Twork, Elton C
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THE REMOVAL OF BEAVER DAMS FROM MICHIGAN TROUT STREAMS, AND SOME OTHER CONDITIONS EFFECTING THE TROUT ENVIRONMENT

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Elton C. Twork
School of Forestry & Conservation
University of Michigan

Table of Contents

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Today with conservation programs of all kinds being enacted the fisherman of the country have demanded that something should be done to improve the conditions in our trout stream for to make better fishing. Because the planting of hatchery fish have not made good fishing, the possibility of improving the streams them - selves to make stream conditions more suitable to the fish life has arisen. What can be done to make our streams self sustain- ing, that a trout stream may always be a good trout stream? This is a question with which the conservation authorities have had to deal.

To answer this question, many methods of stream improve- ment are being tried out. At present, beaver dams are being removed from streams without taking into consideration the individuality of each stream. A generalization has been made that beaver dams are deleterious to trout streams; so, they should be removed. It is this method and its effect upon our trout and beaver that I would like you to consider with me.

The general plan as carried out in State C.C.C camps is that a project is planned for each camp by the district super- visor of stream improvement. The streams that are to be worked upon by a camp are submitted to the Conservation Department at Lansing for approval by the fish division. Upon approval, the project is allotted a certain number of man-days, and sent to the camp superintendent, who starts a crew of man to work on the project with the help of the district supervisor of stream improvement. Because the district supervisor cannot always be on hand to help, it is necessary that the foreman on the job have a knowledge of the work he has undertaken to do, if he is to do a good job.

Because most of the devices constructed to improve the stream do some good or at least do very little harm, the problem of how to install these devices is not as vital as the question, "when and where should beaver dams be removed?"
The removal of beaver dams from our trout streams without knowing the needs of the stream and the conditions as they exist, has in many cases been harmful to both trout and beaver.

In the past, there have not been enough trained men to supervise the work in stream improvement, the supervisor had to look after the work in an area which was too large for him to handle efficiently; and generally, the foreman on the job knew very little about the work. Thus to get the dams removed which were believed to be doing damage, without the help of a technically trained man on the job, the generalization was made that all beaver dams are harmful to the stream and should be removed. As a result many dams were destroyed, doing more harm than good to the trout stream, and at the same time destroying the homes of the beaver.

THE DESTRUCTION OF BEAVER DAMS, AND THE EFFECT UPON THE STREAM

In order to show the effects of removing beaver dams upon the trout environment, it is necessary to describe conditions as they existed before the dam was removed. In the first instance,(Dam No.1), the beaver had selected a site for their dam where the ravine in which the stream flowed was only about 150 feet wide; the stream at this point being 12 feet in width, and having an average depth of one foot. The dam had been built several years previously, and was now four feet high and three feet wide on top. With the creation of a pond the dam had to be widened until it had reached a length of about 125 feet. The dam was well plastered with mud so that it leaked very little; the water leaving the pond had to flow over the top of the dam. The water impounded by the dam covered an area of about two acres, and the stream was deepened over a distance of 800 feet above the dam. For a distance of fifty feet above the dam, mud had been dug from the bottom of the stream to plaster the dam, and this area of the pond was 6 feet in depth, the deepest part of the pond.

The temperature of the water in the pond, taken just above the dam, was 60°F in July.

The dam was opened at the point where the old stream bed had been to a width of twelve feet. When the water had gone down to normal, the small puddles, which were isolated from the main stream, were dipped out to see if any fish had been trapped. Two speckled trout, six inches long were found. In most puddles small minnows were numerous, and many lamphreys, 2 to 6 inches long were found in the mud. All the area that had been flooded was covered with a heavy deposit of black mud. The pond remaining was only that portion which had been dug out to plaster the dam.

The stream above the pond had become very shallow, being only about 6 to 8 inches deep. Sand was being washed down stream filling in the pond. There was very little cover for trout in that portion of the pond that was left, and the stream above, for a distance of 800 feet, had shrunk from a width of twenty feet to one of ten. The tag-alders, which before had offered some protection to the fish and shade to the stream, were now several feet from the edge of the water.

