Upper Midwest Trout Symposiums I & II

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UPPER MIDWEST TROUT SYMPOSIUMS I AND II

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University of Minnesota
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Trout is a magic word. It triggers many responses in the minds of people. It is streams; clear, cold, and pure. It is wilderness, mountains, forests, and meadows. It is fish; mysterious, colorful, wild and free. It is excitement and solitude. It is nature at its best.

Some people become smitten with an insatiable urge to fish for trout. They must try their luck. They are moved to challenge the trout with their skill at deceiving them with their own creations that imitate the food that nature provides.

Trout anglers are a group distinct. They have responded to an urge. They have participated in an activity which sets them apart from other people. They have experienced an event which cannot be communicated to the uninitiated. Having once passed that experience they are changed and, like sailors having heard the siren's song, are forever drawn back.

Times change, trout streams change and trout fishing isn't what it was at one time. These changes have led to an increased concern and thirst for information among trout anglers. They have become aware that the resource is limited, that some management has been applied to trout stream, and that there might be actions to be taken by the angler which would influence the management and protection of this resource.

These proceedings are from the Upper Midwest Trout Symposiums I and II held at the University of Minnesota at St. Paul. Symposium I took place on April 10, 1976 and Symposium II was held April 15, 1978. Both symposiums brought together resource managers from State Departments of Natural Resources, experts from universities, and trout anglers from several states. The purpose of the symposiums was to bring together those who manage and those who utilize the trout resources.

The objectives of the first symposium were to critically examine current trout and trout stream management, develop an appreciation for and an understanding of the unique ecological system which the trout stream is, and to discuss trout streams as representative of the quality of our environment and our quality of life.

The theme of the second symposium was conflict and competition for trout water resources. The objectives of this conference were to develop an awareness of conflict and competition for trout water resources around the country, become familiar with possible solutions to conflict and competitive situations, to perceive the implications of conflict and competition on trout streams to the angler, and to assist trout stream users to defend and protect the streams when conflict and competition occur.

The contributions from Symposium I were taken from the taped presentations made at the symposium. Those from Symposium II are papers contributed by the speakers for inclusion here.

Eugene L. Anderson
Editor

UPPER MIDWEST TROUT SYMPOSIUM I

THE TROUT ANGLER'S ASPIRATIONS

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ABSTRACT: Recollections of experiences with trout, both recent and past as an angler, conservationist and observer provide a perspective for understanding present trout management. Big trout are extremely important as a source for natural reproduction. No kill areas on streams are vital to maintaining the trout population.

Quality fishing is my big interest. The line, "Quality fishing reflects the quality of living" appears under the masthead of the sports fishing institute's publication. That's what I believe. I feel strongly about quality fishing and that is the subject of my discussion.

First we need to examine the reason why we fish. We need to consider what we could have. When we go fishing, we go out there and soak up sunshine, we have fine exercise, there is great companionship and fellowship, there is nice solitude, we commune with our creator and we study nature and so on. But I don't think those are the real reasons why we fish, I think those are the bonuses. I think the reason we fish lies back in the dark ages, before the dawn of civilization when our ancestors had to fish and hunt for their livelihood. I think there is a latent desire in many of us, not all, and more so in men than in women to follow in those footsteps. It's a powerful, powerful urge out of the past. I think the people who want to eliminate hunting and fishing and bring about gun control need to understand this strong pull. They need to understand this as the most ardent kind of hobby.

Fishing is a strange series of paradoxes. We set forth to catch fish, but we don't want to be successful in landing everything we hook. We want to catch big fish, but we don't want them all to be the same size. We want to reduce a fish to possession but when we are possessing we don't want to have to reduce him to a piece of meat, dead flesh. There was a very great Eastern fisherman and hunter who was a very talented writer by the name of John Painter Foote. He produced some of the greatest short stories that were ever written in the outdoor field. Unfortunately we anglers and hunters lost him when talking pictures came in. Hollywood grabbed him up to write dialogue for the new vita-phone pictures. Among the works of John Painter Foote, the two most famous are "Wedding Gift" and "Fatal Gesture". He had another one called "The Diver Takes to Pinochle". The Diver was a character in all of his books. The Diver and a group went up to a lake in a secluded area and camped there. They went out fishing and right away they got into fish. The action was fast and furious. Every fish was the same size. They came very easily and after a day or two of this they were fed up with fishing and the Diver and his group took to pinochle. There was no quality involved.

I had a friend who took a long hard trip on a tramp steamer that brought him up to Moose-in-Aye. When he got to Moose-in-Aye on the Seal River, he decided to catch a bit of brook trout. He wanted to get a brook trout over four pounds. It was up in the tundra country and it was terrifically windy. They had to put rocks on the edge of the tent to hold the tent in place and he fished and he got fish. He got two fish out of every three casts. They were very very handsome brook trout by our standards. After a few days of this an Eskimo came along who wanted fish. So as fast as he would get the fish the Eskimo took them. He needed them of course. After a few days he was fed up and he came home. I asked him about his trip. He said he didn't want that any more. He had had enough of that. It didn't amount to anything. No challenge, no problems, just an automatic thing. He said he would rather go up to the Yellow-Britches in the evening and try to get a trout or two. A trip such as that is expensive. What I'm getting at is that there needs to be some uncertainty, there has to be a challenge. There have to be problems or fly fishing or trout don't amount to anything. There have to be fish there too, incidentally.

There is only one way in this world that we can have fish of a decent size for fishing. We are going to have to create areas where there is very limited killing. The killing must be reduced to nothing or almost nothing. Let's turn back the clock a little bit. There was a dynamic young forester in Pennsylvania by the name of Gifford Pincho. He went down to Washington during Teddy Roosevelt's administration and Teddy was just fascinated by this young man who started the American Forestry Society. As a president, Roosevelt broke all precedent by attending the little meetings that were held in the Pincho apartment every week or two. Pincho along with his associate Overton Price were the fellows that coined the word conservationist. It was Teddy Roosevelt who put a dictionary definition to that word.

After Pincho left Washington for his native Pennsylvania, he managed to get himself elected in a very close election as governor of Pennsylvania. One of his inlaws was named Huet. The two of them fished together. Pincho had quite a nice place up in North Eastern county of Pennsylvania and Huet had a place close by. They traded back and forth. Neither Huet or Pincho killed fish. They had gotten by that stage sometime prior to that. Huet at that stage was selling a little fishing tackle and a few publications. He went through several fortunes and he thought that to go broke was very invigorating because it had gotten him going again. Among the things he sold during one of his low points was a little booklet on stream improvement work. It featured the undercut dam which was originally called the Huet dam and Huet related how well this particular type of stream improvement was working. One year this dam was responsible for catching nineteen trout that were working their way up stream. These were nineteen trout over nineteen inches in an area which had produced two trout over nineteen inches the previous year without the dam. Of course Huet was great for fishing for big fish and Pincho was into that game with him. Pincho got the idea that there ought to be an example of stream improvement work that people could see and a place where they could fish and also a place where there would be good sportsmanship exhibited and where people would be educated to put trout back. Pincho brought Huet over to look things over. They wanted this special place at a point in the central part of the state. They selected a spot in the dead center of Pennsylvania on Spring Creek which comes down from State College and flows into a river called the Bald Eagle at Bellefonte. There was a beautiful piece of water several miles above Bellefonte. Pincho had the state buy it. Then he had Huet come over and lay it out the way it should be according to Huet's idea of stream improvement. The improvement in this area was for the fisherman rather than for the fish. They opened this thing up to public fishing. There were some strings attached. A person could only go there five times a year. He checked in and he checked out. He could kill two fish if he wanted to and for many years there was a fifteen inch limit. That was about 1931 or 1932. This was the first regulated trout fishing area I know of. It was a mile in length and was very well patronized. To make things better they brought in George Harvey from State College. He was a tremendous fisherman who was teaching fly tying and casting and had a fishing clinic at the Pennsylvania State University. He taught fly tying for free in a little booth along the stream side. George had learned to tie on his own. There were no books on the subject then. A lot of these fellows became interested in fly tying and became decent fly tyers by visiting this development that Pincho finally called Fisherman's Paradise.

This Fisherman's Paradise is still in operation. However, there is no killing now. There are tremendous trout in the place. I think that there is no killing now because Penn State University has grown so greatly at the head. The disposal plant is too great a burden on the watershed although it isn't enough to kill the trout. I'm sure the fish commission doesn't want anybody eating those trout. That's why I think there is a no kill regulation.

I have a very dear friend - Vince Marinaro. We were invited over to the Theodore Gordon fly fisher's club annual meeting some years ago. Vince is a very convincing speaker, in fact I'd say that Vince and Ernie Schweper are the two most articulate persons we have in our trout fishing clan. Vince talked about the potential of regulated fishing, whether it would be very little killing or no killing as we had experienced it. Not only at the old Fisherman's Paradise in Pennsylvania but at some other places in Pennsylvania where the fish commission had adopted these things. The head of the fisheries department of the New York Conservation Department was in the audience and he was so impressed with Vince Marinaro, his sincerity and his reasoning and so on, that after the meeting was over he told a mutual friend of ours that this fellow had sold him a bill of goods. He started a similar area in New York on the Beaver Kills. I haven't fished it, but the fellows tell me it's just about the best trout fishing in the East. The Beaver Kills is a beautiful thing and of course it is our temple, rich in tradition and history and so on and it gets great hatches and wonderful rises of trout. The three mile stretch there is probably fished harder for more angling hours that the rest of the whole stream put together.

Yellow Britches Creek, a big stream near my home, is about thirty-eight miles long. It has a short mile of regulated fishing which Pennsylvania calls Fish For Fun. Trophy fish can be kept. An angler can keep one a day over twenty inches. In this mile there are a lot of very fine trout. It produced a fourteen and one-half pounder last year, which is big down our way. It consistently produces many good fish and many hours of fine fishing. It has excellent rises due to good hatches and a little stream improvement work has been done there. The point I'm getting at is that there are more fishing hours spent in this short mile in the Yellow Britches in a year than there are in the other thirty-seven miles put together, it's that popular.

There are seventeen or so of these Fish For Fun areas in Pennsylvania. Their development followed the Pincho and Huet business up on Spring Creek several decades later. Dr. Albert Hazzard came to Pennsylvania from the University of Michigan and developed these areas in which there would be either just trophy fishing or no killing whatsoever. They cropped up one after another and became very popular. They have become so popular that there are a number of fisherman who don't fish in any other place.

Let's consider the fishing in there a little bit. I talked to George Harvey one day last winter. George is a tremendous fisherman, the greatest trout catcher. He fishes a section where they put them back and he said, "You know, a trout will come up and you have no trouble getting him. You take him on maybe the first good drift over. You put him back and in a day or two he's back in the same old place, operating in the same way. You go after him and by gosh it takes you a week to fool him this time, but you get him and you put him back, and the same thing happens again. The next time it takes about three weeks of fishing before you can fool that fish. Then after that you just don't fool him". Whether this is learned or instinctive is a good question. But that's exactly what's happening in these so called Fish For Fun or no kill areas. They are now being developed in adjacent states. They are spreading all over and everywhere they come into being they are terrifically popular. The fishing is very sophisticated but the trout aren't scaring. They are actually getting used to seeing people. An angler can even move a trout over a little bit by walking towards him to get him over in a different set up. Then let him settle down, watch him feed and fish over him. I have played that game a lot with Vince Marinaro. There is one section where our standard procedure is to first line the trout up so there would be more competition between them and then work over them.

Now let me turn the clock back a little more. There was a very great fisherman in Pennsylvania by the name of Charlie Wetsel. He was the first real fishing entomologist in this country. He produced a book called Practical Fly Fishing and only 1,400 copies of that first edition were ever sold. Once we got to know Charlie, we got to understand a few things. We got to know that there were caddis flies and may flies and stone flies. We got to know that there were dunsons and spinners and we began to hook some of these things together. The most confounding thing that I ever saw in fishing was to try to connect up two flies that I saw a lot on the Breeches. There were early ones with big dark wings that stuck up and were so dense they would float in the great rafts for a long before they were airborne. Sometimes there would be some flies in the evening that had a yellow egg sac hanging on them which would hover over the riffles, not over the flats. These flies would appear weeks after the ones with the big dark wings which stuck up. We never suspected it was the same fly, the Hendrickson. Charlie Wetsel straightened us out on that.

As we began to understand a little bit more about entomology, we got into a game of planning to intercept the hatches. This is a fascinating activity and the only way to do that right is to keep good notes year after year. If a person hits a good hatch in a good rise in a certain place he wants a record of that so he can be back there the following years at that same time and same place. Then he can have a comparable experience.

Quality fishing is very very exciting. The challenge is great. An angler needs good tackle, a good approach, fine leaders, and good imitations. It is a ticklish game. It is pretty fishing, without problems and challenges. It has those paradoxes of not wanting to kill them all, not wanting them all the same size, and not wanting to land them all. Trout fishing is an interesting activity. Part of the success formula for good fishing is a certain degree of uncertainty and a certain amount of failure along with what does work out well. Personal satisfaction stems from these things and after all, that's what we fish for.

During the time Charlie Wetsel worked for Dupont a laboratory accident resulted in a material that was later named nylon. On weekends Charlie Wetsel used to come over and fish with Bob Lacaferty and myself on the Breeches and he brought over some of this new stuff for leader material. It was revolutionary. You didn't have to wet it and it was awfully fine. We experimented with it and because Charlie was a well-known fisherman and understood fishing, Dupont turned over the application of this new material to Charlie to apply to fishing. Later, of course, we had nylon leaders and nylon line, nylon fly-lines, nylon braided lines and so on, but when Charlie Wetsel brought these fine leaders over we tried putting them to all sorts of uses.

An angler can capitalize on competition between trout in some areas. There's one at Falling Springs, which is a beautiful little stream that flows through Chambersburg, Pennsylvania and then into the Potomac River. There are two springs close together, one ultimately flows into the Susquehanna and the other into the Potomac. The stream that flows into the Potomac gets a tremendous hatch of a little may fly called a canous. It breaks about the first of July. It's a morning hatch and continues until about the 15th of October. Any morning that the weather isn't atrocious there's going to be a fine hatch and a heavy rise of trout. Those trout get so tough to catch that the average angler just can't cope with it. A fine leader is needed. In addition one other thing is necessary. Two of these fish must be together so that two of them can see the fly at the same time. An angler must look for pairs. One of them starts to move a little bit and the other quickly goes in and gets it. I've fished with Vince Marinaro up there and we had the time of our lives picking off the more greedy customers out in front of us. When we fished over the singles they'd seen so much food that they'd become almost immune to the wares of fishermen.

It may sound as though the fishing in these Fish For Fun and no kill areas is very complicated. It's interesting, it has its problems, but if you want to take a boy fly fishing for the first time, you could do no better than to take him to one of those areas because there's certain places in all of them where it isn't difficult to fool a fish. Anyone who can flop a fly on the water is going to get some action. They're tremendous in that respect.

As far as a trout stream is concerned, I think the four elements that need to be considered, for natural trout fishing are: food, homes or space, brood fish and spawning grounds. Most of the mountain streams are low in the food category. The limestone streams are a different proposition. The limestone streams are usually in flat valleys and they are slow flowing. If a person were to take a geological map and transpose onto it the location of the big springs they would not be in the heart of the limestone areas. They are at the very edge. They crop out there. They flow through fertile valleys. All the farmers down there now are using chemical fertilizers. The chemical fertilizers get into the silt bed of the stream. As a result, there are more beds of weeds than there ever were before. The weeds become so dense that water can't flow through and has to go around or over. As a result, there's a widening affect on the stream. The flow slows up a little bit. This is a mixed blessing. It makes fishing a little more complicated, but an examination of a handful of that weed anywhere will reveal a couple dozen sow bugs and quite a few fresh water shrimp. Any trout in those limestone streams can't go hungry unless he's going blind. The homes exist all through the weeds, the food is everywhere in great quantity, there are brood fish, but the spawning ground is lacking.

I'm doing stream improvement work at my place by putting in gravel. I've experimented with gravel over quite a few years, starting with pressed stuff. That's no good. It won't roll and it even scratches the hens a little bit when she makes the nest. The next gravel I tried was half-inch river gravel. I watched it carefully. The first year spawners liked it well, and the big ones did too. But it appeared to me that there weren't enough crevasses in there that would permit the escape of the little one after it had absorbed the egg sac. So I stepped it up to three-quarter inch gravel. Then it became obvious that the big hens were the valuable ones. They're indispensable for natural trout fishing. They have many more eggs in them and they make much better nests than the first year spawners. So I decided to play up to the big hens entirely and forget about the first year spawners and get a lot of stuff in there the size of golf balls which would have good crevasses. The only place it is available is down on the Eastern shore. It's beautiful white stuff. I have put this out for the last two years. All together there are about thirty excellent spots available for individual nests. I built an aerator upstream of them to get more oxygen in the water that goes down over the eggs. I did that because I had read in Frank Sawyer's book that he attached great significance to well-aerated water before it goes over eggs. Frank Sawyer is one of the last great English river keepers. The aerator was constructed right above a big gravel bed and one big hen would get in there and she'd dominate it.

A hen will stay in there for four or five days with several bucks and others are afraid to come in. So I built stall-like divisions in there with chunks of rock. Those hens will spawn within two or three feet of each other as long as they can't see each other. This is on a late-spawning stream. The browns start coming in late October and there's heavy spawning throughout all of November, all of December and it spills over into January a little bit. The brook trout spawn up in the branches in the very shallow water in January, but it even gets into February and over into March a little bit. So we have a very late spawning situation in our limestone streams. That is typical of them. The first step in stream improvement is to determine the needs. Are the needs homes, food, brood fish, or spawning ground? Then act accordingly.

The no kill Fish For Fun areas have been given to us more or less as a gift. They are a special concession to the fly fishermen. Some of them have been obtained deviously through hot political pressure. But nevertheless, they are a sort of gift. I consider them as refuges and I think they should be so regarded. I think they're just as important as a refuge as they are of a place for fellows to fish with the expectation of getting into good fish. I like to think of them as carefully chosen places where they'll do the most good for the watershed.

Dr. Ed Cooper is head of fisheries at Penn State University and every summer he does a lot of electro shocking to take the census of various streams. He has a team of students working with him. He told me that he has never yet shocked a stream where there was no native population. Sometimes it's very meager, it doesn't amount to much. But sometimes it's pretty good. When water is fished down too hard, there is simply not going to be enough big brood hens around. I attach great significance to the big brood hens. The valuable ones are one in a million or one in a hundred thousand.

There are some big trout around. The day after Christmas two years ago I watched the late season spawning at my place. I saw a great big trout come up. She looked over the different sites and finally chose a nest. She was over thirty inches and over ten pounds. That's the biggest spawner I ever saw. I saw a male this year that was a good two footer. From watching them at spawning time, it would appear to me that very few female trout in limestone water will exceed twenty-two inches. But every once in a while there's one that just keeps growing.

In the meadow above mine the other year, we had the number one trout in the field and stream contest. That one was ten pounds, four ounces. Last year there was a fourteen and one-half pounder. These streams are capable of producing big fish. The food supply is adequate. There are plenty of nymphs for the babies, plenty of sow bugs and shrimp for the middle-sized trout, and the crayfish are the meat and potatoes of the big ones. There are lots of them in the weed beds. They're nocturnal, they come out at night. A seven and one-quarter pound trout was caught recently and he had sixteen crayfish in him. Everyone was the same size, little fellows about an inch long. Trout can pick and choose and they're not going to pick some great big old tough thing if they can get enough of the smaller ones. In the winter, when the digestive process is slow, big trout eat minute things. We've learned from our Fish For Fun areas, there is no closed season. I thing there should be a closed season during the spawning time, but there isn't. What we simply do with the spawning areas is to put up signs that ask the fellows not to fish there. I think they're respected. Big trout can be seen taking small food in the winter time in these streams. Cold weather or cold water doesn't mean extremely low temperatures. The water comes out of the ground at about 52°. Even a mile down stream, the water temperature doesn't approach anything like freezing.

I firmly believe in regulated fishing, and I'm hopeful that we're going to get to the point where there's going to be management that will regard these as refuges, as conservation measures, and stream management tools. I think we're swinging that way. I feel there's a deep moral obligation to a beloved sport and to stream conservation which unfortunately has some victories that seem so temporary and some defeats which seem so very permanent.

LIMITATIONS OF TROUT STREAM MANAGEMENT*

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ABSTRACT: The objective of stream improvement is more fish and bigger fish. The size and number of fish cannot increase beyond the limits of the stream. Trout stream improvement can modify the limitations, but only to a certain point.

Certainly, in stream management for sport fisheries--or in any resource management--it is important to keep in mind that everything is limited. Everything--the extent of every material object or substance, the degree of every attribute, the rate of every process. Maybe it is more emphatic to say that nothing is unlimited. We may often have blundered in stream management by failing to recognize limitations--ours and those of the resource. To name just a few timely limitations: space, food, energy and knowledge.

Among anglers, inadequate appreciation of the limitations of management and of resources probably underlies many of those wasteful misunderstandings in public controversies of our field. It is our responsibility as biologists to promote professional capability, to reduce our limitations while better understanding those of the resource, and to foster realistic expectations among laymen.

Limitations and Stream Ecosystem Health

The limitations confronting us are numerous. Many of them are obvious but often disregarded. Pondering them and facing up to them squarely is essential if we are to protect and husband stream fisheries. The word husband seems especially apt; it means to direct and manage with frugality.

Some people regard consideration of limitations as unbearably negative. The red-blooded American outlook involves, after, quite a strain of fanatical optimism: Life is a bowl of cherries! (Ask a Central European the prevailing counterpart in his region and he may say, "Life is like a hen house ramp: short and dirty.") Other familiar New World refrains are: The forests will never give out! Keep your eye on opportunities, not on hinderances! Don't worry about anything! There is a relief pill or technologic solution for anything that might ail you! All these common assertions deny the existence of limits. They are glib.

But we have a tradition of sober advice, as well: Look before you leap! Think of tomorrow! Don't overdo it! Surely, to plan and act on the basis of sound information and with regard for limitations is the best kind of conservatism. Sound information in stream fishery management involves, for example, monitoring changes in fish populations and in habitat.

Ecologists are developing the view that ecosystem management should be based on concepts of health. Healthy functioning is important in the single organism, in groups of them, in ecosystems and in human institutions.

It is easy to forget basic principles in the everyday rush. In the field of medicine there are voices pleading that accomplishment be measured not in terms of numbers of pills prescribed and operations performed but in terms of the health of the patient. In our field, programs should be judged not by the numbers of stream improvement devices installed or trout stocked, but by how well the fish population thrives, and not in terms of angler-trips

*Variations on this paper have been presented at the National Symposium on Wild Trout Management, San Jose, California, Feb. 3, 1977, and at the National Workshop on Trout Stream Habitat Management, Stevens Point, Wisconsin, Aug. 1, 1978.

stimulated, but in terms of angler satisfaction.

We find ecosystem health, integrity and limitation expressed in Barry Commoner's four basic laws of ecology: 1) Everything is connected to everything else. 2) Everything must go somewhere. 3) Nature knows best. 4) There is no such thing as a free lunch. The stream manager and the angler would do well to learn Commoner's further thoughts on these principles in his book, The Closing Circle.[1]

In stream hydrology and morphology, health is implicit in the concept of conservative dynamic equilibrium. This describes the counter-balancing interplay of discharge, velocity, depth, slope, channel width, course curvature, bed roughness and other variables. Alteration of one results in adjustment of all the rest--some variables responding more than others, of course. The stream is ever changing yet ever tending toward a form which equalizes expenditure of energy along its path. The conservative dynamic equilibrium can certainly be applied to stream life, as well, and we might tie Commoner's laws together in those terms.

Another ecologist, John C. Neess[2] of the University of Wisconsin, has characterized a healthy lake ecosystem as one in which: 1) Inherent potential is fully realized, not overstrained or underused; no inherent capacity is lacking, but inherent limitations are fully acknowledged. 2) Condition is stable, not on its way to exhaustion. 3) It is capable of response of adjustment to ordinary stresses with least energy expended. 4) Need for support is at an absolute minimum. It can be readily seen, as Neess intended, that these criteria apply to an individual organism, such as the human body and to an ecosystem such as a stream, just as to a lake. Criterion 4 means that no physician need hover about. This holds special importance for management of wild trout fisheries.

Let us set about acknowledging some limitations in our special field of trout stream management. The ones I touch upon may provoke you to think of others. Let's, for the moment, not divert our efforts into devising solutions to the problems posed by limitations, though. Concentrating on limitations alone should be a useful enough exercise right now, if, as we often hear, defining problems is a major step in the battle of overcoming them. In the long run, with understanding of limitations, solutions may largely suggest themselves.

There are upper and lower limits to the ranges of the things and processes that interest us in streams. The amount of water flowing in the stream is likely to limit trout production. The limiting flow may be an annual low-flow far below the average discharge or it may be an extreme of high water. Annual survival of any age group cannot be greater than 100% and will, of course, usually be much less than that. Body growth can proceed only at some rate below that of the genetic capacity of the fish. Reproductive rate cannot be infinite. If it reaches levels that outstrip the capacity of the habitat, it will be compensated for by adjustments in survival, growth and dispersal.

Often in journalistic writings on fishery management (sometimes even in technical ones) we see such statements as, "If the gravel is not cleared of silt, spawning success will be limited." Absurd! If you clear away the silt, spawning success may improve, but it will still be limited at some higher level by something. Whenever the word, limited, occurs without qualification of degree or kind, then it is probably superfluous.

Consider also, the statement, "Unlimited access to the spawning grounds can be provided if the logjams are removed." Or worse yet, "Spawning was so successful in the last few years that anglers should soon have an unlimited supply of trout." The unqualified word, unlimited, should also arouse skepticism. (I readily grant that its use in the names of some prominent conservation organizations is well justified on the basis of eye-catching appeal.)

Tampering With Ecosystems

Let us look now at capacities and constraints of stream ecosystems and at consequences of our tampering with them. Then we will move on to consider capabilities in us as managers and constraints on our activities.

