructed almost wholly of waterlogged logs, timbers, dead-heads, and aspen poles, the latter chiefly being incorporated into bank rafts and covers. Current deflectors are almost invariably fastened in place by means of stakes (usually tamarack) and are very rarely banked or reinforced with stone or boulders, an adequate supply of these being unavailable until the Lower Dam is reached. From that point to one a short distance beyond the Ford (about one and three-quarter miles of stream), a

majority of the deflectors are composed of boulders, or of one or two large logs extensively banked and reinforced with boulders. Through the remainder of the improved section (about two miles) the first type of construction is resumed.

From the Upper to the Lower Dam, the stream bed is composed almost entirely of fine shifting sand. The rather wide valley, flanked by low sand hills supporting an open growth of jack pine, is occupied by marsh grass, and by scattered clumps of alder, which often meet to form almost impenetrable thickets. In the main, alder supplies the only stream shade through this section, although isolated stands of white cedar, spruce, and tamarack occur sparingly along the streamside. Because of their sandy character, the banks are seldom undercut. Excessive quantities of sand, which make this section of stream wide and shallow, derive not only from the eroding banks but from the Upper Dam, which has at various times been filled with sand and subsequently washed away. Aquatic vegetation is very local in distribution, the dominant species being pondweed (Potamogeton heterophylla), eel grass (Vallisneria), and Chara, or stonewort. Potamogeton filiformis seldom occurs except where there is at least a small amount of gravel. Presence of P. heterophylla is indicative of relatively slow current and of elevated water temperatures induced by the shallow flow and lack of shade. Chara is probably the most valuable of the species mentioned, not only because it harbors a large variety of food organisms, but because its root systems are better able to stabilize shifting sand, forming permanent bars upon which silt and organic debris are subsequently trapped out by the plants themselves. Here and there islands have been formed through the continued action of improvement devices. They have been most commonly produced by tepee and square covers in the channel. These become embedded

in sand, following which an island is built up in the lee. Sedges of the genus Carex first appear, giving way to various grasses, composites, and even shrubs. Such islands are of value chiefly through their role in narrowing and restricting an overly wide channel. Their food producing function is largely lost when they emerge above the surface. Since covers of this type are almost invariably artificial and unattractive in appearance, their further construction is not recommended.

Food production in the upper section is very low. Limited numbers of insect larvae inhabit weed beds, cling to improvement devices or natural drift and deadhead material, or burrow in the narrow zone of silt and organic debris at the extreme edges of the stream. The bottom itself is quite barren, owing to the almost universal prevalence of shifting sand. At rare intervals small gravel strikes run across the bed, and even more rarely rough peat outcrops offer harborage to fish food organisms. These peat outcrops are peculiar formations of a strongly fibrous texture. Although crumbling readily in the hand or under foot, water action alone does not destroy them, but erodes rough, pitted, deep-walled holes which offer excellent hiding places for aquatic insects.

At the Lower Dam the stream undergoes a sharp change. The valley narrows to an average of 100 yards. The immediate flat shore line disappears or is much reduced, and steep banks rise almost from the water's edge. A heavy mixed stand of maple and aspen, with occasional cedar, spruce, and balsam, clothe these banks and the adjoining hills, affording ample shade to the stream. The bed composition changes from sand to gravel and rubble and falls more rapidly, increasing the rate of flow. The gravel is thickly coated with spongy marl concretions on which moss (Fissidens sp.) grows thickly. This combination is one of the best known for bottom fauna production. One square foot of gravel and rubble, coated with marl and

Fissidens, yielded 15 cubic centimeters of food organisms, comprising 2089 individual specimens, 1739 of which were larvae and pupae of caddis flies, a highly favored trout food. Deep holes, long pools, and attractive gravel riffles occur in abundance. Cover is available from improvement devices and lodged drift material, as well as from large boulders.

