WILD TROUT V

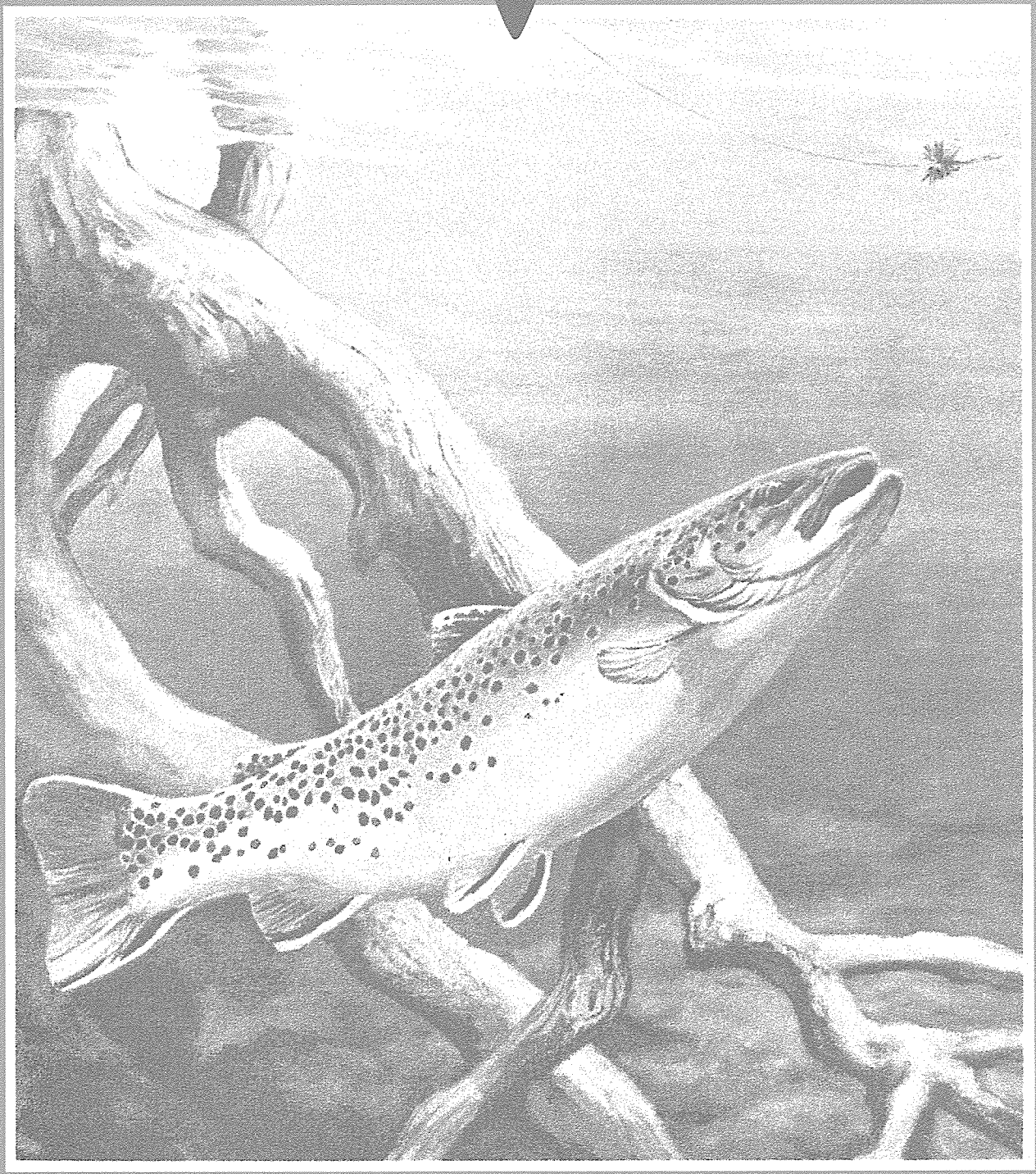

Illustration by Bob Hines

WILD TROUT V

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WILD TROUT V:
WILD TROUT IN THE 21ST CENTURY

Yellowstone National Park
September 26-27, 1994

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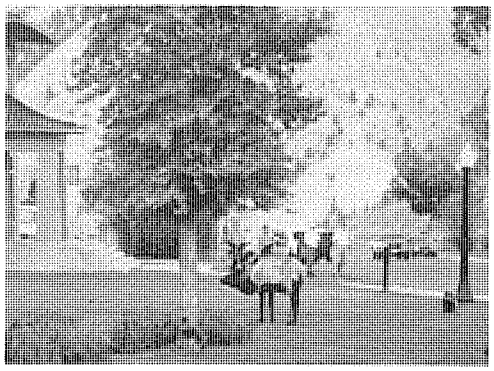

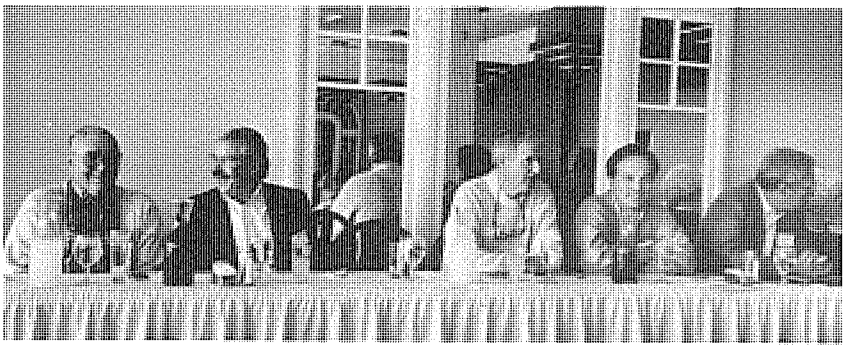

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WILD TROUT V: INTRODUCTION

Roger A. Barnhart[1]

Welcome to Wild Trout V. Wild Trout I was held almost exactly 20 years ago, September 25-26, 1974 at this same location. Some of you were here for that meeting. Wild Trout I was co-sponsored by the Department of the Interior, largely due to the enthusiastic support of Assistant Secretary Nathaniel Reed, and by Trout Unlimited. The symposium was a success and was followed by Wild Trout II, III, and IV at 5 year intervals always at this location. As we begin Wild Trout V, I would like to recognize and thank our co-sponsors: Department of the Interior (more specifically the Fish and Wildlife Service and National Park Service), Department of Agriculture (specifically the Forest Service), Environmental Protection Agency, the American Fisheries Society, Trout Unlimited, and the Federation of Fly Fishers.

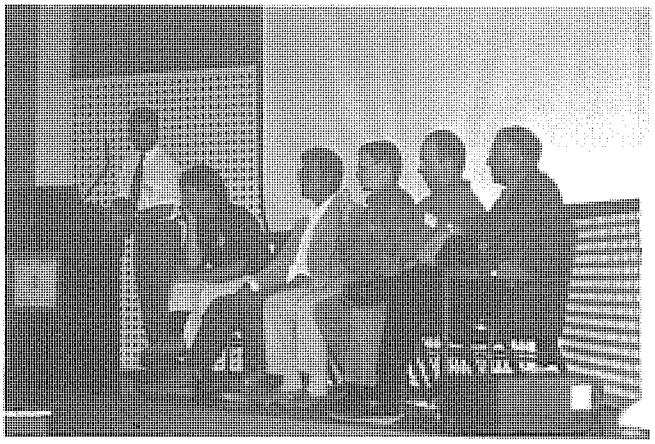
We keep coming back to this beautiful setting -- it seems like just the place to talk about Wild Trout. The theme for Wild Trout V is "Wild Trout in the 21st Century". Management agencies are increasingly aware of the importance of preserving wild stocks of trout and salmon. Such stocks represent a pool of genetic integrity and are necessary to insure the existence of many species for future generations of anglers and fish watchers. However, each year additional fish species are being considered for listing as threatened or endangered. The co-sponsors and organizers of this conference hope that Wild Trout V will stimulate new efforts to enhance, preserve, and properly manage wild trout and salmon. Thank you all for coming. Let's go "wild" for two days!

[1]Leader, Calif. Cooperative Fishery Research Unit, Humboldt State University, CA 95521.

Panel presentations:

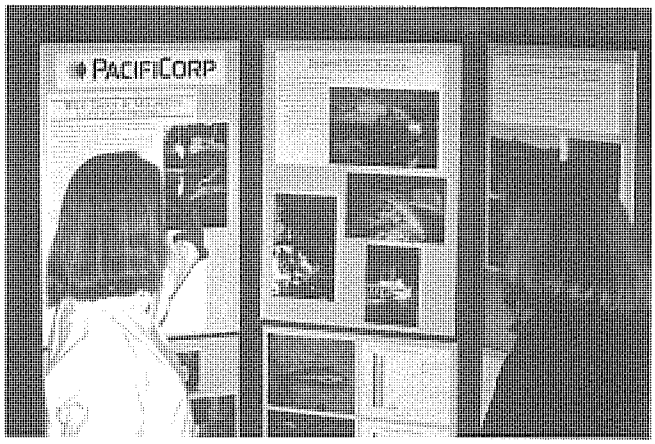
Perspectives on wild trout fishing,

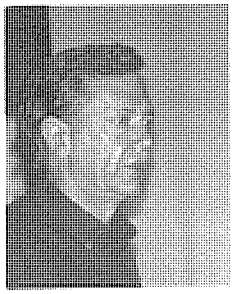
future of wild trout fishing,



what is a wild trout?

Poster presentations were also a major part of the technology transfer process.





Keynote Address: Wild Trout in the 21st Century

Secretary of the Interior Bruce Babbitt

I suggest that, maybe, we should call this Wild Elk Number V, after spending last night here at Mammoth. I was here earlier in the summer under the guidance of Dan Sholly and John Varley. We had a wonderful time examining the history of the park and doing some on the ground sampling of trout issues. First of all they marched me across a couple of mountain ranges and into the upper regions of Slough Creek. For two days we looked at the wonderful cutthroat fisheries that have been preserved in the watersheds of Yellowstone. Then we revisited Yellowstone Lake and I listened to the story of that lake and what has happened in the past. Yellowstone Lake is a success story that ought to radiate confidence and optimism. It is an example of what we need to do in the rest of this country. The lake also reflects the history of mistakes we've made in freshwater and trout fisheries in many places in this country. When the park was created the first thing the Army did was take a look at the lake and say, "We ought to stock fish in it." So they went to the United States Fish Commission and first they tried Atlantic salmon in the lake. There are rumors they even tried some northern pike. They stocked a number of different species and over time they watched the lake decline to near collapse. Finally, in the 1960s a couple of park superintendents in succession began looking at the natural environment in the lake. First they terminated all artificial stocking of Yellowstone Lake, and second they limited the take of fish which then allowed some adults to come back to spawn. What we see now is a shining example of what we need to do elsewhere in this country. The lake is now a wonderful vital fishery. And with the restoration of the fisheries came the return of much of the rest of the ecosystem. As the fish began to spawn and use the surface of the lake we saw a rebound in the white pelican population. The ospreys are back on the lake, and most dramatically and most remarkably, the grizzlies are back at Fishing Bridge after a long and protracted political battle in that area.

