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Report 181

A REPORT ON THE TROUT STREAM INVESTIGATIONS AND IMPROVEMENTS AT THE HURON MOUNTAIN CLUB

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To our old and tried methods of conserving and increasing the trout supply, namely: introduction, propagation, and protection,—there is now being added a new method—habitat improvement or trout stream improvement.

We are all aware of the great importance of correct habitat or proper environment for the maintenance of animal life. The quickest and most thorough way to drive an animal from a region is to destroy that habitat. It is well known, for example, that the forest species disappeared as the farm lands advanced. When man alters or destroys the proper environment of an animal, it is forced to move on or perish.

The purpose of trout stream improvement is to provide more and better fishing for the angler. It aims to accomplish this desired end by restoring the trout streams (as nearly as possible) to their former natural conditions, and by scientific methods to make environmental conditions even better than they were formerly. The principle of environmental improvement is the production and maintenance of situations which are necessary and conducive to growth survival, and reproduction of trout. These conditions are pure water of a suitable temperature, sufficient quantities of food organisms, good pools, hiding places and shelter for all times of the year and for all sizes of trout, adequate spawning areas, suitable waters for the rearing of young.

The industries of man have destroyed some or all of these conditions in many of our streams. By removing the forest and allowing the land to burn over, man has destroyed shade and decreased the flow of springs. The outcome is the warming of the streams so that they become unsuitable for trout life or unfavorable for a large production of trout. Lumber driving necessitated the removal of jams and other cover, and widened the streams creating numerous open, shallow stretches absolutely devoid of pools or cover, and entirely unsuitable for trout. Deforestation accelerated erosion. Immense quantities of sand are being added to our streams every year and sand is the most ruinous element in Michigan trout streams. It fills up the pools, covers the spawning beds, and encroaches upon the food producing areas to form actual aquatic deserts. Shifting sand bottom is barren of food. In it there is virtually no animal life suitable for trout food. Consequently an unimproved sand section cannot support many trout.

All the factors listed above are necessary for good trout production. If only one of these is absent or poorly, the trout production will be seriously lessened, this condition becoming the limiting element in trout increase. In the Salmon Trout River, specifically from the Dam to the High Banks in the gravel bottom section, the absence of pools, and cover is the limiting factor; whereas, lack of cover and adequate food supply are limiting factors in the sand section of the stream, extending from the High Banks to the Hog-catch pool.

Trout will not stay in a section that has no pools. While they can and do feed in a shallow, swift section of the stream, they remain in such a section only if there be some pools nearby, since trout do not like to lie in swift water. They require deep, quiet, sheltered places where they need not be continually fighting the current. The capacity of a pool is limited and the number and size of trout in a given section depends on the number and size of the pools in that section. Thus if there are not sufficient pools in a given section, increasing the number of pools will provide homes for more trout—increasing the trout population in that stretch of the stream. The large trout require more spacious pools. These must be present or provided if the fish are to remain in a desired section of stream. Deep pools where the water is quiet and warm in winter are also needed as wintering places. It is therefore evident that in a stretch where the number of pools is a limiting factor in trout production, it is necessary to increase the number and size of the pools, if we wish to bring the production of trout up to its maximum. A deflector which accelerates the current and directs it against a cover or digging log below, forms a pool beneath the cover. Where pools have been filled with sand, another use can be made of a correctly placed deflector – namely cleaning out the pool and bringing it back to original conditions. Very good pools can be made at bends by throwing the current along the bank. But pools alone are not sufficient; there must be cover over these pools if many trout are to remain in them.

Many streams have an abundance of good pools but they are so open that trout will not lie in them. There is only cover enough, usually, for a few small fish and not enough to give shelter to large fish. A section of stream will retain only as many fish as there are good hiding places for retreat in time of danger. Trout prefer some dark, quiet spot under a log or a floating raft. Thus, the holding capacity of a stream depends largely upon the degree of development of pools and cover. Nevertheless, the number of trout remaining in the stream can be increased by the addition of artificial hides. It has been found practicable to add shelters in several different ways. At bends, it is well to use bank covers. Raft and triangle covers have been generally successful. At sharp bends, where erosion of the bank is taking place, adding sand to the stream, boom covers work efficiently; for not only do they afford good shelter but they prevent the eroding of the bank. Square cover types are used in the center of the stream where it is shallow on both sides. Proper installation of cover encourages the fish to spread out with the advantage of a larger feeding range. While cover will help to increase the holding capacity of a stream it can increase it only in so far as there is enough food to support the added number of trout.

Of the factors necessary for really large trout production the food supply is probably the most important. In order to increase it, there must be provided a fitting environment for the insects and minnows upon which trout feed. Therefore trout stream improvement includes not only the producing of pools and shelter for the trout, themselves, but also the improvement of insect habitats.