About a half-mile above the Farm, the stream enters a clearing, and at the same time much of the gravel disappears from the bottom. The banks are about four feet high, composed of a stratum of sandy loam surmounting sand. Fibrous peat again appears in the bottom, and although sand is dominant, the deflectors have been successful in producing a few good riffles of fine to moderate gravel. Bank erosion and absence of shade and cover are the factors in greatest need of control or correction. Food production when last checked (July, 1935), ranged from 0.5 to 3.5 cubic centimeters, which is much below that of the gravel and rubble section, but better than the sand section lying above the Lower Dam.

Improvements in the upper section are, as has been stated, almost entirely composed of wooden materials. Wing deflectors and bank covers are most numerous, followed by reverse and V- deflectors, bend rafts, and tepee covers. Considering the fact that this work has been in place for seven to eight years, and that it has had to withstand heavy ice action, its condition is quite good. Many of the stakes have been heaved up through ice pushes, and should be redriven. The fact that many structures are still in place despite great upheaval of anchor stakes, testifies to the desirability of driving stakes as deeply into the stream bed as possible, up to a distance of six or seven feet. Next to this, the most common form of damage is impairment of the seal, allowing wing deflectors to undercut. Strong current rushing through such wash-outs effectively destroys any muck bars or weed beds which may have been formed in the lee of the wing, weakens

the strength of the current around the outer end, and subjects the mooring stakes to extra strain. To compensate for this, a deep hole is formed under cover of the structure. Damage to the deflector proper, such as loss of one or more logs or sections of logs, has occurred less commonly, and appears to have been caused, in most instances, by breaking of wires or upheaval of stakes during periods of ice action, or as a result of heavy drift lodgement which imposed unreasonably severe strain. Washing around the bank end of deflectors, a failure frequently observed on other streams, is of rare occurrence in the East Branch, where such devices were deeply embedded in the bank at the inner end. Bank rafts and bend covers are continuing to give good service. Few have gone out or been damaged sufficiently to impair their efficiency. After seven or eight years of weathering, the covers present a pleasingly natural appearance.

In the section from the Lower Dam to the Ford, and for some distance below the latter point, most of the wing deflectors are built of logs and large boulders used in combination. One or two large, sound logs are deeply embedded in the bank at one end, the other end very securely lodged between two or more large boulders. Other boulders are stationed at intervals along the downstream side, and the whole face well banked and sealed with sizable stones. In most cases, devices so constructed have suffered little or no damage. An excellent hole is created around the outer end, while drift and detritus is collected in the lee. In the few instances where the wooden elements of such barriers have been swept away, enough stone and boulder material from the anchorage and seal persist to maintain a most attractive riffle, even though the previously collected detritus is scoured away.

Bank rafts and deflectors constructed wholly of wood have fared worse in this section than in the sandy portion upstream. Apparently the factor

most responsible for this is the increased rate of flow, which has rendered the strain from ice push, flooding, and lodging of drift much stronger than in the slower current upstream.

Improvements in the Farm section are, in the main, continuing to serve their designed function. The deflectors have dug through a deep layer of sand to gravel, and have caused smaller gravel to pile up below and form riffles. Added structures are needed for control of erosion in this very unprotected section. Planting of shrubs and sand-loving grasses such as dune grass (Ammophila arenaria) should not only aid in checking erosion, but should supply needed shade and cover to the stream.

It is felt that repair and rehabilitation of existing stream improvement devices in the East Branch of the Black should be carried out before any additional stretches of water on this stream are improved. The upper section should receive attention first. Its need is greatest. Re-driving of pulled stakes, and occasional replacement of wire and logs, would place a majority of these barriers in excellent condition.

There follows a copy of notes on individual improvement structures taken when the writer recently waded through the improved sections of the East Branch of the Black River. The investigation, made on September 1, 1938, covered the stream from the Upper Dam to the Farm. The sky was clear with light clouds, following a cold, rainy day. At 10:00 a.m. the air temperature was 55°F., that of the water 57°F. Numbers assigned to individual structures are those stamped on copper tags and used by Tarzwell at time of installation to permit the maintenance of separate records for each improvement device.