What I'd like to do today is just reflect with you on my own experiences of issues of trout and ecosystems. I've discovered something which many of you know and have talked about for years -- vital trout fisheries really depend on a whole lot more than just the fish. Fish, of course, are perfect mirrors of such things as water quality, turbidity, and water temperature, and the quality of the water in a stream is a perfect mirror of every single activity that has taken place in that entire watershed. A sample of water from that stream is as accurate a gauge of the complexity and activity of the entire ecosystem as a blood sample is of the health and biochemistry of your body or mine. I began to understand the mistakes that we've made historically not only in Yellowstone but all over this country, and that we are still making. For example, destroying the landscape and then thinking that we can expiate the sin by building fish hatcheries, and simply dumping fish in the river to mitigate the losses of the habitat and degradation of the entire ecosystem. As we look up from the fish to the water, the watershed, the ecosystem, it becomes clear that we're going to have to begin managing all the parameters of the entire picture. It is an ecosystem issue. There are a number of approaches that we are now making that will have extraordinary importance to the quality of streams and fisheries.

First, one that you've heard a little bit about, is grazing. I come from a ranching family. Grazing practices can, in fact, affect water quality and streams in a dramatic and destructive way. I saw this lesson and the possibilities most dramatically in a place called Trout Creek Mountain in western Oregon -- one of those large geologic outliers in that arid landscape. Just a few years back the Fish and Wildlife Service began to look at Lahonton cutthroat trout still hanging on in a few upland

streams that come off this large desert mountain. It became clear that the Lahonton cutthroat trout in that area were headed for early extinction. Clearly the grazing allotment of cattle on Trout Creek Mountain was causing erosion and sedimentation. The streams were clogging up, cover was being destroyed by trampling along the riparian zone. A combination of sedimentation and rising water temperatures meant the virtual end of those fish. At that point we brought together a group called the Trout Creek Mountain Working Group. We had some very contentious discussions. We finally agreed to remove cattle from the allotment for several years, to adopt a riparian management plan, and to carefully administer the Trout Creek allotment by looking to those streams as the indicators of a sustainable level of grazing. If you go back to Trout Creek Mountain today you will find cattle back on the allotment, you will find them being grazed and moved. You will not see the cattle like you did in the old days, all summer standing right in the middle of the water, trampling streams or trampling the riparian vegetation or knocking back the cottonwood and willow sprouts. BLM has a biologist named Wayne Elmore who came out of the Trout Creek experiment. He has helped us draft some grazing regulations which are now out in draft form and will be go in final form to the federal register by the end of the year. Those grazing regulations are going to wipe out a statement coming from old grazing literature that the riparian areas be called "sacrifice areas". The new regulations will protect the riparian areas and will state that the cattle have to be kept moving in the upland areas. Cattle will only be able to use the riparian area under the restrictions of the Federal Endangered Species Act and the requirements and strengths of the Clean Water Act, Section 404, and non-point pollution standards along with the other protective measures. Its a strong statement. The lessons of Trout Creek Mountain have been learned and henceforth must be implemented in every stream in the West.

The next land use activity that we see affecting streams and, therefore, the entire ecosystem is mining. Mining for the most part doesn't take place in the streambeds, with one exception and that is placer mining. The big problem with hard rock mining in the West is acid drainage. Just that simple. I talked with my staff just last summer. I had just read "A River Run's Through It". I think this is the most extraordinary piece of fishing literature that I've ever read. I liked "Big Two Hearted River", I liked Hemmingway, but Norman Maclean's book added two or three new dimensions to the experience of being out on a Montana river fishing. I wanted to see the river that Norman Maclean wrote about but I was advised that I really would not want to do that. Why? Because you won't see what Norman Maclean wrote about. When they made the movie "A River Runs Through It" they had to go to a different river than the Big Blackfoot River. It is now full of mine tailings and it seems that in odd numbered years the acid leaching out kills off many of the fish. Its not the river it was. You can see the same thing in a lot of other places in the West. Summitville is the most recent mine tailing disaster, sitting right on the top of Wolf Creek Pass, at the head waters of the Alamosa River. Fish kills reach miles and miles down that river. A lot of you are familiar with the extraordinary historic problems of the Arkansas River in Colorado. I have seen the San Pedro River in Arizona running red. We must have federal legislation that makes a clear simple statement to every hardrock miner in the West that "you're not going to mine anything until there is a land use and reclamation plan, and you can demonstrate your capacity to meet the literal requirements of the stream protection guidelines and restrictions of the Clean Water Act".

The mining reform bill is sitting in Congress as we meet here today within striking distance of success. I can't tell you whether it will pass. Mining law has not been substantially reformed for 124 years. If you were to write one letter or to make one phone call on the way out the door of this meeting you can tell your Congressman, "We've got to have this." The conference committee is down to one or two items, there is still time. It has extraordinary importance to habitats -- rivers, watersheds and ecosystems of the West.

I have to say a word about logging. Jim Lyons is here and I expect he will have a word or two to say about what we've been doing together. I did not appreciate the connection as deeply as I might have until the early months of 1993 when Jim and I and others in the Pacific Northwest met -- where, because of the crisis with the spotted owl and the failure of our predecessors to enforce the legislation, we had a train wreck of epic proportions over timber cutting. Well, I went to the Pacific Northwest. I saw the spotted owl problem, but it only took me a few days in the Northwest to understand that the spotted owl was just a warning sign of an ecosystem in collapse. Right behind the spotted owl came a marine bird called the marbled murrelet and dozens of other species. As is always the case anywhere with an ecosystem stressed and under trouble because of management practices. There at the heart of the entire old

growth forest ecosystems of the Cascade Mountains from Washington to northern California was the salmon. And I realized that in order to understand how to restore this ecosystem and to build an ecosystem management plan based upon a sustainable future we had to start at the other end. We had to begin rebuilding from river up. We had to go back to looking at those salmon stocks and examining the spawning conditions in the stream and listening to the message sent by those streams. And, of course, when we went out and looked, what we saw were streams in which salmon were not spawning because of clear cutting that was going on where slopes up to 60 and 70 degrees were picked clean of every green tree and every sapling. What was left was scratched up and burned until there was nothing left but ash and mineral soil. And then, when you watch through the winter there are many small slides down in the bottom of the watershed and sediment traveling down the stream and you know why there are no salmon.

Those facts are what drove us toward the construction of the Forest Plan Management Act. It began with the establishment of buffer zones along all streams -- fish bearing streams, intermittent streams, dry feeder gullies. The biologists agree we have to protect those streams. You can't cut close to the streams. We will have buffer zones connected across the entire landscape. And from there we were able to not just look at one or two species but hundreds of species. We were able to construct forest practices that are consistent with maintenance of the ecosystem, forest practices which effectively eliminate clear cutting. Jerry Franklin, a wonderful biologist from the University of Washington, took me on a helicopter trip over Mt. Saint Helens and he said "This natural catastrophe is what, more than anything, gave birth to what is known as the "new forestry." What he showed me was a devastated landscape which is now growing back in wondrous green profusion. The reason was because that even with the destructiveness of that volcano, even with all that was lost -- the mass, the biomass left on the landscape gives rise to regenerative power. And so, instead of picking everything clean and planting a forest of trees that looks like an Iowa cornfield, you cut selectively and leave some biomass on the land, allowing the forest to come back, protecting the soil and making certain the streams are running cold and clear and that the diversity of the ecosystem continues. I am sure that Jim will talk about PacFish as it is now known, and the establishment of buffer zones in forest management practices, not just in the Pacific Northwest but throughout all of the timber lands managed by the Bureau of Land Management and the Forest Service.

I've discussed grazing, mining, and logging. There are a lot of other things to talk about -- ultimately road building and urban expansion practices are going to have to be factored into consideration of how we array our presence on the land. The concepts of planning and zoning following state and local government regulations and providing ultimately the ability of those trout to survive in rebuilding a pristine environment, of a working ecosystem that reflects all of our activity on the land and ultimately whether or not we have the capacity to live more lightly on that landscape.

One other factor, and that is of course, water consumption. By that I mean water use. Because of the way we developed the West we wound up in the onerous position in the 20th century of having a public domain consisting of the national forests, parks, BLM public lands, wildlife refuges, but we found for the most part we didn't have the water to go with the land because of the nature of the development. The water had drifted out into state control and private appropriations, over appropriations with the result that an awful lot of the streams in the West, all of the lowland streams, and many of the highland streams were appropriated to the point where there simply was no water left in the natural channel. Now we are involved in a excruciatingly difficult process of coming back a century later and asking again and again across the West, "Isn't there some way to accommodate the uses? Can't we go back and look at those water uses and establish the concept that we ought to leave enough water in the streams to support a fishery and to reestablish them in many cases?" Its a tough process. We're underway in California in the Bay Delta system. I doubt the day will ever come when there will be salmon migrating and spawning up the San Joaquin River. Those people in California will understand what I mean. There hasn't been a drop of excess or unappropriated water in the San Joaquin River in the memory of man or woman. But there's a lot of possibilities in the Sacramento River coming through the application of the Central Valley Project Improvement Act, the Clean Water Act, Section 404, and the Endangered Species Act. I think we're at the point now where we can go back and marshal some of those water resources to reestablish the vitality of some of those spawning streams, in this case for steelhead and salmon. The same issues are in play in the Rocky Mountains. One example is the greenback cutthroat which is now making a

pretty impressive comeback in Colorado. But we have a lot of water problems there and we now have to go back across the Rocky Mountains and through combination of Section 7 of the Endangered Species Act, the provisions of the National Forest Management Act, the Clean Water Act, Section 404, see if we can move toward finding an equilibrium in water use which will make a statement about managing our ecosystems. We can learn from the tragedies and mistakes of the past and begin to move toward an equilibrium upon the landscape.

Lastly, a word about the politics of this process. I can tell you by my own experience over the last 18 months that it ain't easy. This is tough stuff. There's been a conflict going on for many years over these issues. It flairs up in each generation. The Sagebrush Rebellion in the 1970s, the Great Fight in the 1950s, now the emergence of the Wise Use movement. Our response has not been adequate. One reason it has not been adequate is because over the last several generations there has been a tendency of the environmental movement and the classic sportsmen conservation groups to drift apart. I see far too many signs of this. We have begun to lose many of the sportsmens groups. They are not really pulling as much weight as they should in terms of ecosystem management issues. What is so important about your role is that more than any other group that I can think of across the entire spectrum of people who are fond of "wild trout" and all that is related to that term, you can bridge the gap across resource conservation and the sportsmen tradition of Teddy Roosevelt. Wild trout advocates have a rich history and tradition of understanding that the condition of fish really relates to the entire environment.

I would hope that out of these meetings and out of these considerations you remember that these things don't come automatically. Good science is wonderful and learning lessons of the past is great. In the final analysis, in this society, in this democracy called America its really about political clout. Its really about finding our constituencies and making certain that they understand that their narrow specific concerns are tied to yours and everyone else's and to quality management of entire ecosystems. We have to translate that into political action.

Thank you very much.

Wild Trout: The Result of Successful Ecosystem Management

Paul Brouha
Executive Director
American Fisheries Society
Bethesda, Maryland

In this final banquet presentation the author provides an overview of Wild Trout symposia to date, details the current controversy regarding use of wild trout vs. cultured fishes in fisheries management, and presents considerations to ensure both are properly used. He concludes his remarks by offering four management principles with which all angling constituents and fisheries managers agree and calls for everyone to rally around them as we work together to preserve wild trout and productive ecosystems in the 21st Century.