A stream ecosystem, as any ecosystem, has four general classes of components, processes or limitations: 1) climatic features - those having to do with light, heat and movement of wind and water; 2) morphometric features - matters of the earth's shape--primarily of the channel and valley for our purposes; 3) edaphic features - those of the soil and of the chemical medium; and 4) biotic features - involving the living parts of the system. Figure 1 is a more detailed and expanded representation. The lines of interaction between features signify again that everything is connected to everything else.

Each species, and within each species, each natural strain of trout is adapted to perform at a certain level within certain conditions of climate (its immediate climate being water temperature, current and light), of the chemical medium (the water's content of salts and gases), of bed sediment, of channel form and of biotic surroundings. The latter includes food supply, predators, disease organisms, competitor species and associates of the same species. We can call the conditions within which the trout operates, its limits. Any single environmental condition or synergistic group of conditions may at some level limit body growth, at a further level of severity block reproduction and at some still more extreme level force the trout to move to another area or die. Of course, for some trout stocks in some places, some of the potentially limiting conditions may seldom come into play--because something else is limiting. For example, how can modest food supply limit trout abundance if a stream's hiding cover is so deficient that all trout spawned there except for a few either move down stream or are killed by predators?

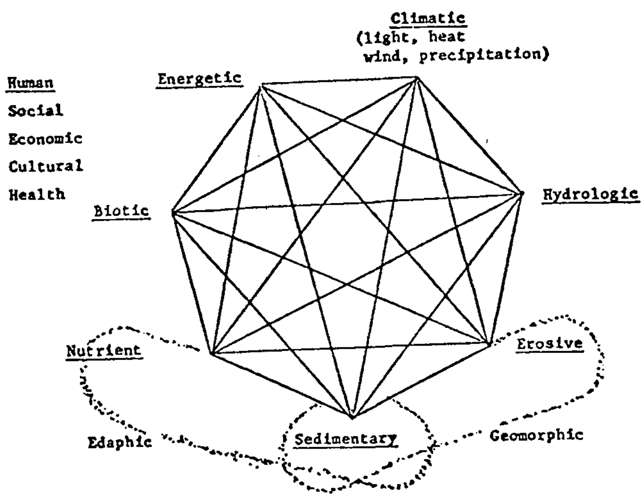

Figure 1. Categories of components and processes in the ecosystem. In each, significant limits to trout stream management exist.

Limits to Trout Populations and Recreational Yield

For the manager, yield is the objective--long term yield, of course. In a commercial fishery, it is yield of protein and/or money. In a sport fishery, it is yield of fish in desirable kind and amount in pleasant surroundings, giving above all, yield of recreational satisfaction or enjoyment. While I can't say what levels of enjoyment, relaxation, adventure and satisfaction can be attained--these are largely personal capacities of the angler--still we must recognize that yield of fish whether to the creel of just to the hook before "catch-and-release" remains a major part of the recreation. The yield of fish will always be confronted with some limits of stream capacity, and it will often be desired to increase yield by stream management.

In Figure 2, lines from various habitat managements trace pathways of effect, resulting in greater abundance of trout. Note that some kinds of habitat manipulation affect several other aspects of habitat. The single basic habitat change which seems to have the most numerous favorable ramifications (most lines radiating from it) is the increasing of base flow. Base flow is the amount of water flowing during times of no runoff from rain or snowmelt. Indeed, the importance of preserving and enhancing base flow of trout streams was one of the major points brought out again and again at the recent landmark conference on "Instream Flow Needs" in Boise, Idaho.[3] Base flow is a major natural limitation on trout abundance in midwestern U.S. streams, though not in all of them,[4] as well as in the West where human withdrawal of water constitutes a crisis for many trout fisheries.

When habitat is favorably manipulated, the fish in the stock become more numerous and/or larger in body size (Fig. 2). But the increasingly abundant stock sooner or later bumps up against some resource constraint, some barrier to further increase. It may be lack of additional spawning beds, lack of cover or whatever. Then compensatory processes take over, such as more intense competition, heavier predation or increased disease. Negative feedback is involved. The result: a leveling off of the population or of its biomass. Whichever feature of the stream resource forms the main barrier to further stock increase is called the limiting factor. Liebig's "Law of the Minimum" states that biotic increase will be limited by the factor which is in least supply relative to the organism's requirement for it. In planning stream fishery management, it is well to find out ahead of time which component of the resource is the limiting factor. That will be the barrier to reduce. It is also well to know what barrier(s) will next stand in the way of the newly expanding trout stock. If there cannot be enough increase before the next impediment is reached, it will not be worth undertaking the original management.

The result of successful management is an increase in abundance of trout, which then levels off at the raised ceiling of stream capacity. In the sigmoid curve of trout population growth in response to suddenly improved conditions (Fig. 3), abundance fluctuates year-to-year about the original and the new levels.

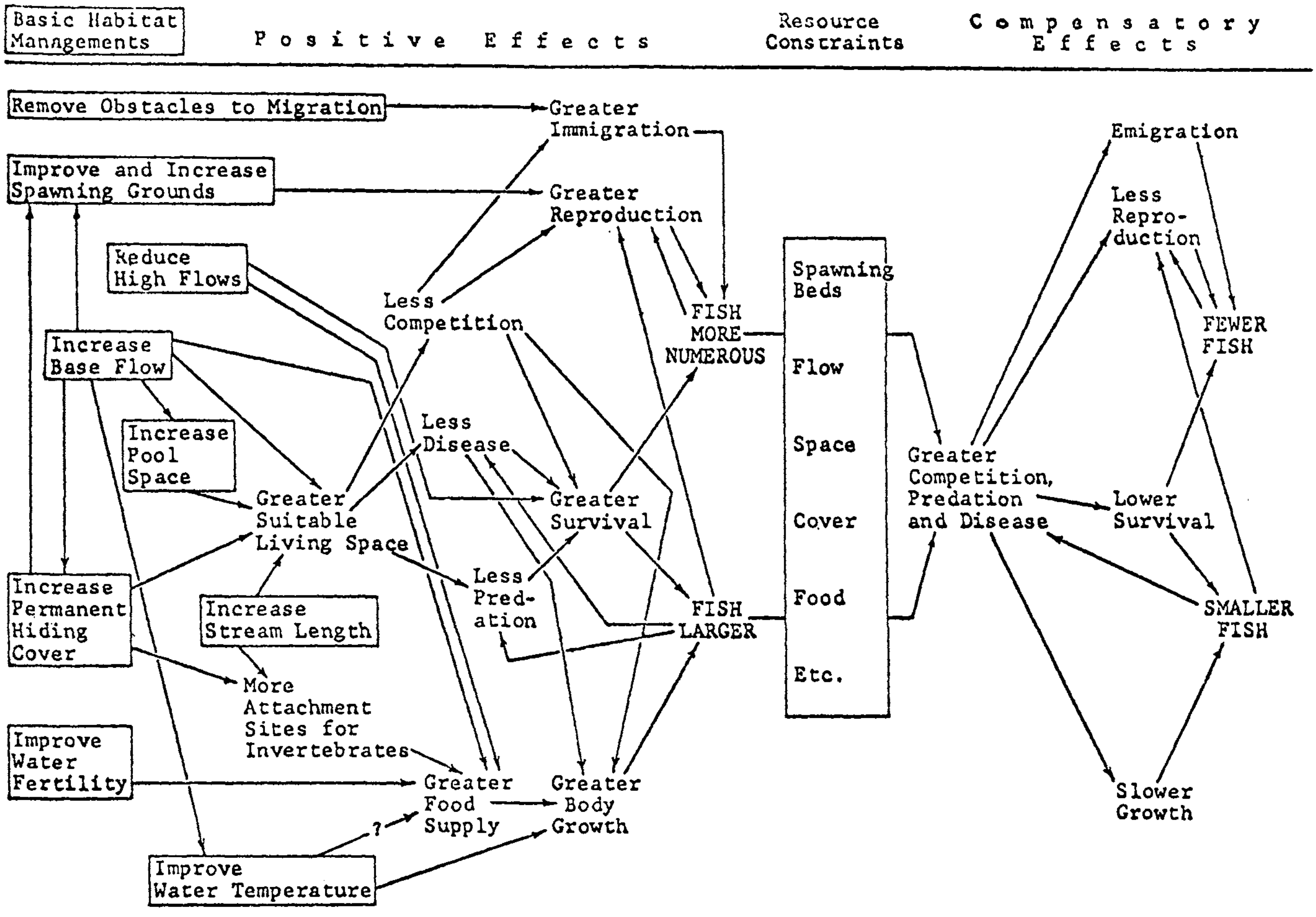

Figure 2. Pathways of effect from various trout stream habitat managements.

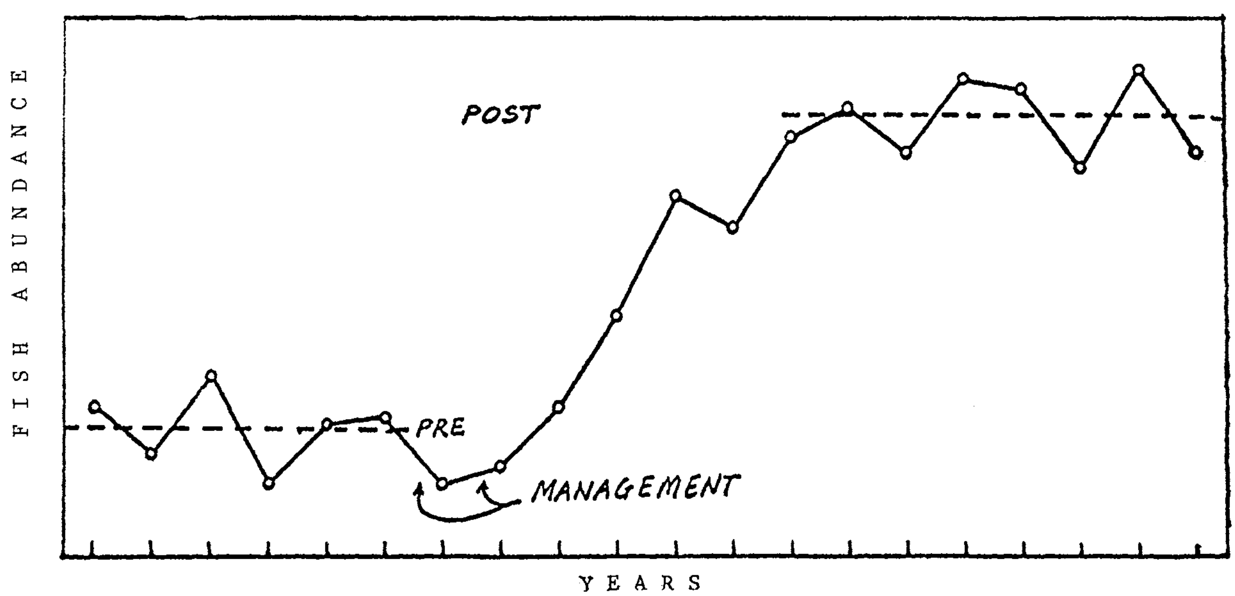

Figure 3. The type of response to improve stream habitat shown by wild trout populations.

Stress and Strain

Trying to drive habitat capacity, food supply or the abundance of the trout beyond inherent capacity of the stream will provoke stresses on various parts of the ecosystem and on all parts to some extent. Due to the stresses, deformations which we call strains will appear in the ecosystem. If we do not like the strains, we must then exert energy and funds to relieve them. This means either removing the stress or compensating by sacrifice of some other part of the ecosystem. (Do I hear someone say trade-off?) There will always be a cost, either of effort or of sacrifice.

If the stress of what we do--and this may be angling or it may be a management--is carried too far, some part of the system will collapse, sometimes the very part we cherish most. Envisage for a moment the supplemental feeding of trout in a stream. This seems to be a fad just now, at least among some amateur stream managers. It is conceivable that if the feeding were overdone the stream could undergo eutrophication, as happens from other overenrichments. The water's content of dissolved oxygen could then fall to about 2 ppm one hot summer night when decay of the feed-and-fecal sludge added to respiration of overabundant aquatic plants burns up most available oxygen. At that point, the object of feeding would vanish. The limits of sound management would certainly have been exceeded.

Consider such a fanatical effort to "stabilize" stream banks (another "conservation" fad, perhaps of longer standing) that a landowner shores up the swampy margins of his spring brook with corrugated iron and pours in concrete behind these bulkheads, creating a high, sharp curb and virtually a sidewalk along each side of the creek. A certain stability of channel edge is achieved, yes, but little if any cover for trout is gained, and the esthetic sacrifices are tremendous. I've seen them. Such brute-force procedures have, of course, traditionally been the approach of the Army Corps of Engineers and other Federal water project agencies which have ruined stream fisheries on a massive scale.

Cultural and Societal Aspects

This brings us into the area of cultural and societal capabilities, constraints and consequences. Here we are dealing with values, institutions and the interactions and well-being of people.

So, we see that there can be losses in the realm of nature and in the social area, as well. The concept to focus on in this regard is that of the irreversible change. Bella and Overton[6] give examples of classes of irreversible change that are frequently serious. We can see how each applies to the stream resource and to its management and use.

1. Ecologic types such as species and habitat types are totally eliminated.
2. A harmful condition is permitted to expand and permeate society and/or the ecosphere to the extent that it cannot be corrected.
3. The corrective action directed toward some perceived evil itself becomes a catastrophic evil--a kind of Faustian tradeoff.
4. The lag effects of good programs may years later destroy not only the good achieved but much else besides.

How can we consider values gained and values lost in management? Aldo Leopold[7] maintained that the quality of recreational experience is inverse to its artificiality. We can rank trout stream managements roughly in order of their artificiality (Fig. 4). The alternative of no management can be placed at the least artificial end of the list. The least possible management in keeping with needs is certainly the most economical and least disruptive approach. Where that means no management at all, so much the better. With increasing intensity and artificiality, the stream managements become more and more agricultural in nature--or "aquacultural" as is now so fashionable to say. My 6-year-old son's recent question, "Daddy, how do the men at the ski hill make fake snow?" reminded me that artificial is in many context a fancy word for fake. How about phony? Next time you catch a hatchery-reared trout, try saying to yourself, "Gee, I sure am proud of this fake fish!" Well, to be fair to the hatchery trout, the more time they've spent in the wild, the less fake they are. Stocking can often be done so that the hatchery product lives several months in the stream before the fishing season. During that time it loses much of the unnatural appearance, flavor and behavior that many anglers find objectionable. In other managements also, let us keep our eyes on Commoner's admonition that nature knows best. I've heard the crack that modern technology has discovered so many substitutes that it's sometimes hard to remember what was needed in the first place. I believe that resistance to the injection of artificiality into trout fisheries forms an important kind of limitation on management--one based on cultural values. Other cultural limitations are evident in the expression of desires for and objection to various methods and intensities of angling controllable by management.

Reflect for a moment on the initial Great Lakes stocking of coho salmon in the mid-1960's to fill a void in the predator-prey structure of Lake Michigan and to provide anadromous trophy fishing in the Lake and its tributary streams. This was in many ways a huge success.

A bonanza fishery ensued. The northwestern part of Michigan's Lower Peninsula became a real estate goldcoast. But there were prices (no such thing as a free lunch). Greed prevailed. The rush for the new fishing opportunity rapidly became an elbow-to-elbow situation along streams. Tempers flared, and there were sometimes fist-to-jaw situations. Stream banks were trampled. Riverfront property was destroyed and littered. Slum-like weekend encampments developed sometimes adjacent to temporary commercial egg-taking stations reeking with the stench of rotting fish guts. Snagging (intentional foul-hooking) flourished. In some river sections, streambed rocks and logs were so festooned with heavy monofiliment that retrieving lures, baits and snag hooks became annoyingly difficult. After a fishing trip to one of these rivers, a biologist-administrator who had played a key role in developing the anadromous salmon program, bemusedly observed that a recreational self-limitation was taking effect. Certainly the cultural sacrifices were high. (In fairness to Michiganders, I would point out that one can find crowding, greed and dispute on the banks of salmon rivers in the home range of these fish, as well.) Additionally, misgivings have arisen about effects of the exotic anadromous fishes on native trout populations.

The other increasingly respected and feared limitation of the Great Lakes salmonid fishery, which extends up into the streams, is contamination of the fish flesh with persistent chlorinated hydrocarbon chemicals. Restricted human diets of the larger salmonids caught from several of the lakes and their streams are now officially recommended, and New York has banned consumption of Lake Ontario salmon altogether, owing to their content of the pesticide, Mirex. I can imagine that an enthusiastic promotion of catch-and-release fishing will soon be regarded as the most appropriate management of the Great Lakes salmonid resource.

Other limits on management, or on its effectiveness, arise from the nature of our societal goals--or from the lack of them. It has been said that if we don't know where we are going, most any road will get us there.

Education and Training

Another group of societal constraints on management lies within our educational limitations. In the education of fishery managers, it has often been the case that appreciations of important cultural values, sportfishery philosophies among them, were poorly developed. Time and time again, the fishery curriculum product has been turned out into the world blissfully confident in his store of finny facts, but lacking the outlooks and the understanding of theory that would allow him to wisely apply the knowledge. He has all too often been infected with a bad case of fish flesh productivity-worship.

This situation is recognized and deplored from within the profession. Standards are rising. The curriculum will, I hope, become broader, as well as deeper and longer. It is increasingly difficult to enter the field without at least a masters degree. The profession of fishery biologist still lacks formal certification, but steps are being taken in that direction, and this is tending to raise the quality of educational offerings.

It has always been the case that much of the fishery manager's education must be completed on the job. This is as it should be. If the stream fishery manager can make angling and quiet observation of life in and around streams part of this post-graduate learning, our fisheries will undoubtedly be better for it.

One especially bothersome educational limitation on trout stream management is the tendency of some professionals to slow or stop their learning once they have left college. Most anyone burdened with major responsibilities is going to have demands on time that understandable prevent as much study of newly published material as he/she would like. It is hard to be sympathetic, however, toward the person who makes no real effort to keep up with developments--and especially toward the one who resists new knowledge.

Communication

Closely related to educational limits are communicational limits. I am talking about communication of fishery professionals with each other, with allied professionals,and with the public. Biologists in one state are often poorly aware of the activities and innovations of biologists in the next state. That large lakes and mountain ranges form barriers is understandable and inevitable, but often the greatest problem may be economic restriction on the travel of state employees. Overly expensive accommodations at national professional meetings are another problem. More small, special-subject conferences and symposia, such as we are having today, conducted under modest circumstances are needed in the field of trout stream management and research. The same goes for meetings between biologists and anglers.

To point up the limits imposed by poor professional-to-public communication, I will cite one of those catchy laws of human perversity that one sees so much of nowadays. It is known as Zoob's Law. It states that the less that people understand about a program, the more vigorous will be their opposition to it. Now, there is a challenge to communicate!

There is profound gratification in turning an antagonist into an appreciator or even a

Figure 4

Stream Fishery Managements

(Increasing Artificiality ↓)

No management

Protecting habitat- water supply & quality, stream form

Regulating harvest

by: Time- closed seasons, hours
Location- refuges
Habitat type- spawning, nursery, feeding, etc.
Amount- daily limit, annual quota
Species
Body size- minimum or maximum size or both
Sex
Angling method or gear

Manipulating habitat- stream form, flow, temp., plants

Controlling predators- mammals, birds, reptiles, fish

Manipulating fish stocks- bolstering indigenous stocks
removing undesirable fish introducing exotic fishes

Manipulating water chemistry- liming, enrichment, etc.

Feeding the fish

Confining the fish

Closed-cycle aquaculture/angling- fee fishing

cooperator. As the biologist's management is often opposed mainly out of a fear that comes from not knowing what the biologist is really doing or why, then simply telling what you are doing can and often has worked marvelous changes in attitude. I've seen the transformation take place in just minutes.

Important principles in communication are: Know your subject, speak plainly, tell it like it is, and don't raise false hopes. So much of this is, again, a matter of explaining limitations. If the brown trout in a stream are going to continue to be hard to catch even after a management program has tripled the population, let's not deceive the public that the stream will be a fishing paradise for everyone.

Of course, all these easy-to-give suggestions are based on faith in the stream manager's capability--and in his powers of self-evaluation. If he/she is overly inclined to self-delusion, then all the well-intentioned words in the world will have little effect. That sort of person will probably get the message eventually via Zoob's Law-in-Reverse which says: The more that people understand about a poor program, the more vigorous their opposition will become. This might be known as Booz's Law, I'm not sure. Anyway, it sounds like something it could lead to.

Politics

With that, we find ourselves having slid over into the realm of political limits. Politics seems repugnant to many biologists. But it is always with us, and it may help in facing up to it by recognizing that it means essentially the ways and means by which humans get along with each other. Politics has also been described as the art of compromise. This may be one of the biologists' sources of discomfort with the subject. In numerous cases, politicians can agree to give in part way on an environmental issue, but the biologist realizes that nature will not compromise. The fundamental principles of stream flow, vegetational succession and fish behavior will not change to suit people.

Certainly, public receptivity, support and demand form important limits to management. It is through education in the extension sense and through communication that such limits are held in a reasonable state. In this connection, I understand from people who seem to have been successful at overcoming unreasonable resistance to sound management that holding preference polls on such issues helps to point up common desires of the angling public. Anglers are apt to find the results of a preference survey much more acceptable than a unilateral decision by an agency, no matter how well-founded the decree may be.

Economics

The political pressures find their expression not just in pressure of public opinion, but, of course, in legislation constituting legal constraints, which I shall not discuss, as well as in economic limits via the appropriation process. We are all painfully aware of economic limits. Sportfishery biology and management have suffered in this limitation more than most other resource management fields. With increasing professional visibility and credibility, the budgetary situation in our field should improve. I believe it may also take an upswing when anglers come to understand that they are not paying their way in the world.

A British wildlife biologist observed after a year's work in the United States that, whereas the typical British sportsman focuses his efforts on an area within a few minutes' driving or bicycling distance of his home and spends several hundred dollars per year and much time in managing the habitat toward replenishing the population he hunts or fishes, the American sportsman, who spends the same amount of money or more on his hunting and fishing, dishes out most of it for the transportation, lodging and meal costs involved in long trips. Only a few dollars in the form of license fees and equipment taxes are plowed back into the resource, and he seldom develops enough sense of responsibility and stewardship toward any piece of land or water to spend much of his time protecting or improving it for game or fish. The American angler is still taking much more than he/she is paying for or putting back--borrowing lunches that in the long run are not free.

Certainly most of us over here would not want to trade some of our relatively free access to land, water, game and fish for the European ownership system. If we can avoid their degree of overpopulation, maybe there won't be too great a trend toward that elitist system. Still, there is a very useful lesson for us in the British and North European sense of responsibility for resources.

Institutional Considerations

The last group of human-related limits on trout stream management I'll mention are the institutional and technical ones directly involved in getting the job done. As a general policy guide, we might adopt a statement by Lee M. Talbot:[8]

"The privilege of utilizing a resource carries with it the obligation to adhere to the following general principles:

1. The ecosystem should be maintained in a desirable state such that:

   a) consumptive and non-consumptive values can be maximized on a continuing basis.

   b) present and future options are ensured.

   c) risk of irreversible change or long-term adverse effects as a result of use is minimized.

2. Management decisions should include a safety factor to allow for the facts that knowledge is limited and institutions are imperfect.

3. Measures to conserve a wild living resource should be formulated and applied so as to avoid wasteful use of other resources.

4. Survey or monitoring, analysis and assessment should preceed planned use and accompany actual use of wild living resources. The results should be made available promptly for critical public review."

Adhering to these principles is affected by such limits as those of staffing, which includes considerations of staff size and staff quality or capability. Capability involves not only ability in the form of having facts and the wisdom and skill to apply them, but in having the initiative and industriousness to get the job done. Crank in here limitations of morale, attitude and leadership.

The wisdom part of the formula comes, as already mentioned, from education, including experience. The skill factor derives from training and experience.

Now we get down to the part of the institutional framework that involves actually administering or applying the managements. Limits of organizational deficiency and bureaucratic delay come to mind here. Let's pass over those old saws and move on to the planning part of administering resource management. (You know what a planner is: someone who writes about something he doesn't understand and tries to make you feel it's <u>your</u> fault.) One of the big limits to planning is, again, lack of goal. Often the lack of goal is so evident that one suspects it is intentional. To describe this situation, John Neess has formulated a corollary to the aforementioned goals-and-roads proverb: "Knowing where we are going would impose unacceptable constraints on our choice or route." Again looms the specter of the technique-oriented type of fishery worker rushing out to apply cookbook-fashion the cherished bag of tricks and resenting any hinderance to doing it.

Right beside lack of goal comes lack of strategy as a planning limitation. Strategy may be viewed as planning that derives from a definite policy and lays out a path toward a definite goal. It can also be viewed as guiding our management so that it does not enter areas of unacceptability. McNall[9] urges us to take future demand into account, not to be limited in our planning by immediate needs.

Other advocates of the long view in strategy point out that we should anticipate future limitations--rampant population and economic growth that will lead to resource depletion and environmental degradation.[10] They feel that these problems are not going to be solved for once and for all by some technologic fix that scientists are about to produce. They imply that we are going to have to devise long-term strategies and start carrying them out soon, instead of waiting around for "miracles of modern science," if we are to salvage the resources we want, such as our trout streams.

Acknowledgements

Aside from references already cited, I have drawn from writings of Henry A. Regier.[11]

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THE TROUT'S ENVIRONMENT

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ABSTRACT.--Temperature, quality and oxygen content are important water conditions affecting trout. These, plus space and food, comprise the important environmental factors which limit trout numbers and size. The interrelationships of these factors must be recognized when the trout's environment is manipulated by man.

The elucidation of the environmental requirements of stream trout has been the subject of laboratory experimentation and confirmation in the field for many decades. The basic outline of the fish's physical requirements is well known.

Three factors that are probably the most frequently quoted as strict requirements are cold water, unpolluted water, and water rich in oxygen. Yet these factors constitute only a bare-bones list of required physical factors in the stream trout's environment.

It is clear that the topic of greatest concern at this symposium is not simply the environment requirements of trout--but rather the question, or part of it, What is a Trout Stream?

It also became clear, too, that the participants in this symposium were not to be mainly biologists who had a scientific interest in the stream ecosystem; rather, the audience would consist mostly of trout anglers--not scholars of trout streams, but lovers of trout streams. The participants would bring here a much more wide-ranging interest in trout streams than mere science.