Wing on left 50 yards below Upper Dam. Undercut throughout, no permanent muck in lee; fine gravel instead. Outer end stakes upheaved

12 inches, but most of current still diverted. Small patch of Scirpus and Carex in lee half way to end. Hole at end 21 inches deep, bottom coarse gravel and rubble encrusted with marl.

583

Wing on left. Not much undercut but muck in lee not permanent. Partially broken down in center section but still diverting most of current. Depth at outer end 10 inches. Bottom as for 582. Hole opposite outer end under right bank 20 inches deep, 40 feet long.

584

I-deflector (underpass type) in center. Logs spread and stakes lifted. Upper two logs above surface of water. Hole at left end 28 inches deep, extends from left bank to front middle of deflector. Bottom as before, no plants. Shallow sand and gravel bar below barrier 20 by 40 feet divides stream into two channels averaging 24 inches deep for 30 feet. Below this sparse Potamogeton heterophylla over fine to moderate gravel in center, estimated 60% gravel, 40% sand. Unsightly in present condition.

585

Open V-deflector, apex jammed with large logs from Upper Dam. Hole beneath jam at least 40 inches deep, has eaten through gravel layer to sand and peat. Stakes badly upheaved. Big hole in center unfishable. Twenty feet below on right about 15 square feet of Vallisneria.

586

Bank raft on right in good condition. Vallisneria and P. heterophylla around it and appearing through openings. Hole 18-24 inches deep. Red osier shade. Ten feet below is upper row of stakes used to block off upper section of 1935 trout count.

567

Wing on right has lost center log, thus destroying its usefulness. Muck bar gone. Hole at end still 20 inches deep due to presence of three large boulders. Bottom 70% sand, 30% fine to moderate gravel, no plants. Lower row of stakes from 1935 trout count have caught drift material and formed a 36-inch hole under good shade from clump of spruce. Banks open here except for red osier. Bottom quite sandy, some Chara and Vallisneria on bars and in bank pockets. Some flat mud Carex flats merge with water. Banks now low, grown with marsh grass. Outer channel 18-22 inches deep.

No tag

Bank raft on left in bend, about 30 feet long. Hole 30-38 inches deep along right. Still in good shape and looks quite natural. Bottom 100% sand, no shade. Some Vallisneria at lower end. Bottom composition of 20-30% gravel, balance sand, appears just below.

No tag

Wing on left, somewhat undercut; stakes lifted, but several patches of Vallisneria persisting in lee. Outer end broken down. Hole along outer 30 feet averages 22 inches deep. Bottom, 70% sand, 30% fine gravel. One hundred feet lower there is evidence of flooding--detached log and wire lodged on small island two feet out of water.

592

Wing on left at foot of above-mentioned island. Inner end cut around, outer end overflowing. No muck in lee. Sand and gravel as before. Stakes lifted badly, some actually gone cut. Hole at outer end 18 inches deep. Despite damage, there is an impermanent muck and sand bar 40 by 150 feet below structure on left; no plants. On right opposite end of bar is a patch of Vallisneria with some S. heterophylla, 5 by 20 feet.

593

Wrecked wing on left just below bar. Stakes gone. Hole still 28 inches deep, bottom sand and muck, no plants, but some fish cover afforded by logs of wrecked structure.

594

Wing on right. Center section broken to below surface, most of flow now going through the break. Subsurface logs create a 36 inch hole. Outer end upheaved, two logs out of water and unsightly. Hole at outer end 30 inches deep, some muck and sand in lee, no plants. Bottom 100% shifting sand.

595

Wing on left. Inner end cut around, outer end undercut. Hole around outer end 30 inches deep over sand bottom. Small island built up in lee of wing, supports some grasses and sedges.

596

Bank raft on right--partly broken but still gives good cover to 30-inch hole. Bottom remains 100% sand. Only shade from bank furnished in morning by red osier. In this vicinity the stream is flat, water uniformly knee deep, bottom entirely made up of shifting sand. Along the edges is a narrow muck zone where sparse growths of eel grass and P. heterophylla occur. There is no shade. Along the low banks are marsh grass, sparse clumps of red osier, goldenrod, and joe-pye-weed.