The first Wild Trout Symposium was held here at Mammoth, Wyoming 20 years ago. It focused on habitat and species management, regulations, and angler politics. It also focused on the effect of stocking fish on wild trout populations. Wild Trout II focused on habitat and management and added sessions to elaborate the wild trout constituents' point of view and to describe research needs. Wild Trout III plowed a lot of the same ground but focused especially on catch and release regulations, water quality and watershed management, and for the first time on the economics of wild trout fisheries in relation to conflicting fisheries and multiple uses. Wild Trout IV took a different approach by focusing on case studies of wild trout restoration and management from around the United States. With the West-wide drought a recent factor, it also highlighted for the first time the effects of wild fire on aquatic systems. In addition, a full session was devoted to the socioeconomic implications of wild trout fisheries to local communities and regional economies. Finally, a contributed paper focused on the endangered Apache trout (as a poster also had in Wild Trout II). Since Wild Trout IV the debate has turned with increasing emotional intensity to the perceived role of cultured fishes and exotic fish introductions as a threat to wild trout fisheries. The debate grew during AFS meetings and in various Fisheries articles but reached a fever pitch at the AFS 1992 Annual Meeting in Rapid City, South Dakota. At that meeting we convened a working group to determine how we could move beyond the polarized "hatchery bashing" biodiversity seekers vs. the state fish chiefs and the fish culturists. We've made some noteworthy progress since then with the 1993/94 point-counterpoint debates on the introduction of exotics beyond their native ranges, with the March 1994 Symposium entitled "The Use of Cultured Fishes in Aquatic Ecosystems", the May 1994 "Wild Trout, Planted Trout, Balancing the Scale" workshop, and the "Conference on Defining Significant Units in Population Conservation." In July we held a facilitated workshop of state and provincial fish chiefs or their designees to develop consensus-based guidelines for the use of cultured fishes in fisheries management. Concurrent with these efforts, executives of the recreational fishing industry, federal fishery management agency representatives, and state resource agency directors and fish chiefs have been working to redefine roles, responsibilities, and partnerships to enhance recreational fisheries stewardship while at the same time conserving federally threatened and endangered species in the context of ecosystem management. At this point several draft and working interagency documents have been prepared detailing principles and procedures to avoid and resolve conflicts among

management strategies for sport, native, and threatened and endangered fishes and fisheries. I expect improved communication and more consistent application of federal policies will result.

A preview of the results of our July workshop is interesting. The facilitated session yielded considerations for the use of cultured fishes for fisheries management. We addressed five areas -- biological feasibility, risk assessment, economic evaluation, public involvement, and interagency coordination. Under biological feasibility:

- complete baseline watershed habitat assessment
- determine opportunities for habitat restoration
- consider fish population status and trends
- consider environmental requirements of cultured species
- determine the carrying capacity of the aquatic system

Under risk assessment:

- The stocked fish should not contribute to extirpation of native stocks. Consider all possible effects on biodiversity, with particular emphasis on threatened and endangered species
- evaluate any genetic effects of the introduced fish on wild, native stocks if interbreeding of stocked and wild fish is possible
- evaluate interspecific and intraspecific behavioral interactions (e.g., competition, predation, changes in reproductive behavior) that would <u>affect compatibility of stocked fish with native fish</u>
- evaluate effects of the stocked fish on population abundance and population variables (e.g., size structure, growth rate, recruitment rate, mortality rate) of native fishes
- consider the history of stock transplants
- consider any possibilities for introduction of diseases to native fishes
- consider the stocked fish's ability to invade nontarget areas or expand its range

and then to reduce the risk of adverse ecological effects there are four recommendations:

1. Remote, isolated aquatic habitats managed for preservation of native species should not be stocked for put-and-take fisheries. If put-and-take management must be used, the stocking should have no detrimental impact on established fish stocks.

2. When fish are stocked into an altered habitat for the purpose of creating a put-and-take fishery, the species or stock used should be the one best suited to use the productivity of the altered habitat. In determining the species or stock:
   - Primary consideration should be given to native species or stocks;
   - If no native species or stock can meet management goals, select the best suited nonnative species or stock to use the productivity of the altered habitat;
   - If nonnative species or stocks are used, impacts on resident species should be considered.

   When nonnative species or stocks are stocked into an altered habitat as part of a put-grow-and-take program, long-term consequences on native species and reversibility of the stocking should be considered.

3. When a species or subspecies is stocked that can interbreed with native wild populations, a genetic analysis of existing populations should be conducted.
   - If the wild population was founded from native fish, native stocks should be used as broodfish
   - If the wild population was not founded from native fish
     - consider alternative available stocks
     - consider benefits and costs.

   In all cases, stocked fish will be from hatcheries with genetics plans and appropriate disease certifications.

   Stocking should be discontinued if self-sustaining populations at levels sufficient to meet management goals are achieved.

4. Nonnative aquarium and display fishes should not be released to the environment

These guidelines will be published (probably before the end of 1994 as a separate document and again as part of the proceedings of the March 1994 Symposium). When you get a chance to review the final document I think you'll agree it is a comprehensive effort to establish a framework for use of cultured fishes in fish management.

It has been a good year for advancing the debate about wild trout, native species management, and use of cultured fishes as we strive to perpetuate healthy, productive aquatic ecosystems in North America. This symposium has advanced many of the past Wild Trout symposia themes -- themes that underlie effective fisheries management in the 21st Century. There are four basic principles that I see emerging from previous Wild Trout symposia and from the recent four years of debate. Two principles relate to coordination of agency efforts and two to Aldo Leopold's environmental ethic:

Coordination Principles:

1. Every jurisdiction must respect the roles and responsibilities of other affected jurisdictions when considering decisions about species and aquatic ecosystems management

2. Every jurisdiction must respect the public's right to make value judgements about resource management objectives within biological limits. The public pays the bills and the resources belong to them. Before actions are taken efforts must be made to educate the public about the biological and social benefits of various alternatives so their value judgements are more informed. Contrary to popular belief knowledge is not power -- shared knowledge is power.

Leopold's land ethic may be stated as "a thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise" (Leopold A. 1949.) Callicot expands on this statement by offering several commandments, three of which are especially appropriate to fisheries conservation: (1) Thou shalt not exterminate species or render them extinct; (2) Thou shalt exercise great caution in introducing exotic species into local ecosystems and (3) Thou shalt exercise great caution in damming and polluting water courses (Callicott, J.V., 1991.).

Ethical Principles:

1. The first ethical principle derives from Leopold's model: When considering management alternatives in pristine habitats where native fish stocks exist; we must preserve their integrity, stability, and beauty. It is the right thing to do. If only because such habitats are so rare (an estimated 1-2% of the total), it's the right thing to do. Where fisheries managers have the authority and all the "cogs and wheels" (Leopold, L.B. 1953.) of the functional ecosystem remain or are recoverable, managers must work to restore them.

It must be noted at this point, as Fred Harris stated on behalf of the AFS Fisheries Administrators Section at the March 1994 "Symposium on the Uses of Cultured Fishes in Aquatic Ecosystems", the fisheries manager only rarely has the authority to manage habitats, control pollution, or determine the quantity, quality, and timing of water flows. For more frequently the manager is faced with making the best of a habitat altered or polluted by human activities. As I stated at the conclusion of the March Symposium, in such cases the fisheries manager is more like the auto mechanic at the corner garage working on an old jalopy. The measure of success might best be just to get that tired old ecosystem to "run", let alone be beautiful, or stable. Similar to the auto mechanic, economics and politics dictate the manager use the full toolbox of fisheries management tools if necessary, to "get her back on the road and running along, good as new." Where habitat, pollution, and water regime manipulation are not possible, species manipulation/augmentation and restrictive regulations or access control must be available for the managers working with the 98-99% of the aquatic systems that have been altered.

2. The second ethical principle that applies to such altered habitats is to manage for fisheries that are as nearly natural (wild) and as

productive as possible while conserving or restoring as much ecosystem function and integrity as possible.

In my experience there is general agreement on these four principles among fisheries scientists, managers, and the angling and informed general public. We can all rally our disparate groups around them. Taken together they might be termed the biologists' Hippocratic Oath to do no irreversible harm, to preserve the biotic community, and to respond to the public's desire for productive fisheries -- even where "cogs and wheels" have been discarded through mindless tinkering with aquatic systems.

As we look back over the 20 year history of Wild Trout symposia, I think we recognize what the real challenge to wild trout is in the 21st Century. As my editorial in the current issue of Fisheries points out: It's the people, stupid! As I challenged National Wildlife Federation President Jay Hair to develop a fisheries initiative for the organization he leads, I now challenge you -- develop a fisheries agenda for wild trout in your area. Have a bias for action -- do something for native and wild fish and their aquatic systems. You have the information; share it to educate and mobilize a broader constituency. As the movie "A River Runs Through It" did and as the program "The Killing Tides" did on CNN, we need to emulate National Wildlife Federation and get fish and fisheries issues on T.V. and in the movies regularly. Somehow we need a 'fish channel' -- As Del Graff said we have to get the public emotionally involved in preserving productive aquatic ecosystems in the 21st Century. We owe our children no less!

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SYMPOSIUM SUMMARY

Robert L. Martin[1]

I was asked to summarize these proceedings from an outsider's point of view, someone familiar with the jargon but not someone whose opinions would be subject to professional peer review. Summarizing thirty-one presentations plus guest speakers is somewhat daunting if not presumptuous. With almost ten years experience as a fisheries manager by avocation, I believe I am up to the task but apologize in advance if I have minimalized the import or effort by the participants.

In keeping with the times, I will attempt to grasp the major themes of Wild Trout V by the use of sound bites mindful of the theme, "Wild Trout in the 21st Century." I offer the following for your recollection:

we need to listen to the message of the streams; our response to the "wise use" movement is not adequate; sportsmen' groups are not pulling their own weight; our commitment to conservation sets us apart; fisheries management agencies have caused as much [wild trout] loss as other factors; hatcheries and wild trout are competing interests; wild trout are considered something special; these are the best and worst of times, we are facing tremendous loss of biodiversity; we need to be provocative; we need to make fisheries relevant to society; we are still talking about the definition of wild trout; we need to get the public on our side as new partners; it is our quest to be the world conservation leader; rivers and fish are considered sacred; it is a question of the economics of wild trout; the public trust needs to emerge; coalition building is necessary; are we making a difference; if you feel passionate about wild trout, you need to take the message back home; the political class of '93 is a once in a lifetime opportunity; we need to get involved in the process for the long run; decisions need to be made on scientific information, not on social-economic info; hatcheries sinned in the past and now repent; don't alienate anyone you don't have to; we need to be humble; we need answers to questions; our goal is to protect the genetic diversity of natural populations; behind every rock is something magnificent; when is a trout domesticated; definition of wild trout in the eye of the beholder; wild trout are not necessarily native trout; native trout are not necessarily wild trout; people need to know what are wild trout and what is their value; we need to manage ourselves; hatchery programs harm wild trout; anglers who catch fish are more satisfied than anglers who didn't catch fish; 11 to 15 fish experience will please only half the anglers; the attitudes of users are changing the role of management; organized groups can have a disproportionate effect on the process; we must question if management agencies are responsible for unorganized interest groups; conflict could increase and we can't afford conflict; people need a sense of place; 9.1 million trout anglers in USA, 44% are fly fishers of which 10% belong to conservation organizations; we are not able to harness our constituency; conservation and fisheries organizations must form coalitions; there is an assumption that experts know what is right; we need to develop an economic incentive to get people involved; a missing ingredient is marketing for participation; there needs to be a paradigm shift to be an advocate for influencing the value of wild trout; disparate stakeholder groups want to be told what is right; there is a need for value clarification; native fish more of value than just fishing; we are making our last movie, there are no sequels; we must practice wilful self-restraint; and, our future focus needs to be broader than just trout management.