The purpose in this presentation, then, was to relate, within the above sensitive framework, the scientific principles that deal with stream ecology, to the beauty of the wild trout stream that we all love.

The three factors mentioned above; temperature, pollution, and oxygen, will be dealt with only briefly, because there are other factors more complex and more important to the trout stream in nature.

First, water temperature. We refer to trout as cold-water fish and trout streams as cold-water streams. And it is true that trout have a lower temperature tolerance than other so-called warm-water fishes. Among our three common species here, the brook trout has the lowest temperature tolerance, the brown's in the middle, and the rainbow's the warmest. But as a general rule of thumb, we can say that 70°F is about the upper limit for all three. Most good trout streams will almost always run cooler than that, and on the other hand trout can withstand warmer than that for brief periods. But 70° is a good general guideline.

Of course, we realize that the temperature factor is important only for a short period of two months or so, in middle to late summer. For the rest of the year, all streams are cooler than 70° anyway. In fact, in the winter, the same factor that makes for cool streams in the summer, a good groundwater source, keeps a trout stream warm relative to other streams. The sign of a good trout stream is frequently the fact that it is not frozen over in the cold winter months. In fact, the average annual temperature of a trout stream, being close to the temperature of ground water, is often warmer than the average annual temperature of a warm-water stream.

This leads us to the conclusion that randomly dipping a pocket thermometer in streams doesn't usually tell us what we want to know about trout water. Only if we measure temperatures at certain critical times, and interpret them critically, are they good criteria of trout water.

Secondly, trout require unpolluted water. This factor may be more difficult to evaluate than water temperature when we attempt to quantify pollution. Virtually every substance we regard as pollution, if released into streams in large quantities, is present naturally in small quantities. Nevertheless, trout are particularly susceptible to toxic materials such as heavy metals and poisons, pesticides, and certain fine sediments causing turbidity. Generally if a stream is obviously polluted to our senses of sight and smell and taste, it will bode ill for trout, too.

Third, is the water's oxygen content. It is true that trout require a higher oxygen concentration than most other species. In almost all cases, the oxygen content of trout streams is the result, not of photosynthesis by algae and other aquatic plants, but of diffusion into the water from the air. The usual oxygen content will be that which is in equilibrium with the air at a particular water temperature; the cooler the water, the more oxygen it holds. At temperatures normally found in trout streams, this equilibrium oxygen concentration is fully ample for the trout's requirements.

So if the stream is cool, and unpolluted, the oxygen factor is something we really don't have to worry about. Adding waterfalls and cascades to aerate the water does not add more oxygen, and besides no more than that at atmospheric equilibrium is needed.

Now that we have covered, however briefly, these three factors in the trout's environment, we may consider some other environmental factors that perhaps are more important.

The three factors just discussed, water temperature, pollution, and oxygen, are what we might call density-independent: their effect on trout is not related to the density of the fish present. Once these factors are within tolerance limits, lowering the temperature or increasing the oxygen will not produce more trout.

But there are some other factors making up the trout's environment that are density-dependent, that is, they determine, either directly or inversely, the quantity of trout present and the rate at which trout can be produced.

The two most important of these are food and space. And these lead us to the concepts of carrying capacity and production rates.

First, let's take up the factor of space. By this term we refer to space that is acceptable from the fish's point of view. It is the kind of space that provides for the fish's needs, for shelter and protection from predators, room to maneuver away from competitors, and an area in which to forage. These are the places that are readily recognized; pools, overhanging banks, under logs and ledges and in broken water in rapids. To a large extent stream trout are territorial, they need a certain territory for their shelter and foraging, and the more aggressive individuals will defend these territories. Consequently, a stream trout population will rarely be crowded; if there are too many trout produced (or if too many are stocked), the unfortunate, weaker ones will be pushed out, usually to more vulnerable areas where mortality will increase.

We can look upon the space factor then as setting an upper limit to the size of a trout population that the stream can support, the physical carrying capacity. Is this capacity filled in a good trout stream? Probably not quite, and certainly not continuously. But there always is a tendency, because of the usually satisfactory reproduction and growth that we would find in a good trout stream, toward filling this capacity.

And how quickly and how continuously it can be filled depends on another important environmental factor, food availability. We will hear much more about trout foods and the different kinds of organisms that serve as food later today by experts in that subject. We may make here a few general points.

First, the food organisms, aquatic insects and other invertebrates, depend for their food primarily on organic detritus that is washed into the stream from the land. Some organisms do eat the algae that are produced in the stream, but the great majority depend on detritus. Knowing this then, our treatment of the terrestrial part of the watershed takes on added significance.

Secondly, it appears that stream trout depend primarily on drifting organisms for food, rather than foraging from the bottom. This is particularly true for the smaller sizes of fish. An important factor in selection of a choice territory for a fish is the best spot from which the fish can intercept the drift. We probably can tell more about the quantitative aspect of food availability by taking drift samples, properly interpreted, than by taking samples of the bottom. Of course, the same organisms are involved in drift that live on the bottom; but if drifting is involved in the life history of an organism, it will generally be more important as trout food. Drifting has two important results: the organism is more visible and therefore more available to the fish while it is moving. Secondly, drifting serves to transport the food organisms from an area where they are being produced (such as a shallow riffle, where there is little cover for fish) down to an area where the fish maintain their territories and lie in wait (such as under cover and in pools). This factor adds considerable importance to the spacing and alternation of food-producing and fish-holding areas, such as the riffle-pool sequence.

Space and food emerge as the two main environmental factors determining carrying capacity: space sets the upper limit--food availability determines the degree to which this capacity is filled and the rate at which it can continue to be replenished under conditions of exploitation by angling. Of course, the two interact. An abundance of food may allow the foraging territories to be smaller and then the physical space can accommodate more individual territories, and more fish.

We should mention a few points on the manipulation, by man, of the trout's environment. All of us are much concerned with this activity. We used to simply call it stream improvement. More commonly today, we call it environmental management, or habitat alteration, or some similar term. If we had good experimental data available, we would probably conclude that of the enormous amount of stream improvement work done in this country since the 1930's, very little of it amounted to actual improvement. And much of it was actually detrimental.

Back in those early years we noticed that stream trout most commonly were found under sunken logs and log jams left over from the lumbering days, which had passed not too many years previously. Stream managers "improved" streams largely by placing in logs and artificial log jams of various design and sizes, without regard to, or knowledge of, ecological principles involving the relationships between food and space.

Today, of course, we've made much progress, and habitat management programs have matured along with our knowledge of stream ecology, the hydraulics of in-channel structures, and an appreciation for the aesthetic aspects of trout stream management. We may make stream habitat alterations for three purposes: (1) to improve the aesthetic quality of the stream by reducing bank erosion, restoring natural vegetation along the banks, creating attractive pools and cover; (2) to improve the fishability of the stream by removing obstructions, brushing, creation of pools and cover that are not only attractive but fishable, and (3) to increase the production of trout.

This last objective--increasing productivity--is done primarily by manipulating the space factor, raising the physical carrying capacity of the stream by the creation of pools and cover that constitute the acceptable space within a trout stream.

The big catch to this, of course, is that it will not work if there is not already available an over-abundance of fish food. The increase in space will not increase fish production by allowing more fish to live in the stream unless there is more food to feed them. That's only common sense.

Probably most stream improvement projects completed in the early years of trout stream management involved streams in which food availability was already the limiting factor. These were middle to large streams which already had plenty of deep water and good pools and acceptable space to hold fish. Adding more pools and more cover was wasted effort and actually detrimental when structures were built with dimension-sawed lumber, wire, iron posts, concrete blocks and even sheet steel piling.

On the other hand, the projects that have stood out as successes have been invariably the small riffle-type, flat stream originally without much cover or pools, but with an abundance of food-producing bottom types that provided food supplies that were not being fully utilized by the small fish population. These include Lawrence Creek in Wisconsin, Hunt Creek in Michigan, and in Minnesota the Split Rock on the North Shore and several in the southeast. These were all small, food-rich streams without much cover to start with; habitat management provided additional space, and the food was there to produce the additional fish.

Today, coupling sound stream ecology with the stream building artistry of biologists like Ray White and Mel Haugstad and Bob Hunt has produced and preserved some trout environments that are productive of both fish and aesthetic values. The last point, aesthetic values, should be emphasized. Recreational fishery management has as its product recreational values, not meat for the table, since that can always be obtained easier and cheaper at the supermarket. It used to be that management was directed at increasing the recreational value of angling only by increasing the catch of fish, either more fish or bigger fish. Today, in stream trout fisheries particularly, we are trying to increase recreational value of trout fisheries by raising the quality of the angling experience. And that's different than just making the creel heavier. We may not be able to define quality in precise quantitative terms, but we generally know it when we experience it.

One overwhelming truism we have come to appreciate fully, a high quality environment for stream trout goes hand in hand with a high quality fishing experience for the trout angler.

TROUT POPULATION DYNAMICS

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ABSTRACT. Both the number and size of trout in a stream are important to the angler. Many factors work together to determine the size and number of trout present. An understanding and appreciation of the dynamics of these processes that affect a trout population will increase the trout angler's satisfaction from his fishing experience as well as provide the necessary scientific basis for wise management.

I think we have failed to succeed many times in the area of wise trout management because we have failed to understand the basic biology of the creature we are working with. I say that as a professional biologist; trout anglers and other resource users may not agree. Many trout management ideas that sound good may conflict with basic principles of trout biology. Proponents of such ideas are often hard to deal with because it is difficult to reconcile their well intentioned views of what should be done to improve trout fishing if there is no awareness of basic biological functionings of trout population dynamics that follows will provide a better understanding of why some trout management program have worked and why some have failed.

I would define "trout population dynamics" as the changes in the number, weight and age composition of a trout population. Trout populations, even when not fished, are limited and regulated by natural controls both biological and physical. Usually there is no single factor which determines whether a trout stream is a good one or a bad one or how many trout happen to be there at any given moment. Rather, population control is best viewed as an interacting network of many factors-like a cobweb rather than a single strand. There are some limiting factors that act independent of the number of trout present and some that act differently as the number of trout changes. Some are predictable and some are not in relation to the number of fish in the stream.

Over a long period of years, if the environment is fairly stable, there will be a long term average around which population abundance fluctuates. Every now and then, however, radical departures from that norm or carrying capacity occur. For example, population numbers may drop way down as a result of a once in a hundred years flood. But then gradually, the population will tend to increase rather than decrease more. Eventually it will build itself back up to its normal carrying capacity again. Or perhaps there might be two exceptionally strong year classes of trout in a row and high water conditions all summer without flooding so there is greater than normal carrying capacity. The result is a population that greatly exceeds the average abundance. Gradually, however, in succeeding years, the number of trout in the stream will tend to decrease rather than increase.

These kinds of processes go on whether it is a population of brown trout in a big stream such as the Madison River in Montana which you can hardly throw a stone across, or a population of cutthroat in a little unnamed tributary in British Columbia, a stream so small you could jump across it. The important thing to remember is that many of the same processes apply to determining the number and weight of trout present in streams of all sizes and to stream trout populations of all species.

Life Cycle Trends in Number

The number of trout surviving from any one year class over the life span of that generation of fish drops very rapidly from the time the eggs are laid through the period covering the first few days after emergence. Success of egg fertilization is usually high, as is the survival rate during the incubation period in the gravel pockets excavated by the spawning females. Although research data are sparse, the most critical stage of high mortality seems to be during the first few hours or days of free-swimming life. Population decline then tends to diminish less gradually during the remainder of the life cycle. The shape of the numerical curve representing this population decline can take many different configurations. I studied a brook trout population in one stream over a period of several years. It didn't make much difference whether 200,000 or a million eggs were spawned in the fall. It wouldn't have made any difference either whether we had planted an additional 1 or 2 million more eggs in Vibert boxes. The following fall there would be only 10,000 to 20,000 age o fingerlings. Next spring there would be 2,000 to 9,000 yearlings, 2 or 3 percent at best of the original number. Above a certain threshold it didn't make any difference how many more eggs were spawned in the stream. The carrying capacity of that stream, like any other, passed through a series of "bottlenecks". The "bottlenecks" in this stream limited the population to 2,000 to 9,000 spring yearlings. The threshold number of eggs needed was about 200,000. Additional eggs did not automatically insure additional yearlings.

In another Wisconsin stream a Vibert box experiment failed completely. All 40,000 eggs that were planted died during the winter. This example illustrates an early "bottleneck" in the life history of a year class. The carrying capacity was there for large trout, but the number of eggs successfully hatched was too low to take full advantage of it. Winter water temperatures were too cold. Even if there are a lot of spawners in that stream, winter water temperature acted as a "bottleneck". In order to maintain a fishery in this situation, fish must be stocked after the winter "bottleneck" occurs.

Most habitat improvement techniques are aimed at the later stages of the life of a generation of trout. We attempt to manipulate the environment in such a way that the fish benefit after they have exceeded six inches or so. In Wisconsin we have been very successful in many of these habitat management efforts because we have by-passed one or more of the early life history "bottlenecks". Successful trout management depends on understanding such population "bottlenecks" and then doing something about them.

Life Cycle Trends in Growth and Biomass

Another important dynamic factor in trout populations is the rate at which individuals grow. Unlike people, trout usually grow continually throughout their lifetime if adequate food is available. We reach maximum height somewhere around 45-50 years old and then we atart shrinking. Grandpa isn't as tall as he used to be, but that's not true of "Grandpa trout". The length and weight factors for a given individual trout usually continue to increase throughout its lifetime.

The interaction, the dynamics of the process of rapidlydeclining numbers and steadily increasing growth rate throughout the lifespan of a generation of trout, produces a third curve called the biomass curve. This curve represents the pounds of fish present in the stream at a given time. For any one generation of brook trout the curve usually exhibits a hump near the end of the first year of life, in September or October, when the young-of-year peak in biomass. The year class then declines a little bit in weight over the winter because some individuals die and growth rate of survivors slows. Then the next spring, as yearlings, they begin growing rapidly again. This cumulative growth exceeds weight loss due to mortality so that usually, in brook trout populations, the maximum biomass for a generation is reached in the fall of the second year of life. The trend in year class biomass is usually downhill thereafter. If this were a brown trout population, a third even higher hump would occur in the curve at the end of the second year of life when the maximum biomass would be reached at the time the fish spawn for the first time. Thereafter, biomass would usually continue to decline for a year class of brown trout. So there are two important processes that a biologist looks at in understanding trout population dynamics: the rate at which trout of various ages or year classes are growing and the rate at which they are dying. These two processes primarily determine what is going on in the trout population. They interact to determine the number, weight and age structure of the population.

Another Look at Year Class "Bottlenecks"

As indicated previously, one of the areas about which we know very little is what happens to all those trout fry that come out of the gravel. They enter the life of the stream and ninety percent or more of them soon die. We just don't know what causes this tremendous mortality to occur during the first few days or weeks of life, but it is a very efficient natural selection process. Only the very lucky and the very hardy make it. But, if we could change this "bottleneck" by just a percentage or two, it might make a great deal of difference how many of a catchable size will be there a year or two later.

We know that winter water level (base flow) is one limiting factor which often determines whether there will be a strong year class or a weak one. If there is a good year of groundwater flow chances are good that the stream will have high over-winter carrying capacity and a strong year class result. Conversely, if stream flow is low, the little fry will be so crowded when they emerge that they need to promptly disperse from spawning areas to areas which are less suitable. During such dispersion they are subject to increased mortality. The result is usually the production of a very weak year class.

The chances of a trout surviving increase tremendously as it increases in size. This factor is normally independent of the number of eggs laid by the parent stock, but can be markedly altered by competition for food and space after emergence. Consequently, factors which determine the growth rate of trout are very important in determining the dynamics of that trout population. If we can manipulate the environment so that these young trout can grow faster, they will survive much better because they out-distance many of their potential predators as they get larger.

Behavioral Dynamics

"Territory" is another important concept in determining the dynamics of a trout population. Trout tend to live in an envelope of space. The size of this envelope of space depends upon many things-the size of the trout, the species, the abundance of food, water velocity, time of year and the amount of hiding cover to name a few. This spacial envelope in which each trout lives tends to increase like a balloon as the fish grows larger. With increasing body size it also tends to move out into more rapid water.

A typical stretch of a midwest trout stream might be silty on one side, gradually slope off into a sandy stretch and then contain deep water on the other side next to a high bank. An examination of the trout present in a few yards of that type of habitat might find four or five young-of-year on the silt flat, a couple of yearlings out a little farther, and one larger two or three year old fish occupying the niche under the bank all by itself. The largest trout is free to move wherever it wants in this portion of stream. The yearlings, however, don't dare intrude upon its territory, or they do so at the risk of their lives. Similarly the young-of-year may argue about food and space with each other but not with any of the yearlings.

In another place, the stream might flow into a nice deep pool, undercut the bank and then flow out again. A study of the fish community might identify a series of subgroups in that little stretch. There might be a few fish which always hang around at the head of the pool, some in the middle, some down at the tail, a few always around a far weed bed. If this aggregation of trout were observed individually over several days, three kinds of individuals would be identified. They would be differentiated on the basis of their behavioral patterns. One group constitutes the "residents". They will stay in the central part of the pool day after day until they get considerably larger and need a different kind of environment. Also occupying the middle of the pool are the "transients". They constitute about ten to fifteen percent of the trout present. They are fish on the move, looking for niches which aren't being utilized. They move up and down the stream from pool to pool, from habitat type to habitat type. They are looking for a habitat that will satisfy them more than their old one. The third kind of behavioral group we would call the "hermits". From under the bank someplace, if our observations continued for several days in a row, one such hermit might emerge. It has a very large territory and may swim up the stream through several pools and gobble one or more fish along the way, or maybe a crayfish or some other large food. Then it will disappear under the bank and not be seen again for a couple of days.

Fish vs Fishermen Dynamics

Another of the dynamic processes that must be mentioned when thinking about most trout populations is the predator-prey interaction between fish and fisherman; the predator being the fisherman and the prey being the fish. As trout become fewer they don't necessarily tend to become smarter. Consequently, anglers cause an unusual kind of mortality which is inversely related to the abundance of trout in the stream. It works like this. Suppose you were to fish a certain pool that held ten trout. You were a pretty good angler and you fished it diligently and you caught four fish. That is a harvest of forty percent. On the other hand if there were only half as many trout, five, in that pool and if it was fished just as hard, maybe three would be caught. The catch is reduced a little bit, from four to three, but now sixty percent of the trout were caught not forty percent. That is why looking at creel census statistics only doesn't necessarily tell us what is going on in the dynamics of a trout population. Fishing mortality becomes more and more severe as the density of the trout decreases. This is a very important principle in understanding the dynamics of trout populations that are being fished. Just looking at what anglers catch, three rather than four per trip, may not signify that there are half as many fish in the stream. Fishing can continue to be quite good long after over-harvest has occurred. Trout can continue to be caught in substantial numbers even though the population may have been radically reduced from what it was in the previous month or year.

In review then, we see that looking at the interactions involved in the dynamics of a trout population can become very complex. Each trout population is subject to a whole series of processes which interact in very complex ways. Some of these processes can be labled and rates determined. Some processes haven't even been discovered yet. A great variety of physical and biological factors influence a trout population, some tend to push the population up and some tend to push it down. An understanding of such processes can do much to increase the satisfaction of angling as well as provide the basis for more scientific management. An eight or nine inch brook trout, for example, may represent about one in 10,000 trout of the same age. It survived while all the others have died. There is only one left out of 10,000. Does the angler keep it or let it go? If it is a twenty inch brown trout it may represent one in a million or maybe one in two million. Does the angler keep it or let it go? Such a trophy size trout represents the product of many "millwheels" which have ground very finely. The mills of growth and mortality have ground on and on and now it's the only one left. The decision whether to keep such a fish or not should not be made in the greed of the moment. The journey through which it has passed has been extremely tortuous and highly interesting to reflect upon. What should be done with such a large fish? I suggest that you make your decision well ahead of time, perhaps during a quiet winter's evening offering an unhurried time for reflection as well as contemplation of future actions. Your decision is important to the future recreational quality of your angling experiences but important also to those youngsters who have yet to experience the unique joys of fishing for trout.

TROUT FOOD HABITS

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ABSTRACT. Mayflies, stone flies, and midges are favorites of trout. Deceiver fishing based on these insects is a basic method of trout fishing. An understanding of the characteristics and life cycles of these insects can result in a successful and enjoyable trout fishing experience.

There are two fundamental ways to catch trout. First, the angler can attempt to stimulate a strike reflex from the trout through his choice of lures and manipulation methods. An example is the snatching of a ridiculously large maribou streamer through some potential fish holding water. The usual response is a slashing type of strike from the fish. Sometimes they don't find the hook. This is usually called attractor fishing. It seems to be unrelated to the trout's desire to feed. It is the basic approach when fishing for non-feeding fish such as steelhead, migratory brown trout and Atlantic salmon. Even though there are occasions when steelhead may be encountered in feeding activity, it is not common enough on which to base a steelhead fishing strategy.

We're concerned here with the food habits and feeding behavior of the trout. This implies deceiver fishing, the opposite of attractor fishing. Deceiver fishing is the second fundamental approach to trout fishing. The idea is to obtain feeding response from the fish. Artificial or natural baits are used and an attempt is made to present them to the fish in a natural manner. The most appropriate situation for deceiver fishing is when individual fish are seen feeding on a known item of food.

Food habits of the trout in a given stream are determined by the availability of food types which the trout can capture and digest. The food availability itself is determined ultimately by the physical and chemical characteristics of the stream eco-system. The feeding habits of trout are influenced by the types of food available to them. There is a distinction between food habits and feeding habits. Food habits denotes the specific food items on which the trout habitually feeds. Feeding habits are the different forms of behavior that the trout displays as it goes about capturing these items of food.

Food habits, the type of food eaten by the trout, influence the feeding habits or behavior of the fish. As an example, consider the feeding habits of trout which are associated with grubbing for insect larvae on the bottom of a stream. These are considerably different from the feeding behavior of trout which are sipping emerging midge pupae from the surface film. These differences in feeding behavior which are generated by differences in food availability are of considerable significance to the angler because feeding behavior ultimately influences the angling characteristics of the stream. If the food produced by the stream becomes available to the trout in such a way as to make the trout more accessible to the angler by exposing himself in the stream where the angler can see him and get at him to present a fly to him; then a desirable deceiver fishing situation develops. This is the circumstance that is attractive and interesting to the fisherman. The feeding habits associated with midge activity produce a more desirable angling situation than the feeding habits associated with bottom larvae. The surface rise forms of the midge eaters can be seen. This constitutes a challenge to angling knowledge and expertise and at the same time it offers clues as to how well the angler is doing based on the response made by the fish. This can be seen when the angler starts fishing for them. So, as most anglers are aware, food availability and angling characteristics differ from stream to stream and from time to time within the same stream. This is a familiar,basic truth of trout fishing.

This discussion of trout foods in Midwestern trout streams is limited to aquatic insects. It should be noted that there are three major categories of non-aquatic insect forms that are quite important in most trout waters. All of them are not necessarily found within the same trout water. These categories are terrestrial insects, crustaceans, and forage fish. The terrestrial insects including the ants, beetles, leaf hoppers, and grasshoppers are seasonally limited in their availability; while the crustaceans, and forage fish are present year round.

First, the mayflies. They are the most glamorous and most well-known of the aquatic insects. Curiously enough they're not considered, or at least at one time were not considered, to be very significant in Minnesota and Wisconsin. Early in my angling career I was often told that we didn't have very much classic dry fly fishing in Minnesota because the hatches, particularly the mayfly hatches, were lacking. Most trout anglers now know that this isn't the case. There are substantial emergences of mayflies on the various streams in the area and they provide a tremendous amount of quality angling. The mayfly has what entomologists call an incomplete metamorphosis life cycle. There's no pupal stage between the underwater nymph and the adult pupal stages. A complete metamorphosis type of life cycle is found in the caddis flies and true flies such as the house fly. Mayflies do not spend a great deal of time in the winged stage, maybe as little as an hour, seldom more than three days. So consequently most of their time, more than 99% of their life cycle probably, is spent under water. Adult mayflies differ from other insects in that they undergo another molt once they reach the winged stage. The first adult stage that emerges from the nymph is the subimago which anglers call the dun. The subimago later molts into the imago which is a true reproductive adult and which most anglers call spinners. The dun makes its way to stream-side vegetation, avoiding swallows, cedar waxwings and other enemies. After a length of time which varies with the species and the current weather conditions, the dun molts into a spinner.

Generally the mayfly dun provides the most food for trout. The dun stage is in a little bit more vulnerable position where the trout is concerned. Since it appears in a consistently dependable fashion, dependable fishing also occurs. There are some species that seem to produce better fishing during spinner falls. They will be mentioned again later.

Next, some of the mayfly species will be considered. The nymph of Ephemerella subvaria, which most anglers know as the Hendrickson, is probably familiar to most people. It is the first major mayfly emergence of the season in the Midwest. There are some others, but this is probably the most well known. Dun emergence, called hatching by anglers, occurs from late April through mid-May. It usually occurs in mid-afternoon, although I have seen it happen at 8:30 in the morning during hot spells in May. After the molt from dun to spinner, the flies make a mating flight over the stream. This usually occurs in early evening in reasonably good weather. Following mating and egg laying, the flies drop to the water. That is when trout feeding activity on the spinners occurs. The female Hendrickson drops her eggs from the air over riffles and the egg stage persists for an unusually long time. The new generation of Hendrickson nymphs doesn't appear until after mid-summer. These eggs are laid sometime in May and there are, from my observations, no Hendrickson mayflies in the stream, other than the potential Hendrickson nymphs that are contained within the egg until sometime in late July. The life cycle is a year long.

Only one generation of flies is produced each year. Hendrickson nymphs hatch in early August, begin growing immediately, and continue to grow throughout the winter. The nymphs are therefore available to trout throughout the year. This is particularly important in early spring when the trout, which hasn't been feeding much during the winter, experiences an increase in metabolism due to the warming of water temperature and an immediate source of food is needed. The Hendrickson nymphs, which are large and available at that time through some changes in their behavior, provide food for these fish. There are other immature forms of spring and early summer emerging insects which also provide food at this time when the metabolic requirements of trout increase. The Hendricksons are usually associated with the larger Midwestern streams which often contain a fair amount of fast water.