The stream above that portion directly affected by the beaver dam is well shaded and contains numerous small holes and plenty of cover in the form of logs and fallen trees for the trout to hide under, although this portion of the stream is generally considered too shallow for trout to over-winter in. Further up stream about a mile, a large dam was removed earlier in the season, and the stream above has become so shallow that the stream had dried-up between holes during the dry season.

The removal of the dam, which was in the upper course of the stream, shows very little benefit to the stream. Temperature conditions of the water taken several weeks after the removal of the dam show this portion of the stream to be warmer than further down stream, where the maximum temperature reached was 56 F. This condition was probably due to the greater number of cold springs that were found further down stream. The slight warming effect of the beaver pond on the stream, instead of being injurious to the stream below, rather, ameliorated the temperatures of the stream below for better trout growth.

The purpose of removing the dam to allow free passage of fish during spawning season was not sound, as their were few places above where spawning conditions were satisfactory. This was due mainly to the scarcity of gravel beds, and because the stream was very much subject to seasonal changes.

The fact that trout were caught in the pond in the spring, and that some trout were seen when the dam was opened, was evidence that the pond was still inhabited by trout. This pond, because it was fed partially by spring water from the nearby hills, and because it was deep, was, with probility, a wintering pond for many trout which retreated from the shallower waters above. The pond also acted as a settling basin for silt which would have otherwise gone down stream where its effects might be more injurious. Although there was a heavy accumulation of black mud in the bottom of the pond, the water was cool enough, and there was enough water running in and out of the pond, that the pond did not become stagnant. It is well known that beaver ponds are fertile fields for the production of trout food. Destroying the pond, eliminated an important source of food, thus decreasing the number of trout the stream can maintain.

Before any beaver dam is destroyed, the purpose for which it is to be removed must be kept in mind. The purpose is usually one or all of the following:

1. To allow free passage of fish in spawning season.
2. To remove the warming or cooling effect of the beaver pond and dam.
3. To prevent stagnation of the water and improve the pH condition of the stream ,.

Having these purposes in mind, consider the location of the dam on the stream, and if its removal will bring about the results desired.

As another example, let us consider dam No.2. This dam was located in a small soft-bottom stream about a quarter of a mile from where it emptied into a larger river which contained brook, brown and rainbow trout. The branch stream is about seven miles in length. The source of the stream is a marsh. The stream has cut its way through the pine plains, and now lies in a "flats" which is three hundred to a thousand feet wide, and covered with a dense growth of tag-alder, spruce and cedar.

Probably these flats were produced by beaver action in the past

This dam had been built where the stream was about fifteen feet wide. With the rising of the water the dam was increased in height and length until it was now four feet high and one hundred-sixty feet in length. It was an old dam which the beaver were repairing, and had caused an area of about an acre to be flooded. The main stream channel was three to six feet deep and it contained some holes which were deeper. Upon examining the bottom, it was found not to be as heavily silted as is usually the case of old beaver ponds. This was probably due to the fact that repairs on the dam were recent and much of the water had been escaping.

The dam was torn open to the width of the old stream, and after the water had gone down to normal, it left the stream channel above where the dam had been with a depth of one to three feet of water.

Within a mile further up stream were four major dams, and twelve secondary dams. These were all removed, and four days later the temperature of the water was taken at the place where the first dam was removed, and it was found to have dropped from 57°F. (temperature before dam was removed) to 55°F.

The main objective for removing these dams was to allow free passage for trout going up stream during the spawning season, and to allow the larger trout to go down into the larger stream at other seasons, where they can find a habitat more to their liking. In this way the small stream would act as a nursery stream to stock the larger river with legal size trout, and at the same time give the large cannibal trout a chance to get out of the smaller nursery stream.

Beaver dams cause damage, in many cases. other than to the stream itself. However, these cases can usually be remedied without destroying the home of the beaver, and as the number of dams destroyed because of these damages is small as compared to the dams destroyed in stream improvement projects, these damages will not be discussed. There is, on the other hand, a condition where beaver dams have caused a great amount of damage to both the stream, and the surrounding land.