I believe that the above snippets may say more about where we have been since Trout IV than the future of wild trout in the next century. There is no dispute that we must be aware of where we have been in order to know where we are going. At the same time, the gnashing of platitudes and "I told you so!"s won't save one wild trout. It should come as no surprise to you that the **public**, and I mean the greater public, fisherpersons and non-fisherpersons, cares not about your pedantic discourses on "when is a wild trout a wild trout." To the greater **public**, any trout that is not confined to an aquarium is a wild trout. It is the will of this greater **public** that will determine the future of wild trout in the next century.

A similar comment about the righteousness of the battle between wild trout and hatchery programs. There should be no dispute that in the environmentally balanced world wild trout would always be preferred over hatchery

[1] *Lee, Martin, Green, & Reiter, Inc., Bellefonte, PA.*

trout. Hatchery trout represent a mitigation of a condition in the real world. In my profession, any mitigation is a loss. A mitigation plan does not put you back into the position you where in before you were harmed. It is only an attempt to limit the extent of your harm. Such a logic should apply to wetlands and hatchery stocking programs. Let's call a stalemate in the fray between wild trout proponents versus hatchery program managers. It serves no purpose at this time. Let's agree that hatchery programs should be considered as temporary mitigation programs due to the loss or absence of wild trout as a result of our poor stewardship. Wild trout is the ideal objective. Hatchery trout should be constant reminders of what we lost or never had.

If there was a clarion theme of Trout V, it was the recognition that those involved in the management of wild trout must convince the greater **public** of the value of wild trout if wild trout are to survive and prosper in the new century. The concept of wild trout in our present society is too often perceived as the fixation of an elite user group having little to do with the reality of our daily lives. While we debate the lineage of wild trout, another shopping center parking lot is paved quite possibly making the debate moot. I was alarmed at the statistics offered in one presentation to the effect that only 10% of fly fisherpersons belonged to environmental groups. I queried a participant of the proceedings as to his reaction to the statistics. He disputed the percentage of fly fishers to the total angling population. I fear that is symptomatic of those involved in scientific peer review.

What was missing from Trout V from my perspective was the initiative and planning to protect, preserve and enhance wild trout habitat into the 21st Century. The destruction of habitat, *a fortiori* will control the fate of wild trout in the next century. For every step forward in restoring wild trout habitat, there will be hundredfold proposals to degrade that habitat. There will be more conflicts and you will alienate some segment of the population that considers their own job more important than habitat that supports wild trout. Any plan or program to preserve, protect or enhance wild trout will be provocative. Those who are entrusted with the management of wild trout must become resolute advocates of the resource not just when dealing with the angling public, but with the greater **public**. Those entrusted with the management of wild trout are the experts and the **public** assumes they know what is right.

Wild trout managers must not assume that the greater **public** is not competent to comprehend the significance and value of wild trout. The outsider observing the proceedings at Trout V might walk away somewhat jaded as to the future of wild trout in the next century. After all, if the experts can't agree on the definition of a wild trout, how can I as a member of the greater **public** know what to value? I believe the most salient question raised in the symposium was whether or not fisheries management agencies are responsible to represent and protect the interests of unorganized groups?

The answer to the question should be a resounding "Yes!" if we expect to educate the greater **public** as to the value of wild trout. I would be very surprised if any of the enabling legislation creating fisheries management agencies restricted its focus to listen only to vocal user groups. Too often we forget why we created fisheries management agencies in the first place. Too often we are naively unsettled when users who require management disagree vociferously with proposed management measures designed solely to sustain the resource to provide continued use by the complaining user groups.

It is time for wild trout managers and advocates to stop arguing amongst themselves as to the value of wild trout in our society. It is time for the scientist and academician to mingle with the greater **public** and share their passion for wild trout. It is time for the outsider to take responsibility for the destruction of wild trout habitat. I am not sure there is enough time to have a paradigm shift to sustain wild trout into the 21st Century.

I offer in closing a description of realty involving wild trout. I live in a small town in Central Pennsylvania that has a limestone stream, as the movie states, that "runs through it." This stream is rated as a "Class A" wild trout stream. It has been classified as a "High Quality" water resource under the provisions of the Clean Water Act. Knowledgeable fly fishers from out of state descend upon the stream in the Spring to take advantage of the increasing sulphur hatch. The court house proudly carries a trout weather vane the size of a compact car. Anglers in neoprene are a common sight walking through the commons. Once a year a civic group holds the "Fish Fry" on the banks of the stream with musical entertainment from the gazebo. The tourists and locals ostensibly come to the affair to feed bread and fish food to the large stocked trout dumped in the stream for the occasion, purchased by a local merchant. Toy ducks race over the dam, mallard ducks vie for handouts with their white feathered domestic relatives. It's a great time for everyone except the wild trout. Thy are temporarily displaced and certainly unnoticed. It is pretty hard to compete with fried haddock and palomino trout. That is the value of wild trout in the greater **public.**

Meeting the Challenge of Trout and Salmon Conservation and Avoiding Gridlock in the "Information Age"

Charles F. Gauvin[1]

Two things have impressed me most since I joined TU's staff in 1991. One of them is the pace at which we are gaining knowledge in disciplines of immediate relevance to conserving, protecting, and restoring North America's coldwater fisheries and their watersheds. The second is how much a decade that was supposed to be the "environmental decade," and an era of great promise for wild trout and salmon resources, has become the "age of gridlock." I think that the two phenomena are related. Let's look first at the knowledge acquisition process.

Until about 1980, the knowledge acquisition process that drives environmental and natural resources management was slow in gaining momentum, but it quickened in the 1980s and today poses unprecedented challenges to conservation efforts on behalf of wild trout and salmon and their watersheds.

Thirty five years ago, when a group of Michigan anglers joined together as "Trout, Unlimited," most fishery biologists were mere aquaculturists, whose mission was to raise catchable-size fish, usually from non-indigenous stocks, and dump them in frigid streams still chock full of snowmelt, often only hours before the dawn of opening day. Eleven years later, when Congress passed the Clean Air Act, government inspectors still measured air emissions with the help of a chart that showed varying tints, from beige to solid black, in the plumes of smokestacks. Two years afterward, the Clean Water Act introduced terms like "biological integrity" to wastewater treatment operations that had not evolved much since Victorian times.

In the late 1970s, an impassioned and prescient group of Trout Unlimited (notice that someone had wisely chosen to drop the comma from the corporate name) activists in the Southeast challenged the Tennessee Valley Authority's Tellico Dam project and nearly won by arguing that the dam would destroy the habitat of a little fish called the snail darter and, along with it, the Little Tennessee River's outstanding wild trout fishery. The federal government had listed the darter under the still-new provisions of the Endangered Species Act, and most Americans, who would not hear of the benefits of biological diversity for at least another decade, wondered why a homely fish should stand in the way of "clean" alternatives to fossil fuel sources over which OPEC's shadow then loomed large.

Today, whether we like it or not, better trout fishing turns on the semantic valences of terms like "ecosystem management." The first principle of ecology--that everything is related to everything else--has come home to roost. The fate of Pacific salmon is entwined with that of the northern spotted owl, the marbled murrulet, and the dozens of Northwest communities that once bustled to the tune of their local sawmills. The survival and recovery of cutthroat and bull trout species in the Intermountain West depend on reconciling competing habitat requirements of native and non-native species and questions of water resource, forest, and rangeland management that have reached a new level of intensity. In the East, managing coldwater fishery resources now involves vexing choices about public water supplies and hydropower development, in addition to such seemingly archaic considerations as pollution.

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Yet the grandeur of discourse about ecosystems and terms like "biotic integrity" and "watershed analysis" should not lull us into believing that resource decisions will incorporate the best available science and economics. For better or for worse, decisions about our trout and salmon fisheries face the same political hurdles as decisions about health care and the criminal justice system.

Yet knowledge really is power, and effective conservation work now requires stepping onto the playing field with equal measures of passion and know-how. Angling is one of life's most consuming passions, and anglers always have been passionate conservationists. Successful conservation of North America's wild trout and salmon resources today requires building constituencies outside the traditional and, still, rather small group devoted to fishing for wild salmonids. To succeed in the age of ecosystem management, wild trout and salmon advocates must have the know-how to address the larger, cross-cutting issues that often arise in environmental and natural resources policy and decision-making.

It is one thing to be able to argue that a state or federal agency, or a state legislature or the United States Congress, should act to protect or restore a wild trout or salmon fishery because X number of anglers and angling-related business depend on that fishery, or because that fishery is unique in its particular setting or region. It is quite another thing to be able to reach out to non-anglers and enlist their support by demonstrating that the future of a fishery resource is vitally linked to larger questions about how we manage our water, forest, and rangeland resources, or our native species gene pools.

To meet today's challenges, we must realize not only that knowledge really is power, but also that knowledge, while necessary, is still not sufficient. Because everything is related to everything else, the choices confronting decision-makers on matters vital to the future of our trout and salmon fisheries are becoming progressively tougher. Despite the weight of "hard" scientific and economic facts, the tendency of those who must make such choices to digress into debates about property rights, unfunded mandates, and risk assessment is becoming ever more apparent So success in the information age requires using the first principle of ecology, together with the "hard" knowledge that is becoming ever more available, to build coalitions that are sufficiently robust to overcome gridlock.

We must realize that, shorn of its rhetorical appeal as device to dislodge incumbents, gridlock is nothing more than the inability of government to make choices necessary to accomplish important objectives. Poll after public opinion poll has demonstrated that Americans continue to view objectives like clean water and native species conservation as critical to the nation's and their own well being. The foundation for the "environmental decade," and the promise of a golden age of trout and salmon conservation, remain within casting range, and we have sufficient information to match the hatch. The remaining challenge lies in the presentation. Let's do the coalition-building necessary to make Wild Trout VI an occasion to boast about our success astream.

Thank you.

A Sense of Place: Keeping the Wild in Trout Fishing

Jay H. Hair[1]

To begin my remarks today, I ask you to envision this scene:

About 30 grown men, elbow to elbow, are standing on the banks of a river. They're waiting for that magic moment to cast their lines to catch some trout. Hatchery Trout. They're certain to reel in lots of them. And you can be sure that the catch is going to taste like Purina fish chow.

I've witnessed such a display, and it left me feeling sick in the pit of my stomach.

That's why my message to you today is how our society desperately needs to return to a sense of place.

I ask you, as one wild trout angler to other wild trout anglers: Is there anything more exhilarating than stalking a quick flash of bright colors through frigid fast-running waters?

You're surrounded by some of the most magnificent, breath-taking natural wonders God bestowed on our great land. Peaceful solitude. The beauty of nature. A challenge to a true, personal skill. It's wild trout fishing at its finest.

And it's an endangered experience.

Why? What is the current situation facing wild trout fisheries and other natural resources in our nation? The picture is grim:

* Most of the United States' fresh water has been "developed". In our lifetimes we have developed thousands of huge lakes, some more than a hundred miles long, flooding an area the size of Vermont and New Hampshire combined.

* There are now about 75,000 dams in the United States. Our rivers are not those that the frontiersmen encountered as they explored our great land. The Tennessee is a slave to electricity production. The Columbia's rapids are smooth lakes for navigation and power. The Mississippi and Ohio are chopped up into barge canals.

* On the Columbia River, the salmon runs have been so badly damaged by dams that barges of young salmon have to be shipped downstream.

* On the Platte River, sandhill cranes no longer have the gravel bars they need for habitat due to dams controlling the high water so well.

* The magnificent Glen Canyon is obliterated, due to refashioning of the Colorado River.