There are several methods of enlarging the food store. A sand section is barren of insect life and the only food encountered in such a section is to be found in occasional patches of dark mucky material along the edges of the stream, in plant beds, or in various piles of brush or rubbish lodged in the stream. The aim, then, in the problem of food is to furnish more insect-rearing areas. Installation of deflectors can accomplish this. The accelerated current passing around the end of the deflector removes the sand, piling it up as a bar in the quiet water below the deflector. Mucky material settles on this bar in this same quiet area below the deflector. This material is the natural home of burrowing mayflies and midges which are produced in large numbers and form a suitable diet for young trout. Plant beds begin in this dark material. These aid in supporting the trout population, the plants provide shelter for many insects and food for some species of insects. These plants also give shelter to the little fish. The quiet water below these deflectors becomes warmer than that in the current, resulting in a greater production of food. This nursery can be made better by fastening brush to the deflectors and letting it float downstream. The brush shortly becomes covered with aquatic insects, adding more food. It gives cover to the young trout and protects them, not only from the large cannibalistic fishes, but also from fish eating birds. We have provided, at this point, shallow warm water, an abundance of food suitable for young trout and minnows, and adequate shelter,— in all, a very good nursery. In the Salmon Trout River in particular these areas will be of assistance, since they encourage the growth of minnows, lacking here as food for the large trout. Minnows are exceptionally scarce in the Salmon Trout River. In fact I did not find any above the lower falls except one species, the red-bellied dace (*Chrosomus eos*), which was present in the pond above the dam.

If gravel lies under the sand, food production may be increased in another way. The accelerated current caused by the deflector removes the sand from the gravel, uncovering sizeable areas of gravel bottom. And since gravel is the natural home of many aquatic insects—producing large numbers of caddis flies, may flies, and stone flies,—the food productivity of the stream is greatly increased in this way. Accelerating the current will in itself produce more food, for swift water supports many more caddis larvae than slow water. Some forms, also, such as stone flies, live only in swift water. The barriers, themselves, become massed with the larvae of caddis flies, black flies, and certain midges, and furnish excellent places for the transformation of insects. In these ways it is possible to increase many times the food supply of a sand area. This, in turn, enlarges the carrying capacity for trout in that area.

The section of the Salmon Trout from the High Banks to the Hogcatch Pool can be improved by the methods just mentioned and so be made to produce more trout. Gravel exposed around the deflectors, will increase the spawning area, thus preventing crowding and working-over of the beds.

Even in gravel areas which are naturally many times as productive as sand areas, the quantity of food can be increased. I have already stated that to remove the sand from the gravel is to aid food production. It is not necessary, however, for the sand to cover the gravel entirely in order to cut down the food supply. A mere sprinkling of sand around each pebble or small stone, filling up the crevices around them, will cut production in half by reducing the surface, which is required for the attachment of insects. It is possible to accelerate the current by means of a deflector so that the sand is removed and made to form a small deep bar, leaving the gravel clean and water-sorted, and in such condition that the supply of food is materially increased.

Plant beds and productive dark muck flats are easily started behind the barriers in the same way as in the sand areas. (If, however, there is not already a stand of aquatic plants in the stream they must be planted for a beginning.) The new plant beds will be very helpful, because in a gravel bottom area, they are usually not developed in sufficient quantity. In order to support all ages of trout, a variety of conditions and a variety of foods are needed. These warm-water nurseries will provide the needed variety of conditions and will add large quantities of insects, as well as minnows, to the diet, for this mucky material is even more productive than gravel. Plant beds which are usually scarce in gravel areas, grow behind these barriers, as experiments have shown. They offer more foods than any other medium, and give excellent cover.

Riffles,—the fast-water, food-producing areas, or larders of a stream,—can be formed by the proper location of deflectors. These swift water areas are teeming with life, whereas, in gravel areas, where the current is slow, there are fewer insects.

Deflectors in combination with covers can be utilized to make ideal fly fishing conditions. Raft or bank covers can be placed below deflectors, so the current from the deflector flows the length of the cover. The deflector concentrates the drifting food into one food channel, sending it along the edge of the cover. A trout can, in this way, lie in security in the still water under the cover with all the drift food continually flowing past his nose. He has only to move a few feet in order to have access to the supply. It is apparent that trout have definite food channels in which to feed. Because they do not range all over the stream, they generally lose a greater part of the drifting food. By concentrating the drifting food into a single narrow channel, we induce an added consumption of drift food; In reality, we thus increase the food store. The fisherman who drops his fly into this food channel, if the trout are feeding, has a reasonable chance of taking one or more.

The result of removing lifeless sand from productive gravel, accelerating the stream to produce riffles, producing warm water nurseries with rich, mucky bottoms, producing plant beds, and adding brush and logs for the development of insect life, must be a tremendous increase in food production in any stream. This augmented food supply supports a much larger population of trout, which is the end that fishermen desire.

Investigation and Improvement Work

The East Branch

Only a small section of the East Branch of the Salmon Trout River is owned by the Huron Mountain Club. It is made up of falls, rapids, and deep pools. For this reason, no seining was done here. This section from the south line fence down to the beginning of ponded water above the Burned Dam is not in dire need of improvement. There are two large pools requiring cover. Other improvements in this section should consist of logs laid along the bank in suitable places, to furnish rests and shelter. Some quiet water with mucky bars would be excellent. Food organisms are fairly abundant, but due to the swiftness of the current they are buried in the moss covering the stones.