597

Large wing deflector on right. A muck bar has formed in the lee near the outer end. The inner half is overflowed, thus producing a 28-inch hole near the inner end. The hole around the outer end is 20 inches

deep. Bottom estimated made up of 95% sand, 5% gravel. Banks unchanged.

598

Wing on right--inner end overflows, as does outer 6 feet. Hole at inner and outer ends 24 inches deep. Stakes are badly heaved. A sand bar has formed in the lee, near the middle; no plants.

No tag

Wing on left. An island 12 inches out of water has formed in the lee, and occupies about 75 square feet. It is grown with Carex and mint. Hole at outer end 20 inches deep, some gravel appearing. Deflector and island throw current against right bank, where there is a pool 20 inches deep and about 100 feet long, shaded in the forenoon by cedar and tamarack. No aquatic plants here.

No tag

Just below the above, there is a wrecked wing on right side of stream. Drift has lodged on the wreckage, and now shelters a pool 30 inches deep. Pubble appears in bottom as width of stream is decreased by half.

No tag

An open V-deflector. Left half overflows, inner end of right half cut around. Hole in channel at center 20 inches deep. No bar or plants. Stream widens to normal width just above here.

No tag

Wrecked wing on right. Only one log, the bottom one, remains. Hole at outer end 15 inches deep. No sand or muck bar, or aquatic plants. Bottom 100% shifting sand again. Between this and next structure, Chara (Stonewort) begins to appear, hit or miss, in patches of variable size, on

sand bottom. Once a small stand of Chara becomes established, it spreads and speedily builds itself a bar. Sand accumulates and is bound by the roots. Muck, silt, and organic debris are trapped out by the plants, with the result that long, deep beds may be formed, to the advantage of the stream.

605

Wing on right. In the lee are two Carex-grown islands each about 20 square feet in area. Lee also encloses a shallow muck flat at head of long bend, approximate dimensions 50 by 200 feet. Cedar shade on right bank. Channel on left with 2-foot-wide fringe of P. heterophylla next to bank. Channel around outer end 12-18 inches deep.

606

Wing on left shelters island built up in lee which, with deflector, forms a triangle. Outer end is undercut, hole 24 inches deep. No weeds on bars. Structure forms a fine deep run under deadheads along right bank opposite outer end. Bottom 80% sand, with small patches of gravel or rubble, encrusted with marl and grown with Fissidens moss.

608

Square raft cover in midstream. Downstream side heaved up at an angle of 30°. Would be better removed. Weed bed just above on right made up of scanty growths of Vallisneria and P. heterophylla.

609

Single log deflector on right. It is likely that the inner end became dislodged from its stakes and has subsequently lodged against bank further down. Gravel and sand island which has formed in lee next to barrier supports Carex and grasses. Hole and channel around outer end from 20-24

inches deep under overhanging red osier and alder. White pine on right bank; ground rising.

610

Large tepee or triangle cover in center. Now wrecked and sanded in to bottom, but a large island is formed just below. Island about 50 feet long, 8 feet wide, 12 inches above water, thickly grown with sedge and grasses. Channel on left 20 feet wide, 18 inches deep. On right, 15 feet wide, 8 inches deep.

611

Wing on left. Inner one-fourth is undercut, hole 36 inches deep. Sand bar near surface in lee. Hole at outer end 20 inches deep. Current is diverted under overhanging red osier for fifteen feet. Bottom sand with rare peat outcrops; no plants.

612

Wrecked and stranded high and dry on right bank.

613

Bank raft on left. Still in good condition. Hole too deep to be waded. Some drift lodged here.

614.

This structure, once an open V, now functions half as an I-deflector and half as a reverse. Most of the flow goes around the left end, 20 inches deep. Bar in middle, no plants.

No tag

Bank raft on right just below 614. Wrecked and sanded in. Stakes protrude four feet above water. Should be removed or repaired. Very deep sand bottom hole around outside of bend, too deep to wade. Just below

bed, a large amount of Chara all over bottom, which is sand with a few scattered boulders.