Well known Hendrickson streams include the Namekagon, Brule and Wolf Rivers in Wisconsin. Luxemburg Creek near St. Cloud, Minnesota is probably the Western limit of the Hendrickson distribution, although there may be populations on the Straight River in Minnesota. The color of the Hendrickson dun can vary from stream to stream, even though it is the same species. The Hendrickson spinner is characterized by transparent wings. In some other species there are some markings in the wings. Sometimes the body color changes a little bit. Prominent eyes are often characteristic of the male spinner.

The next major mayfly emergence in the Midwest is called the sulfur. For purposes of distinguishing it from other sulfurs, it should be called the Midwestern sulfur. It is a member of the same genus as the Hendrickson, Ephemerella. The Ephemerella dorthea,the famous eastern sulfur, is found as far West as Eastern Wisconsin. The Minnesota version is very similar, a little smaller and a little paler in color. It may be a separate species or just a geographical variant. This is of little consequence to the angler since the type of fishing produced by the Midwest sulfur emergence is very similar to that produced in the East. The Midwest sulfur is quite similar to the pale morning duns of the Western Ephemerella. Sulfur emergences occur during the transition from spring to true summer from late May through mid-June. They may come out at anytime during the day but the major dun emergence activity occurs in the evening. The spinner fall follows that, usually as it is verging on complete darkness.

Sulfurs are found in somewhat slower water habitat than the Hendrickson. Even though they are found on rivers like the Kinnickinnick River, they are not numerous on the true meadow type stream in the Midwest. They are usually found in the slower portions of streams that have some gradient. The most well known Midwestern sulfur river is the Willow River.

The sulfur spinner flight is sometimes accompanied by the spinner flight of another mayfly, the Gray Fox (Stenonema sp.). The Gray Fox and the March Brown mayflies occur in similar types of habitats. They come out during the sulfur hatch which is usually in early June. The March Brown may be earlier. Nymphs of these species are different from those of the Ephemerella species. These nymphs are the highly flattened clinging type nymphs associated with fast water habitats. They are found in the Willow, Namekagon, Wolf and similar rivers. March Brown nymphs exist in almost every stream, but in most cases they don't have the numbers necessary to produce a fishable emergence.

A Light Cahill type dun also is present in Minnesota. They are on the water throughout the summer, but do not produce a fishable emergence. They are unpredictable and don't seem to be numerous enough to generate a lot of feeding activity.

After the sulfur hatch, and coinciding with the Gray Fox and March Brown activity, the heavyweights of the mayfly/trout relationship begins emerging. The Brown Drake Ephemera simulans, is a burrowing nymph. It is found in slower water habitats than the other species mentioned so far. It burrows in mixed sand, silt, and gravel bottoms. It is not the largest mayfly, but very large compared to what is usually seen on a trout stream. It occurs in the East and in the West, but its real importance for trout fishermen is limited to the Midwest. There are fishable populations on the Straight, Namekagon, Brule, and White Rivers. These are not the only places these insects are found, just the more prominent, more familiar ones. They emerge during mid-June as part of a life cycle that appearently lasts two years. The duration of the emergence period doesn't last very long, there may only be a week of dependable fishing hatches. The spinner fall occurs after sunset, while there is still enough light to see. The emergence of the Brown Drake blends into the emergence of the Giant Yellow Drake or Hexagenia limbata. The life cycle of Hexagenia limbata in most trout streams is about three years. They are a burrowing nymph found in a little bit different type of habitat than the Brown Drake. They are characteristic of the black oozy, terrible to wade, silt beds that are quite common on the more placid water, Midwestern streams. There is a larger species of Hexagenia than limbata, but limbata is the largest that has any extensive distribution on trout streams. This species is unique to the Midwest. Emergence occurs right at dark and it is followed by a spinner fall of previously emerged flies. The streams on which the Hexagenia limbata is found are the same as those mentioned for the Brown Drake. The Kinnickinnick once had a fishable hatch of Hexagenia but perhaps changing water temperature, destructive floods, and possibly the increased usage of agricultural chemicals have reduced the population below fishing levels. Floods seem to be the major factor in washing out the silt beds. If destructive flooding is avoided for a few years it is possible that the hatch may recover.

From the largest Midwestern mayfly we go to one of the smallest. This is Tricorythodes and it is the current favorite of the fly fishing community. Trout anglers are becoming more interested in Tricorythodes now because its emergence is a remarkable spectacle and they occur in a lot more places than once thought. The common name is the tiny white wing black mayfly. It is a very important insect to the trout. It provides a consistently dependable source of daily food from July through September and sometimes later. During the early part of this period, emergences start right after sunrise and may continue for several hours. Then the hatches occur progressively later during the day as the season progresses. This is an insect, the only I know of in the mayflies, that molts from the dun to the spinner stage without landing once it leaves the water. It molts on the wing, almost immediately after emerging from the nymphal stage. A trout angler observing a Tricorythodes hatch early in the morning would first see a sort of snow fall of subimago cast skins coming down from tree top level, hitting the surface of the water. Shortly after this occurs, the spinner fall itself occurs and the trout begin to rise. Tremendous numbers of little black bodies, with shiny wings sticking up, sparkling in the early morning shunshine are often seen. The emerging duns themselves seem to provide very little feeding activity. It isn't necessary for the angler to concern himself too much with tying an imitation of the dun or fishing it. It all happens quickly and once the spinners are on the water, unless the weather changes drastically, there is a long period of rising fish on which the angler can work.

The amount of space devoted to the various insects here doesn't necessarily reflect their relative importance. In many cases it is an indication of the amount of knowledge that is available. Mayflies are a good primary example of the kind and amount of knowledge that an angler needs in order to fish effectively. When fishing in conjunction with the mayflies, an angler needs to have a fairly intimate knowledge of the mayfly life cycle in order to be at the right place at the right time with the right fly pattern. In the case of other insects, less is known and less needs to be known.

Changes in the emergence times occur throughout the season. It is generally believed that emergence times are influenced by water temperature which acts as a sort of a triggering factor. In the early Spring, whatever species emerge at that time usually emerge during mid-day. As the water warms up in mid-season, it gets too warm for some species and they emerge during early morning or late evening. Mayflies which emerge towards the ends of the season come out in the daytime again, when the water and air are of the correct temperature.

Stone flies are another important trout food. When they are considered in trout fishing, all the angler needs to know is the type of habitat in which they are likely to be found and the size and general appearance of the nymphs. They are commonly associated with fast rocky water such as the Brule, Namekagon and Wolf Rivers. Occasionally the common Pteronarcys spi nymph is called hellgrammite by anglers, but that is not the correct name because the true hellgrammite belongs to an entirely different order. The large Pteronarcys stone flies emerge sporatically during early summer, usually after dark. Most fishing with stoneflies is nymph fishing in the spring when the mature nymphs are most plentiful. Pteronarcys has a three year life cycle and the growing nymphs mature in year classes. These nymphs are available as fish food throughout the year.

One species, the early brown stone fly, hasn't been particularly important in Minnesota previously because it emerged before the season opened. But there is now a March first opener in Minnesota. The emergence of the early brown stone fly now occurs during the trout fishing season so it may assume some angling importance. Southwestern Wisconsin also has an earlier opener now and these stone flies may influence fishing there too.

Midges are the final group of insects to be discussed here. The midges of importance to anglers have only one pair of wings. They are members of the order Diptera which literally means two winged flies. The midge has a complete metamorphosis type life cycle. The immature forms are classed as larva rather than nymphs. They have a pupa stage between larval and adult stage. Midges are found in all types of water, but they seem to achieve their greatest promise in meadow type streams. They form one of the mainstays of the midwestern trout fishing, at least on meadow type streams.

Emergence activity of midges and trout feeding can occur at any time of the year and there seems to be a major period of activity which extends from late winter on into June. Tremendous rises of trout have been observed in January when the midges become active on warm days. The fishing is largely directed at the larvel and pupal stages although occasionally an angler will need a dry fly pattern imitating the adult.

AQUATIC INSECTS OF IMPORTANCE IN STREAMS OF THE UPPER MIDWEST: TRICHOPTERA, ODONATA, MEGALOPTERA, LEPIDOPTERA, COLEOPTERA, HEMIPTERA

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ABSTRACT: Aquatic insects are an important part of the diet of trout. Six orders of insects are described from a trout angler's viewpoint. Suggestions are made for using this information in trout angling.

To the sport fisheries manager as well as to the angler, knowledge of the trout's food organisms is of paramount importance. For the angler, such information means the difference between indifferent success and consistent success on the trout stream. For the manager, a true and total comprehension of the lotic ecosystem is a requisite for sound and intelligent management of this resource. To determine the carrying capacity of trout for a stream, the biologist must know the minimum available food resources of the trout in that watershed. Changes in a water system - such as increased siltation; variations in available sunlight, water quality, or stream flow; addition of stream improvements; and so on - will change the niches available to the aquatic organisms. Those with the highest degree of niche specificity will suffer most from change; those with the least specificity will proliferate. Thus, understanding the life histories and niches of each of the food organisms preyed upon by the trout will increase management potential and success.

Each watershed is a unique microcosm unto itself, containing its own special assortment of organisms and niches. For this reason, broad management and angling tactics must be supplemented with a careful and thorough examination of the uniqueness of each watershed. Ponds will not contain the same insects as will streams, and only infrequently will any two ponds or streams have the same assortment of organisms.

Anglers should take a few minutes to collect, identify, and determine the relative frequency of the various organisms on their home streams. Such information is invaluable for predicting hatches and feeding activity of the trout. Understanding the niche specificity of each organism means the angler can predict which organisms might be found in slow water areas, runs, and, and riffles, and thus increase his chances for success.

To the fisheries biologist, a complete understanding of the food organisms is necessary to make sound management plans. The growing use of river systems for rafting, canoeing, and tubing not only brings the recreational use conflicts into focus, but can put heavy pressure on the aquatic inhabitants. The simple and seemingly innocent act of wading thousands of man-hours through a stretch of water can severly curtail insect populations in that stretch. In Pennsylvania, for example, the Fish Commission has banned wading on many of its spring-fed, trophy trout streams in order to prevent just such an occurrence. Stream improvement can drastically alter habitat, sometimes unfavorably for the lower aquatic forms on which the trout feed. Devices used in stream management should be tailored to increasing not only trout populations, but populations of the organisms that must support the increased numbers of fish. Sound management requires a balance in niches, and with a better understanding of the insect populations, man can better bring about that balance.

In this paper, I will focus on several groups of aquatic insects that are important in the diet of trout in the Upper Midwest. These insects are: the caddis flies (order Trichoptera); dragonflies and damselflies (order Odonata); Dobsonfly, Alderfly, and fishflies (order Megaloptera); aquatic moths (order Lepidoptera, family Pyralidae); aquatic beetles (order Coleoptera); and aquatic bugs (order Hemiptera). With the exception of the caddises, most of these groups are only poorly understood by the angler, and although known to the fish manager, may be neglected in ecosystem analysis. But the seemingly esoteric nature of many of these groups makes them no less important to angler and manager alike, for these incects are abundant on trout streams of the upper midwest.

TRICHOPTERA ("hair wing") or caddis flies

These are small to moderate sized insects (3 - 40mm long) that occur in all types of fresh water systems. There are about 900 North American species and nearly 300 species in the Upper Midwest. Most of the Trichoptera have a one year life cycle with overlapping generations. Metamorphosis is complete: the egg produces a larva which gives rise to a pupa from which the adult emerges.

Caddis larvae are soft bodied insects that feed largely on vegetable detritus. Many species build a protective case from pebbles, twigs, and similar material, lashing the particles together with silk. The larva lives in this shelter, pulling it slowly along the bottom searching for food. Other species build no case, but do construct nets to strain the currents for planktonic microorganisms. A few species are entirely free living; these are usually predacious.

At the conclusion of its final instar, the larva seals itself in its case to pupate. Free living and net building forms construct a pupation chamber from pebbles. Within this structure the larva goes into a comatose state as its body changes. Wing pads develop, legs elongate, the abdomen telescopes to form the shorter abdomen of the adult, antennae elongate, and mouthparts metamorphose from chewing to sucking, as the adult forms within the pupal husk. After several weeks (average 2 - 4) the transformation is complete, and the pupa frees itself from the confines of the case and makes its way to the water's surface. Some species crawl from the water before the adult emerges from the pupal husk. In other species, the pupa swims rapidly to the surface, its rangy structure belying the fluidity of its movements, and there undergoes transformation. Gasses pumped between the pupal skin and the encased adult aid in bouying the insect to the surface. Many caddis emerge nocturnally, others emerge diurnally. In any case, the pupal husk splits along the mid-dorsal line of the thorax, and the adult extricates itself from the fetters of aquatic existence. Once free the adult must wait until its wings expand and harden before flying to concealment in the streamside vegetation. Unlike the mayflies (Ephemeroptera), many caddises have overlapping generations and emerge sporadically throughout the warm seasons, never emerging in heavy concentrations. Some species, however, have rather specific emergence dates and form concentrated hatches.

Adults are usually dull colored and secretive. Antennae are long, mouthparts are adapted for sucking, legs are long and delicate, and the body is about one-half the length of the wings. There are two pairs of wings which are usually clothed in hairs and are quite opaque. At rest the wings are folded down and back along the body in a tent like fashion (an inverted "V"). Adults live about a month. Mating flights occur as massive swarms just above the water's surface. The females crawl or swim beneath the surface to deposit the eggs on bottom structures. Eggs develop in a few weeks and eclosion of the larva occurs.

Trichopterans are ubiquitous and legion in Midwest waters. Ross (1944) felt they were the most abundant insect fauna in this area. Samplings I have conducted in trout streams have shown the caddis flies to be a common denominator in these waters, and stomach autopsies have shown the caddis to be a consistent item in the trout's diet. Fish eat larva, case and all - which accounts for the bits of sand and twigs in the gut. Pupal emergences can cause heavy feeding activity, and adults are eagerly sought by the trout.

To the angler, larva, pupa, and adult are important. The larvae of free living forms are easiest to imitate and should be fished on the bottom. Pupae are perhaps the most productive stage, as fish cast caution to the currents, porpoising and splashing in their haste to capture the escaping insects. Imitations are best cast up and across and allowed to sink as they swing down the current. As the fly reaches the trout's lie, the rod is lifted and jiggled to ape the swimming pupa. Adults resting on the surface are taken by trout, but more frequently it is the ovipositing female that provides feeding opportunities for the fish. A wet fly imitative of the adult and fished during such times is most effective.

In the Midwest, the most important caddis flies, from the angler's point of view, are those listed below.

The Greek Rock Worm (RHYACOPHILIDAE *Rhyacophila* species) has a predacious, free living larva with a bright green body and blackish thorax. This 15 mm long larva is found in swift rocky stretches of streams and gives rise to good May hatches of 11 - 13 mm long adults, although there are some individuals hatching all summer. The adult is recognized by its blue grey wings, green body and relatively short antennae.

Chimarra Caddis (PHILOPOTAMIDAE *Chimarra* species). This insect builds a "finger net" that it uses to strain the currents for the microorganisms on which it feeds. The larva are dirty white and 10 - 12 mm long. Adults are among the earliest emerging caddis flies, coming in late April and early May. They are 6 - 8 mm long and dark brownish; however, they are rarely seen because they are so very secretive.

Net Building Caddis (HYDROPSYCHIDAE, several genera, many species). These insects have many overlapping generations and emerge during daylight hours throughout the warm months. The vast num-- bers of these insects in Midwest streams - Ross (1944) considered them the most abundant insect group in the region - and their hatching characteristics mean that the angler will frequently encounter this group. Adults are variously colored browns, mottled black and white, and mottled brown and white; they range from 7 - 14 mm in length.

Microcaddis (HYDROPTILIDAE, several genera, many species). The miniscul (2 - 6 mm long) very hairy adults of this group are quite common in the Upper Midwest. However, they are often overlooked for (1) their small size and (2) larger insects frequently mask their presence. In slow, spring fed streams where trout continually sample small fare. These insects can be most important. The tiny adults are blackish and on the wing from May through early September.

Limnephilid Caddis (LIMNEPHILIDAE, Many genera and species). There are about 60 species of these caddis flies in the Upper Midwest, and they inhabit all types of water. The larvae are case builders, and the cases cover the spectrum of possibilities. Adults likewise cover the range of sizes and color combinations. Many species are large (15 - 25 mm) and nocturnal, a boon to the night fisherman.

White Miller and Black Dancer (LEPTOCERIDAE <u>Leptocella</u> species and <u>Mystacides</u> species, respectively). Caddis in this family have excessively long antennae (usually twice or more the overall wing length) and very slim bodies. The two mentioned above are distinctive because of coloration and antennae length. Black Dancers are small (7 - 9 mm), blue black, and on the wing chiefly in late summer. The White Miller is slightly larger (10 - 17 mm) with white wings and green body; these caddis hatch during evenings in late July and August.

The American Grannom (BRACHYCENTRIDAE <u>Brachycentrus</u> species) is the "chimney case" builder. Its slender, tapered case is fashioned from bits of vegetation and is usually square in cross section, giving the appearance of a chimney. The larvae are often found in multitudes, lining the fine gravel bottoms they prefer. The adult is brown, the female with a bright green egg sac. These insects are 6 - 9 mm long and emerge in late May and early June.

<u>ODONATA ("toothed" the dragonflies and damselflies</u>

This order is bifurcated into the suborders nisoptera (drangonflies) and Zygoptera (damselflies). These insects have an incomplete life cycle. The larval and pupal stages are replaced by a single stage, the nymph. Odonata nymphs live for several years and are rapacious. The labium is jointed and extensible, snapping forward to capture the prey. Nymphs of the two groups are easily separated. Dragonfly nymphs are squat monsters with short, wide abdomens. Damselfly nymphs have long slender abdomens that terminate in three paddle-shaped, tracheary gills. Adults are also distinct. The Anisoptera ("unequal wings") have a wide hind wing and narrow forewing. At rest the wings are held outstretched in a horizontal position. The eyes are large and widely separated. In the Zygoptera ("yoke wings") the bases of the wings are strongly narrowed in a yoke-like fashion. At rest they are held together and down over the back. The eyes are large, but sit close along the mid-dorsal line, being separated by a distance less than the width of one eye.

Nymphs of most species inhabit lentic systems. Here, they burrow into the bottom or clamber about in the vegetation in search of other aquatic insects or small fish. Several species, however, prefer moving waters, living in the gravelly runs and riffles or in vegetation at the stream's edge. At maturity the insect crawls from the water and the adult emerges. The nymphal husk splits along the mid-dorsal line of the thorax and the tender bodied adult crawls forth. Once out of the husk the adult sits motionless, pumping up its wings and waiting for the exoskeleton to harden.

This group is of significance as trout fodder. Since they live for several years in the nymphal stage, trout are able to find the larger nymphs year round. These big insects are most significant in the winter months. During this harsh period, aquatic insects with a one year life cycle are small and provide little biomass on which the trout may feed. A good concentration of the big Odonata nymphs can mean prime overwintering conditions.

Many rivers in the Upper Midwest contain fair to excellent populations of Odonatans. In the Anisoptera, the families Gomphidae and Corduligastridae are most abundant. The Gomphids are found principally in gravel riffles and runs in streams of all sizes. The Corduligasters are found in gravel areas of small, cooler streams. These insects are about 30 - 40 mm long at maturity and shades of browns and olives. Zygoptera found in trout streams of this area are chiefly those of the family Calopterygidae. Nymphs live in slower areas of the stream or in vegetation along the shore. These insects are 15 - 25 mm long and shades of browns and olives.

Ernie Schwiebert (1973) makes a strong case for the Odonata, and anglers would be well advised to examine their home streams for these insects. Where good populations of dragonflies occur, an imitation tumbled along the bottom can produce remarkable results. Damselfly imitations should be fished along the shore lines in early morning when fish cruise these areas in search of food. In lakes or large pools, fish the fly slowly along the bottom or in the vegetation with a stop/start retrieve.

MEGALOPTERA ("large wing") or Dobsonfly, Alderfly, and fishflies

Insects in this group, along with those of Coleoptera and Lepidoptera belong to what I call the "Wooly Worm Larvae." The life cycle is complete and the larvae bear long abdominal filaments. The Dobsonfly larva (Hellgrammite) and fishfly larvae have eight pairs of these filaments. The Hellgrammite is quickly identifed by the presence of hair like tufts of gills at the base of each filament, a feature lacking in fishfly larvae. Alderfly larvae have only seven pairs of filaments and an additional terminal filament not found in the other two larvae. These insects are predacious and mandibles are well developed, as anyone who has handled them can attest. They live several years and as such provide year round fare to the trout. In trout streams of the Upper Midwest, larvae of the Black Fishfly (Nigronia species) and the Alderfly (Sialis species) are most frequently encountered. These larvae are mottled shades of dark brown. Hellgrammites and other fishfly larvae are more often found in warmer waters more suited to bass.

Because of their size, these insects make a healthy mouthful for even the largest trout. Black Fishfly larvae are 30 - 50 mm long, those of the Alder are 20 - 35 mm long. These insects occur in gravel bottom areas of the stream, and a big wooly worm tumbled along these stretches can take large trout.

Adults in this order are easily identifed. The Dobsonfly and fishflies are large (50 - 100 mm wing span) and clumsey of flight. At rest the great membranous wings are held flat along the back and slightly parted. Mandibles are well developed. Adult Alders look rather like a robust caddis fly and are a uniform shade of dark grey brown. A good imitation of an adult will take trout when the insects are on the wing.

COLEOPTERA ("sheath wing") or beetles

This is the most successful insect group. There are more species of beetles than other insects. A number of beetles are wholly aquatic or have aquatic stages. The life cycle is complete, but in all cases, larvae crawl from the water and from an earthen cell in which to pupate. Adults are strong fliers and may live several years. These insects overwinter as pupae or adults. Some of the more common aquatic beetles are Whirligig Beetles (Gyrinidae), Water Scavengers (Hydrophilidae), and Predacious Diving Beetles (Dytiscidae).

Practically no watershed is without the ubiquitous beetles which, by-and-large, are inhabitants of lentic waters or slow water stretches of streams. Backwater areas, pools, and beds of vegetation are excellent stream sites for beetles. Here, the larvae crawl slowly about, feeding on vegetation, carrion, or small fishes and other insects. Like the Megalopterans and Lepidopterans, these insects are "Wooly Worm Larvae"; they frequently bear many filamentous appendages on the abdominal segments. Color of the larva varies from yellow to olives to browns and black.

The widespread distribution of aquatic beetles makes them of interest to the angler, for, although not often occurring in large numbers, their continual presence makes them well known to trout. In ponds and lakes, imitations should be fished slowly among the pads of vegetation. In streams, the flies are effective when drifted along the shore lines and beds of aquatic plants or retrieved slowly along the bottom of pools.

Some species have true aquatic adults, and this stage may also be important to the angler. Since the insect must breathe gaseous oxygen, it carries an air bubble under its wings or around its body when submerged. Effective patterns are ribbed with silver tinsel to suggest the quicksilver gleam of the airy plastron. Most of these adults are strong swimmers, darting about in their slow water environments in search of prey. The hind legs are usually modified into long flattened sculling "oars" with which the insect rows itself about. Strong fliers, adults may leave the water to migrate long distances to other watersheds. Imitations of the adults are best fished in the same areas that larvae are found and are given a positive twitching motion to suggest the darting character of the naturals.

Terrestrial beetles can also become important to the angler. The June bug (Phyllophaga species) which emerges in late May and early June often blunders about near streams searching for a mate. These 20 - 30 mm long, mahogany to black beetles spark the imagination of big browns, and the knowledgeable angler can raise these fish during the June Bug season. Other terrestrial beetles are on the stream during the warm seasons. As they crawl in the vegetation or fly clumsily about, they often drop to the water surface where they are imprisoned in the film. On meadow streams, beetles can provide fine dry fly fishing.

LEPIDOPTERA ("scale wings") or butterflies, moths and skippers

Only two genera of moths in the family Pyralidae in this vast order of insects are aquatic. The larvae are 10 - 25 mm long and yellowish to straw brown in color. In the genus Nymphula the larvae live in vegetated regions of ponds. Here they often build a case of two pieces of leaf and crawl about feeding on lily pads and other plants. Other species build no case. While several members of the genus Elophila inhabit ponds, a few dwell in swift currents or rocky streams. Here they build a silken tent on the current swept faces of the rocks and crawl about beneath this canopy feeding on algae. The larvae are true aquatic caterpillers and as such bear the characteristic abdominal prolegs of their terrestrial counterparts. This is the third group of "Wooly Worm Larvae."

The highly successful "Wooly Worm" fly owes its reputation to these Megalopterans, Coleopterans, and Lepidopterans. The widespread occurrence of all three orders means that trout are accustomed to ingesting these diverse yet similar appearing insects. And although individually of less importance than some other groups, taken collectively these "Wooly Worm Larvae" can be quite significant in the diet of trout.

Adult moths of the family Pyralidae are smallish, dull-colored insects. Though doutbful these adult moths ever become important in the trout's diet, it is probably to assume they occasionally fall prey to night hunting browns.

HEMIPTERA ("half wing") or true bugs

Insects in this order have a gradual metamorphosis. The nymph appears very similar to the adult, but lacks developed wings and sexual organs. With each instar, the nymph gradually becomes more like the adult. Certainly the most spectacular aquatic members of this group are the Giant Water Bugs (Belostomatidae). These raptorial creatures are 50 - 70 mm long and fierce predators, feeding on tadpoles, frogs, fishes and so forth. They secrete toxic saliva which quickly paralizes the prey; body juices of the hapless victim are then withdrawn. These giants inhabit shallow, usually warm water ponds living in vegetation and bottom trash. They can become serious pests in a fish hatchery. Other aquatic species include the Water Scorpion (Nepidae), Water Strider (Gerridae), Water Boatman (Corixidae) and Backswimmer (Notonectidae). All are equipped with piercing mouthparts called stylets and many can inflict a painful bite.