* What was once hailed as a great country's growth and expansion in an untamed wilderness has become, as Kevin Coyle says, the "Four Horsemen of Destruction" -- dams, diversion, ditching, development.

* Only 9 percent of river miles in the lower 48 states remain undeveloped. Much of that is marked by proposed dams, channels or diversions.

* The Federal Energy Regulatory Commission has issued licenses for 192 new power dams that are not yet built.

And what about the water quality in our streams, rivers and lakes?

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* The EPA says that only 22 percent of all the United States stream miles and 67 percent of the lake acreage have been assessed. Of the total, a third of the stream miles and almost half of the lake acreage are, in one way or another, impaired.

* Based on state reports, only about 15 percent of our river miles and 38 percent of our lake acreage are not impaired -- yet.

* Many of the nation's rivers are in worse shape than they have ever been. They may look cleaner, but they may be more deadly.

* Nonpoint pollution is a major culprit. Out of an EPA list of 18,770 impaired water sites, only 529 are polluted primarily by toxic point sources. Agricultural runoff contributes to about two-thirds of the impairments in rivers, about half in lakes and about one-quarter in estuaries.

* Forest logging is another grave threat to water quality, particularly in the West, where vast clear-cuts allow silt to clog mountain streams. Logging erosion has smothered much of our nation's prime salmon- and trout-spawning habitat.

* Rangeland abuse is another direct cause of stream degradation on our western lands. According to an NWF report published earlier this year, abusive grazing severely damages native biological diversity throughout the West.

Environmentally destructive livestock grazing is a significant factor in the decline of 76 species on Western public lands. Of those, 31 are fish species. Improper management of our rangelands means we stand to lose:

-- The threatened Lahontan cutthroat of the Great Basin in Nevada, Utah and Oregon.

-- The endangered Pauite cutthroat trout in the Toiyabe National Forest.

-- The Bonneville cutthroat trout, a candidate for Endangered Species Act protection.

-- Arizona's threatened Apache trout located in the White Mountains of southeastern Arizona.

-- The threatened Little Kern golden trout.

-- The threatened Winter and Snake River chinook salmon.

-- And, the endangered Snake River sockeye salmon.

* A 1990 EPA report concluded that U.S. riparian areas were "in the worst shape in history," and the destruction continues.

* Another threat to our fresh waters, particularly the wild places where wild trout were at one time plentiful, is hardrock mining.

* By now, most everyone is aware of the outrageous Mining Law of 1872, which allows mining companies to acquire federal land for a cost per acre that's less than the cost for a Big Mac and fries.

* Void of environmental considerations, the law has left 424,000 acres of federal land ravaged and unreclaimed, and 10,000 miles of rivers contaminated by mining.

* Just beyond the boundary of Yellowstone National Park, this mighty crown jewel of our nation's national parks, is a glaring example of the menace these mines pose to wild trout habitat.

* Montana's Yellowstone River is the longest undammed river left in the 48 contiguous states. Now it is threatened by plans for a huge gold mine situated just 2.5 miles from the northeast entrance of Yellowstone National Park. The mind would be owned by the Canadian company Noranda minerals and operated by its partner Crown Butte Resources.

* It is interesting to note that the company will buy its 45 acres from U.S. taxpayers and own it for the remainder of eternity for exactly 225 dollars. Recoverable ore is estimated at 500 million dollars.

* Located in Montana's spectacular Beartooth Mountains, the New World Mine could have devastating impacts on blue ribbon trout streams. It would be situated near the source of three of the Yellowstone River's feeder streams, the Clark's Fork, the Stillwater River and Soda Butte Creek.

* Yellowstone's director of resource management was quoted as stating that the proposed location for the New World Mine is "probably the worst possible place for a gold mine." I'm sure he included in that assessment the 77-acre lake that would be built to hold toxic mine residues, which will require digging out 56 acres of wetlands.

* To sum it up, the threats to wild trout ecosystems are many and daunting.

* These are the kinds of threats that could lead to the tragic scenario of anglers only being able to experience catching hatchery trout that taste like Purina fish chow. Are we going to let this happen? Not as long as there is one glimmer of wild trout running fast in a cold stream that can be stalked by this fly fisherman -- I give you my personal word on that.

Where does the National Wildlife Federation fit in to this scenario? How does NWF work with federal and state agencies to battle these overwhelming threats to our water resources that sustain the habitat for wild trout?

First, the National Wildlife Federation is the strongest grassroots voice this nation has on the need for tougher laws to protect our natural resources.

The list of tough issues NWF has taken on includes:

* Protection of our ancient forests, ravaged by a trail of destruction that claims many salmon and trout fisheries in its path.

* Cleaning up the Great Lakes, and exposing the broader threats to human health from damaged water quality. Among those threats are endocrine disruptors discovered in chemicals as pervasive in our environment as chlorine in our water supplies.

* Fighting the strong Western political interests over several public land issues, including reform of rangeland management and of the archaic Mining Law of 1872.

* The continuing battle for a reauthorized and strengthened Endangered Species Act.

The Federation's legislative specialists, scientific experts, attorneys and activists work with federal and state agencies to come up with better laws and better enforcement of regulations.

Of course, the phrase "working with" is extremely broad. Examples of close cooperation include exchange of data that helps accomplish needed reform. One example is how the Fish and Wildlife Service provided documentation of more than 100 lead poisoned bald eagles that was the keystone of NWF's successful effort to ban lead shot.

I can also offer examples of NWF being the voice of conscience, or the reality check, for federal or state agencies that might not have the political wherewithal to do the right thing.

One example is NWF's recent notice of intent to sue the federal government if it allows the development of the Owyhee Canyon bombing range to proceed in Idaho. This also is an example of cooperation, believe it or not. Data from the Idaho Department of Fish and Wildlife about the proposed bombing range's potential devastating impact on wildlife helps justify NWF's lawsuit.

This work to protect natural resources and the nation's environment has come under the most ferocious fire in recent years than ever before in the history of this nation. The reason: groups of well-financed, well-organized, anti-environment radicals who call themselves the misleading name, Wise Use.

You're no doubt familiar with the name by now. Every wild trout angler in this nation would be aware -- because these wise use groups are the enemies of what we hold dear. They are ready to dispose of our wild, natural places with a reckless abandon that so commonly characterizes greed and short-sightedness. You should know that their propaganda and camouflage are a front for anti-environment interests. They are a dangerous threat to our nation's environmental health.

Who are they? They are groups with names like the National Wetlands Coalition, the National Endangered Species Reform Coalition, People for the West!, American Resource Alliance and the American Council on Science and Health.

The drive behind their anti-environment campaign begins and ends with money. American taxpayers pay more than $800 million in subsidies every year so that industries and a few wealthy individuals can log, graze and mine our public lands. If you look at the funders for the wise use agenda, it's easy to understand the agenda. The backers are big oil, big chemical, big mining and other major corporations who stand to profit from over-exploitation of our public lands.

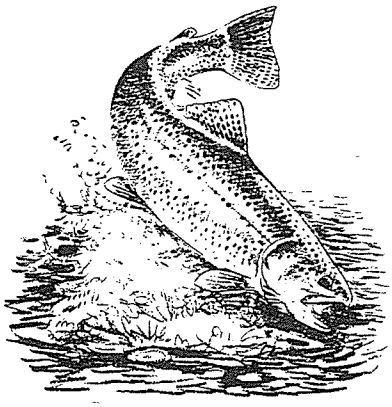
This opposition means we must re-double our effort. We must build our activist strength, and push on with our legislative and legal work. The anti-environment movement consists of a small minority in this country -- but they are a minority with big money. We stand ready to meet their challenge.

In this era of fighting to defend the progress we've made over the past 20 years to protect our environment and natural resources, we must never lose sight of another important aspect of our conservation mission.

I return to the idea of the sense of place. A kind of connection with the natural world through personal experience. It's the kind of appreciation for outdoor experiences that wild trout fishing inspires.

The National Wildlife Federation recognizes that along with our tough battles to protect environmental legislation, we must continue to work to make the importance of nature personally meaningful to people.

The Federation has a number of programs that strive to achieve that goal. Among them are a couple that are particularly relevant to anglers:



* NWF's "naturelink" program gives families the opportunity to learn about the natural world through fishing weekends. These weekends bring people up close to nature. The participants are frequently people who have never held a rod and reel. Often they are families from inner-cities, where a concrete alley is where the children grow up playing.

* Through NWF's Naturelink weekends, we give families a personal experience in the out-of-doors that is educational, fun and helps build a commitment to protect the natural world.

* We also have begun offering Angler Action Workshops that provide leadership training and citizen action guidance. These workshops help anglers acquire the skills to become effective grassroots activists. No doubt, anglers with a stake in the quality of rivers and streams can be some of the most passionate defenders of our wild places.

Wild trout fishing may be just one small example of the need to protect our natural world. But it's a vivid example.

Do we have the right to say to our children they won't have the chance to experience the same beauty, the same magnificent natural world, that still exists today? The answer is unquestionably, "no".

As our society moves further away from a sense of place, it will be more difficult to instill the wonder of nature in our children. But our obligation remains. When you feel the rush of exhilaration on those frigid waters, stalking a flash of bright colors, remember that row of anglers standing elbow to elbow along the river bank. Today we have a choice. We must ensure that the next generation has the same or even better choices.

Thank you.

1994 A. Starker Leopold Wild Trout Awards

In 1984 the National Wild Trout Symposium Sponsoring Committee established the Aldo Starker Leopold Wild Trout Award in memory of A. Starker Leopold, distinguished naturalist, superb teacher, gifted author, and beloved companion to those that shared his fishing and hunting campfires. He died at his home in Berkeley, California on August 23, 1983.

A. Starker Leopold was born in Burlington, Iowa the eldest son of Aldo Leopold. Following in his father's footsteps, he became one of the world's most influential and honored authorities on wildlife ecology and management. He attended the University of Wisconsin, Yale Forestry School, received his Ph.D. from the University of California at Berkeley in 1944 and retired there as Emeritus Professor of Biology in 1978.

Starker Leopold was heavily involved in public policy at the highest levels. In 1968 he chaired the Special Advisory Board on Wildlife Management of the Department of the Interior which led to significantly new national park and refuge policies. He was a member of the Advisory Committee on Predator Control and an international consultant on wildlife conservation policy. He served as a Director and President of the California Academy of Sciences, as a Director and Vice President of the Sierra Club and engaged in a broad range of public service activities.

Leopold addressed the negative impacts of multiple use at Wild Trout I. At Wild Trout II he spoke about degraded wild trout populations and the need to give higher priority to land use patterns and the physical condition of our lakes and streams. The following year Starker told the Federation of Fly Fishers, "For my part, I believe that the limited budget available for trout management is largely misspent on trivial activities, of no present value, such as the catchable trout program. Unless we bite the bullet and attack the habitat problem with vigor, the future of quality trout fishing in America is unpromising".

Starker's main goal was a world suited to wildlife and therefore fit for people. Eminent academic and scientific achievements, love of the outdoors, positive personal warmth, and sensitivity characterized his personality. A. Starker Leopold was a friend to fish and wildlife, and to all of us.

As a continuing memorial these awards are given to a professional and a nonprofessional who over time have made significant contributions to the enhancement, protection, and preservation of wild trout in North America. Prior to each symposium, nominations are solicited from the sponsoring organizations, biologists, administrators, and conservationists that attended these wild trout symposiums.