The West Branch

The holdings of the Club on this branch are in two sections. These are fundamentally similar but they differ in some respects. The upper section is swift, where as the lower section is slower and wider with large pools. Long riffles are altogether lacking in both sections.

The upper section, the stream has largely a sand bottom. Sand is constantly pouring into the stream, covering up the gravel bottom. It is in fact, the chief limiting factor of this branch, for it is destroying food producing areas and filling the pools. This sand should be moved and formed into permanent bars by the proper installation of deflectors. Riffles and gravel areas could be provided here where now there is only sand and smooth water. Pools at the bends should be cleaned out, also by means of deflectors. There are many places where good pools have been ruined by being filled up. If these are opened and a number of poles or a log laid along the banks for shelter, this section of the stream will be greatly changed for the better.

Shade here is very good. In some places the alders are so thick and overhang the stream to such a degree that it is difficult for one to fight his way through them. In order to facilitate fly fishing the alders extending across the stream must be cut away. This might be done to a certain extent without harm to the stream or perceptible warming. It is common belief that sections like the above are the very best for the fish. On the contrary, my experience does not bear this out. In a sand section such as the one on the West Branch where the stream is deep in the center and shallow on both sides (as it usually is in a section where the alders nearly cover the stream), fishing is usually poor. Fish do not appear to favor a section where the stream bottom is dish-shaped—shallow on both sides. If deflectors were installed here to deepen the water on one side, and some floating cover added, conditions would be entirely different, and, I believe, better. Though alder shade cover is good, fish appear to prefer cover that is in the water,—a shelter that they can get directly into and underneath. Perhaps that is because the latter type of cover makes a darker retreat which they prefer.

There are at present a number of dead-head logs in the stream, but they have swung around parallel to the current, doing very little good. With proper placing these could be made to function advantageously.

The lower section of the West Branch is also choked with sand. There are few riffles or gravel areas. The pools are larger and deeper and are in more need of cover. The main task here is to produce riffles (food producing areas) by means of deflectors and to place cover in the pools. Again, the mucky bars produced below the deflectors would add surprisingly to the food supply—especially to that of young trout. If it is so desired some of the overhanging alders could be removed to facilitate fly fishing.

At the lower end of this section there are three abandoned beaver dams. These are forming very good pools by ponding the water and should remain in place unless the beaver build them higher and flood the banks. Cover is needed in these pools.

The trout population in this section is fairly good. Most of them have gill lice but they are not so heavily infested as the trout in the ponded water above the dams. As I went downstream toward the dam I found the trout to be more infected. It appears that the gill lice are more persistent in the ponded water.

Food is rather scarce in this section as the sand has covered most of the stones. There are scarcely any aquatic plants in the entire section.

The Burned Dam

The pond above the Burned Dam is in need of cover, since under present conditions it is quite open. Flooding has killed the alders along the edge. If these dead alders were cut and used to make brush shelters, the appearance of the pond would be improved, besides providing valuable shelter for young trout. These brush piles would also increase the amount of food produced in the ponds by forming suitable habitats for insect life. In the deeper water in the center of the pond, floating cover in the shape of rafts is needed. These would give shade and protection to the larger fish and would localize them for the fisherman.

The Salmon Trout River

The section of the stream between the Burned Dam and the beginning of ponded water (at the foot bridge) has a fair stocking of trout, but not so heavy a population as that in the West Branch. It could support more. As I proceeded downstream below the dam the gill lice became less and less abundant, and below the Middle Falls only occasional fish had them. This section of the stream is in little need of improvement, as it is in good shape. Shelters over some of the larger pools and a few deflectors where the stream is too wide are all that are needed. Still water behind the deflectors would be beneficial since, as a whole, this section is fast.

From the foot bridge to the point at which improvement was begun this year a great deal can be accomplished by the addition of cover. This can be done rather easily since the material is near at hand. The dead trees along the banks would be the material.

The pond above the dam was improved this year by the addition of cover. Dead bushes and trees--killed by flooding--were used. In all, about 50 covers and shelters were constructed. Brush shelters were placed in the shallow flooded area for the purpose of giving food and shelter to young trout and minnows. The trees were put in the channel to give cover for the large fish.

Minnows were planted among these brush piles this fall. It is hoped these shelters will be an aid in establishing a population of minnows in the pond, as minnows are considered necessary for rapid growth in large trout. While large trout can live on insects, minnows make a more substantial diet. Investigations have shown that as trout grow larger their food habits change, and they become more cannibalistic.

Many questions have been asked about the fish lice now infesting the trout in the Salmon Trout River. These organisms are small crustacea and are related to such animals as the crab, lobster, shrimp and crawfish. Technically they are known as copepods. While they do not ordinarily kill the fish, if they become too abundant they weaken them since they suck their blood. The larva are free swimming organisms which begin to seek a host as soon as they break out of the eggsac of the mother. Since they die within two days if they do not succeed in fastening themselves in to a fish it is easy to see why ~~why~~ they are more troublesome in the dam than in the stream. They have more chance of finding a fish in the still water of the dam than in the swift current of the stream which sweeps them downstream.