To the trout fisher, the Water Boatman and Backswimmer are the most important aquatic bugs. These insects are superbly engineered for aquatic existence. The hind legs are quite long and flattened, serving the organism as oars. Hairs fringing the legs increase the insect's thrust. The body is flattened top and bottom and is quite compact. Like all aquatic bugs, these two must carry a plastron of air with them when they dive.

Riparian and pond organisms, they inhabit stream edges, slow moving stretches, and areas of vegetation. In such places, Water Boatman and Backswimmers often proliferate wildly, forming great darting schools. Anglers should watch for these insects, as trout often cruise into shallows and feed on this abundant fare. In ponds, fish the imitation along fallen trees, around boulders, and among the vegetation.

Terrestrial bugs hold a special spot in the angling world, for it was the leaf hoppers (jassids) on Pennsylvania's LeTort Spring Creek that first brought Vince Marinaro to examine the trout's preference for terrestrials. From his work came, in 1950, "A Modern Dry Fly Code" which still remains the most lucrid primer on terrestrial minutiae. In slow moving meadow streams where ants, jassids, beetles, flies, and grasshoppers are continually falling or being blown onto the water, terrestrial fare becomes extremely important to trout and angler alike.

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LIVE NOW, SERVE NOW

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Abstract: In these excerpts from his luncheon speech, Mr. Mulready expresses his feelings about preserving the fishing environment. He calls for increased concern and involvement from trout anglers.

I am associated with the fishing tackle industry. In fact I sometimes only half-jokingly tell people that fishing is the most wonderful thing a man can ever do, especially if his wife won't let him drink at home! In the fishing tackle industry, as in the trout fishing fraternity, there is a common shared interest. That is, of course, in the improvement and protection of our environment and growth and productivity of the sport, fishery. We have a great tradition in this country of ours, of free access to the rivers and the streams and the lakes and to all of the other resources that make fishing such a great and pleasurable sport. The U.S. Fish & Wildlife Service reports that in 1975 over 62,000,000 people went fishing in this country. About one-fourth of our population went fishing at least once and some people every day.

A couple of years ago I was in Europe; my company was doing a little market research to see if we could sell any of our products there and the answer was no we couldn't, not very well. One of the reasons is not that the people don't like to fish, but that very many people do not. We have a fabulous tradition in this country of ready access to fishing waters. In Europe, in order to fish, in most cases, one has to belong to a club much as joining a golf club or a tennis club in order to even have access to those streams and lakes and rivers where fish might possibly be. I went to Zurich, Switzerland, and I made inquiries to find out where fishing tackle was sold. There were two retail outlets in that city of 450,000 people where one could buy a fishing reel, whereas in St. Paul and Minneapolis within eight blocks of any location there are probably seven gas stations selling fishing reels. And there are probably hundreds of people going in every day looking for fishing tackle. So that's part of the difference.

Selling the tackle that we make is really only one of my interests and obviously it's a selfish one. I think more important than that is the fact that the American Fishing Tackle Manufacturers Association--the people who produce fishing tackle--not only recognize their selfish interests in providing equipment to people, but also their deeper responsibility to do everything possible to help the cause of the environment and provide an improving and more productive sport fishery for all of our people. I think that that's an interest that goes beyond just serving the selfish needs of the company or the selfish needs of fishermen, for that matter. I think that the environmental protection programs for fishing waters benefit all of the citizens whether they ever go fishing or not. But all of these things have some kind of price. There isn't anything that any of us ever do that's really worthwhile that doesn't somehow exact a price.

During the last decade in this country, if you liked trouble you could have picked your favorite kind. We've had poverty, pollution and drought and disease and crime and corruption and Watergate and war and on and on. But I'd like to submit to you that I think it's probably always been that way. And it's always been that way in the world. In this country we've always had some trouble and we're going to continue to have it, but this is the greatest country in the world because we can have that trouble and survive. I think that the efforts of organizations like the Sport Fishing Institute, the Sport Fisheries Research Foundation, Trout Unlimited with all of its myriad local chapters, and the Boy Scout programs, Save Our American Resources and all these things that go and help provide a better outdoor environment are so important to us. All of these things contribute to a better life. A few years ago not much enthusiasm existed for the hard work of improving the environment. We've had some problems as our country, population and industry expanded. There is a terrific little dilemma in our interests. How can we maintain prosperity? How can we continue to grow and expand our gross national product and at the same time preserve the priceless heritage that we have? How can we improve it and protect it for our children and our children's children and their children? That's a tough challenge.

When we attempt to do things to protect this heritage we can expect to encounter opposition. There are winners and losers. Sometimes we lose, but we sometimes win too. Winning requires effort. It first requires interest--being interested enough in the great outdoors world to work to preserve and improve the environment. There's no such thing as a free lunch. If you really care about this environment of ours, you need to use your energy and your resources and your articulation and your hope and your money to help improve and protect it because it doesn't happen by people sitting around hoping that it happens.

In closing, I want to share the following, called Live Now and Serve Now:

Some people think of life in terms of
building to the day
When they will have sufficient wealth to
start their golden way,
When they can make their dreams come true
of how they want to live,
Including contributions they have always
hoped to give.
But when the years go by and when they
reach that special date
So often it develops that the hour is too
late.
The time to live, the time to strive, to
carry out each vow
Of working hard and doing something for
others is right now.
So live now, today, this moment, to the
utmost that you can
To bring yourself more happiness and serve
your fellow man.

FOCUS ON TROUT

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Abstract: Much trout stream improvement work has been contributed by volunteers. A trout stream was created by volunteers in Oklahoma. Trout can be placed in streams through an artificial means of incubating and hatching trout eggs in the stream.

There are a number of areas around the country where people are becoming concerned not only with just fishing, but also with fish management. It is a very healthy sign that fishery people are working with fishermen and landowners. I am pleased to see this finally come about. A trout is a very unique creature and because he is so unique he attracts a lot of attention. Many people ask how I, from Bartlesville, Oklahoma, can be so involved in trout fishing when I am from an area that doesn't have many trout fisheries. It is because of the trout and its environment. They appeal to me as they do to many other people. These people don't have to live in the North where the trout are native to the streams and the lakes. Trout represent everything beautiful and dynamic and interesting and mystic in the world of outdoors. Most game animals are located in a range or in an area that the general public usually does not get to see. If a person lives on the East coast he won't see elk, but he can see trout. Trout also live on the West coast and throughout the country. Trout, whether they are rainbow or brown or brook, have become adapted all across the country. They are found in the Rocky Mountain region, all through the Northern interior states and even down as far South now as Arkansas and Louisiana. It is a species that has become available to a lot of people in a lot of different waters. There are terrific demands on it. A trout, to an angler, is something to go out and enjoy fishing for. To a fishery management person, it may be a commodity that is in demand and his job is to maintain those strains. Wherever various groups of interests come together, whether as a good product, as a recreation interest, or as the basis for employment, changes are taking place and pressures are being exerted on the trout. Our population is growing every day. Trout are being exploited by commercial firms in order to sell tackle and camping paraphenalia. The fishermen themselves, whether they are bait fishermen, beginners who are just learning, fly fishermen, or spin fishermen, are interested in trout. They will spend a major part of the trout season pursuing them.

In addition there are the people who are interested in trout not for the trout itself but for the environment that the trout represents--clean waters and beautiful landscape. When these people come together, they demand things of the trout that nature cannot provide normally. This is the problem developing today. Fifty years ago or a hundred years ago, trout in their normal ranges were not subjected to water pollution, to fishing pressures or to management manipulation as they are now. This is why it is so important that fishermen, fishery biologists, management people, land developers and others come together and recognize their mutual problems so better use of the trout streams can be made.

Trout water is not being made any more. The Corp of Engineers down South does manage to dam forty or one hundred miles of river and the cold water that is released below can support trout. But for the most part, though, it's a give and take situation. Whenever trout water is destroyed, it will not be replaced like it was. It is amazing that out West there are a number of famous streams such as the Big Hole River which have dams proposed on them. It is hard to believe the number of people supporting those dams. They want those dams made because the economy of the area will be enriched. A stream such as the Big Hole River can never be replaced by man or nature once it has been dammed up and destroyed. Yet the resident people and politicians are willing to sell this river into oblivion so they can have plenty of irrigation water and plenty of power water. This is a situation where even the people who understand and love trout are willing at times to sell that particular area of natural trout water down the drain so that it fattens their pocketbook or makes their life a little bit easier. We try to manipulate nature and the land

and the trout in order to facilitate these demands and needs. Fishery management has done a good job over the years. Unfortunately, however, the general public has made such a demand on the streams that they have been forced to try to compensate for the lack of potential and have had to deal with the users and the public.

A pair of trout will spawn in a stream and produce about two thousand eggs. From the two thousand, there is a diminishing until only a few dozen trout actually reach adult form. The reduction in numbers from eggs to catchable fish is considerable. Then man comes along and tries to further decrease this by rod and reel or whatever means that he may need to take the trout. The fishery management people are then given the problem. They study the situation and usually decide to increase the population. They usually turn to some method of reproduction, often by stocking of the stream not totally in concert with the nature of that stream.

A few years ago I worked with a program that taught me much about the delicate balance of a trout stream. I learned the importance of the fact that whenever trout are put in a stream they must be as capable of maintaining their life in that stream as wild fish. Hatchery fish cannot be put into a stream that has degenerated through poor management policies and expect them to improve and maintain the stream as a wild environment. That would be just like taking your child after raising him in his room, hand feeding him, putting his clothes on and taking care of him from the minute of his birth until he is 18 years old to downtown New York City and leaving him on his own. It isn't difficult to imagine what could and probably would happen to him. The same situation confronts a newly released trout. He is the offspring of four or five generations of hatchery life. He has been hand fed. He has had no problems except not being able to eat all of the fish pellets given to him. Then one day he is released in a stream and expected to suddenly grow and become a three or four pound mature fish on the end of a fly line or begin reproducing itself. There is just no way it can happen.

A trout stream or a trout lake is a jungle that is more severe than anything experienced on dry land. Each stream and lake receives a great many more environmental extremes than we see on land. For instance, whenever a trout stream is flowing at a normal rate everything seems in harmony, however, the fish is constantly exposed to environmental extremes. When it rains the stream has a rain or water storm that lasts many days. We may have rain on our head for a few minutes, but the trout has to live with that flood for many days and can be completely displaced from his natural environment. His food source also is temporarily gone. In the summer when droughts come the living space shrinks and all the trout get jammed up in the stream.

These factors and others make it very very tough for trout to live in a stream. Stress is present 24 hours a day. In this environment, somebody is trying to eat somebody else twenty-four hours a day. There is never a time in daylight or in the dark that somebody is not there trying to eat somebody else.

The environment in a trout stream is so precarious that good main trout stocks that have developed reflexes, strength and ability to feed and to endure the various hazards without any problem are absolutely essential. This cannot be accomplished easily on a large system, even with a very low efficiency rate. It costs lots and lots of money to maintain trout in streams. Just to make it possible for people to be able to go to the stream and catch a few fish during an afternoon is costing more and more money. The United States has been endowed with a richness of natural resources to equal no other country. In Europe, for years and years, most of the fisheries have been of the pay-as-you-go type. They have been managed very carefully and the average person is not allowed to go and fish those streams without paying a terrible price from the pocketbook. Americans don't want this, but it will come if they are not allowed to or do not use the opportunities available to apply very strict management to fishable waters and allow the natural potential of those waters to develop.

A few years ago an angler could go out and pay $1.25 for a fishing license and this entitled him to 29 to 400 pounds of trout, whatever he could take in that year. He could go to a stream or lake and spend a season harvesting trout. Now he is lucky if he catches ten pounds of trout a year. The reason for the change is that there are probably a hundred other people going to the same stream expecting the same harvest. The take must be divided among them, and unfortunately the take is not the same as it used to be. There are smaller fish and fewer fish and they are probably from a hatchery.

This situation calls for action. It can be improved. It can be done if anglers learn to put back into their sport some percent of what they get out of it. If they would simply abide by that rule, then they would see a drastic change in the enjoyment of their sport. The quality of the sport and the harmony between management and fishery people would improve. What can the angler do? He can get involved one way or another by putting something back--not dollars and cents, necessarily, but using mental capacities and even physical strength. These can be contributed in several ways.

The Oklahoma example is a good one. I had a dream from childhood that I would be able to develop a trout fishery in Oklahoma. One needs to develop the attitude that a $5.00 license is not a license to harvest so many pounds of game.

A license cannot be thought of that way anymore. An angler must not only just release the fish caught back to the stream, but he must invest some time, effort or money into the streams. Once he begins to do that, once he begins to put back some of what he takes out--not necessarily just pounds of fish, but hours of enjoyment on the stream--then there will be a drastic change in total improvement of the quality of the environment that anglers seek.

A few years back a fly fishers club in Oklahoma began a project for developing a trout stream in that state. They studied a small stream for several years. They went out and took temperatures, seined the stream, and evaluated it day by day. This was a club of about 35 members. They were sort of underground fly fishermen. Oklahoma is not the swiftest area for traditional fly fishing. There aren't many Theodore Gordons walking around there, dead or alive. However, it is an area where people enjoy fishing and there is potential water there, but no one had ever been concerned to the point where they would go to a meeting like this and get together with a bunch of people and talk about what they could do.

After the second year, the group went to the fish and game department and begged one afternoon with them. They were quite reluctant to do this, particularly after they found out that the group wanted to talk to them about a trout stream in Oklahoma. Several pages of data were presented and a request was made to start a trout stream in Oklahoma. The fish and game department replied that they didn't have any money or this or that. The group said they were not asking for that. They only needed permission to go into an area and be allowed to stock a stream with trout. The group would pay for the trout and provide all the labor. They would invite a fishery biologist or somebody else to come along and oversee the operations. The fish and game department went into an almost total state of shock because no one had ever before come to them and said, "Look, we want to do something for you. Here's what we want to do. Let us do it." With that kind of an attitude, it's hard for a fish and game department to say no. Most people come to them and say, "give me, give me, give me," with their hands out.

This may or may not be a new concept in working with a state fish and game department. It worked in Oklahoma. From that initial effort a program was developed which has resulted in one of the most promising and dynamic methods of reproducing trout naturally in trout streams on an economical basis. This was a single effort by a few people who really didn't know much about it but were willing to spend time studying, talking to the right people, reading a few books, making a few phone calls, and most of all bending a lot of backs and digging some holes in the gravel.

The project turned some concerned individuals into a group of people who have harmony with the stream, with the land, and with themselves to a level they never ever imagined.

The project changed my whole life. It really did. It's hard for me to even talk about it without being emotional because I once thought that a trout was a spontaneous thing, like the weeds in your back yard. I had even quite often heard fishery people say that taking a five pound fish out of this lake or out of this stream would result in another one taking its place. That isn't so. Another one doesn't take its place like that. Maybe the fish from the riffle down the stream might take its place, but the bucket is being emptied and the inferior ones are left.

I was in Canada once, talking to two Pennsylvania fish and game people. I really didn't know who they were, but they apparently were two very well thought of and very high in the Pennsylvania fish and game department management area. They made a remark about a vibert box system that had caused problems. I asked them about the problem. Apparently some group had used the box and had almost complete failure. I had to respond to those fish and game people when they criticized the volunteer effort. I asked why they criticized a group of people who bought those eggs, bought the vibert boxes and went out and dug some holes in the streams and tried their best. Whether it was very good or very bad, they tried to do something about a stream. They hadn't asked the fish and game people to do it. Even if the thing was a total failure, they did two things. They spent some of their time and effort learning how unique a trout stream is and the problems of fish and stream management. After that year of work, those people had far greater respect for the fish and game department and a far greater respect for that stream. They were better people for it. They were now more open to further projects rather than throwing up their hands and feeling like that its all over with. A person-to-person involvement, putting some of what is obtained from a stream back into it, changes attitudes. It increases the enjoyment from the sport. It causes an increased appreciation of the stream and suddenly it isn't work at all, it's a pleasure. Sometimes it develops to a point where fishing becomes secondary; helping build a better system for the fisheries becomes more important.

If one looks over his life, everything that was really accomplished, that a person is proud of, probably meant some sacrifice of time, money and pleasure to get it done and get it done right. That's exactly what we want to do with our trout streams. We need to turn around and put something back into the streams after we have gotten something out of it. A person will be highly regarded. It can be stream improvement. It can be working with the Agriculture Department, trying to cut down some of the agricultural pollution that is going into the streams. It can be forestation. It can be reproduction of trout. It can be so many areas. There are a number of different ways that a person can improve the stream. The spectrum of involvement that the stream has in the community, whether it is because of realtors interested in the land adjacent to it, farmers, forestry, fish management people or anglers, there are bound to be some areas, some niche there that each person can find to get into.

Our trout waters are becoming increasingly popular. In a situation where there are a few miles of water and a few thousand fisherman, there are special population and management problems. Here the problems center around maintaining wild, semi-wild or domesticated stocks of trout for the angling experience. The management objective is to maintain a high fish population. But that is not easy. There are three methods that have been effective for one reason or another in repopulating a stream of wild and dynamic fish. There are the hatchery, vibert box, and natural spawning. I have found in the work that I have been doing in natural reproduction with vibert boxes and with fishery management that all three can play a major role in any trout stream if done intelligently. There are, of course, some streams that need no man stocking. There are some streams that must have heavy hatchery plants. There are other streams where the breeding stock has been destroyed or where the laws of the streams themselves would make it impossible to have a heavy stock where the vibert box system would work quite well. Spawning trout, although relatively efficient in the sense that they do reproduce well, do not populate a stream to the numbers where they can be depleted to any extent by man. The natural stocking system is not that dynamic. The hatchery system allows us to put many, many thousands of tank fish in any given stream at any moment, but this is extremely expensive. Natural reproduction is totally free, except for those costs that might be involved in producing the ideal environment for the trout and in providing law enforcement. The federal (national) fish hatchery and the state fish hatcheries all over the country produce many millions of fish a year for the angler. Unfortunately, this is a very expensive thing. It is a situation that does not maintain itself; it has to be constantly replenished. It does not, regardless of how many dollars per pound are spent, produce a superior fish. There are no hatchery systems operating in this country today that I know of where fish are retained in a man-made environment and released at given intervals that produces a satisfactory wild game fish.

My son once caught a large rainbow that was stocked in a very rich Michigan lake. When it was stocked it weighed eight pounds and was twenty-six inches. When it was caught it weighed three-and-one-fourth pounds and was less than one-half inch wide through the back. It was a tame hatchery fish put into a wild environment. The same thing happens on a lesser degree to the smaller fish. Once they are put in a stream or in a lake they slowly begin to self-destruct because they do not know how to maintain themselves. For years and years it was felt that a ten-inch fish or twenty-inch fish put in a stream would be big enough to take care of himself. There wouldn't be any predation or other loss and there was going to be a good catchable fish immediately. This is not true. Such a fish is a terribly, frightfully expensive fish to feed. Dr. Vibert, head of the fisheries in France for a number of years through the late forties and fifties, came up with one of the most unique alternatives to stocking. He realized that fish could not be raised in hatcheries that would generate natural responses. He developed the concept of the vibert box. This is an in-stream trout incubator. It simply allows the eggs of the trout to be placed in a stream and incubate there. The result is an on-the-spot hatched population of trout that for most purposes assume the wild trout environment immediately upon hatching. Using the live fertilized eggs of fish, either taken directly from the stream or from hatcheries, salmon and trout can be hatched in given areas of the stream or a lake with this system.

It was discovered in the last few years that the original vibert box was not efficient in waters that were not absolutely ideal for incubating these eggs. Different configurations of the box were developed. Usually the boxes are planted in a stream in the riffle area or the tails of pool areas where trout normally spawn. Three or four people can put the eggs in the stream and in the stream incubators at a rate of approximately 15- 25,000 eggs a day. This is a very efficient way of reproducing the natural population in a stream with a man-made effort. Wild trout eggs are just simply randomly laid in the gravel, where they incubate. This is a fine system, but not very efficient. They are subject to various predators that live in the gravel, such as crayfish and insects. In addition, environmental extremes such as floods, anchor ice, and siltation destroy a number of the freely distributed eggs of natural reproduction. When a pair of wild trout spawn they normally produce fifteen percent or less fry from the several thousand eggs that they spawn. With the standard original vibert box one can expect eighty to ninety percent hatched production of fry. The eggs incubate in the box. After hatching, the fry drop through the slots. Then the fry, as their yolk sacs are absorbed, gradually advance up to the gravel and begin the free swimming life of the trout fry in the stream itself. This is an involved process. It usually lasts from about four to eight weeks after the eggs have been implanted. It is a function of temperature and the stage of development of the eggs when they are put in. It is an interesting method and allows a great number of trout to be incubated and produced in any area. The vibert box can be used if there is a natural spawn there or not. The new box which was developed utilizes a more efficient incubator system plus a nursery system so that the fry are protected. This box is called a Whitlock Vibert Box. The top part or the incubator section has space for two rows of eggs. This box with approximately five hundred trout eggs will incubate them efficiently in any type of water that a trout can live in during incubation process. The original box would only incubate the eggs efficiently in the most ideal water habitat where there was lots of oxygen, lots of water flow and almost no siltation. The new box can incubate eggs in practically any type of water that a trout can live in. These are sloughs, lakes, streams, and spring creeks. Once the eggs hatch, the lower part of the nursery comes into play. The box must be implanted in the gravel. The box is immersed in a hole dug on the bottom of the stream. The box is placed in the hole and covered with gravel. It is protected just as natural trout eggs would be protected in the gravel in the stream. Four people working with this type of a box in most streams or lakes can do the stocking work of fifty pair of trout per day, thus producing a natural wild trout population in that stream. As the eggs hatch in a Whitlock Vibert Box, they drop into the nursery section below. The nursery section protects the egg sac fry from predators and free of gravel entrapment until they are ready to swim out of the box and escape into the stream itself. They do this in three to six weeks, depending upon the water temperature and the development stage of the eggs when they are implanted. At this point a trout fry has been produced that will assume a natural wild trout attitude to the stream as it feeds and grows. If they survive those few weeks of initial entry into the stream, they are for all purposes a wild trout. They are capable of dealing with the environment within the stream and grow into maturity, providing a fine sport fish as well as a naturally reproducing adult.

The box is uniquely designed so it will accommodate any type of salmon, char or trout eggs. The one box will accommodate any of these sizes. It won't hold as many king salmon eggs as brook trout eggs, of course. It will hold six hundred brook trout eggs and about two hundred of the king salmon eggs.

In the Whitlock Vibert Box, after hatching the fry fall through slots into the nursery section. The little fry stay for several weeks in the nursery section as their egg sacs are absorbed. Here they are protected completely from any type of harm. Several hundred fry in the box can keep the siltation out, plus their movements constantly bring in fresh aerated water. There is no problem of suffocation as there was in the original box. After egg sac absorption, they swim out through the escape slots to freedom. The egg will not pass through the slots between the incubation and nursery section, but once the little fry is hatched he will slip through the slot into the incubator section just like a piece of Jello. The egg sac fry have little or no directional swimming ability and therefore they don't escape the box until they are capable of actually swimming and fending for themselves. They escape by swimming up at an angle which is approximately forty-five degrees, as they would in nature, working their way up through the gravel.

The outside diameter of the escape slots are smaller than the inside. This allows the trout to escape at an increasingly larger degree of angle than the straight slot. This was worked out in the research and development of the box so that any size trout or salmon fry can easily escape the slot that restricts predators from getting inside.

The original vibert box will hatch eggs at a rate of seventy-five to ninety-five percent when placed in an ideal habitat, and produce from that seventy-five to ninety percent around twenty to fifty percent swim-up fry. The Whitlock Vibert Box will hatch between eighty-five and ninety-seven percent of the eggs in a wide variety of environments. From those it will produce fifty to ninety-two percent swim-up fry. Many factors influence these rates for the Whitlock Vibert Box. In cold sloughs--those that are spring fed--it is fifty to eighty percent production; in cold lakes, fifty to eighty percent; in streams, eighty to ninety-five percent; and in larger rivers, seventy to ninety percent. This data is based on a three-year study.

Let us consider one hundred trout eggs. They are of average quality and are taken from a stream where they were naturally produced by trout. About thirty of the one hundred eggs will be abnormal. They will have crooked spines, will be mentally deficient, or have some other abnormality. About thirty will be normal, and about forty will be superior. The resulting fish from the superior eggs will probably be the ones that will reach maturity. Under natural conditions of reproduction, twenty eggs will hatch and twelve fry will be produced. The twelve fry are normal and superior fry. The abnormal didn't make it to the fry stage. Using the percentages above, we can expect 3.6 normal fry and 4.8 superior fry from one hundred naturally hatched trout eggs.

With the standard vibert box, one hundred eggs would produce fifty fry. These would include fifteen normal fry and twenty superior fry. The Whitlock Vibert Box will produce a hatch of ninety-five and eighty-five fry from one hundred eggs. Of those eighty-five fry, twenty-five and one-half will be abnormal. They can be erased the minute they leave the box, if they even get out of the box. There will be twenty-five and one-half normal fry and thirty-four superior fry. Most of the potential superior fry--thirty-four out of a possible forty--are allowed the ultimate chance through this method of incubation and nursery entrapment to enter the stream. This beats nature and any type of hatchery production. With this method, a small team of people can produce natural or wild fish that have the potential to grow and reproduce successfully.

I want to close with a success story. A three and a half-year-old brown trout was found in a shallow, dead-end riffle where it had been trapped by low water in part of the Oklahoma project. It was twenty-one and three-fourths inches long and was there in December to spawn. It was discovered about five feet from where one of the vibert boxes was planted. It had come back to that area after being introduced as a vibert box egg itself. It was a very emotional moment, seeing one of the babies back there working on a spawning bed. The process works. It works in any stream and it works a little differently in some streams than others. One can't predict placing a Whitlock Vibert Box full of eggs in a stream will mean that it will be full of trout in a couple of years. It depends on the trout stream and how well the fish do there. It does have a fantastic potential. The ideal, in the Whitlock Vibert Box program, is to establish a wild reproducing population, to reclaim a stream's potential for fishing.

QUESTIONS AND ANSWERS

UPPER MIDWEST TROUT SYMPOSIUM I

The respondents names are indicated, where known.