The first A. Starker Leopold Wild Trout Awards were made at Wild Trout III in September, 1984 to Martin M. Seldon, a long-time fisherman-conservationist, Sunnyvale, California and to Dr. Robert J. Behnke, Colorado State University, Fort Collins, Colorado, a noted trout biologist. The 1989 awards were made to Otto H. Teller, past President of Trout Unlimited, Glen Ellen, California and to Frank Richardson, retired U.S. Fish and Wildlife Service Assistant Regional Director and the initiator of these wild trout symposiums, Lithonia, Georgia.

The 1994 A. Starker Leopold Awards at Wild Trout V were made to Gardner Grant, past President of the Federation of Fly Fishers and one of the initial organizers of these symposiums and to Ronald D. Jones retired U.S. Fish and Wildlife Service, Project Leader of the Fisheries Assistance Office at Yellowstone National Park, Wyoming.

RONALD D. JONES

The A. Starker Leopold Award in the professional biologist category at Wild Trout-V deservedly goes to a person that has had a significant impact on wild trout that started in the Fisheries Assistance Office in North Carolina's Great Smoky Mountains National Park, and which was followed by seventeen and a half years service with the US Fish and Wildlife Service in Yellowstone National Park. Ronald D. Jones, this year's recipient, was born in Lucas, Arkansas and attended Arkansas Tech and Utah State University. After a break in school to work on red salmon research in Alaska, he graduated from Utah State University with a B.S. in Fishery Biology in 1964 and the U.S. Fish and Wildlife Service Marion In-Service Training School in 1967. Ron retired from the U.S. Fish and Wildlife Service in August 1993 and is Symposium Cochairman of Wild Trout V.

Mr. Jones' first position involved early striped bass research at the North Carolina, Edenton National Fish Hatchery and became Assistant Manager of the Marion Hatchery and Training School in Alabama. In 1967 he was project leader for the North Carolina Cherokee Indian Reservation fishery program and in 1970 became project leader for the Great Smoky National Park fish

management program. Ron moved to Yellowstone National Park in 1976 as Project Leader of the Fishery Assistance Office.

He was responsible for projects that developed Lewis Lake lake trout for use in restoring Great Lakes trout populations and the investigation of the effects on trout of the 1988 wildfires including sediment transport in the Yellowstone and Lemar River drainages.

Ron has authored a broad range of technical reports and has made presentations on subjects like the impact of road construction on aquatic biota, changes in the distribution of trout in Great Smoky Mountains National, and regulations and angler catch on selected Yellowstone National Park brown trout streams. He gave presentations at Wild Trout II on the role of national parks in wild trout management and at Wild Trout III on ten years of Catch-and-Release in Yellowstone National Park.

Ron Jones has the ability to get along with everyone, which made it possible for him to successfully satisfy the dual-agency requirements of both the U.S. Fish and Wildlife Service and the National Park Service. He was uniquely able to obtain continuing funding to support wild trout activities at Yellowstone National Park, managed a very professional Fisheries Assistance Office, and worked willingly and effectively with volunteers and private conservation groups. His efforts not only resulted in the achievement of maximum benefit for the fisheries under his responsibility, but made Yellowstone National Park a national leader in wild trout management.

Mr. Jones is the recipient of several U.S. Fish and Wildlife Service awards and was the recipient of the Federation of Fly Fishers 1983 Conservation Award. Ron is honored this year as the professional recipient of the A. Starker Leopold Wild Trout Award for his contributions to the resource and as a major contributor to the success of these symposiums.

GARDNER L. GRANT

The recipient of the A. Starker Leopold Award in the non-professional category is Gardner L. Grant of Purchase, New York.

Gardner is a native New Englander—graduate of Yale and the Harvard Business School, fishing guide in Maine, creator and pioneer in automatic toll collection, wine merchant, boat distributor, and now operates his own real estate investment and management firm. His successful business ventures have allowed him to fish in many parts of the world for trout and salmon and, more importantly, to be an active conservationist. Following is a chronicle of some of his accomplishments:

1981: Selected by coalition of conservation organizations to speak for all U.S. anglers to carry their message in passage of the Wallop/Breaux Fund at a national conference in Washington comprised of congressmen, senators, cabinet members and the Vice President. These funds add more than $200 million annually to state fishery programs.

1965 – Present: Trout Unlimited Life Member, Trustee contributing level, National Board Member 1979-91, Chairman of numerous committees, Senior Advisor.

1968 – Present: Federation of Fly Fishers Life Member, past President, National Director, Senior Advisor.

1974 – Present: Wild Trout Symposia; 1974 Wild Trout I featured speaker, Wild Trout II Co-Chairman, Wild Trout III Vice Chairman, Wild Trout IV Co-Chairman, raised funds for I and V.

1968 – Present: Theodore Gordon Fly Fishing Club of New York, Trout Unlimited Chapter. Conservation Chairman, Past Vice President and President.

1978 – Present: American Museum of Fly fishing. Trustee, Past Vice President and National Director, present Senior Advisor.

1985 – Present: Atlantic Salmon Federation. Chairman, Management Committee.

1984 – Present: A Director of Catskill Fly Fishing Center in Roscoe, N.Y., Birthplace of American Fly Fishing.

1982 – Present: International Fly fishing Center, West Yellowstone. First Chairman in raising funds for building, Trustee.

1974 – Present: American League of Anglers. Charter Member, Past Vice President, Board Member.

1975 – 1978: National Park Service Advisory Committee on Fishery Resource.

1970 – 1971: Special Assistant in reorganizing New York Department of Conservation.

1975: Co-Chairman, Governor's Task Force on Environment, New York.

1972 – 1979: Chairman, New York Council of Environment Conservation (under three Governors).

1977: Governor's Task Force on reservoir water releases for trout resources (New York).

The above list partially documents Mr. Grant's lifetime contributions. In addition, he has given hundreds of talks on trout and salmon conservation and fishing. He has written numerous articles that have been published in conservation journals, sport fishing magazines, and books. He has been recognized many times for his accomplishments by state, federal, and conservation organizations.

Gardner will likely cherish this award above all others, as among his fraternity of fishing friends was that gentle giant of an angler, Starker Leopold. Certainly Gardner has distinguished himself as one of the most respected conservationists and productive workers for trout and salmon resources in our lifetime.

Wild Trout In North America: Regional Perspectives Angler Group Viewpoint

Bill M. Bakke

"If the trout are lost, smash the state."
Thomas McGuane

Abstract - Anadromous salmon and trout have been managed on the West Coast of North America for over 140 years. This management has been ineffective, resulting in lost biological diversity, extinctions, Endangered Species Act listings, and reduced productivity of native fish fauna. The strong commitment to commodity production of salmonids among fish management institutions has eclipsed their conservation mission. Fish management agencies, therefore, have contributed as much or more to the decline of native salmonids as other development interests. This paper examines this problem and recommends reform measures.

I have just recently fished the Alaganik Slough and the Katalla River in Alaska. The coho came up these waters in waves. Wolf packs of salmon. Herds of buffalo salmon. Hours from the sea these fish had the translucent gleam of new fish. They were the products of 300,000 acres of muskeg, peat bogs and beaver ponds. The silver hoard overwhelmed the imagination of one who comes from a place where coho are ESA candidates. Sixtytwo coho on the fly; 38 in one exhausting day. These fish were 12 to 25 pounds. A seven weight rod was not enough.

As an angler and a naturalist, I need to experience wild rivers with wild runs. I need to see what natural loading of large woody debris looks like. It looks a lot different than log weirs we call stream enhancement in Oregon. I visited a place where the Copper River's cement colored glacial waters rolls heavily up against Childs Glacier. A sign at the parking lot says picking salmon up off the beach is prohibited. We pondered that one; why would salmon be on dry land? That same sign said if the glacier calves, run like hell. A woman in her 60s was smashed by a wave of water thick with glacial silt, boulders, wood and salmon this spring. When the glacier calves the woods are full of sockeye salmon and the bears scrounge through the brush for a meal. By any measure this is a dramatic and unpredictable place.

I walked along the Katalla looking for coho, very aware that the foot prints I was following were bigger than my own. A lot of us were fishing that day: brown bears, black bears, bald eagles, mink, and me. My senses were sharpened realizing I was residing in the middle of the food chain. Wolves howled in the timber across the muskeg. And the salmon kept coming up the silver tide in waves, like migrating sandhills that filled the sky with their prehistoric croaking. That's fishing. Its fishing that can hurt. It can also instruct and create memories. It is fishing that the Katalla can give but the Cowlitz no longer can. It was like reading an old book of history that still had all the pages. In Oregon, the history book is abridged, and one can only dream about what it once was. The reference points are gone and those who knew what it was like in the old days are dying off, so how are we to know what it was like before our time? Go to Alaska. We are not only losing our heritage in Oregon, we are unable to visualize what it was.

[1] Bill Bakke is Director, Resource Conservation, Oregon Trout.

Alaska is a grand reference. But will it last? No. It can't last because the culture that transformed the Columbia is busy reducing the Copper River.

We spoke to an employee of the Alaska Fish and Game Department. The escapement goal for the Copper River had been reached, so they reopened the commercial salmon fishing even though the processors were not buying any more salmon. How can you reach your escapement goal when the full spectrum of the coho run had not yet made landfall? And what good is it if one cannot sell what is caught; Alaskan officialdom discounted that problem as being only the concern of the commercial fishers.

It is my experience that not only are the native trout and salmon stocks of the Pacific coast being lost at an alarming rate, affecting their overall abundance, their quality is also being lost as wild stocks are replaced by hatchery fish. Fish come from hatcheries rather than from rivers and we are seeing less diversity in size, run timing, and less opportunity. For those who can, British Columbia and Alaska are the places to go because the fish are abundant and they are wild, reflecting the places where they live.

The preoccupation with commodity production by the fish management agencies has not only ruined the runs but it has bled the soul out of the animal. The successful fishery is based on catch per unit of effort, rather than challenge, excitement, learning, and respect. As Mr. Martin, Oregon's chief of fisheries, is so often heard to say: "Hatcheries fuel the fisheries." But hatcheries equal lost biological diversity and a degraded human experience that comes from severing the connection with wild nature.

Fish managers are fond of describing hatcheries as "tools" serving management policy. But management policy follows the money and the hatcheries are the largest program the agencies have. For example, from 1981 to 1991 the GAO reported that $537 million was spent on hatcheries in the Columbia Basin, consuming 40% of the available dollars. There was no expenditure noted for wild salmon, but if one assumed the expenditures for habitat are a surrogate for wild stock funding, which it is not, it represented just 7 percent of the funds over this ten year period. In fact one cannot determine how much money is being spent on wild salmon conservation and management in the Columbia River Basin even though there are at least 76 wild stocks at risk.

In Oregon another example can be found. The natural production program, initiated in the 1989 legislature by Oregon Trout, represented an investment of $5 million compared to $36 million for the hatchery program over a two year period. At this time the Oregon Department of Fish and Wildlife is dismantling the natural production program as a cost savings feature, removing the institutional commitment for policy and management development for wild salmon and trout. The head of the freshwater program said, "We have focused strongly on conservation issues over the past five years; now it is time to plan recreational and commercial fishery development opportunities..."

Another way to look at hatchery costs is to look at how much it cost to produce a returning adult. It costs $10,000 per spring chinook adult from the Irrigon Hatchery. On the Grande Ronde River it costs $872 per spring chinook adult and these fish are exotics that stray and interbreed with endangered chinook listed under the ESA in that basin. On the Oregon Coast it costs an average of $25 per hatchery coho, when the commercial fishers sell that fish for $5. Not only is the hatchery program a gross subsidy to the user groups, it represents a lost opportunity cost, because these dollars could be spent recovering wild stocks and their ecosystems.