The parasite kills the fish only when it becomes very abundant. However, it does considerable damage by injury of the delicate membranes which it attacks. Also they open the way for the attacks of other organisms and disease.

No efficient remedy for this parasite is known. In hatcheries the fish are treated with salt water. This is of course impossible in streams. In some instances the introduction of certain types of top minnows have proven efficient in reducing the number of the parasites. These parasites were probably secured by the introduction of large hatchery fish.

The Dam

A great deal of discussion has taken place concerning the level of the water in the dam and the algae nuisance. The summer of 1931 was unusually hot and dry. The high temperature, coupled with low water and the decay of vegetation in the flooded area produced an unusual growth of algae. Perhaps this would not have resulted if the dam had been built about 2 feet lower. Since, however, the banks have already been flooded and the trees and alders killed, I do not think the level of the pond should be permanently lowered at this time. A large pond has the advantage of being a food reservoir, and it furnishes a wintering place for trout. Besides, the algae was not troublesome this past summer-the sods and grass in the flood areas has not all decayed but when it has I believe the algae growth will diminish. If the level were to be permanently lowered now after the trees and bushes are dead, and a dark, mucky substance has been deposited, the dam pond would become an unsightly and malodorous place.

Any algae that accumulate can be removed by flushing. This could be accomplished by cutting an opening in the top of the dam(without removing any timbers) then putting slash boards in so that the water level could be controlled as desired. Care must be taken, however, not to vary the level except when absolutely necessary as unnatural changes in level are detrimental to the stream. The water should be let out slowly and not allowed to go with a rush. To avoid the possibility of heavy flooding, the opening of the dam should be made narrow.

One of the main reasons for the algae growth and stagnant appearance of the dam pond is that the dam is leaking badly. This should be fixed. Under present conditions all the cold water is draining out at the bottom of the dam and under normal water levels none flows over the top. Since there is a range of temperatures of as much as 12° to 14° F. difference between the surface and the bottom of the pond there is sufficient difference in density to prevent the water mixing. The cold water is drawn off at the bottom while the upper warm layer remains, becoming stagnant. By preventing this flow through the bottom, the warm upper layer would continually be removed, and stagnation or algae growth lessened or entirely prevented. Also, the cold water should be retained at the bottom of the pond as a refuge into which trout can descend during hot weather. Clear Creek comes in at the correct point to furnish a supply of pure, cold water at the bottom of the pond. Since surface temperatures become high— 74° F. or more—the cold bottom layer should be retained and drainage taken from the top,—which, in turn, will lower the surface temperature.

Since my examinations were made late in the season I cannot make a definite statement concerning temperatures of the dam. While I was present, there was, however, some very warm weather, though temperatrues did not become dangerously high. A check of temperatures should be made during July in order to be certain.

The advantage of the present level of the dam is that it produces a wide, large, shallow area which is an excellent place for the production of quantities of food. Aquatic vegetation thrives here since the water is shallow and the sun's rays can easily reach it. These plants and the muck bottom of the flooded areas are the agencies that produce the flood. Examination has shown that there is here present abundant food for both old and young trout. Amphipods, isopods, aquatic beetle larvae, snails (Physa), various forms of caddisflies, leeches, midge larvae, aquatic hemiptera, sticklebacks, and some minnows are all found here. This area is a suitable place for the food and cover both. A few minnows are already present, but they are small and do not appear to be doing well. Other river species should be planted. If a good population of minnows can be established, the maximum size of the trout taken in the pond should be materially increased.

At its present level the dam has greatly increased the food supply and has added to the size of trout taken there. After the dam is fixed so there is no leakage, the water at the bottom of the pond will remain still and in winter will stay near 39°F.— the temperature at which water is most dense, making it warm enough to winter the trout safely.

Some question has been raised concerning the condition of the water in the dam. The water in the dam pond itself is clear. It is only the greater depth which lead many to believe it is cloudy. The dirty appearance of the water in the stream below the dam is caused by a prolific growth of a brown algae in the stream below the dam. When anyone walks through this section from the Dam to the Lower Falls they stir the algae up and it floats down stream making the stream have a dirty and unpleasant appearance. I hope the improvement work in this section will help to remove the algae.

The algae growth has virtually disappeared below the Lower Falls. This leads me to believe that the growth is due to certain water conditions caused by the dam. At least aeration and the stirring up of the water appear to change the condition.

This fall, the section of stream from the Dam to the Lower Falls was improved. Various types of deflectors, dams and covers were added. In all, about 50 barriers were installed in this stretch. Next year when pools have been formed, and bars built up, brush shelters can be added to good advantage.

This is one of the best sections of the river as far as food production is concerned. And since improvement, it should supply a greater total number of fish than any other section of the river, except, perhaps, the gravel section from the falls to the High Banks. Below, in the deep pools of the sand section, larger trout will be caught but there will be only a fraction as many trout there as in this section. At present fish are not as abundant here as below the falls. All of the trout in this section are brook trout.