Question:

Neither Waters nor Hunt mentioned the role of creel limits in population dynamics. One speaker said creel limits are essentially based on the put and take system. But the habitat improvement or management philosophy that was mentioned here is a little bit different because it is concerned with providing natural populations. Should something more be said about creel limits?

Answer: Robert Hunt

I was paid to look at creel limits for quite a few years. In normal populations of fish, angling mortality and natural mortality compete with each other. In a sense, we are dealing with a renewable source. If the angling public decides that one of the ways of managing that resource is to harvest the surplus which trout streams produce, one way of spreading that harvest around is through creel limits. They aren't usually very effective biologically, but they can have some sociological impact. For example, if one block of streams had a creel limit. of ten and another block os streams had a creel limit of five, the fisherman who thinks he is capable of catching ten is going to fish the block of streams with the high creel limit. A more effective method of controlling the harvest is through a size limit and not by the number of fish which are kept. The problem with a creel limit is that it doesn't provide any protection until the limit is reached. That is, it protects the eleventh fish but not the previous ten. The size applies to every fish that is caught. Either it is or is not legal size.

Very few trout fishermen can go out and catch five wild trout or more. In that sense, a creel limit doesn't provide very much protection. It can, however, influence the numbers of fishermen who go to a given stream or area. If there is an increase in fishermen and each catches one or two or three fish, the total harvest goes up as a result.

Creel limits are a way of controlling fishermen more than a way of controlling the fish population. In wild populations very few people can catch ten. On the other hand the guys who can catch ten are also the fellows who tend to fish a lot. The fellow who is affected by the creel limit is also the fellow who is out there quite a bit.

Another interesting aspect to creel limits is that they can encourage people to continue fishing. There is some data which shows that with a creel limit of ten, the guy who has caught eight will not quit. He will keep fishing until he catches ten. If the creel limit is five and he has been successful in catching four, more than likely he is going to continue to fish until he catches that fifth fish. If there were no creel limit he might decide to fish enough for supper and then quit at three or four. Creel limits can have a reverse impact from that which is intended. Limits do influence the dynamics of the trout population. This is due primarily because of the influence on numbers of fishermen and their expertise. I don't necessarily agree that they have been developed simply on the basis of spreading domesticated stocks around.

Seventy-five percent of the trout harvested in Wisconsin are wild trout. Fish stocking is increasing but fewer and fewer trout are being stocked each year. Wisconsin has mostly a wild trout fishery. The domestic hatchery product isn't as important as the publicity it receives. Just as many fish are being raised as ever, but they are being put into lakes, not into the trout streams. Wisconsin regulations for creel and size limits apply to wild trout fisheries.

Answer: Tom Waters

When I was in Michigan, in charge of a compulsory permit type creel census, our data indicated that the creel limit would have to have been somewhere between one and two per day in order to have any affect. I would agree wholeheartedly that we must look elsewhere for a productive management rather than creel limit. I think it may serve primarily as a control on gross violations.

Answer: Robert Hunt

A limit of one or two would be good if we could keep fishing pressure constant. However, I think if we dropped it to one or two, fishing pressure would fall off tremendously. If anglers could go someplace else and catch them, they would. Most trout fishermen are very optimistic. They think they are going to catch those ten fish. Fishing pressure can be changed even though it won't have much biological effect on the numbers.

Question: for Robert Hunt and Ray White

What should fishermen do to help promote the things they believe in?

Answer: Robert Hunt

Get informed to the best of your ability. I don't think it would hurt you to subscribe to and to read a few of the technical journals in fish management and fish research that are available. Secondly, support those things which do work. The fish manager doesn't really have a lot of choices and gimmicks and tools in his bag. He has really only a few. We need to work to extend the use of those kinds of techniques which we know do work. In other words, use political pressure if that is what it takes to see that resource agencies set the proper priorities on using the tools that are available. We know that Midwest trout streams can be developed. The techniques are there to do it, to go out and make the habitat better than it is now. We have the tools and we know the streams where it is needed. We need to see that proper priorities on the budget are set so that a greater segment of that pie goes to using the rehabilitation techniques of habitat development that we have. So, get informed and then put on political pressure if that is what it takes.

Then thirdly, continue to push for more research and investigation to find out what that resource is that we manage. We need to try to fill in some of the gaps in the knowledge that we have in order to do a better job. You can help to support research through Trout Unlimited or through the natural resource agency. Fourth, be inquisitive. Stop in and see your local fish manager. Talk to him and see how you can help, rather than just sitting at the club and talking about it amongst yourselves. Go and see him at his office and take some time to chat with him. He would be glad to share his expertise with you because he is a servant of the public.

Answer: Ray White

Support educational and informational meetings by attending them. Politically support your fish managers based on the facts that they have. Go to hearings to protect streams, when it counts, in time and get the people who can do some good to attend. Hire lawyers and get biologists to come and give the kind of testimony needed to get the job done. Get out on the stream all year around. Get to know your streams.

Question:

There seems to be three different kinds of trout management that are widely accepted. These are wild trout management, put, grow and take management; and put and take management. What type of trout stream habitat fits in best with these three different management practices?

Answer: Thomas Waters

Wild trout management does not include stocking and it requires the highest quality environment. We've misused this kind of environment a great deal in the past. Because it is a high quality environment that has supported a wild trout population, we have in many cases superimposed hatchery plantings on top of wild trout populations. We have generally concluded in these situations that stocking was unsuccessful.

The put, grow and take type of management has been used in our reclaimed lakes. These have been stocked with fingerlings and have produced some fine fishing. This has provided a substantial part of our trout fishing resource. There are some streams that can take this kind of stocking too. For example, if we have a marginal stream that can support trout on a year around basis, but for one reason or another does not have a natural reproduction. This is the type of stream that can utilize the hatchery product, putting fish into it that will utilize the environmental facilities that are there, particularly the food for growth and carry over. This is not the case with the third type of management, the put and take, where we don't depend upon the productive capacity of the stream. These are usually a created fishery habitat.

Stream trout lakes now make up seventy-six percent of the total trout stream resource. Twenty-five years ago or less, none of these existed. They were low quality waters that supported some warm water fish but never provided very good fishing. There are 1,600 miles of trout streams in Minnesota. There are also 140 stream trout lakes, which amount to a total of 6,400 acres.

There are really four types of trout management. The fourth one is not planning. These are diverse types of management. There are several different ways to do things. I think we should approach all types of management and all uses of our resources with an open mind that allows for diversity in use and diversity in management. If we have all streams for fly fishing only I don't think we'll be as rich in our trout stream resources as if we have this diversity.

Question:

Has the research been conducted so that we can definitely say that stocking hatchery trout on top of wild trout is harmful to the wild population?

Answer: Ray White

The question is whether it makes much sense to pile hatchery trout on top of wild trout. We have seen one very recent case where the stream certainly supported this, royally. It piled up over four hundred pounds of trout per acre and it wasn't about to do it by wild trout alone. In certain people's eyes, the easy to catch, fast growing type of rainbows and perhaps the Brown Trout that were stocked on top of a fairly good, very fast growing wild trout population may have aesthetically offended somebody's sensibilities or something. I don't know. There is something to be said for that. However, it did make for a diversity of fishing. The stocked fish for people who weren't so skillful and the wild trout there for those who were skillful. It was quite something to see. It was a very successful instance and I think that it was conducted as put, grow and take stocking. Fingerlings were put in in the fall. They were seven to eight inches long. It was a stream with good spring flow, relatively warm water temperatures, and excellent fertility. It was far South in the state of Wisconsin. There was good growth during the winter time. By April those fish, that were seven inches in September, were up to ten and sometimes even twelve inches. It was fantastic. The growth is as good as is obtained by keeping them in the hatchery, so why not put them out there in the stream. There is sixty percent mortality, but one hundred percent growth. So it does seem to work sometimes.

Question:

Should stocking trout on top of wild trout be determined on a stream by stream basis?

Answer: Ray White

Absolutely. With put, grow and take stocking, we need to find out where the put, grow and take stocking can be done by a good survey of stream potentiality. This cannot be applied on a blanket basis throughout the state or even throughout part of the state. You need to know the stream.

Question:

Some Southeastern Minnesota streams have protection. A good wild trout population has been created where only stock trout were once found. Since the natural reproduction has been adequate to maintain the trout population at stream carrying capacities, stocking has been discontinued in a number of these streams. This change in management has produced better fishing for the skilled anglers but many of the other anglers catch very few fish simply because they can't catch wild trout. How can we convince the poorer fisherman that catching no trout is good for them?

Answer:

I think that you can please everyone. I think you can have a darn good fish truck chasing program for those who want to chase the fish trucks and I think you can have a good program for those that aren't interested in chasing fish trucks.

Question:

If we discontinued stocks of these streams, what are some of the alternatives that might be considered to satisfy what some of our skilled anglers call the fork-stick or cane pole fisherman?

Answer: Dave Whitlock

I don't think we should ever set up a strategy to develop the fish truck clientele. I think we ought to have our eye on something higher. We need to promote the idea that put, grow and take is much better than put and take. Even if they're only there for three weeks or a month that's still better than catching them the minute they are dumped off the truck. We have used some of the inherent growth potential of the stream and we have allowed the fish to take on some natural coloration and a little better taste. I have seen a place in Arizona where they simply dump them off the truck. They lay on the riffle and some kid goes out and fills his creel. I don't think we want that in the Midwest. I think we ought to establish a policy that we are not going to perpetuate or encourage this kind of management.

It is very well and good to have streams that have a wild trout management policy because it gives us a certain baseline. As those types of streams increase in their popularity and as the love of the fisherman for them and their skills improve, we hope to develop more and more. But I would not want every stream to be that way simply because it does not provide meaningful fishing to all the public. A trout is a lot of things to a lot of people. Although I'm not totally for the put and take type of fisheries, they have a potential in certain metropolitan areas and elsewhere where the other type of trout will not live. They provide meaningful recreation to certain people. It is a first step up the major staircase of development and we should have some water for everyone, the type of water that best suits their individual needs, with the idea that once the quality stream idea catches on the and public demands more and more we will have our fishing management program set where we can convert more and more water into that as needed. I wouldn't want to have a mile of quality water and 100 people using it any more than to have 50 miles of put and take water and have 10,000 people needing that kind of water. I think we need to find a balance in fishery management so that a person can find the water that suits him and as his skills and the skills of the general angler improve then we will have quality water ready and waiting with that in mind.

To stimulate fishing, we could have people learn to appreciate the blue gills and the rock bass and small mouth bass that they have just outside towns like Detroit. They could have beautiful fishing there. Maybe we shouldn't be making the trout so sacred. It would be good to appreciate some of the other fine kinds of fishing that we have.

Question:

Who should decide what is a big fish and who should define what is acceptable quality in angling?

Answer: Charles Fox

This is a difficult question. Things are not going to be white. They're not going to be black. They're going to be gray. It will vary in different situations and different localities. It is going to vary with the angling needs, the angling thoughts, the angling person and angling requests. Part of this has to be a meeting of the minds, it has to be a meeting of management and a meeting of anglers to determine how certain things today can be managed. I think the thing we have to do is to try to bring about a situation whereby everyone is given something out of this. I'm afraid of generalities, they scare me to death. Generalities scare me in conjunction with stream improvement work, management, almost everything. I think that one needs to look at things on an individual basis. We must also regard trout as being very individualistic. Their individualities are going to get a person into trouble. In fishing, in management, in improvement, and whatever, I think a hard look at a lot of different things must be made and then a meeting of the minds on these things must occur.

Question:

What should be done before plowing ahead with a habitat restoration project? Sometimes I get the impression that fisheries managers can be strictly project oriented. How much emphasis should be placed on the screen study before starting a project? I think we could learn from our sister biological sciences. An analogy to medicine seems appropriate.

Answer: Ray White

An agricultural analogy is probably more appropriate. They have a kind of technical information and know how that would do us a lot of good. The question here about the approach used could be the very words that I think MD's use in approaching their biological problems; examine, diagnose, prescribe, treat and evaluate. This is a very sensible step by step procedure. You ask how much to examine; that would vary according to the goals and objectives. Usually, for the managers that I have seen, they can't do anywhere near as much examination as they would like to because they simply don't have the funds to do it. One guy might cover several counties and be responsible for maybe several hundred streams, lakes and ponds. How is he ever going to get enough time to put in a good survey on each one of these streams? It is impossible under present conditions. Many more personnel are needed. The diagnosis is part of the examination. A person combines what he discovers with what he knows from background information and previous experience. The prescription is the very careful suiting of the treatment to the situation at hand. This must be done on an individual basis. The treatment is the application of management. The evaluation is often the most overlooked part of the whole process. The money is issued to carry out a stream improvement project or a stocking program with little concern for evaluation. Does anyone look at the results of stocking program, really? There is some push to evaluate habitat management programs, but usually we go in, do the work, are glad that it is over, take the final exam and then go away, leave it and forget about it. All too often that's the case and it's regretable.

Question:

Has any thought been given to the creation of streams for various types of fishermen such as fly fishermen and spin fishermen, or of streams for various skill levels of fishermen?

Answer:

Wisconsin does have a stream classification system which is based almost entirely on the biological characteristics of the stream. The criteria are probably based on the naturally sustained trout population and a good supply of the proper quality water. A first class stream is one that fulfills those characteristics. If we look at it from the standpoint of food and feeding habits, we may find a first class angling stream is not necessarily biologically a first class stream. For instance, the Willow River near Hudson, Wisconsin is a stream that can only be classified as marginal for trout. It has limited natural reproduction and is definitely marginal in temperature which is indicated by the numbers of carp, large mouth bass and crappies. It doesn't have a great population of trout, but because of the physical nature of the stream; it is attractive looking, there is room for a lot of people to fish and because certain unique types of food organisms occur there, it turns out to be a first class angling stream. There may not be a need for this sort of classification. It would be valid to consider classification because fisheries management is concerned with producing a commodity that includes not only catching fish but the fishing experience too.

Question:

Since there is an excise tax on fishing tackle in Minnesota which supports our operation, what sort of effect would fly fishing only and no kill have on tackle sales which give us considerable revenue to operate with?

Answer: Charles Fox

I was at a beautiful new tackle shop near Pittsburgh recently. I was astonished at the traffic in and out of there. It was amazing. The Trout Unlimited chapter in the area conducted a very fine fly tying class, one night a week for nine weeks. It was attended by one hundred and fifty people including a number of children. I think the interest is going to spread with the development of these nice tackle shops, with more organization, with more Trout Unlimited Councils, and with more fly tying classes. The sale of tackle is going up. Some shops have told me that there has been a phenomenal increase in the sale of fly fishing equipment over the past several years.

Answer: Robert Hunt

It is a little different in Wisconsin. I would make a wild guess that half of our trout water is never going to be anything but big fishing water. That is a fact of life, but it produces trout. They are there to be harvested within a reasonable number and there is no reason why six to eight inch brook trout shouldn't be cropped. In addition, it is very enjoyable and aesthetic experience. So we can't blanket all of our water as being conducive to the techniques which are needed for spin fishing and fly fishing. I think we have begun to deal with a question here in the Midwest which is a fact of life now in the East. That is to determine when fishing density, on these special regulation waters, becomes so high that the very experience which one attempts to have as a part of his quality experience out there is destroyed simply because so many numbers of fishermen are using a very short piece of water. If I see another trout fisherman I don't enjoy myself. That's what quality is to me. If I come to another person on the stream I turn around and go back or I go someplace else.

I was in Pennsylvania. They can have that kind of fishing. We don't appreciate what we have in the Midwest. There they have a couple of pools and a piece of flat water between anglers. A fellow can dabble around there for a half a day and have a great time, I guess. But that's not my kind of fishing. I want to get in and get a mile downstream someplace. We don't have the power in Wisconsin and I don't think Minnesota or Michigan has it either, to control angler numbers as well as controlling the technique by which fishing is done. I think we can reach a point where there are going to be so many fellows that are attracted to fishing with artificial lures that the experience will be so bad that people won't go even though fish are present. We need to look at numbers of fishermen as well as the means of fishing.

Question:

A prevalent attitude within the Minnesota Department of Natural Resources is responsibility to provide recreation. Isn't the time of limited resources upon us and the time is past when it is the responsibility of the DNR to attract additional people to a limited resource? Shouldn't they be preserving the resource rather than exploiting it?

Answer:

As a resource manager I think our job is to put the trout in the stream and not to teach the fellow how to catch them. I don't think it is the responsibility of the agency to tell them in the paper how great the fishing was over in XYZ lake last week when a fifty inch muskie was caught there. We could pull fishermen into any body of water we want, simply by having a local sports writer come out and write an article about it. I think our job as resource managers is to provide the opportunity by putting the deer in the woods, the ducks in the sky and the trout in the stream but it's not necessary to teach the guy to shoot straight. Maybe to shoot safer, but not to shoot any straighter or fly fish any better. I think we need to deal with the problem of numbers of people which can destroy the quality one is seeking.

Answer:

I agree with that and I want to add a remark made by a person who was asked about classifying water fishability. His remark was, "For heaven sakes we don't need to advertise our trout water." This fellow said that the knowledge of where to fish is the very personal bit of property which is passed from friend to friend as a cherished possession and I certainly believe there is much to be said for that.

Answer:

I'd like to disagree with that, because it seems to me that we don't have a real problem with dedicated trout anglers. They are not going to go out and try to get their limit of trout and kill them and bring them home. It's the uninformed angler, the new man that goes out with the worms and so forth. It we can teach that man to respect fly fishing and how he can go out and enjoy a stream and take a trout once in a while, put all of them back and help our resource, then we have accomplished something. I think that is the responsibility of the state.

Question:

Minnesota hasn't used a Whitlock Vibert box program. I think it was used in a wild river study in Wisconsin. What were the results?

Answer: Bob Hunt

I think it is a vastly over-sold program. I think Whitlock lacks some basic biological understanding and I encourage him to read of the technical data. It is not unusual to find, in a good Midwest trout stream, not fifteen percent survival from egg to fry, but ninety percent. This is just as good, in many cases, as the vibert box. Ninety percent is not uncommon. I have counted thousands and thousands of brook trout eggs over the years and it is common to find that at least ninety percent survival from egg stage to sac stage. The big problem is often after they emerge, then there is this tremendous ninety-eight or ninety-nine percent mortality. As a biologist I must object to this kind of inaccurate information.

Secondly, a statement was made that we don't know of a situation where domestic stocking has provided a good sports fishery. That's just wrong. We have hundreds of miles of fine trout streams which have tremendous carrying capacities, tremendous food supplies and are very aesthetic but the trout can't reproduce. We simply put them in past the bottleneck stage and get beautiful fish, four or five hundred pounds per acre. It wouldn't do any good to put vibert boxes in there. They just aren't going to work.

Thirdly, concerning the developing embryo in that box, it doesn't make any difference whether it is developed in a hatchery raceway or in the gravel, the genetics of that individual hasn't changed in any way. If after fifteen generations of domestication, eggs are taken from those fish, stuck in a box and hatched, it's still a domestic fish. There is no change in the genetics of the fish. It still has the capabilities to grow well under domestication. If one was transplanting wild trout, that would be another thing. The other thing that I want to say is that I firmly believe that wherever vibert box planting will work, a fry planting will work just as well or better, because one hasn't accomplished anything really except to hatch the egg. If the genetics of the fish haven't changed you might as well hatch those eggs in a hatchery rather than putting all that time into digging those holes in cold weather and counting eggs and putting them all out there. The hatchery manager can do it much better. He can take a pail full of fry from the hatchery and go out and dump them along the stream and accomplish precisely the same thing and a lot cheaper. The vibert box has worked, but where it has worked, I believe fry planting would accomplish the same thing. The process needs a lot more vigorous testing, by you and by us in a lot more varieties of situations. Some of the biology is wrong, you can't change the genetics of that egg by hatching it in the stream. The genetics are fixed and they have been there dependent upon the generations and generations of fish. By and large you are stocking domesticated eggs from domesticated fish. They are blue eyed and brown haired and they are going to be that way. I think the program is over-sold. I'd rather see us improve the environment in such a way that the natural brood stock that is there can spawn.

Answer:

First of all I think that the vibert box approach is a kind of put, grow and take stocking. It is doing the put part about as early as it is possible to do. Another positive aspect of it is that it gets people out on the stream and builds a sense of communications with nature. It gets them out in the winter, it is a very important time to be out there and to get a feeling for what is going on. I think vibert boxes are a good way to get fishing started in a stream that doesn't have fish already. It is a good way to introduce fish.

Answer: Dave Whitlock

First of all, I didn't come to praise and defend the vibert box system. It does not need it. I have been researching this for the past six years as a fly fishing professional. Before that I was employed in petroleum research and I have the equivalent of two Ph.D's. I do know how to research a project to the point where I get research data that is valid. I have, without fanfare during the past two years gone into extensive research with the vibert box program in streams throughout the country. I have worked through individuals as well as in my own labs at home and that was the reason for the development of the box. The vibert box is a management tool that can allow average people who want to become involved in a stocking program to be able to utilize their manpower in this program. The vibert box itself is an instream trout incubator with a nursery system on it. Keep in mind, first of all, that trout eggs regardless of whether they are fifteenth generation hatching degenerates or wild hatchings from a stream of thirty generations, the vibert box will allow the maximum amount of production from these eggs. They will be allowed to develop their full natural wild potential in that stream.

People in New York state attacked me on this program five years ago. Now they are using the box there. They are enjoying its success. It is not the answer for all streams. It is only ideal for a few situations, but it is one of the practical answers other than natural reproduction of trout. Where there is ample reproduction, it isn't needed. Where there is limited pressure so trout can develop a resident population it will not work, it doesn't need to be there. It is useful and I'm very sorry that fishery departments around the country, from time to time, see fit to disregard it because this is a tool that you can use either through their own labors or through the help of other people.

If a trout that is in an egg form is hatched in a stream it will have the best chance to survive. I can't emphasize that enough. We have put fry in three different streams in our research. We can take freshly hatched trout all the way up to about the two and one-half to three inch fingerlings stage of either domesticated or wild trout and placed them in a stream environment. There is a terrific mortality rate when they are initially introduced. It doesn't make any difference where they are placed. With the vibert box, eggs themselves or the fry do not have the shocking mortality due to the impact of introduction.

For instance, in Missouri one year we put 15,000 brown trout from one and three-fourth inches long to two and one-half inches long in a sectioned off two mile stream that contained no trout and a marginal population of warm water fish and various predators. Within three months time those fry were gone. Shocking, skin diving and seining revealed less than four fish in the two miles. The next year we implanted the same section with 20,000 brown trout eggs in vibert boxes; the same water, the same situation. The following June the Missouri fish and game department and the land owner came out and recovered over four hundred brown trout from one and one-half to four inches long from that vibert box hatch.

Now then, what does that tell you? That tells you that because the eggs were hatched there and because they grew up there, they developed the necessary skills to survive in the stream. The vibert box hatch survived because they hadn't become, in one way or another, dependent even for a short time upon what the hatchery could give them in protection and easy handouts. This is where the fish are lost. If there are streams in Wisconsin and Minnesota where the vibert box will work, I think that it should be worked there. It is not a cure all for all streams but it is unfortunate that the system is attacked because people refuse to realize that it could be a help in trout stream environments. I believe that, intelligently used, it will be one of the major natural tools in the future. It isn't for all situations. If other things work better and management people understand the problems, you shouldn't grab for the vibert box and run to the stream and plant it and expect fish to be there. It is a beautiful method that works when it is intelligently used. If natural reproduction needs to be defended then so does the vibert box, but if you don't need to defend natural reproduction don't defend the vibert box either. That's as simple as that. It's a supplement to the natural reproduction process.

Questions for Charles Fox and Ray White

Question:

Is the practice of rocking up the stream sides to prevent erosion of the stream banks a good practice?

Answer:

I have seen places where that has been done in various ways. I've seen it done by highway departments in which they have meticulously laid in masonry, one stone next to the other with good fit and so on. They have more or less paved the bank to prevent erosion. That was horrible. It really ruined that stretch of the stream. On the other hand, great big chunks of rock that are just blasted and split up any old way can be tumbled in. This would mean using a lot more rock so it would be more expensive, but in the tumbling they lie like jack straws, this way and that with lots of crevices and ditches and places for fish to use. There isn't any behavioral data on it and that's one of the reasons we are studying fish under water. It appears to be much more successful and much better than a bare and eroding bank.

Question

Can't some of those dams that are put in for oxygen and holding water to increase the depth also be partially made with logs in the upper section at the top of the dam?

Answer:

Yes. The so-called Hewitt ramp is made of logs and boards and the beauty of it is that you can't see it when it's done.

Question:

I've seen some of those dams which didn't seem to be stopping much water. Why is that?

Answer:

Some are built below the crest of the riffle. They don't dam the water up to any great volume. Instead a pool is created below. The plunge is the important effect. We like to see those things built where they won't dam up the water because we all know the bad effects of siltation and slowing of water that might occur.

Question:

Would there also be some places where water is held immediately above the dam which are hard to fish?

Answer:

Well, that's certainly true, but I would say that under many circumstances that's also going to silt in eventually.

TROUT WATER: CONFLICTS AND COMPETITION FOR RESOURCES

UPPER MIDWEST TROUT SYMPOSIUM II

WHERE THE TROUT ARE

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ABSTRACT: Trout have specific requirements for food, temperature, shade, water quality and stream bed conditions. Trout are found where these conditions are favorable. Trout streams in Pennsylvania, Wisconsin, Idaho and Wyoming are described.

The trout has long been my enchantress, its very name can evoke the bright clean streams and soft spring days of memory. As a fly fisher I have pursued this fascinating creature across the face of our continent, and in the end, the trout has also become my teacher. Delving with fervent abandon into the life rhythms of this fish and its food organisms, I have discovered many secrets of its life and learned some basic laws of nature.

Streams, I have found, are not just masses of flowing water. There is a wedding between this fluid and the land through which it flows. Pure water is an absolutely sterile growth medium; it is the earth that supplies the necessary ingredients to support life. The rocks and soil yield up materials to the ground water seeps that feed the streams. Surface runoff carries organic material into the stream. The minerals support aquatic plant which harvest the sun and store the energy in their cells. These plants and the organic input from the land serve as the food stuffs for an exotic array of insects, crustaceans, mollusks, worms, and others which in turn feed the trout.