On the west coast we do not have fish management; we have fish manufacturing. If we had fish management we would be concerned about the wild stocks. But the fish agencies do not care about wild stocks, therefore, wild stocks are going extinct and being listed under the Endangered Species Act.

History has presented us with many choices about what fish management direction to take. Fish management and the crisis we are faced with today flow from the choices we have made.

To begin, let us review a major historic choice

we did not make. It began in 1880 when A.C. Anderson, the Inspector of Fisheries for British Columbia, made the following statement based on his observations:

> "Salmon stocks in major B.C. rivers are discrete, that the supply of salmon available varies from river to river and there is a relationship between the number of spawners and the resulting return to the fishery."

In 1902, John Babcock, B.C. Fisheries Commissioner, supported Anderson's observations by saying:

> "The placing of restrictions on salmon fishing is justified only upon the ground that they are necessary in order to allow enough fish each year to reach spawning grounds to ensure perpetuation. To be effective in this regard, regulations governing fishing on a river should be framed so as to conform to the conditions which exist upon that particular stream."

In British Columbia, observations by biologists brought home the idea of managing for spawner escapements by river, and that by doing this the fisheries could be perpetuated. It was the beginning of the stock concept of salmon management. But that was British Columbia.

In the United States, in 1869, the U.S. Fish Commissioner had charged a retired Unitarian minister, Livingston Stone, to collect Pacific salmon eggs from the McCloud River in California and ship them by the new transcontinental railroad to be stocked in New England rivers. The reason the United States quit importing Atlantic salmon eggs from eastern Canadian streams was due to the adoption of an egg tax by Canadians to stop the U.S. from robbing their salmon rivers of spawn. To the U.S. biologists a Pacific salmon egg was just as good as an Atlantic salmon egg, and since both coasts had salmon they must be interchangeable.

Later, in 1877, Livingston Stone, was hired by a group of salmon cannery owners to operate a salmon breeding station in Oregon on the Clackamas River. Their purpose was to increase the supply of salmon since they were alarmed by the dramatic decline in the commercial salmon catch on the Columbia. They thought the solution was to build a hatchery to increase the supply of salmon rather than suffer the regulation of the fisheries.

It was not until 1938 when Willis Rich wrote the first research report for the fish commission of Oregon, that the United States began to entertain the stock concept of salmon management. In this report, Rich developed the "Home Stream Theory Of Salmon Management." In this report Rich said:

> "In the conservation of any natural, biological resource...the population must be the unit to be treated. By population I mean an effectively isolated, self-perpetuating group of organisms of the same species regardless of whether they may or may not display distinguishing characters and regardless of whether these distinguishing characters...be genetic or environmental in origin. Given a species that is broken up into a number of such isolated groups or populations, it is obvious that the conservation of the species as a whole resolves into the conservation of every one of the component groups."

The scientific insights of Anderson, Babcock, Rich and later Ricker have been and continue to be ignored by fish management agencies. Salmon continue to be treated as a commodity rather than a component of a natural ecosystem. Salmon have been managed for production rather than their natural productivity. The result has been the failure to perpetuate the species by ignoring conservation management of stocks and stock structure.

This industrial model for salmon management has lead to the collapse of the salmon resource and the economic and cultural benefits they provide

people. Fish management agencies, in rejecting Rich's Home Stream Theory of Salmon Management, made the wrong choice and this cross roads lead eventually to the shrinking of the salmonid ecosystem, extinctions over a wide geographical area, and numerous ESA listings.

The collapse of the native salmon runs of the west coast could be predicted as fish management agencies structured their management programs along the following lines:

- Compressing salmonid biological diversity into an aggregation of one or a few stocks for harvest management purposes. This is done to make the theory of maximum sustained yield work and maintain mixed stock fisheries.

- Where spawner escapement goals were set, and there are very few by stock, they are never a real obligation nor has there ever been an intent to meet them. Harvest managers run the fish agencies and there is no accountability for conservation management.

- The great boon for water resource developers was the early hatchery buy-in by the fish agencies. They believed that hatchery technology could replace wild salmon and their ecosystems and still do.

- The fish management agencies allocated most of their budgets to hatcheries and never invested in the inventory of salmonid biological diversity or a management program to maintain it.

We are now presented with another choice initiated by listing salmon under the ESA. That choice is to transform salmon and trout management so that it is responsive to the conservation of native fish biological diversity. But to make this transition, the following actions must be taken:

SOLUTIONS

Basic Management Principles

Identify the biological diversity of salmonids including genetic and life history attributes design a management program to maintain that diversity and the evolutionary potential of the stock. The management program must conserve the substock structure

Focus on native stocks as a conservation management priority.

Adopt a gene conservation policy and specific protocols to direct management actions.

Estabish measurable biological objectives that maintain genetic and life history characteristics and evolutionary potential by stock.

Develop a conservation audit to evaluate whether objectives of management were met.

Escapement

Estimate the rearing area available by stock or substock and provide spawner escapement 50% above that level. This would increase natural selection. As habitat improves, escapements are increased. Manage for the qualitative features of a stock in order to perpetuate biological diversity.

Conservation Triggers

Conservation management must be activated to prevent a stock or substock components dropping below the replacement line, or when there is a threat of reducing genetic structure or life history characteristics, or a potential loss of rare alleles.

Harvest

Redirect harvest management so that escapement needs of native stocks are the driver.

Calculate the escapement needs, and regulate the fisheries to achieve those escapement needs. This is just the opposite of how it is done now: escapement is something the salmon get after harvest management.

Evaluation

Establish a conservation audit that is independent of management, but reviews the management of ecosystems and species to determine whether stated biological objectives are being achieved on an annual basis. The fish management agencies have a built-in conflict of mission: commodity production and conservation. Commodity programs eclipse the conservation mission in every case. Since the fish management agencies cannot successfully carry out their conservation mission, this mission must be housed in a separate and independent agency that holds the commodity program accountable to conservation annually.

Habitat

Protect, protect, and protect. Protect the productive potential of the habitat as well as the reproductive capacity of the stocks. Integrate habitat protection and especially habitat restoration with stock life history attributes. Reconnect the life history habitats. The goal should be to end fragmentation of habitats and reconnect them. Identify the carrying capacity by species/stock and the limiting factors. Investments in habitat restoration must result in integrating life history diversity with habitat complexity. Its important to note that habitat restoration is theoretical and experimental therefore it cannot be relied upon as an alternative to habitat protection.

Native salmon and trout are going extinct because they are in conflict with our cultural view of nature. It's a species conflict; we will always make decisions that favor us over salmon and trout. We have designed our natural resource management institutions according to the industrial model focused on the production of commodity benefits to society. This is the model that insists on economy of scale and assembly line technology. Making salmon and trout is like manufacturing brown shoes. This model is hostile to healthy ecosystems and their productivity. There is no place for habitat complexity, stream sinuosity, gene conservation, or biological diversity. We have created the best possible institutional model for the destruction of natural productivity, and we implement it daily.

THE COLUMBIA RIVER EXAMPLE

It is said the Columbia Basin is the size of France. Since 1850 over 200 salmon stocks have gone extinct, the Snake River chinook and sockeye are listed as endangered under the ESA, and the American Fisheries Society says there are at least 76 stocks at risk of extinction. This is the purposeful legacy of our cultural view of nature. This brief account, if nothing else, should tell us that our management programs are a failure. If you review the last ten years you will discover that this region of the United States spent over $ 1 billion on salmon recovery only to dig a deeper hole of loss and degradation. So what should be done? Well, I can only recommend what has not been tried. The following shows how the solution elements listed above would be applied to the Columbia River.

1. Inventory Biological Diversity

This means conduct an extensive inventory of the basin's salmonid biological diversity, paying particular attention to genetic and life history attributes of stocks. This inventory would become the benchmark against which the region can measure the effects of its countless management experiments through setting measurable biological objectives. It can also be used as the basis for adaptive management (learning and changing human behavior) and could even be used to describe success. Until there is an inventory of the basin's salmonid biological diversity, we will be unable to determine whether we are being successful in our recovery investments. Doing this work has been resisted by the fish agencies and tribes since 1991 when it was first recommended.

2. Set And Achieve Spawner Escapement Objectives:

This means that for each stock and substock, an escapement goal is established and met annually. An aggregate goal for example could be set for spring chinook at Lower Granite Dam and verified by stock and substock in the spawning tributaries. This means we must know what the carrying capacity for spring chinook is by substock and manage for exceeding it. As long as spring chinook are below replacement by substock, management is not meeting its objectives. Fish managers have criticized this, saying that it would mean the end of the mixed stock fisheries.

3. Establish An Independent Conservation Audit:

Each year there would be an independent scientific audit to determine whether the biological objectives were met. But first, the fish agencies must set biological objectives for each part of the life cycle. The audit would give the management community and society important feed back about whether objectives were met for mortality in the fisheries from Alaska to the Snake River, at each hydro dam, and whether we met escapement objectives by stock and substock. Right now there is no such audit in place so we do not know from year to year what objectives have been met and what additional objectives need to be put into place. This audit would help to assign accountability, something no one in the region wants. Its better to continue the status quo where the fish managers can point the finger of blame at the hydro system and the hydro guys can accuse the fishers for killing off the assets of their investments. An audit could help to break this killing gridlock.

4. Eliminate All Hatchery Production:

Particularly in the Snake River but also elsewhere in the basin. The hatchery program is killing the native salmon runs through ecological and genetic impacts as well as through institutional goal setting. We can't harvest hatchery spring chinook, so why propagate them. Use those dollars to fund more ecologically sound management and research. We know that hatchery fish survive at much lower rate than wild fish (wild salmonids survival is 2 to 10 times more than hatchery fish). Institutional arrangements such as water budget and transportation are geared to hatchery releases rather than to wild fish outmigration. We know that hatchery fish are infected with diseases and that treatment could create resistant forms of pathogens. Closing the hatcheries would eliminate the compounding problems of straying and the introduction of exotic hatchery stocks, both of which cause loss of genetic information and reduced productivity of native stocks.

5. Remove Lower Snake River And John Day Dams:

The only way Snake River salmonids are going to survive into the next century given persistent drought conditions and aggressive water withdrawals from streams for agriculture is to remove the dams. Lowering the reservoirs behind these dams to increase flows and thereby smolt travel time, would make these dams inefficient power producers, so removal is the best solution. As long as the dams remain, we will be tempted to tinker and the salmon don't need more tinkering.

6. Implement Coherent Federal Policy:

The only way Columbia and Snake River salmonids are going to be recovered is to have all federal agencies committed to implementing the same salmon recovery plan. This means that BPA, NMFS, SCS, USFWS, USFS, BLM, BR, develop a coordinated plan of action by objective that is binding on each agency. Without this coordination, public investments through these agencies for salmon will continue to be wasted.

7. State And Federal Policy Development

The state and federal agencies do not have a conservation policy for native wild stocks of salmonids, a regional or national gene conservation policy, or a specific program for the conservation of native wild stocks. Lacking these policies, there will be no recovery of wild salmonids whether they are listed or

not. There is now no provision to implement a native wild stock management program that would prevent the ESA pipeline from overflowing. The state federal and tribal fish management agencies have refused to develop management measures to conserve the basin's wild stocks. The fish agencies remain committed to expanding hatchery technology and focused on a commodity production program rather than protecting the productive capacity of the ecosystem.