The section of the stream from the lower falls to the beginning of the sand section--that is, near the High Banks,--is very similiar to the section from the dam to the lower falls. It is largely a gravel, rubble, and boulder ~~dam~~ bottom. At present, this section contains more trout than any other part of the river. Brook and rainbow trout occur here in almost equal numbers. Of a random sample of 67 which I obtained by seining, 35 were brook trout and 32 were rainbow trout. It was here that I found the first minnows and suckers in the stream proper. The long-nosed dace and common white sucker were the species taken. Both are scarce. In all my seining I caught only one sucker.

These two sections extending from the dam to the High Banks are rich in food, since there is a sufficiency of riffles. A large share of the stones in the bottom are covered with Fontinalis moss which is a good home for insect life and serves to increase the total amount of food produced. Caddis larvae are especially plentiful and furnish the greater share of the food. The larvae of stone flies, may flies, and crane flies, and some amphipods or fresh water shrimp are also present. Some muck flats would be helpful in this section since the type of food produced in them is needed for the young trout of the section. Cover and nurseries for the young as well as deeper pools and cover for the large fish are essential. Still water, such as that produced behind the deflectors, would undoubtably increase minnow and sucker production. More minnows and suckers are needed in this section since they are almost absent.

I think this section should be improved next in order, since this one and the foregoing one which was improved this year are capable of supporting more trout than any other parts of the river, due to the greater amount of food which can be produced. This section has need for pools and cover for the large fish, some micky flats, quiet areas for the production of food for the young, and a more favorable place for minnow production.

From a short distance below the High Banks all the way to the Mouth, the stream has a sandy bottom except for a few patches of clay and a few riffles where the bottom is rubble and boulders. This section has the best pools from the standpoint of depth and size, although many of them are greatly in need of cover, since they are now quite open. Some are filling up with sand and should be cleaned out with deflectors. From the standpoint of food production, this is the poorest section of the river since a sand bottom is devoid of insect life. For this reason this section will have fewer trout than the other stretch, in spite of the fact that it had better pools. But since these pools are large and deep the largest trout will lie in them, so this stretch will yield the largest fish.

The only places in which food is found in this section are in the patches of mucky material along the edges, and in piles of trash and brush. Every year tons of sand are being washed into the stream, filling up pools, and smothering food. Every sand bank at bends is adding its share. Each year the covering of sand is becoming thicker and moving farther up stream. Something should be done concerning this sand as soon as possible. Protectors to prevent further undermining of high sand banks should ~~He~~ be installed stream-side shrubs and bushes should not be cut in order to make paths, and paths should be kept back a short distance from the stream. Paths of entrance and exit along the stream should not be near sand banks, because eadh time an individual enters or leaves the stream, he causes more sand to slide into it, giving erosion a better chance to get in its destructive work. In many places the stream is excessively wide due to some tree catching in an incorrect position. These sections should be confined and the stream made narrower.

In connection with the building of boom covers to prevent the stream from eroding these sand banks at the bend, it would be well to do some planting of shrubs to prevent downward movements of sand and wash during rain. Mr. Wesley Curran who is working on "The Relation of Stream-side Vegetation to Fish Production" would be glad to undertake the problem. I believe it would be well to plant some of these banks. These banks in this section could be reclaimed at a cost of about $100.00, the work being done by Mr. Curran and one helper.

While it would be impracticable to alter this section so as to make it as rich in food as the rubble or boulder sections above, it nevertheless can be very materially helped. In fact, such a section as this can be improved to a proportionately greater extent and the improvements will be more noticeable than in a boulder section. It is much easier to dig deep pools in a sand section. In a sand section such as this, the increase in food production is the chief problem, since the scarcity of food is the stronger limiting factor in trout production.

The food supply can be increased in much the same way as has been explained before in methods of improving a sand section. This improvement, coupled with the cleaning out of pools and the addition of adequate shelter will overcome the two limiting factors of this section and total trout population will be increased.

Of the entire sand section, that portion from the High Banks to the Highway Bridge is the one most in need of improvement. It is here that most of the high sandbanks occur. Also, in this stretch there is a large number of logs and trees that have fallen into the stream or that have been washed into it. These have no arrangement and are lying just as the current left them. While some of these are doing good, many are definitely doing harm because of incorrect placement. Good holes are filling and being destroyed. In a few cases these jams are widening the stream. These trees and logs should be arranged more advantageously and made into deflectors so that the sand will be cleaned from old pools and they will be restored to their former excellence as hides. Trout are scarce in this section. It was with difficulty that any could be caught. Here rainbow trout appear to be more abundant than brook trout.

The section from the Highway Bridge to the Hogcatch Pool is not in such urgent need of improvement as the section above since there are fewer high sand banks. This section is, however, in one respect badly in need of improvement, since the sand is even deeper than in the section above. The problems here are approximately those of the section above,—the addition of cover, the cleaning out of pools, the creating of a favorable habitat for the young, and the increase of the food supply. Riffles are absent, but there are many places where they can be made. Brook and rainbow trout are present in about equal numbers with the majority perhaps, on the side of the brook trout.