EROSION OF SOIL DUE TO BEAVER DAMS

The erosion of soil caused by beaver dams in streams which flow through sandy regions has caused much damage to the trout environment. As a result of having their bottoms covered with a layer of yellow sand, many streams which were formerly good trout streams have become barren of trout. The sandy bottom is not productive of trout food, as most of the organisms upon which trout feed need larger and stationary objects upon which to cling in order to grow and reproduce. Even where there are places that the swiftness of the current keeps stones and other objects exposed, the action of the drifting sand along the bottom of the stream kills much of the insect life.

As an example of how beaver cause erosion and the resulting "sanding" of the stream, let us consider Dam NO.3. This dam was located in the upper course of a large trout stream. The dam had been built where the stream was about thirty feet wide, and where it ran next to a sand bank about fifty feet high. The dam was four feet high and three feet wide on top. The bank opposite the sand hill is about six feet higher than the normal level of the water, so that the dam did not create the usual wide beaver pond, but caused the stream above to be deepened for a distance of 500 feet up stream from the dam. The deepening of the water and the working of the beaver under the banks,in which they lived, caused much of the bank above the dam to break off, and the pond became heavily sanded; whereas before it had a hard bottom of gravel.

During the high water in the spring, a hole had been washed-out around the end of the dam next to the sand bank, causing more of the hillside to fall into the stream. That this had happened was evident by the large cut made into the bank at this point, and that the material of the dam at that end was still fresh. It is probable that wash-outs of this nature occur each spring, especially where heavy spring thawings of snow occur on sparsely timbered and burned-over lands.

Further up stream,within two miles of the latter dam, were two similar cases. In both places the dam had been built at the base of a large sand hill. In the one case, the end of the dam next to the hill had been washed out, and never repaired. The remaining part of the dam was now acting as a deflector, throwing the full force of the current against the base of the hill. The washing away of the base of the hill was causing the hill-side to drop into the stream, and for 70 feet up the hill-side ,which now had a slope of about 45 degrees, there was nothing but rolling sand, and wind erosion had already begun.

In the other of the two cases last mentioned, the dam had been repaired again and again. Erosion of the hill-side had already proceeded to the top of the hill. Here large pieces of hard-pan had broken off and rolled to the base of the hill and into the stream. This material was not acting as a barrier to keep the sand from rolling into the stream and, at the same time, protected the hill from further washing.

THE DESTRUCTION OF DAMS STILL IN USE .

In most cases when a pond is destroyed which is being used by beaver, it is only a few weeks before the pond is again filled with water by repairing the old dam or the construction of a new one. In the previous discussion of dam No.2, it was mentioned that above this dam were four major dams and twelve secondary dams, all of which were removed. One month after their removal, all five major dams were found to be replaced either completely, or were in the process of being replaced. Dam No.1, previously described, was not rebuilt, but a new dam, larger than the old one, was built in September about a thousand feet above the old site. Thus it can be seen that the work of removing beaver dams and trying to discourage beaver from building again is a futile task.

With the repairing of the old dams or the construction of new dams, comes a great deal of excavation work by the beaver. The beaver dig the dirt from the bottom and banks of the stream to plaster the dam. The digging away of the banks and bottom of the stream not only disfigures the stream, but causes the water to be muddied, and much of the mud excavated is washed through between the sticks of the dam to be deposited on the stream bed further down stream. Again, if the beaver do not repair the old dam and move to a new site, the removal of the old dam has just shortened the period over which the beaver would naturally inhabit the old pond before the food supply gave out. It means, that by removing such dams, we are only increasing the number of dams built on the stream during a period of years, thus increasing the number of places where the topography of the stream will be altered.

Part II.

Fresh-water fishes require a certain degree of acidity to carry on their normal activities.