No tag

Below last mentioned structure a reverse deflector. Only inner ends and some boulders left. Stream uniformly flat, sandy, wide, 10-12 inches deep. No shade.

No tags

Two wrecked barriers on right--stakes alone remain. Stream now knee-deep, otherwise as above. Occasional large Chara beds below here. Sand continues.

No tag

Submerged open V-deflector. Central channel 24 inches deep. Other conditions unchanged.

Just below is wreckage of another tepee cover which has embedded itself in head end of a Carex-grown island about 20 by 3 feet, 18 inches above water. Blue vervain and mints appear among sedge on island.

No tag

I-deflector in center--only bottom log left. Dense Chara bed, 50 square feet in area, over left end.

No tag

Embedded square raft in center. Stream still uniformly sandy.

No tag

Wing on right wrecked and thrown up on bank. Shallow, sandy. This was at site of middle section trout count conducted in 1935.

590

Wrecked bank raft on right, still giving some shelter. Water 14 inches deep.

From this point on to Lower Dam, no more devices were installed. The balance of the stream, to the Lower Dam, is broad, flat, shallow, and sandy. In most places there is little bank shade, the valley being broad and grown with marsh grass and isolated clumps of alder. Much of the sand is so soft that one wading the stream sinks into it ankle deep at each step. Cover, shade and pools are the greatest need here. It is likely that a series of obtuse-angled A deflectors, apices directed upstream, might create a series of islands which would deepen and accelerate flow by producing two narrowed channels.

Lower Dam to Ford, cruising started at 2 p.m., September 1, 1938. Temperatures at this time: air, 59°F; water, 62°F., other conditions unchanged.

Many tags were found to be missing in this section.

No tag

A wrecked bank raft lodged on a deadhead just below dam.

No tag

Stone deflector on left just below makes a nice riffle.

No tag

Log and boulder wing on right in first bend below dam has formed a pool 20 by 10 by 3 feet. Bottom nearly gravel and rubble, only occasional patches of sand. Most of nearly stones supporting thick growths of Fissidens moss.

No tag

Log and boulder wing on left creates a fine riffle. Water trickles through interstices, obviating collection of muck or debris. Enough water is diverted to create a long, fast pool about 20 by 4 by 2 feet ending in a shallow riffle of fine to moderate gravel.

No tag

Log and boulder wing on left, very similar to above.

No tag

Riffle in center produced by several large, artificially-placed boulders. Water about 14 inches deep around ends and in front. Bottom coarse gravel and rubble, no aquatic plants. Cedar and birch shade.

No tag

A similar boulder riffle in center just below the above.

No tag

Large log and boulder wing on left. Many sizable drift logs have lodged on it. Although somewhat undercut, there is some Chara in the lee.

No tag

Boulder wing on right has formed 24-inch hole around outer end.

No tag

A curved wing of stone and boulder material on left side. This structure has formed a small cascade, and limited shelter for fish is provided under the lower face of the stones.

No tag

Large log and pole cover on right bank. Previous structure diverts water under this cover, which shelters a 24-inch-deep pool.

638 (1930 series)

Log and boulder wing on right--undercut but still in place. Hole at end 24 inches deep, current very swift. Log is grown over with moss in which sedges and mints have taken root, making the structure appear very natural and attractive.

No tag

Just below, a large log wing, several old stumps, and deadheads are piled up on an island. Doing little to stream, but rather unsightly.

No tag

A stone V-deflector has caught a number of drift logs. The left end is wholly jammed across, the right open, water 14-20 inches deep.

639

Partly artificial and partly natural log jam on right. Gives protection against erosion, but offers little shelter for fish.

No tag

Log and boulder wing on right in bend. Log badly undercut, but most of current still deflected. Some cover under log.

504

Log and brush wing on right. Badly damaged, but a permanent island built up in lee which probably can now sustain itself. Hole around outer end 20 inches deep. Conditions of bottom and bank shade unchanged.

No tag

Just below the above a log wing lies wrecked on left bank. Stakes apparently failed under the additional load of lodged drift material.