In the whole stretch I have seen no extensive areas that appeared suitable for spawning beds. I believe they are inadequate in this entire reach from the High Banks to the Mouth. If there is a gravel bottom under the sand the sand can be removed with deflectors to make the gravel available for spawning. But if the sand is not underlain with gravel it may be necessary to haul in gravel for spawning purposes. While this is an expensive process I think that in a number of years it will more than pay for itself, by making it possible to cut down on the number of fish planted.

Six side streams come into the main stream in this section. They are, with one exception, warmer than the main stream itself. I believe the reason for this is because there are beaver dams on these feeders. In order to make these streams a benefit and not a detriment to the main stream, the beaver dams, in this instance, should be removed.

The section from the Hog-catch Pool to the Mouth is wide, slow, and extremely open. The bottom is sand and uniform, without pools. Cover is absent. I do not think it practicable at this time to do any improvement work here, for under present circumstances, this section becomes too warm for trout in summer. At least all other sections should be improved before any work is done here.

The cost of trout stream improvement depends on the availability of material (logs, poles, brush, slabs, and stones), the size of the stream, the present condition of the stream as to pools and cover, and the accessibility of the section to be improved. If the stream is large and in poor condition, material scarce, and if it requires some time in getting to or from the stream, the cost of improvement will be high. The only other factor in the cost is the materials to be purchased, as wire, staples, and spikes. This cost is usually only a fraction of the total cost. It is apparent that the greater part of the cost of improving the stream will be that of labor necessary to collect the material from the forests along the banks or from the bed of the stream itself, and that of converting the material into finished products. Therefore the type of labor, the length of the working day, and the wages paid determine the cost. Experienced men can accomplish a good deal more than new men, since it requires one to two weeks to train a crew to work efficiently.

Along the Salmon Trout River logs, poles, and brush can easily be obtained but it is difficult to secure good stakes. This makes them expensive. It might be better to use old boilder tubing which is very tough and can be had for a cent a pound.

In making an estimate of the cost of improving the Salmon Trout River all the different factors mentioned above must be taken into consideration. I have examined the Salmon Trout and both its branches with the idea of discovering the number of barriers necessary to improve it. With this number as a basis, I have made an estimate of the cost of fully improving the river. While these estimates will not be exact due to unforeseen circumstances arising, I do not believe the actual cost will vary much from the estimated cost. The estimates are as follows:

The East Branch down to the Burned Dam Pond..................	$30.00
The West Branch (both sections) and down to the Burn Pond....	250.00
The pond above the Burned Dam..............................	70.00
The section from the Burned Dam to the beginning of the Large Dam Pond..	150.00
The pond of the Large Dam..................................	200.00
The section from the Large Dam to the Lower Falls...........	200.00
From the Lower Dam to the High Banks.......................	400.00
From the High Banks to the High Bridge (this includes the rearrangement of drift material and plantings to retard erosion of sand banks).......................................	800.00
From the Highway Bridge to the Hog-catch Pool..............	900.00
Total	$3000.00

Since the pond above the Large Dam and the section from the Large Dam to the Lower Falls is already improved, $400.00 can be subtracted from the total amount leaving $2,600.00 as the cost for the remaining work.

Recommendations

It is recommended:/

1. That the section from the Lower Falls to the highway bridge be the next section to be improved.

2. That the improvement work be done during the warmest part of the summer since the water is so deep here thatneither boots nor waders will be of any use.

3. That some stream minnows be planted in both dam ponds.

4. That fishing in the rubble and boulder section be carried on from the banks whenever possible, since walking in the stream destroys many of the insects living in the stones.

5. That paths be kept back a short distance from the stream, especially along the high sand banks.

6. That no trees or shrubs which are helping to prevent erosion should be cut.

7. That no one enter or leave the stream near a sand bank as a path at this point gives erosion a better chance to add more sand to the stream.

8. That the dam be repaired next summer and so fixed that all the water must ~~flow~~ flush over the top.

9. That the dam be left at its present level until further studies have been made, but left with the provision that boards can be removed when necessary to flood the dam pond.

10. That temperature records be kept by the guards to determine maximum and minimum temperatures.

Other Trout Waters

Clear Creek

Clear Creek is the best feeder stream flowing into the Salmon Trout River on the club property. It has a large flow and a much lower temperature than any of the others. It enters the river at the most advantageous point, just above the Dam. It is so located that it supplies the bottom of the Dam pond with cold water in the summer and with warm water in the winter. When temperatures on the pond become too high the fish can go up into its cooler waters. Under present conditions, this stream is not in need of improvement. Cover appearsto be good.

Snake Creek

Snake Creek was much warmer than Clear C reek. I t is however a trout stream and a fairly good feeder. Trout are taken from it at the bridge on M. 35. I should not recommend any work on the Snake for the present at least. Beaver are working on it rather intensively. A list of temperatures on this stream are given on the last page of this report.

Sullivan Creek

Sullivan Creek has a good flow but at present is quite warm. This warming is due without doubt to beaver dams. If these were removed it would serve as a feeder and nursery. It should be examined for suitable places to make spawning beds. At present with a water tmperature of 70° F (at an air temperature of 74oF) it is too warm. What has been said of this creek applies to the other small feeders entering the stream in this region. With proper improvement the temperature of these could be lowered and some of them could then be converted into nurseries by the addition of spawning beds and a suitable habitat for young trout.