The quality and quantity of minerals and organic runoff supplied by the land determines the total biomass and species of organisms the stream will support. Hard water streams contain large amounts of dissolved minerals which plants need. Such waters are rich in plant growth and hence can support a large number of trout. Soft water, on the other hand, tends to be acidic and lacks a heavy charge of minerals. As such, it cannot support as large or as diverse a plant population as hard water. Trout in soft water streams tend to grow slower and be fewer in number than those in the more mineral rich waters.

In south central Pennsylvania, the earth is underlain with vast beds of Paleozoic limestone. Over the eons, water seeping through the cracks of this carbonate rock has dissolved it, etching out a network of underground rivers. The caverns of the earth cool the water which in a few spots emerges from these secret passages as full blown surface streams. The rich load of carbonates in the water supports luxuriant beds of water cress and elodea. Trout grow robust on the copious invertebrate fodder.

The smooth currents of such limestone spring creeks as the Letort, Big Springs, Yellow Breeches, and Falling Springs wind through a pastoral countryside of rich farm lands. Black walnut and willow trees grace the banks where wildflowers add their pastel voices. It is an idyllic land for the fly fisher, rich in angling heritage and pregnant with promises for big trout.

My first angling trip to the Big Springs near Newville had started with an all night downpour. By ten o'clock the next morning the rain had slowed to a drizzle, and I headed for the stream, expecting to find it high and dirty. But the abundant streamside vegetation had sponged up the rain, and the river ran clear. Other streams in the area, flowing through cattle pastures and freshly plowed fields, were not so lucky. Unchecked by plant growth, the rain simply drained off the fields. This heavy surface runoff carried the soil with it, swelling the streams to angry brown torrents. Buffer strips of trees and heavy undergrowth along the banks would have done much to ease these rivers' burdens.

Trout in the Big Springs were feeding heavily after the early morning rain and provided me with sport as is seen only a few times during a lifespan. Trembling hands photographed each big fish then gently released it back to the river.

The quality angling on these limestone streams is no accident. It has been preserved by the efforts of great anglers such as Charlie Fox and Vince Marinaro who have not only lobbied for special fishing regulations but have spent their own monies to help save the streams and surrounding lands from the malignant inroads of man.

In the northern highlands of Wisconsin, glacial till covers the vastly older granite of the Canadian Shield. The ground waters of this region are mineral poor. Streams depend largely on organic input from the land as a nutrient supply. Numerous shallow lakes left by the glaciers 11,000 years ago have now been filled by the persistent efforts of sphagnum, tamerack, cedar, and spruce. These bogs and swamps are living blotters that hold back the rains, releasing them slowly so that the streams run at nearly constant levels year-round. The shade of the trees and the cold bog temperatures keep the streams refreshingly cool. It is ideal brook trout water.

Anglers at the turn of the century report catches of big brookies that exceeded 150 pounds per person per week! Unable to withstand such radical over-harvesting, the populations of this lovely, scarlet flanked fish declined sharply. Brown and rainbow trout were introduced. These exotic fish further reduced the brook trout populations by competing for available food and shelter.

The trout's need for cool water is well known among anglers. For best growth and survival, this fish prefers water that rarely exceeds 75°F (24°C). Brook trout require even cooler temperatures; best body growth occurs at 55 to 61°F (13-16°C). Their eggs require a frigid 46.5°F (8°C) in order to develop. When the big pines fell to the cross cut saw and double bitted ax, the waters of many streams were no longer shaded. Warmed, they became unsuitable brook trout habitat.

The bogs and swamps, however, have resisted the pressures of logging, farming, and development and still supply their balm of cool water to the sparkling gravels of many smaller streams. And although the big fish are now only legends, their smaller ancestors still inhabit many of the headwaters across the northern region of the Lake States. Here, where the air is sweet with the pungent fragrance of the conifers, the angler can still enjoy the beauty and solitude of an earlier time.

To trout fishermen, large dams are hateful devices. They bury favorite riffles and pools, obliterate hillsides where the shadbush and flowering dogwood grow, and drown the trees that shade the river. The large surface area of the impoundment absorbs vast amounts of solar energy, and the surface water warms above the tolerance limit of the trout. If water is released from the top of the lake, the stream below the dam is also warmed, often greatly lowering its capacity to sustain trout.

But a few dams have unwittingly aided the trout fishery. At some dams in the southern U.S., water is released from the bottom of the reservoir. This water has been cooled by the depths of the lake, and trout thrive in the cold, nutrient laden streams created by these undershot dams. However, this plus is offset by the loss of the warm water species that occupied the original stream. Much is gained but much is lost by man's continual interference in nature's processes.

The West! I don't know whether it's the majestic grandeur of the mountains, the haunting, Andrew Wyeth beauty of an abandoned homestead, the primal vastness of the land, or the allure of innumerable, tumbling rivers that so attracts me. Perhaps it is all of them. To the trout fisher, the West is paradise found; teeming rivers still yield impressive catches in a landscape that gentles, like a poultice on the soul.

Here, the largest rivers are still trout streams, giants such as the Yellowstone, Madison, Snake, Salmon, Missouri, Flathead, and many others, reflecting, as yet, a minimal impact of civilization. Their eastern counterparts have long since been swallowed up by the pollutants of man's good life.

There are spring creeks and mountain lakes, too, each a jewel of inestimable value. Silver Creek in south central Idaho is one of the crown jewels. It's future was uncertain until Jack Hemingway (an avid angler like his father) persuaded the Nature Conservancy to purchase a sizable tract of the headwater springs area. Anglers all over the nation contributed to the over one-half million dollar price tag. This land and its spring creek will now be conserved in perpetuity for the trout, the birds, the animals, and man.

Mountain lakes offer a uniqueness of their own: a chance for solitude, a place to satisfy the indefinable need to be near water, and a time to awaken instincts deadened by modern pressures. To know the tranquility of the lake at eventide and feel its beastual power during a storm is to look into its very soul and see yourself reflected there like the mirrored images of snow topped peaks.

My favorite piece of western real estate is Yellowstone National Park. This hissing, bubbling land of mud pots, fumerols, and geysers is a link to a more primal time when the earth was still vibrantly youthful. Although there are in excess of three million tourist visits per year to this first national park on earth, you can still get a feeling of the pristine times when this area was known as "Coulter's Hell."

The trout are there too. The mighty Yellowstone River supports an excellent population of the black spotted cutthroat trout. These fish stand as a tribute to man's ignorant neglect and his almost-too-late wisdom. Early catch limits were high, reflecting the large numbers of fish in the river and the relatively few trout fishermen.

Tourist visits jumped dramatically in the 50's and 60's, but the catch limit was not decreased to balance the vast increase in anglers. Total take from the river rose beyond its productive capacity. Both average fish size and total trout population declined alarmingly. So much so, in fact, that the birds which normally fed on the trout were having difficulties finding fish. Managers moved to eliminate all killing of trout from the Yellowstone River.

This catch-and-release program has been remarkably successful. During hatches of aquatic insects, cutthroats now dimple the surface in large numbers. The fly fisher can take 10-15 fish per hour--a hundred-trout day is not impossible! And the fish now average several inches larger than just before the no-kill regulations were imposed. There are few places on earth where such angling can be had in such grand surroundings.

All these places are not just important to the trout fisherman, they are of significant value to everyone. While three quarters of our planet is covered with water, less than three percent of it is fresh water, and over 75 percent of the fresh water is frozen in the polar ice caps. Thus, less than 0.75 percent of the fresh water is actually free; nearly all of this is ground water. In fact, only 0.0001 percent of the world's water runs in rivers and streams at any one time, and most of these are not suitable for trout. Less than one millionth of one percent of the world's water flows in trout streams.

When man thinks of fresh water he envisions the cool, clean, bubbling water of trout streams, not the tepid, silt laden water of "Old Man River." Not only this, but trout streams flow in the wild places of earth. These are the areas man seeks in his retreat from the crush of the work-a-day world. Trout streams represent the last bastions of cold, pure water and wild country.

Ernie Schwiebert has called the trout the "canary in the mine," an indicator species, one that signifies the quality of rivers and gauges man's destruction of ecosystems. All of us need the trout, because all of us need the pure waters and wild places where the trout are.

DEALING WITH CONFLICTS IN PLANNING FOR RECREATIONAL RIVER USE

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ABSTRACT: Conflict over trout water usage is one of the many problem areas which has developed from conflict in recreational use of our lands and waters. Planning recreational use is necessary to reduce the conflict. However, planning is difficult because to plan is to resolve the conflict. The sources of recreational conflict are examined and the conclusion is that the view we hold of recreational areas must change before the conflict can be fully resolved.

INTRODUCTION

Those of you who know me might find this hard to believe, but in my youth I was greeted by the proprietor of the local sporting goods store as the "purist." I was always looking for the finest gut leaders and number 16 dry flys. At one point I'd even considered making my own split-bamboo fly rod. The Whitewater Valley of southeastern Minnesota was my favorite haunt; back then it was, or at least seemed, much larger, wilder and more remote. A lot of changes have occurred. I no longer consider myself an avid fisherman. My participation in the sport has decreased largely due to circumstances and the demands of other interests; but other changes were occurring even before I left southeastern Minnesota. Opening day lost much of its appeal when the streams became crowded with fishermen of all kinds, along with their camps and vehicles. My first response was to wait until mid-summer when the bugs, nettles and temperatures discouraged most of the others. Even this tactic was less rewarding when the trail bikes and 4 wheel drive vehicles began to penetrate the upper reaches of my favorite streams. Suddenly the Whitewater had become much smaller, a tiny remnant of what was once a vast sanctuary.

I needn't dwell on the vulnerability of trout fishing to conflicting land use; most of you have learned from both your own experience and from others. Few, if any, recreational activities are as susceptible to intrusion or development. When encountering other, conflicting activities in the field the trout fisherman is practically defenseless. We have come to realize that in order to provide a quality experience we must have rational land use planning with ample controls and enforcement. The kind of experience I enjoyed in my youth can no longer exist by de-fault.

The threats of pollution, erosion, residential and industrial development are obvious. I would like to focus on the conflicts <u>within</u> the realm of recreation. This is the area of conflict that is becoming more and more severe as more recreationists, with more consumptive demands, are being crowded into less and less open space. Intra-recreation conflicts reflect the ambivalence in a society which is torn between the desire for material possessions and the more subtle benefits of a natural, unaltered environment. In the recreational setting the conflict is direct, we needn't understand some complex econometric model in order to appreciate how another person's recreational pursuits are impacting on our own.

As I suggested earlier, the more vulnerable activities must resort to planning and land use controls in order to obtain a fair share of our outdoor resources; in other words, the battle for more and better trout fishing opportunities must be fought in the political/public agency arena. Here, we might easily assume, the trout fisherman ought to fare quite well. After all, he isn't asking for expensive facilities; trout fishing is consistent with good conservation practices; the trout fisherman asks little but to be left alone. But we know that the trout fisherman hasn't done all that well. More often than not he has lost ground to other recreational demands which are far more consumptive, expensive and less consistent with the protection of the environment. To many of us, this seems unreasonable and difficult to understand; but, we must realize that we are dealing with an entirely different mind-set. I'd like to offer a quote; it doesn't deal directly with trout fishing, however it should help to illustrate the problem. This is taken from a presentation defending the use of off-road-vehicles: "The beauty of the ORV phenomena is that the people who use the vehicles rarely, if at all, ask that land be set aside for their exclusive use. They are multiple users ready and willing to use lands already in use by other people for other purposes." I wasn't there, but I have to assume it was said in all sincerity. It gives us some idea of the kind of reasoning that must be dealt with.

WHY ARE RECREATIONAL CONFLICTS SO DIFFICULT TO RESOLVE?

I am not going to dwell on the mechanics of land use planning; this is a constantly evolving process. Rather, I would like to point out the fundamental characteristics of recreational conflicts which make them difficult to negotiate in the planning context. Recreation, after all, is not a matter of life and death; why then are the conflicts between competing activities often so intense and bitter? I'd like to offer the following reasons:

1) Recreation is the most direct form of land use

By this I mean that the individual derives immediate and primary benefits from occupying the land or water. Any conflicting use or development is felt and understood at once. By way of contrast, other benefits are derived indirectly; for example, food and fiber are processed, packaged and transported to us through a complex network of "middlemen."

2) Recreation is the last bastion of freedom

Most people are more or less resigned to the circumstances of their home and workplace, at least for the immediate future. At the same time they would like to maintain, even if it is a partial illusion, that their leisure is their's to use as they please. To complicate matters, our notion of freedom is constantly evolving. The traditional, narrow concept was concerned primarily with freedom of activity. Only recently have we begun to fully appreciate the importance of freedom of place, in other words, the freedom to enjoy the kind of environment we prefer. The best example is our changing attitude toward smoking. The trend is encouraging, but the transition isn't complete. There are still those who cling to the more limited, traditional concept and thus have difficulty understanding how preserving a natural environment contributes to freedom.

3) Most recreational conflicts are "one way"

I have already alluded to this characteristic; and trout fishing is one of the best examples. If two recreational activities are mutually offensive to each other negotiations can be relatively simple -- neither has anything to gain by using the same area. In the real world, however, one of the antagonists usually tends to displace the other by his mere presence; he may be quite indifferent even oblivious to those who are seeking a different experience.

Ironically, the dominant form may also have a psychological advantage in the political arena; they can present the appearance of generousity, after all, they are willing to share, while their opponents are selfishly asking for exclusive use.

At this point I'd like to insert a word in defense of canoeists. This type of activity is often caught in the middle; for example, canoeists are forced to seek quieter waters because the experience they desire is pre-empted by motorboats on the larger rivers and lakes. The creation of non-motor zones on the larger waters can thus benefit trout fishermen even though motorboats are not a direct threat to their streams. This is a good example of the need for a comprehensive planning framework.

4) It is difficult to identify legitimate representatives

Even within a group of trout fishermen there is probably a wide range of opinion as to what is required for a good trout fishing experience. For example, some may disagree on the appropriate means of access to a trout stream, for example, should we have a road to every pool? So, who do the planners and politicians listen to? "Uncle Tomism" is quite prevelant among advocate groups. To cite an example from a conflict I am very familiar with, that between ski tourers and snowmobilers, it is common for someone to claim that they are a ski tourer who enjoys the company of snowmobiles; it costs little to obtain the equipment necessary to legitimize this claim.

It helps to have an organization which acts as an official voice for the participants in an activity even here the organization may be ignored because its members constitute only a small percentage of the participants. A refinement is the full-time paid executive. This can introduce another bias. A professional may perpetuate the conflict in order to preserve his role.

The best way of getting legitimate representation is probably a random poll of the entire population. This is expensive and it is very difficult to formulate the right questions.

5) Perception of space is very subjective

This is especially true where recreational land use is concerned. The benefits can not be readily matched to area in terms such as "bushels per acre" or "board feet per acre." Yet is is quite evident that the type of recreation experience is determined by the size of an area as well as other characteristics. Perceived size is dramatically affected by the means of access. Motorized access effectively shrinks the size of an area. A person's proximity to an area also tends to influence their perception of size. Those of you who have followed the Boundary Waters Canoe Area controversy may have noted how the local residents will often refer to the Boundary Waters Canoe Area as a "vast" area; while others, viewing from afar, are more likely to label it a "tiny remnant." In spite of these difficulties, in the final analysis we must decide, in concrete terms, exactly how many acres or how many miles of stream we are going to allocate to various purposes.

6) Local interests differ from those of the larger community

Reasonable people accept the notion that different areas must be dedicated to different uses; yet, even these reasonable people may balk at locating a specific type of recreation area near to their home. As a rule a local resident desires fewer restrictions so that he can enjoy a variety of activities conveniently, close to home. Those who visit from afar are seeking a specific experience and are more willing to accept the restraints necessary to preserve that opportunity.

Even the "purist" trout fisherman is not immune to the local bias. It is easy to reason that we can let the nearby streams deteriorate as long as we can afford to travel to other areas where the water is sparkling clear and the fish plentiful. And, we can afford it if we promote local development and exploitation. This line of reasoning can only take us so far; every stream is local to someone.

7) The demand for outdoor recreation is unprecedented

Land management agencies have not had time to adjust to the new situation. In the past we could look upon recreational opportunities as a pleasant extra, something which everyone would appreciate, no matter what the kind. Now insatiable appetites, in particular those aided by "technological multipiliers," have filled all the available space; now the primary concern is one of equity, for instance, how do we allocate limited resources to these unlimited demands? This is a new problem for the administrators of our public resources and it will take time to develop the appropriate tools and procedures. It is particularly important to derive meaningful, unambiguous definitions of the various types of recreational lands. We can no longer simply designate public recreation lands and allow everyone to use them as they please.

8) Recreation activities symbolize widely divergent life styles

Recreation behavior is both an integral part and a symbol of an individual's life style. As a symbol it tells others something of one's attitudes and values. In many instances the symbolism involved may elicit more antagonism than physical incompatibility. Those of you who do any running or bicycling probably know what I mean; some encounters are hard to interpret in any other way. Dr. George A. Sheehan, the runner's philospher, argues that runners are seen as a threat to society's prevailing values.

Most Americans have been sold on ever increasing comfort and material consumption; they have difficulty comprehending anyone who would deliberately engage in an activity which limits the use of technology or demands what they consider unnecessary physical exertion. They cannot help but interpret this behavior as a direct attack on their values.

Recreation conflicts are part of a larger war for men's minds. The allocation of our natural resources is the major battleground. How we use these resources not only reflects the values we have today, it also helps to shape the values of the future.

THERE ARE NO EASY ANSWERS

Many of you may feel that I have made planning unnecessarily complicated or that I have not really talked about planning at all. I feel that we cannot begin to plan until we have some understanding of the fundamental forces at work; and I have only scratched the surface.

There is another set of factors characteristic of the administrative structure which tends to influence land use decisions. I hesitate to call them biases, they are simply human traits which tend to slant decisions in a particular direction. Some examples: administrators will tend to defend past decisions; people who are working hard at their job often resent the opinions of outsiders who don't have to deal with the day to day crises; because administrators place a high value on the survival of the organization and their job, they often tend to favor land uses which produce income.

Only through better understanding can we hope to negotiate more effectively with administrators and conflicting user groups. For example, it is difficult to communicate with local groups if we cannot show any empathy for their unique relationship to the resource. It is also important to acknowledge the administrator's limitations so that we can play the role of cooperator rather than simply critic.

Some significant changes are occurring in the recreational land use planning process: first, we are beginning to think of recreation areas as part of an integrated, complementary system, rather than unrelated, isolated components; second, we are seeking ways of involving the public more directly by developing a better language for the expression of environmental preferences. We are beginning to realize that there are no simple "formulas" when it comes to the question of providing for human values, there is no substitute for public involvement.

We cannot deal with the preservation of trout streams, or any other outdoor recreation resource, without considering the entire land use problem. There are no easy, narrowly conceived solutions. It is possible that we could breed a variety of trout that would thrive in sewage and drainage ditches, but first we must ask if this would provide the kind of experience we are seeking. Most trout fishermen are not simply interested in catching fish; they derive benefits from the total environment.

We tend to think of planning in terms of manipulating the physical environment; as complex as that aspect is, it is only a part of the problem. Planning must also deal with people, their perceptions and their behavior. I would like to end with a couple of quotations which I feel are especially appropriate. Aldo Leopold defined the problem quite accurately, I believe, when he said: "Recreational development is a job not of building roads into lovely country, but of building receptivity into the still unlovely human mind." It is obvious that we must take immediate steps to protect the physical environment. Yet, at the same time, it is imperative that we also plan to instill in others an appreciation for the values that we cherish. If we don't succeed in the later, any amount of protection will provide only temporary benefits. In the words of Laurance S. Rockefeller: "Recreation is no longer simply having fun. Rather, it involves the kind of America we have, and want to have, and the kind of people we are likely to become."

TUBERS, CANOERS, AND THE BRULE RIVER FISHERMAN

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ABSTRACT: A study of conflict between tubers, canoers and fishermen. Density of users was compared with the crowding perceptions of the various user groups. The relationship between crowding and user satisfaction is examined. Implications for public policy are listed and alternative methods of reducing user conflict are suggested.

A study of the Bois Brule River in Northwestern Wisconsin was conducted in 1975 to determine conflict among users.[1] The study was made because of the increasing demand for outdoor recreation and little scientific data existed which would help planners decide how to deal with the increased use. The satisfaction of visitors, as crowding increased, was a particular concern.

Three recreational activities take place on the Bois Brule River. Trout fishing is the longer established and the river is quite well known for it. Canoeing is a popular activity and tubing (floating down the river on an inner tube) has developed since the early 1970's. An increase in canoeing, continuing fishing pressure, and the development of tubing has led to controversy over how the users should be controlled. Table 1 shows usage by canoers and fishermen for a seven-year period.

Table 1. Canoers and fishermen visitation on the Brule River

Year	Canoes Passing Cedar Island Bridge Memorial Day - Labor Day	Department of Natural Resources Official Estimates	
		Canoers	Fishermen
1970	NA*	7,800+	23,500
1971	NA*	13,500+	25,500
1972	4,116	13,650+	21,000
1973	5,224	16,199	23,900
1974	4,109	13,720	25,230
1975	4,586	15,930	16,750
1976	4,270	15,615	19,364

*Not available
+Canoers and boaters combined, along with day use and special use.

1 The study, from which this report is taken, is entitled "Crowding and Visitor Conflict on the Bois Brule River". It was conducted by Thomas A. Heberlein and Jerry J. Vaske. Copies of the study report are available from the authors at 240 Agricultural Hall, 1450 Linden Drive, Madison, Wisconsin 53706.

During the twenty-four day study period, recreational users of the river were interviewed and later were sent a questionnaire to obtain additional information. Table 2 indicates the numbers of river users in each of the three recreational categories and the number of those included in the study sample.

Four types of information were collected and analyzed during the study. The characteristics of Bois Brule River visitors was the first type of information analyzed. The majority of visitors (84.2%) came from Minnesota and Wisconsin. The majority of the fishermen (60%) came from Wisconsin while the majority of the tubers (56.7%) come from Minnesota. Table 3 indicates the distribution of Minnesota and Wisconsin visitors among the three recreational activities. The average age of river visitors increased from tubers to canoers to fishermen. All groups of users had similar levels of family income. The level of education was highest for the fishermen and lowest for the tubers. The nature of the visit to the river was examined next. The findings indicate that canoers, fishermen, and tubers all found a sense of communion with nature, that the visit was relaxing and peaceful and most felt there were few substitutes for the Bois Brule River for their particular activity. There were differences in which section of river was used for each activity. The fishermen being the most spread out along the river.

Table 2. Population and sampling distribution of Brule River visitors.

Rank Ordered Days	Population Distribution			Sampling Distribution		
	Fishermen	Tubers	Canoers	Fishermen	Tubers	Canoers
LOW DENSITY - RIVER USERS < 75						
August 29	3	0	12	3	0	4
August 28	9	0	7	9	0	2
August 27	4	4	26	4	4	9
August 25	7	0	31	7	0	11
August 26	7	0	31	7	0	11
August 22	0	2	50	0	2	18
August 19	7	3	43	7	3	15
August 20	3	5	54	3	5	19
August 18	10	8	46	10	8	16
August 21	3	15	50	3	15	18
MEDIUM DENSITY - RIVER USERS 75-150						
August 12	14	10	69	14	10	24
September 1	9	7	79	9	7	28
August 15	10	9	82	10	9	29
August 11	5	23	83	5	23	29
August 23	6	3	105	6	3	37
August 24	8	25	107	8	25	38
HIGH DENSITY - RIVER USERS > 150						
August 31	13	22	136	13	8	48
August 30	7	4	167	7	2	59
August 13	7	33	144	7	12	51
August 17	7	28	160	7	10	56
August 16	7	21	203	7	7	70
August 14	4	61	178	4	21	62
August 10	4	131	161	4	46	57
August 9	16	69	215	16	24	75
TOTAL	170	483	2,239	170	244	786

Table 3. Wisconsin and Minnesota visitors to the Brule River.

State	Type of visitor		
	Tubers	Canoers	Fishermen
Wisconsin	25.5% (123)	44.2% (989)	60.0% (102)
Minnesota	56.7% (274)	33.5% (750)	18.8% (32)
Other	17.8% (86)	22.3% (500)	21.2% (36)
Total	100.0% (483)	100.0% (2239)	100.0% (170)

Nearly all users were day visitors. Tubing is an activity participated in if it is convenient and appropriate while fishing and canoeing take place on a more regular and frequent basis. Fishermen are more likely to make repeated visits to the river than are tubers and canoers. Nearly two-thirds of the tubers and canoers used the river only once during the summer of the study (1975). Visitors to the river, whether as a fisherman, canoer or tuber, rate it as an intimate experience with nature where one can relax and forget the rest of the world and yet grow and learn.

The third part of the study's analysis examined the affects of density on the user's perception of crowding and overall satisfaction. While density refers to the number of individuals in a particular area, crowding is the subjective judgment of an individual that a certain density level exceeds his preference in that situation. Table 2 indicates the density of the three classes of river users each day during the study.

Contacts between visitors was used as one measure of density. Table 4 shows the encounters reported by the river users during the study. The density of river usage is related to visitor contacts, but does not correlate perfectly because visitors are spread out along the river's length. Certain river sections are more heavily used than others. Certain time periods are more popular with one user group than with the others', tubers, for example, prefer the afternoon. One group, fishermen, often remain stationary. Another factor is that river users are not uniformly sensitive to contact with others.

To determine crowding, the river users were asked to indicate, on a 1 to 9 point scale, how crowded they felt. Table 5 shows the results, The overall results are that 49.1% did not feel crowded at all. Fishermen were most likely to believe the river was crowded (52.7%) and tubers least likely, 43.4% felt it was crowded.

Another attempt to measure the users' perception of crowding is reported in table 6. This information summarizes the responses to six statements concerning users' reactions to meeting other people on the river. A majority of all three groups were not bothered by meeting a group of quiet people on the river. However, fishermen (65%) more than either of the two other groups, felt that the character of the river is changed meeting people. In response to the statement, "The river is too crowded for me", 45% of the fishermen agreed while only 8% of the tubers replied affirmatively. These responses indicate that tubers view the social contact with others on the river very positively, the canoers less positively and the fishermen negatively.