No tag

Jam of logs and stumps along left bank. Water 20 inches deep along outer face, a small sand bar just below.

No tag

Long stone and boulder wing on right. Overflows enough to prevent formation of muck bar in lee, but accelerates current well and has produced an excellent pool (about 30 by 3 by 2 feet) opposite outer end under dense cedar and spruce shade.

No tag

Boulder wing on left. Overflows somewhat, as usual, but creates an attractive riffle and affords some shelter under stones.

No tag

Complicated log and boulder device, functioning much as a reverse deflector. The right element, composed of logs and huge boulders, extends about two-thirds of the way across the stream, at an abrupt angle, approximately 75° . A single large boulder banked with a few smaller stones protects the left bank and forces the water through a deep, narrow, swift channel, where it is broken up by another boulder. The channel is 30 to 36 inches in depth. Muck, silt, and sparse growths of P. filiformis and Chara occur in protected areas.

No tag

Boulder wing on right, hole around end 28 to 30 inches. Bottom still gravel and rubble with marl incrustations.

No tag

Gently curved dam of boulders. Bulk of flow goes through low place in center. Produces an excellent riffle, and a hole 30 inches deep under

the downstream face.

No tag

Low stone and boulder wing on right produces good riffle but does not greatly accelerate current. Hole around end 13 inches deep.

No tag

Boulder wing on right, large stump lodged at outer end. Rubble and small boulders in bottom around end form riffle 20 inches deep.

No tag

Boulder V-deflector, in good condition, central channel 30 inches deep, current greatly accelerated.

No tag

Boulder wing on right. Much of flow trickles through interstices. Hole around end only 14 inches deep. No muck or silt deposits.

513

Log and boulder wing. Undercut badly near end, and doing little good, although still in place.

516

Log and boulder wing on left--log undercut, but nice 20-inch-deep riffle around outer end. Bottom material and type and quantity of stream-side shade remain much the same through this section. Aquatic plants, other than moss, rare.

No tag

Stone and rubble wing on left. This barrier is overflowed throughout, effectively preventing bar formation. A very excellent riffle is created, with limited amounts of shelter afforded by the stones.

521

Log and stone wing on right. Outer end section washed away. Just below, the current is split by a large stump on which deadheads have lodged. This is at the site of the third trout count made in 1935.

No tag

Stone reverse deflector in good condition. Water through central channel flows rapidly, 24 inches deep, ending in a shallow riffle of fine to moderate gravel.

526

Log and stone wing in fine preservation. Produces an attractive gravel bottom run about 20 inches deep and 15 feet long.

No tag

Boulder wing on left. Conditions as usual.

No tag

Log and stone wing on right. Gravel bar formed in lee, fast run around outer end, 20 inches deep. Just below this deflector is the Ford.

No tag

Reverse log deflector near gate at upper end of open stretch at the farm. This structure is in a good state of preservation. Channel at center 24-26 inches deep, gravel bottom, fine gravel riffle at end of run. Considerable sand and some peat outcrops form the bottom in this section. Bank shade almost totally absent, banks 3 to 5 feet high, eroding somewhat. Occasional beds of Chara growing on sand and silt bars, especially near edge of stream.

No tag

Large jam of deadheads and drift 50 feet below preceding structure. Hole formed by jam too deep to wade. Nice cover afforded by drift material over hole.

No tag

Large log jam in bend where river is nearest the fence. This jam is effective in erosion control to the extent that it is now almost entirely silted in. It will soon be necessary to add to it if its efficiency is to be retained. The present appearance is untidy and unattractive.

No tag

Open V-deflector of logs 75 feet below jam mentioned above. The left side element is overflowed, the right badly undercut. Although the current is but little deflected by the structure now, the central channel is still about 36 inches in depth.

No tag

Jam on right. At this level there is a gravel island in the center of the stream, formed by the embedding of a tepee cover.

From here down to Farm bridge the improvements once present were removed at the time of the 1935 trout count, and were not replaced.

INSTITUTE FOR FISHERIES RESEARCH

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