Cedar Creek

Cedar Creek was examined from a point a short distance above the end of the Painted Trail down to the point where the stream enters the large swamp. At this upper point the temperature is low. On Sept. 6th at 1:15 P.M. the water was 51°

with an air temperature of 58°F. In this upper section the bottom is largely sand. There are numerous old beaver dams which have collected a deposit of mud about them. Although the bottom consists largely of barren sand the food supply is fairly good due to the numerous dense patches of White W ater Buttercup. Food is plentiful in these plans beds. There is a succession of old beaver dams from the end of Painted Trail down stream for some little distance. These have formed fine trout pools but they lack cover; some since under former flooded conditions the alders have been killed. Raft covers are needed here. The pools are open//so much so that I was able to count 14 trout in one pool. In the quiet water of these pools mucky material, which is ~~used as~~ rich in food, has collected.

At present the beaver dams are impossible to trout except at very high stages of water. Their condition should receive consideration. These dams should not be entirely removed, as they are forming good pools, but a small opening should be made on one side to allow trout migration.

Below these dams the stream has more gravel bottom and riffles. T he stones are covered with Fontinalis moss and in this there is a supply fo food organisms. The larvae of caddis flies, may flies stone flies and crane flies are abundant.

The next section has a succession of short falls. These aerate and cool the water, while there are very nice pools between them or at their bases. Cover is good in this section. Shrimp occur in the moss covering the rocks. There are enough riffles here for good production.

This stream as a whole is very good. Some stone dams would do good work but the need is not urgent. While sand is coming into some of the pools it is not yet attaining dangerous proportions. The open pools should have cover and the beaver dams (as long as they are not enlarged by the beaver) should be undisturbed except for a channel at one side to allow fish migration. This is an exceptional stream not at present in need of extensive improvements.

Cliff River

The Cliff River was examined from sone distance above the falls to where it enters the large swamp near its mouth. This stream, like the Cedar, is a cold stream in its upper waters. At the upper point of examination the stream was blocked by a succession of beaver dams spaced abour every 100-200 feet. These are now abandoned but still back up water to form pools. T hese pools are open since the high water killed the alders during the time the beaver were inhabiting the region. At present the water is deepened to form good pools which would be benefited by the addition of cover. Some of these pools are filling up with mucky material and silts. This will necessitate the removal of some of the dams if the damage continues too far. These dams form a barrier to the spawning migrations of trout and they should be opened in such a way that the trout can ascend. But since they create good pools they should not be entirely destroyed. Trout are present in large numbers; they even more plentiful than in the Cedar. Some pools contain as many as 30-5- fish, a few as large as one foot in length. All appear to be in good condition as far as I could tell from such a cursory observation. A greater share of the bottom in this section is sand but the food conditions are good, due to the aquatic plants and the great amount of brush and trash in the water. Arrowhead, white water, Buttercup, and algae are fairly profuse and add materially to food production.

A short distance above the falls the beaver dams end, and the bottom changes to gravel. Here there are riffles with their usual amount of insect food. Below the falls there are so thick and are collecting so much sand that they are damaging the stream. If some of these dams are not carried away naturally by undermining, some of them should be removed. Since all the bushes along the stream have been killed by former flooding this section is exposed to the sun, and it is here that a great deal of the warming of the water takes place. This section of the stream is wide and due to the old beaver dams, has been split into two or more channels in many places. Sand has collected in some sections to such an extent that large shallow sand flats have been formed. Minnows are present here.

Farther down there is a very shorg gravel section where the stream has more slope. Just below, the beaver dams appear again. Then, from this point, the entire way to the canyon, there is an endless succession of beaver dams. They widen the stream, split it into many channels, and make it very difficult for trout to migrate. Since most of the bushes have been killed by flooding some time ago, this section is unshaded, and because of this the Cliff River becomes warmer than the Cedar at their confluence. Although the bottom is sand there is so much brush and trash in the stream that food habitats are plentiful. Trout are numerous in all the pools, and they are easily observed in most cases since the pools are so open. Just above the canyon the beaver are making a new dam. This is backing the water up to flood a large area. This dam must be removed at once or a geat deal of timber and valuable shade will be killed.

After entering the canyon the stream becomes ~~strong~~ swifter and is of an entirely different type.

The Cliff River, in general, is a fine stream. It might be better if the beaver had been kept out since they have very nearly ruined many sections. While it is now quite open, shade will increase in time, holding the temperature down. Improvement would consist in removing some of the old beaver dams, making passageways through others, putting cover on the unshaded pools and planting shade in the open stretches. I do not believe that extensive improvement of ~~this tyep~~ the type (necessary to remedy the conditions brought about by the beaver) would be advisable in this case. The improvements outlined above are all that would justify the expense involved. Temperatures along the Cliff are given on the last page of this report.

<u>Fisher Creek</u>

Fisher Creek as shown on the map is the outlet of Trout Lake. When I examined the creek there was no out-flow from the lake, and from the lake down a distance of 1/4 mile there was only a dry channel. The creek began as a number of springs.