In a study made by Morris Miller Wells (13), it was found that (a) fresh-water fishes are negative to neutral waters, and in favor of either slight acidity or alkalinity. (b) Species of fish differ in the degree of acidity selected, but that fishes can tollerate very much higher concentrations of H ions than OH ions. (c) The principal stimuli to which fishes react are H and OH ions. There is no doubt but that fishes recognize the differences between very slightly acid or very faintly alkaline and neutral water. Henderson's (4) work upon the mechanism which maintains a constant proportion of H and OH ions in the blood of animals, suggests the physiological reason for this extreme sensitiveness of the fishes. It is clear that even very small variations in the proportion of these two ions in the blood of the organism, are of grave importance. and we find in the blood a combination of gasses and salts that make such variations impossible as long as the animal is normal. The blood will maintain its norman chemical reaction (just on the alkaline side of neutrality) in the face of relatively large changes in the environment, yet we know that the mechanism breaks down when the change is either too great or too long continued. (Acclimination is not considered at this time.) The hypersensitiveness of the animal to the chemical reaction of the water is another important factor in preserving the normal reaction of the blood, as the reactions of the or ganisms work in a way that causes them to turn back from concentrations of H and OH ion that would be detrimental.

The Effect of the pH value of the water on the permeability of the gills of fishes.

The physiological effect of the acid, neutral, and alkaline water upon the organism very probably has to do with decrease or increase in the permeability of the exposed tissue cells(especially gills in the case of fishes). Osterhout (7) has shown that in plant cells alkalies increase the permeability up to death; acids,however, at first produce a rapid decrease in permeability, followed later by an increase which continues up to death. The concentrations of acids used by Osterhout were .001 N. to.03 N.

Since fresh-water fishes are negative to neutral waters, it is beleived that such water exerts a marked effect upon the permeability, or some other physiological condition in the gill membranes. Wells(13), states that the negativeness of organisms to neutral water indicates that they are either over-stimulated in such water, or under-stimulation sets up internal disturbances, thus they may avoid it because of its non-stimulating character. " It may be well that in neutral water, the normal chemical reactions do not go on, for acidity and alkalinity surpass all other conditions in their influence upon many chemical processes. Of all catalytic agents, H and OH ions are by far the most important, and their influence upon the stability of colloidal systems are unapproached by other substances.(Henderson '4).

Changed Stream Conditions Following Logging and Fire

That there has been a change in the water conditions of many of our once good trout streams has often been pointed out by the fisherman who have fished these waters year after year. They speak of the water as having a different color or cast, and that the water now has a peculiar taste, whereas before these were absent. Some of the favorite stretches of water along the stream were no longer yielding a catch, whereas in another part of the stream, trout were plentiful. Many of these fisherman believe that it is due to the destruction of the forests by lumbering and fire that has brought about poor stream conditions, and that fishing will return with the return of the forest cover. Erosion is causing the stream to bear a greater load of organic matter, and the leaching of the exposed soil is causing the natural salt concentration of stream waters to rise to a point where it is deleterious to fish life in the streams.

That these opinions may bear some weight, and that the effect of beaver dams in producing acid conditions may be benifical is suggested by Wells (14) in a study of the reactions of fishes to salts. Wells noted that fish became sluggish when kept in aerated neutral water containing a small amount of NaCl, whereas they became normal when a small amount of acid (HCl or CO_2) was added to the water. It was found that fresh-water fishes can live in the presence of an acid concentration, which would ordinarily kill them, if the proper concentration of the right salts is present; and that concentrations of salt which would be otherwise intollerable could be tolerated when the water was made to show an acid condition.

An interesting fact was noted by Wells. He found that fishes living under unfavorable conditions (in.01 N. $CaCl_2$) showed sign of degeneration of the rays of the tail fin. This degeneration continued until nothing but the blood-reddened stub of the tail was left. The other fins were not effected; the tail fin regenerated when the fish were returned to favorable water. Day (2,p203.) states that in a certain lake in the British Isles, there is a race of tailless trout which some authors claim can be traced as due to the action of deleterious matter in the water. Day(loc.Cit.) also quotes J.Harvie-Brown as saying, about 1876, "that a contraction of the rays of the tail fins of the trout in the River Carron occurred, and was believed due to the continuous polution of the water through the agency of paper mills", Upon looking up the composition of the waste from paper mills, (Griffin andLittle '3 and Phelps '9) I find that among other substances calcium is always present in large quanities, both in chloride and other combinations. Therefore the phenomenon reported by Day was likely due to the presence of an excess of calcium in the water.