The final area of concern for the study is the overall satisfaction sensed by the river users. Table 7 presents the satisfaction ratings made by the three groups of users from both the interview and questionnaire. The combined totals and group specific scores are almost identical for the interview and questionnaire responses. The tuber's and canoer's responses parallel the overall ratings. A majority of these visitors were satisfied with their trip. However, the fishermen's satisfaction ratings were much lower. The satisfaction response by the fishermen may be due to their perception of crowding, but it may be due in part, at least, to their expectations of fishing success as related to their actual success.

The satisfaction of Bois Brule River users is compared with satisfaction ratings reported in studies of five other recreational areas in Table 8. Differences in levels of satisfaction may be due to density and perceived crowding, to the activity, to the characteristics of the resource, or to a combination of these. Visitors are just as satisfied on high-use days as on low-use days.

The overall results of the study indicate that there is a relationship between use level and crowding and that these are related to a sense of crowding. Whether a person feels crowded or not is always due to social and psychological factors. People who feel crowded are less satisfied.

Table 4. Reported encounters with other visitors on Brule River trips.

Type of Visitor Encountered	Response Category	Type of visitor		
		Canoers	Tubers	Fishermen
Canoers	0	4.0% (88)	4.0% (19)	9.4% (16)
	1-10	54.0% (1198)	74.3% (355)	44.7% (76)
	10-20	28.1% (622)	17.0% (81)	24.7% (42)
	30-30	9.5% (210)	3.1% (15)	11.8% (20)
	30+	4.5% (99)	1.7% (8)	9.4% (16)
Tubers	0	48.9% (1088)	17.8% (85)	65.9% (112)
	1-10	29.6% (659)	35.8% (171)	20.0% (34)
	10-20	12.9% (287)	20.3% (97)	8.8% (15)
	20-30	4.9% (110)	13.2% (63)	2.9% (5)
	30+	3.6% (81)	12.8% (61)	2.4% (4)
Fishermen	0	10.9% (243)	38.9% (187)	22.4% (38)
	1-10	84.8% (1890)	60.3% (290)	69.4% (118)
	10-20	3.9% (87)	0.0% (0)	6.5% (11)
	20-30	.4% (8)	.6% (3)	1.8% (3)
	30+	.1% (2)	.2% (1)	0.0% (0)

Table 5. Perception of crowding by Brule River visitors.

Scale description	Collapsed scale rating	Visitors reported perception of crowding Canoers	Tubers	Fishermen	Total
Not at all crowded	1 & 2	47.6% (1053)	56.6% (269)	47.3% (79)	49.1% (1401)
Slightly crowded	3 & 4	26.4% (583)	26.1% (124)	18.0% (30)	25.8% (737)
	5	4.9% (108)	4.6% (22)	6.0% (10)	4.9% (140)
Moderately crowded	6 & 7	16.2% (358)	10.1% (48)	18.0% (30)	15.3% (436)
Extremely crowded	8 & 9	4.9% (109)	2.5% (12)	10.8% (18)	4.9% (139)
Total		100.0% (2211)	100.0% (475)	100.0% (167)	100.0% (2853)

Table 6. Visitor reaction to meeting other recreationists.

	Tubers % Agreeing	Canoers %Agreeing	Fishermen % Agreeing
The character of the river is not changed by meeting people	70	58	35
Encountering a group of quiet people on the river doesn't bother me	92	91	88
I enjoy meeting other people during a river trip	72	58	40
Our trip would have been better if we had met fewer people	9	26	40
It bothers me to see many people during a river trip	24	45	63
The river is too crowded for me	8	24	45

Table 7. Reported satisfaction ratings of Brule River visitors.

Rating	Interview Data *				Questionnaire Data *			
	Tuber	Canoer	Fisherman	Total	Tuber	Canoer	Fishermen	Total
Poor	0	1	9	1	-	-	-	-
Fair	5	3	13	4	1	1	4	1
Good	11	11	24	12	7	8	27	10
Very good	20	19	20	19	16	22	31	22
Excellent	41	46	23	44	56	46	29	46
Perfect	24	21	12	21	21	22	10	21
Total n's	480	2218	164	2862	154	609	113	876

*Percent

Table 8. A comparison of reported satisfaction ratings across different recreation settings and activities.*

	Grand Canyon	Apostle Islands	Brule River		Sleeping Bear Dunes	Brule River Fishermen	Wisc. Deer Hunters	Wolf River
			Canoers	Tubers				
Poor	0	-	1	0	1	9	18	2
Fair	0	1	3	5	5	13	18	12
Good	4	5	11	11	13	24	31	34
Very good	14	12	19	20	16	20	11	32
Excellent	60	62	46	41	21	23	13	17
Perfect	22	21	21	24	25	12	10	3
Total n	212	859	2,218	480	390	164	234	304

*Percent

The implications for public policy which affect the management of recreational areas are:

1. Crowding is a psychological state, so some people will feel crowded regardless of the actual use level and river contacts. It is difficult to scientifically establish a resource is crowded.

2. Fishermen are the most crowded of any group. There is some evidence that they shift their usage patterns to avoid contact with tubers.

3. Contacts with canoers has the largest impact on perceived crowding.

4. Contacts with tubers has a smaller impact on perceived crowding than contact with canoers.

5. Carrying capacity cannot be determined without clearly defined and specified management objectives.

6. The impact of tubers on crowding has probably been overemphasized.

A number of alternative methods of reducing the visitor conflict do exist. Certain activities could be banned from the river, but there is no clear criteria for eliminating one activity or another. The river could be zoned, with the various activities limited to certain times and areas of the river. Understanding between groups could be promoted. Information on best times and area of use for each activity could be provided to users. A higher skill level for canoers could be required. Use could be discouraged by requiring licenses. The method selected to control use and thereby reduce user conflict must be determined after the management objectives for the area have been determined.

THE TROUT FISHERMAN'S LEGAL RIGHTS AND REMEDIES

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ABSTRACT. When conflict occurs it may be resolved by negotiation between the parties involved. If negotiation fails, it may be brought to court for legal resolution. This is a list of court decisions which define the rights and responsibilities of trout fishermen.

I. TROUT FISHERMEN'S RIGHTS IN CONFLICT

A. Puyallup Tribe, Inc. v. Department of Game of the State of Washington, ______ U.S. ______, 97 S.Ct. ______, 53 L.Ed. 2d 667 (1977). U.S. Supreme Court decision in which the Supreme Court held that neither the Puyallup tribe nor its members, under Medicine Creek treaty, had an exclusive right to take anadromous fish, here steelhead, from Puyallup River.

B. Little Tennessee River - Tellico Dam. Hill v. TVA, 9 ERC 1737 (6th Cir. 1977). Suit based on Endangered Species Act to prevent completion of Tellico Dam because of presence of endangered snail darter. Also at stake is 17 miles of trout stream.

C. Reserve Mining Company v. Herbst, ______ Minn. ______, 256 N.W. 2d 808 (1977). Supreme Court of the State of Minnesota held that Reserve Mining Company could use a site near the North Shore of Lake Superior for taconite tailing disposal. The impoundment will bury 9.7 miles of trout streams (7 miles designated as such by the state) and will remove 9.1 square miles of the Beaver River Watershed.

II. LAWS GOVERNING TRESSPASS ON PRIVATE LANDS

A. Minnesota. Minn. Stat. Ann. S 100.273. New law enacted by 1978 legislature.

1. One may not enter on agricultural lands of another for any recreational purpose (includes fishing) without permission. "Agricultural lands" include lands used to raise agricultural products or enclosing domestic livestock, or lands enclosed by a "legal fence" (essentially all fenced lands).

2. If on any lands of another for any recreational purpose, must close all gates opened to pass through and must not destroy property, trees, livestock or "No Trespass" and like signs.

3. Valid "No Trespassing", "No Hunting", "No Trapping", or "No Fishing" signs must have at least 2 inch letters, be signed, and be posted at least every 500 feet on the boundary.

4. Violation of above is a misdemeanor. (90 days or $500 or both). Also, for first offence offender loses license he was trespassing under for a year, and for second offense for 3 years.

5. Note: It is also a misdemeanor to trespass on railroad tracks. Minn. Stat. Ann. S 609.605.

B. Wisconsin - Wis. Stat. Ann. S 943-13.

1. One may not enter enclosed or cultivated land with intent to catch or kill birds, animals or fish without express or implied consent.

2. One may not enter or remain on any land of another after being notified not to.

3. One may not hunt, shoot, fish, or gather on the premises of another, or enter with intent to do so, after having been notified not to.

4. Notice for the above purposes includes personal notification, either orally or

in writing, or if the land is posted with signs at least 11 inches square displaying the name of the owner placed in at least two conspicuous places for every 40 acres to be protected.

5. Violation may result in a $50.00 fine and, in default of payment of the fine, up to 30 days.

C. Michigan - Mich. Stat. Ann. S 13.1482 (2)

1. Farm Lands. One may not enter farm lands or connected farm wood lots to hunt; fish in a private lake, pond or stream; or operate a snowmobile, ORV, or other motorized vehicle, without written consent of owner, whether or not such lands are fenced, enclosed, or posted.

2. Other Lands. One may not enter other lands of another for above purposes without the written consent of the owner if the lands are fenced or enclosed and maintained in a manner to exclude intruders, or posted with signs with letters at least 2 inches high and placed so as to enable a person to observe at least one sign at any point of entry upon the lands. Note: Re: 1 and 2. Limited exception to retrieve hunting dog.

3. Fisherman, permitted entry. "On fenced or posted lands or farm lands, a fisherman wading or floating a navigable, public stream of a length greater than 15 miles may, without written or verbal consent, enter upon the upland within the clearly defined banks of the stream or walk a route as closely proximate to the clearly defined bank as possible when necessary to avoid a natural or artificial hazard or obstruction, such as a dam, deep hole, a fence, or some other exercise of ownership by the riparian owner." Mich. Stat. Ann. S 13.9482 (2) (3).

4. Violation of above provisions is a misdemeanor punishable by 90 days or $100.00 or both.

III. RIGHTS TO THE USE OF TROUT WATERS

A. Minnesota

1. Navigable Waters, i.e. waters which are used or are susceptible of being used as highways for commerce. Must be a substantial body of water the physical characteristics of which are conducive to water travel and must be situated in a location useful to commercial trade and travel. State v. Adams, 251 Minn. 521, 89 N.W.2d 661 (1957). The person whose land abuts the water owns the land to the high-water mark absolutely and has a qualified interest between the high and low-water mark. A land-owner, thus, may prevent a wading fisherman from walking past the water's edge onto the owned land. The adjacent owner cannot control traffic on the river or river bottom. Note that land owner cannot alter bed or shoreline below the high-water mark without a permit from the DNR. Minn. Stat. Ann. S 105.42.

2. Non-Navigable Waters. Even if water is non-navigable under commercial navigation test, Minnesota has "beneficial public purpose" concept (Minn. Stat. Ann. S 105.38: Nelson v. Delong, 213 Minn. 425, 7 N.W.2d 342 (1942)) which distinguishes between the ownership of the bed of waters, and the use of the overlying waters. Thus, "public use" would include such activities as boating, fowling, skating, and bathing, even on a non-navigable body of water.

3. Wading in a non-navigable stream would not be a permitted public activity on non-navigable waters. The wader would be a trespasser unless, he floated the water. Best solution to the problem is for public acquisition of easments to and in the beds of such waters.

4. An interesting sidelight is that anyone who "Interferes with, obstructs, or renders dangerous for passage, . . . waters used by the public" is guilty of a misdemeanor punishable by $500 or 90 days. Minn. Stat. Ann. S 609.74 (2).

B. Wisconsin

1. In 1911, Wis. Stat. Ann. S 30.10 declared all waters which were navigable in fact for any purpose whatsoever to be navigable to the extent that no dam, bridges or other obstruction could be built without permission of the State.

2. Several cases have established that various recreational purposes are legitimate means by which to establish right of public to use waters.

a. Willow River Club v. Wade, 100 Wis. 86, 76 N.W. 273 (1898). Man sued for fishing (for trout) from boat in Willow (caught 10) with access from public highway between lands owned by Minnesota club. Court held that use by recreational boats legitimate public use.

b. Diana Shooting Club v. Husting, 156

Wis. 261, 145 N.W. 816 (1914). Hunter poled skiff in 12" of water in front of private club and shot ducks. Court held that use by recreational boats legitimate public use.

c. Muench v. Public Service Commission, 261 Wis. 492 53 N.W.2d 514 (1952). Held navigable waters are waters capable of floating any boat, skiff, or canoe, of the shallowest draft and that the right of fishing or hunting are incident to the right to navigate. Thus, any waters meeting that recreational use test may be safely fished by a boating or wading fisherman since the rights to use do not turn on bed ownership but the "public trust doctrine." (Note: Muench case saved the Namekagon River from another dam.

C. Michigan

1. Mich. Sta. Ann. S 13.1081 grants the right to fish in any navigable or meandered water where fish have been or may be propagated, planted or spread by the State of Michigan or the United States.

2. A navigable river in Michigan is one which is capable of floating logs, boats and rafts. In Rushton v. Big Rapids Land & Development Co., 306 Mich. 432, 11 N.W.2d 193 (1943) landowner adjacent to Little South Branch of Pere Marquette River attempted to excavate non-boatable stream to make it inaccesible to wading fisherman. The court held the river to be navigable because of its capability of floating saw logs and it said it could not overlook the stocking of fish by the State of Michigan. The holding of navigability made adjacent owners' rights subject to public rights of fishing therein including, presumably, wading the stream bottom since boats could not navigate the river. Such right, however, does not extend to very small trout streams on private property which have not been used by public for logging or boating, nor to private ponds or lakes. (See in this connection item II.C. above).

3. In Kelly v. Hallden, 51 Mich. App. 176, 214 N.W.2d 856 (1974), though not the court of last resort in Michigan, the court found even without a finding of navigability as set forth, for example, in the Big Rapids case above, recreational uses alone, here fishing, could support a finding of navigability and thus the attendant rights to use the stream. "We . . . hold that members of the public have the right to navigate and to exercise the incidents of navigation in a lawful manner at any point below high water mark on waters of this state which are capable of being navigated by oar or motor propelled small craft." 214 N.W.2d at 864.

IV. REMEDIES FOR STREAM ABUSES

A. First Steps

1. Notify local DNR/PCA officials. Collect as much information as possible. Be persistent - call often to see if abuse has been corrected. In Minnesota, persons to contact include Area Fisheries Managers (see back of Fishing Regulations); County Warden, usually in the county seat; the Section of Ecological Services, Division of Fish and Game, 309 Centennial Office Building, St. Paul, MN 55101; or the Chief Conservation Officer, Division of Enforcement and Field Services, 303 Centennial Office Building, St. Paul, MN 55101.

2. In Minnesota, all permits for appropriations of water from designated trout streams are to be limited to temporary appropriations. Minn. Stat. Ann. S 105. 417, Subd. 4. Notify DNR Regional Headquarters (see back of Fishing Regulations) regarding suspected abuse.

3. Participate in hearings, e.g. regarding tubing concessions; irrigation permit hearings (Wisconsin); zoning variance proceedings (Kiap-Tu-Wish Trout Unlimited Chapter has experience here).

4. Communicate with legislators regarding specific areas in need of reform.

B. Private Rights of Action

1. Minnesota Environmental Rights Act, Minn. Stat. Ann. Ch. 116B. Minn. Stat. Ann. S 116B.03 allows any person or entity to maintain a civil action "for the protection of the air, water, land or other natural resources located within the state, whether publicly or privately owned, from pollution, imairment or destruction . . ." If an action is taken under an agency permit, no action will succeed (unless permit is violated). The defendant in such an action may prevail by showing no reasonable and prudent alternative to the action it is taking; however, economic considerations alone will not constitute a defense to the action. Minn. Stat. Ann S 116B.04. Under this act, a marsh was preserved from a county project

(County of Freeborn v. Bryson, ______ Minn. ______, 243 N.W.2d 316 (1976): and a rod and gun club was closed where the evidence presented established both noise pollution and potential lead poisoning effects of the shot landing in the lake behind the club. Minnesota Public Interest Research Group v. White Bear Rod and Gun Club, ______ Minn. ___, 257 N.W.2d 762 (1977). For the similar Act in Michigan (from which the Minnesota Act was styled), see Mich. Stat. Ann. SS 14.528 (201) - (207).

2. Common law nuisance type of suits.

D. Impact Statement Requirements. Several statutes of varying effectiveness in addressing the preservation of natural resources. The National Environmental Policy Act (NEPA) (42 U.S.C.A. 4321 et seq) was the model for many state acts. In Minnesota, MEPA is set forth in Chapter 116D of the statutes. Minn. Stat. S 116D.04, Subd. 1 requires an impact statement "[w]here there is potential for significant environmental effects resulting from any major governmental action or from any major private action of more than local significance." Such a statement may be requested by a petition of 500 persons. Minn. Stat. Ann. S 116D.04, Subd. 3. Minn. Stat. Ann. S 116D.04, Subd. 6 requires that:

> No state action significantly affecting the quality of the environment shall be allowed, nor shall any permit for natural resources management and development be granted, where such action or permit has caused or is likely to cause pollution, impairment, or destruction of the air, water, land or other natural resource located within this state, so long as there is a feasible and prudent alternative consistent with the reasonable requirements of the public health, safety, and welfare and the state's paramount concern for the protection of its air, water, land and other natural resources from pollution, impairment or destruction. Economic considerations alone shall not justify such conduct.

Wis. Stat. Ann. S 1.11 is similar (it requires that State agencies "[i]nclude in every recommendation or report on proposals for legislation and other major actions significantly affecting the quality of the human environment: an EIS), though much more severely limited in types of items requiring an EIS, and does not have the citizen petition provision or the prohibitions of activities as does Minn. Stat. Ann. S 116D.04, Subd. 6.

The material herein is simplified, and does not attempt to be an exhaustive analysis of the areas covered. It should not be relied upon for taking legal action. Specific questions or problems should be addressed to the reader's personal attorney.

BUILDING SITE DEVELOPMENT ALONG TROUT STREAMS

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ABSTRACT: Trout stream shorelines often provide attractive, desirable building sites for year-round and seasonal homes. Improper sewage disposal is a serious problem for trout streams. Proper sewage disposal enforced by local ordinances will insure that the stream environment is not affected.

There are many factors involved in the proper and orderly development of a building site along the shoreline of a lake or stream. Factors to be considered and carefully evaluated are soil texture and depth, land slope, topography, surface drainage patterns, existing vegetation, separation and setback distances, access and construction procedures to minimize soil erosion and removal of trees.

The purpose of my presentation is to explain how a properly designed and installed individual sewage treatment system operates and how the soil treats sewage. There will be little or no effect upon the environment of the stream since technology is available to assure that an individual sewage treatment system will adequately remove pathogens, oxygen demanding materials, and nutrients. However, it should also be noted that proper technology is not utilized in all instances. Thus, it is the responsibility of the local unit of government which issues permits for the installation of individual sewage treatment systems to adopt a proper sanitary ordinance and to effectively administer that ordinance.

The fundamental objective of any sanitary ordinance should be to protect the public health. If the public health is effectively protected, the other objectives of adequate individual sewage treatment systems will also be met. Sewage cannot be discharged to the ground surface or into surface waters. Pathogens (disease-causing bacteria) are often transported by water. An excess of oxygen demanding substances can create an adverse effect upon aquatic life. Excessive amounts of nutrients can cause eutrophication which will result in excessive weed growth and algal blooms. Surface discharges also create public nuisances such as unsightly conditions and odors. It is important to again note that technology is available for the proper design and installation of individual sewage treatment systems, but the available technology must be utilized through an effective sanitary ordinance adopted and enforced by the local unit of government.

In Minnesota, rules and regulations for the orderly development of shoreland properties have been promulgated by the Minnesota Department of Natural Resources. Each local unit of government is required to adopt a shoreland management ordinance and to administer that ordinance. Minnesota Agricultural Extension Bulletin 394, "Shoreland Sewage Treatment", written in cooperation with personnel of the Department of Natural Resources explains how to identify conforming and nonconforming sewage treatment systems. Of particular concern on sewage treatment systems are separation distances, both horizontal and vertical. On most trout streams the horizontal separation distance for the sewage treatment system is at least 150 feet. For the actual separation distance on streams in which you may be interested, check with the local unit of government. The vertical separation distance between the bottom of soil treatment system and the water table in the soil is at least 3 feet. A high seasonal water table in a soil can easily be identified by someone who is familiar with soils. Many existing structures along shoreland properties have been located closer than the setback distances would presently allow. The shoreland management rules and regulations do not require the removal of these buildings. However, nonconforming sewage systems must be eliminated and new sewage treatment systems located at the proper setback distance. To accomplish this, a small lift station may be used to pump the septic tank effluent to a location on the site where the setback distance is proper and the soils are suitable. Such a lift station, including tank and pump would cost from $300 to $500.

An adequate individual sewage treatment system has two parts: the septic tank and the soil filter, preferably drainfield trenches but occasionally a seepage bed or a seepage pit. The raw sewage from the house flows into the septic tank where the settleable and floatable solids are separated. The settleable solids remain on the bottom and become part of the sludge layer which is partially decomposed by the bacteria in the tank. The floatable solids such as soap scums, cooking fats, etc. remain in a floating scum layer, which decomposes very little by bacterial action. Between the scum and sludge layers there is a clear zone of liquid which is allowed to flow out of the tank. A properly located outlet baffle assures that the solids remain in the tank and only the relatively clear liquid, called effluent, flows out of the tank.

While the effluent appears relatively clear, it contains large amounts of pathogenic bacteria, oxygen demanding materials, and nutrients. Thus, the septic tank effluent cannot be discharged to the ground surface or into surface waters. Instead it must be discharged into a soil filter or soil treatment system. To adequately treat the sewage, the soil treatment system must be of adequate size and located in soils which are neither too coarse nor too fine to treat the sewage. The amount of drainfield trench required for a site depends upon the soil texture and the amount of sewage which will be generated by the structure on the site. Thus, the soils on the site must be carefully evaluated to determine if they are suitable for the installation of a soil treatment system.

A thorough and complete site investigation is the responsibility of the local unit of government which issues the permit for the installation of the sewage treatment system. It is absolutely necessary for a representative of the local unit of government to visit each site and investigate features such as topography, land slope, surface drainage, vegetation and other features which will effect the design and installation of an adequate sewage treatment system.

Prior to the site visit, a considerable amount of information can be obtained on what soils are likely to be present on the site. Many Minnesota counties have complete soil surveys performed by the SCS (Soil Conservation Service). Where complete county-wide surveys are not available, local soil surveys may have been performed and the data may be available in the local SCS office. While such information will be extremely helpful in evaluating the site, it is necessary to actually visit the site and make soil borings and percolation tests in the area which will be used for the sewage treatment system. Site evaluations may be performed by consultants, by knowledgeable homeowners, or other individuals. However, it is the responsibility of the local unit of government to be sure that a thorough and adequate site evaluation has been made. It is usually necessary for a representative of the local unit of government to visit the site prior to issuing a permit for the installation of the sewage system.

After the site has been carefully evaluated, the sewage system can be designed. The design criteria and layout suggestions are contained in Minnesota Agricultural Extension Bulletin 304, "Town and Country Sewage Treatment". The design of the sewage treatment system should be located on a scale map of the lot and specifications of the system carefully written.

A properly designed sewage treatment system must be carefully installed. A series of drainfield trenches connected by drop boxes is the most effective soil treatment system. Each trench bottom must be level throughout its length. This means that the trenches must roughly follow the contour of the natural ground. Trenches should be excavated 2 to 3 feet wide and 2 to 3 feet deep. Clean rock, 3/4 to 2-1/2 inch in size, is placed in the trench along with a 4-inch distribution pipe. The rock is covered with a 4 to 6 inch layer of hay or straw and then backfilled with original soil. The sewage system contractor should use a backhoe for excavating the trenches and utilize a tripod transit or level to be sure that the system is properly installed.

The area where the drainfield trenches are located should be covered with grass as quickly as possible and may be kept mowed as part of the lawn area. With a properly operating trench system, there are no odors nor any danger of contact with bacteria.

It is the responsibility of the local unit of government to administer their shoreland ordinance and to use the technology available to them to assure that our valuable natural resource water is protected by the installation of adequate individual sewage systems. We must continue to emphasize the word "treatment" and minimize the concept of "disposal". When a soil adequately treats sewage, disposal also takes place. However, improper sewage systems can "dispose" of sewage without adequate treatment.

When a local unit of government fails to meet its responsibility for the proper installation of adequate sewage treatment systems, individual citizens in Minnesota can take legal steps to assure that local ordinances are enforced. If violations of adequate sewage treatment are observed along streams, the local unit of government should be notified as they may not be aware of the situation. If they fail to act in a reasonable time, the Minnesota Department of Natural Resources should then be notified. If the local unit of government still fails to act, an individual citizen can obtain a Writ of Mandamus under which the Department of Natural Resources will be required to enforce the local ordinance. Thus, individual citizens or organizations which are interested in adequate sewage treatment along our lakes and streams can play an active role in assuring that sewage is properly and adequately treated.

In conclusion, I want to emphasize that technology is available to assure adequate on-site treatment of sewage. It is the responsibility of the permit issuing authority to see that proper sewage treatment systems are designed, installed and maintained. Individual citizens or organizations can play an active role in assisting local units of government and the effective administration of their shoreland ordinances.

REFERENCE MATERIALS:

Single copies of the following publications are available at no charge from county Extension offices in Minnesota or the Bulletin Room, 3 Coffey Hall, University of Minnesota, St. Paul, MN 55108:

Bulletin 304	"Town and County Sewage Treatment"
Bulletin 394	"Shoreland Sewage Treatment"
Folder 261	"How to Run a Percolation Test"
Folder 337	"Get to Know Your Septic Tank"

A more complete reference manual is the 1978 Home Sewage Treatment Workshop Workbook available for $15 from the Office of Special Programs, 405 Coffey Hall, University of Minnesota, St. Paul, MN 55108.