These springs emerge at 52°F. and the water is very heavy with iron. A short distance below these are more springs which enter at 50°F. From here on there is a fair flow of water, about 1/4 cubic foot per second. A few fish though to be trout were seen but they are very small. Pools could be made here. A short distance below, just above the junction of this creek with a branch from the right, the main stream was 52°F., the branch from the right 56°F. Below the junction of these branches the stream is choked with sand. About 1/4 mile beyond the junction of the branches beaver dams begin they have flooded the entier valley and completely ruined the stream for a great distance. Just above the beaver workings the water was 54°F., at an air temperature of 72°F. And below the dam it was 60°F. During the summer the warming would be even greater. For a distance below the dams the stream is sandy and worth little as a trout stream. Then, after about 1/4 mile like this, it enters a gorge and becomes faster; the bottom changing to gravel and rubble. Springs enter enlarging the stream and bringing the temperature down to 54°F. This section, about 1/2 mile long, is good anc capable of producing some fishing, if improved and stocked. There are numerous riffles and rapids for food production. At the end of this section the stream comes out on the flat lands surrounding Pine Lake and here the beaver have built more dams. This section is worthless as it has become flat and sandy. While this section could be made to yield some fishing it probably woudl not pay to improve it, at least until fishing becomes heavier in the other streams.

INSTITUTE FOR FISHERIES RESEARCH

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Temperatures

Salmon Trout River

Place taken	Date	Time	Air	Water
In Pond of the log dam	Aug. 30	5 P.M.	86° F.	74°F.
At Highway Bridge	Aug. 30	5:10 P.M.	86 "	68"
In Pond of the large dam	Aug. 31	9:30 A.M.	76 "	69"
In Pond 1/2 mile above the dam	Aug. 31	10:00 A.M.	76 "	66"
Salmon Trout River between the dams	Aug. 31	10:30 A.M.	76 "	64"
Pond of Burned Dam	Aug. 31	11:00 A.M.	75 "	66"
East Branch	Aug. 31	11:10 A.M.	75 "	62"
West Branch	Aug. 31	11:30 A.M.	75 "	66"
Pond of the large dam	Aug. 31	12:00 A.M.	76 "	71"
Just below the dam	Aug. 31	12:00	76 "	68"
In pond above the dam	Aug. 31	3:00 P.M.	67 "	67"
At Highway Bridge	Aug. 31	3:30 P.M.	67 "	68"
1/4 Mile below Highway Bridge	Sept. 1	11 A.M.	66 "	61"
1 mile below Highway Bridge	"	1:45 P.M.	74°F	63"
Near the mouth of the river	"	3:20 P.M.	76 "	66"
West Branch	" 2	11:30 A.M.	74 "	58"
East Branch	" 2	1:20 P.M.	74 "	56"
Just below Burned Dam	" 2	1:30 P.M.	74"	58"
Above Lower Falls	" 2	5:00 P.M.	77"	63"
Below Lower Falls	" 3	10:00 A.M.	64 "	60"
In Dam pond	" 3	1:30 P.M.	75"	70"
Just below the Dam	" 3	1:30 P.M.	75"	60"
Between Murphys and Highway Bridge	" 3	2:00 P.M.	74"	64"
1/2 mile below Highway Bridge	" 3	4:00 P.M.	74"	64"
At Highway Bridge	" 3	5:00 P.M.	71"	64"

Temaperatures at the other Streams

Clear Creek near its mouth	Aug. 31	9:30 A.M.	76°F	54°F
Clear Creek near its mouth	" 31	3:00 P.M.	67 "	54"
Clear Creek at its mouth	" 30	3:30 P.M.	77 "	52"
Snake Creek at its mouth	" 31	10:00 A.M.	76 "	71"
Snake Creek 1/8 mile above its mouth	" 31	10:05 A.M.	76 "	68"
Snake Creek 1/4 mile above its mouth	" 31	10:10 A.M.	76 "	66"
Snake Creek at M 35 Bridge	" 31	11:45 A.M.	75 "	67"
Snake Creek at M 35 Bridge	Sept. 2	11:30 A.M.	74 "	60"
Salmon Creek at its mouth	" 1	1:45 P.M.	74 "	70"
At junction of Cedar Cr. and Cliff R.	" 6	11:00 A.M	57 "	54"
Cedar Creek at end of Painted Trail	" 6	1:15 P.M.	58 "	51"
Cliff River below Canyon	" 7	9:30 A.M.	63 "	52"
Cliff River above the Falls	" 7	10:45 A.M.	62 "	52"
Cliff River 1/2 mile above the Falls	" 7	12:30 A.M.	62"	54"
Cliff River 1/2 mile below the Falls	" 7	2:00 P.M.	66 "	56"
Cliff River just above the Canyon	" 7	3:10 P.M.	64 "	58"
Cliff River just below the Canyon	" 7	4:30 P.M.	64 "	58"
Cedar Creek just above junction	July 7, 1927		73 "	59"
Cliff River just above junction	" "		73 "	65"