Marsh (6) has shown that the waste of paper mill is very toxic to fishes. However he believes the excess of acidity or alkalinity is the chief causes for the toxic effect, although there are other toxic substances.

Further Investigation Needed

Some of the reasons given for the necessity of removing beaver dams need further investigation. In regard the bad physical and chemical effects of beaver ponds to trout streams much more investigation is needed. Cowles (1),in a study of the hydrogen ion concentration of a creek, its water fall, swamp and ponds has demonstrated that:

1. Various sections of the creek show decided differences in pH values.
2. These differences are emphasized when the pH of sections in which water is flowing actively is compared with the pH of sections in which the water is flowing less actively, in other words, when the pH of rapids and waterfalls is compared with the pH of pools and ponds.
3. In Ponds the pH is modified by the aquatic fauna and flora. Aquatic vegetation reduces the CO content of the water and causes a rise in pH value of the water.
5. When water flows rapidly over a clean bed, most noticably at falls and rapids, the pH is raised, probably as a result of aeration.

These findings should be of help in constructing plans for stream improvement , and in judging the relative merits of certain stream improvement practices.

CONCLUSIONS

1. The improvement of trout streams necessitates that each stream be treated as a separate biological unit. Such generalizations that call for the removal of all beaver dams cannot be made if stream conditions are to be improved.
2. The warming effect of beaver ponds on the stream is negligible to most trout streams.
3. Erosion caused by beaver dams is very prevelent in Michigan streams, and a great amount of damage is being done to trout streams as a result of beaver dams in areas where the stream banks are of sand.
4. The hydrogen ion concentration of a trout stream is an important factor in the trout environment, and further investigations are necessary to determine how to regulate the pH conditions of our trout streams to get better trout production.
5. The health of the fish is closely correlated with the pH condition of the stream. Waters which show a pH value just on the acid side of neutrality are most favorable, however, the fish can stand a much greater concentration of H ions than OH ions.
6. The low pH values sometimes found in old beaver ponds are probably not as detrimental to the trout as the pH values indicate they would be; the natural dissolved salts in the water greatly reduce the toxic effect of a high acid concentration.

Recommendations

Each stream which is to be improved should be treated separately as a distinct biological unit, with reference to what it needs to bring it up to par as a fish producer.

First, a preliminary reconnaissance should be made of the stream. (This can best be done by wading up the stream, or if the stream is too deep, by boat.) At this time make notes of the conditions as you observe them, and also if a good map is not on hand, make a map of the stream.

Items to be observed are:

1. Average depth, and width of stream
2. Character of bottom
3. Speed of current at various places,
4. The occurrence of rapids
   - gravel beds
   - springs in and along bank
   - small feeder streams and their character
   - beaver dams, size, whether occupied
   - Sleuce dams or other barriers in stream
   - Rubbish from logging operations, etc., in stream
   - Amount of shading over stream
   - vegetation in stream
   - amount of cover for fish in stream
   - eroded banks along stream.
   - number of deep places in stream, depth.

5. Describe the food conditions for trout.

Catch a few trout and determine their condition by the general conformation of their body. Examine their stomach for food content. A formula which gives a comparative measure of the food conditions with which the fish have to contend with has been used in England. Hewett (5) has found it of value here in America, in telling whether a fish is prime, medium or in poor condition. It is as follows:

$$\text{Condition Factor} = \frac{\text{weight in lbs. X 100,000}}{(\text{length})^3}$$

The condition factor of a trout in normal condition should be 42. Each number above or below this means a variation of two and one-half percent from normal. The higher the factor,the better the condition of the fish.

Having gathered this information, a plan for the improvement of each stream can be made, which should be put into the hands of the foreman in charge of the stream improvement crew.

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