The Pacific coast states have gone through three paradigm changes since 1850. The first salmon program (1850-1900) was the allocation of spoils from an abundant natural system. As the Columbia River was developed for other economic benefits, and the immense runs suffered from overharvest, fish management shifted from exploiting the fruits of a natural system to mitigation (1900-1994), believing the natural ecosystem and wild stocks could be replaced by hatchery technology. The hatchery system was built by water development interests and Congress for the fish agencies to operate as mitigation for lost wild salmon production. But the salmon continued to decline until the commodity program threatened to collapse. The current stage of management is a shift from mitigation and enhancement technology to one of the Salmon Problems Industry. This period of transition is built upon applied technology such as more hatchery construction and engineered stream habitats, and is perpetuated by political conflicts that mark the Salmon Problems Industry. Fish agencies have no incentive to solve the salmon problem because they are funded to perpetuate the problem.

The salmon problem industry is marked by the fact that fish agency bureaucracies and interest groups continue to grow even though there is less and less fishing. From an economic point of view, the value of salmon is no longer in the marketing of salmon by fishers but the economic benefits associated with management of salmon problems. The risk in this paradigm shift is that the salmon will go extinct removing the excuse for continuing to fund the salmon problems industry. To guard against this, the agencies and interest groups are united around increasing the supply of hatchery salmon so they can justify their continued existence. The recent efforts to include hatchery salmon as endangered species serves as a good example where the advocates of the Salmon Problems Industry are trying to protect their funding against the eventual extinction of wild chinook in the Snake Basin. But this strategy may not work. The egg supply for hatcheries is drying up. In 1993 there were 8 million spring chinook juveniles released, but the forecast is for only a .5 million release in 1997. But the fish agencies can reintroduce exotic spring chinook stocks from other parts of the basin if the indigenous fish are lost, thus saving the agencies the loss of their hatchery funding.

Another force at work is that of hatchery supplementation where native and non-native stocks are released into streams. The practical result of this program, if not its purpose, is to lift any conservation burden form the backs of the fish agencies, allowing them to continue their mixed stock fisheries and commodity program. As proposed, an aggressive hatchery outplanting program or supplementation would eliminate any remaining vestiges of distinctness of 40 substocks of spring chinook. By homogenizing these remaining wild populations with hatchery salmon, the agencies and tribes could escape their conservation mandate and the ESA could not be invoked. This strategy to eliminate biological diversity of spring chinook in the name of salmon enhancement and mitigation was one of the reasons Oregon Trout filed for protection of the Snake River chinook under the ESA. The proof of this point resides in the decision by the NMFS to not list coho salmon in the lower Columbia River because they could find no distinct stocks to list. The reason was the hatchery program had homogenized distinctness out of the stocks. It is worth noting here that this was the result of management policy where the states of Oregon and Washington decided that in order to maximize the commodity production and use of their Mitchell Act mitigation hatcheries they would not manage for escapement of wild coho salmon in lower Columbia tributaries. Instead they would outplant hatchery coho salmon to utilize the natural rearing environment to make up for the extinction of the wild coho salmon. But this strategy failed and now the spawners per mile have dropped from 40 to less than one fish per mile, about what one would expect from straying hatchery fish. Even though the Mitchell Act hatchery program was sold to Congress as a means to maintain natural

stocks in the lower Columbia River, the states decided to abandon that by adopting a program of supplementation that caused the extinction of wild coho. The states have developed a policy of extinction management for salmon and steelhead in order to maximize the commodity benefits of their hatchery programs.

My proposed solution may not be complete, but if it were put into effect it would turn trout and salmon management on its ear. We have gone too far down the road with our current management model to change it by increments. It needs a radical overhaul if we are to change what we have become wedded to over the last 140 years. I was naive to think that listing salmon under the ESA would cause a shift in salmon management to where wild stocks would be protected. If our fish management institutions will not change in order to recover endangered salmon, then they are incapable of learning or change on their own. The changes I am recommending will be forced on fish management agencies from outside. But that takes constant pressure from an informed public, a public that finds itself stuck funding the continuation of the Salmon Problems Industry while trying to cause a shift in management toward stewardship of wild salmon and their ecosystem.

But who is the informed public? So far it has been up to a few groups that have organized around the concept of native fish protection. Their effort will be successful only if it is translated into a broader public outcry for conservation results. But salmon management has been made too complex and it is filled with so much jargon that the public interest is hard to hold. However, saving the wild salmon has strong appeal and it is up to the native fish conservation groups to focus that support.

Unfortunately those who have an economic and/or a political stake in the status quo are not willing to force change. Even the mainstream environmental groups appear to be confused and ineffective as advocates for native salmon conservation. There are only a few public interest groups focused on native salmon and trout management reform and the job is too big for them to be effective over a landscape from California to Alaska. It is my opinion that native fish need informed advocates that are willing to bleed on the battle fields ranging from their own board rooms to Congress. Another thing is certain, even though there are many native fish conservation supporters within the fish agencies working against great odds within their institutions, the fish agency institutions are, on a whole, hostile to the protection and conservation of native fish. If it were otherwise, native fish would not be the most rapidly declining fauna in North America.

Management for Wild Trout Fisheries in the Midwest: Status and Trends

Robert L. Hunt[1]

Based on mail survey forms completed by fisheries management staff personnel employed by natural resource management agencies in six midwest states, I concluded that all six agencies are strongly committed to promoting wild trout management and plan to do even more to enhance wild trout fisheries in their states.

Although trout fisheries in the Midwest are dependent on periodic stocking of domestic trout in the majority of streams, lakes, and ponds managed for that purpose, a common shift in agency management philosophy and operations has occurred in the past fifteen years throughout the six-state region to assign higher priority to preservation and enhancement of wild trout populations, the environments in which they live, and the quality of recreation such wild populations provide. These changes and likely future trends characterize agency management of wild trout fisheries in the three states (Michigan, Minnesota, and Wisconsin) that have substantial amounts of trout waters (16,840, 3,311, and 9,560 miles of trout streams, respectively) and in the three states (Iowa, Missouri, and Nebraska) where such waters are much less abundant but intensively managed (266, 200, and 624 miles of trout streams, respectively).

At the Wild Trout Two symposium in 1979, legendary angler Lee Wulff began his prepared presentation with these words: "It is one of the great joys of my life that I have lived long enough to see us turn the corner in trout management and know that we are swinging back upward toward great trout fishing in the future" (Wulff 1980).

After reciting a litany of several well-intentioned but largely ineffective strategies that natural resource management agencies had implemented during his lifetime to perpetuate sport fisheries for trout in North America, Wulff then listed three of the more recent strategies he endorsed -- strategies he believed provided reasons for his cautious optimism that a "corner had been turned". These strategies were (1) abandonment of maximum sustained yield as a driving concept for trout fisheries, especially wild trout fisheries, (2) less use of minimum legal size limits and greater use of maximum legal size limits, and (3) greater application of a no-kill regulation as "the ultimate modern-day tool" to restore high quality fishing experiences, especially on public waters where the number of anglers could not be controlled.

My assignment for this symposium, 15 years after Wild Trout Two, was to assess the present status of management aimed at benefitting wild trout fisheries and report any likely trends in such management in the Midwest. Based on completed surveys returned to me from 6 state natural resource agencies in the region, I am pleased to report that substantial progress has been made. It is no longer a case of just having "turned the corner". The good news, in my view, is much better. I detect a solid commitment by state Department of Natural Resource (DNR) agencies to aggressively promote wild trout management.

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A "point of no return" has been passed -- no return to the mistaken belief that stocked domestic trout are adequate substitutes for wild trout. Although hatchery-reared domesticated trout still play a major and essential role in meeting demand for trout angling opportunities in all 6 states, I believe there is now widespread recognition within the DNRs in the Midwest that domesticated trout are inferior substitutes for the "real thing".

Itemized below are the primary means each DNR agency is using to enhance the status of wild trout fisheries. It is evident that much effort is underway in the Midwest to raise the status of wild trout management.

IOWA

Of the 266 miles of trout streams in this state, only 5% presently sustain trout fisheries entirely dependent on natural reproduction (Table 1). A few miles of stream also provide fishing partly dependent on wild trout.

Despite the present paucity of wild stocks, due largely to environmental conditions unsuitable for natural reproduction, the Iowa DNR is committed to expanding opportunities to catch wild trout. Efforts are underway to reestablish wild trout and improve trout stream quality so that wild trout can expand their present range. Management activities to attain these ends include:

1. Improving living conditions for wild trout through protection and restoration of stream watersheds and riparian zones, and installation of instream structures in reaches bordered by public lands.

2. Providing DNR expertise, but no public money, to the Iowa Natural Heritage Foundation, a nonprofit private organization that purchases private land along trout streams for subsequent public use via resale to the Iowa DNR at appraised prices. The Foundation also assists and encourages landowners in applying "best management practices" that will benefit environmental qualities needed to sustain wild trout. A video and series of fact sheets were mutually developed by the Foundation and DNR that are designed to encourage land owners to implement good conservation practices along trout streams.

3. Applications of special regulations to the few wild trout fisheries that exist; regulations that restrict anglers to use of artificial lures, a 14-inch minimum size limit on two streams and mandatory catch and release on two streams.

4. Encouraging land owners to promote and practice voluntary catch and release of wild trout in reaches of streams bordered by private land.

5. Carrying out field transfers in the mid-1980's of wild brown trout to two streams where none were present and experimental stocking of wild brown trout from a Wisconsin stream to two Iowa streams in the spring of 1994.

6. Protecting all trout streams from additional degradation by prohibiting deliberate channel "straightening" activities.

7. Eliminating stocking of domestic trout in streams managed for wild trout.

8. Periodic monitoring of the standing stocks of wild trout to assess their status.

9. Promoting the special value of wild trout fisheries among members of the only organized group of trout anglers in the state.

No substantial changes are presently anticipated by the Iowa DNR to improve the genetic characteristics and post-stocking performance of domestic strains. About 343,000 domesticated trout are currently stocked annually. A trend is underway to put more of these trout in urban area lakes.

MICHIGAN

Michigan tops the list of midwestern states in terms of total mileage (16,840) of designated trout streams and acreage (157,600) of lakes that provide trout fishing. Wild trout completely support trout fishing in 11% and partially support it in 20% of the total mileage of trout streams. The Michigan DNR also classifies portions of 50 streams totalling 864 miles (5%) as "blue ribbon" waters worthy of special management attention. Among the 6 midwest states surveyed, Michigan is the only one where such an official blue ribbon status is assigned.

All reaches of such blue ribbon water support excellent populations of wild trout, have excellent water quality (generally free of pollutants other than sediments), are large enough to provide relatively easy wading and fly casting, support diverse communities of aquatic insects, and have reputations among anglers as high quality fisheries. Maintenance and enhancement of healthy trout habitat in blue ribbon streams is stressed by the DNR, plus high priority on acquisition of public ownership of land within the watersheds to preserve naturalness and guarantee public access. Special regulations to reduce harvest also apply to several blue ribbon fisheries.

As a general practice, the Michigan DNR does not stock domestic trout in streams where wild trout are sufficiently abundant to provide good fishing. Most lakes that offer trout fishing are stocked but 23 (mostly ponds connected to trout streams) provide fishing for wild trout only.

Other management strategies and anticipated future changes that focus on the wild trout resources of Upper and Lower Michigan include:

1. Near-future substantial revisions of trout fishing regulations that will reduce the number of wild trout harvested. Combinations of species-specific higher minimum size limits and lower daily bag limits will be applied in relation to the biological potential of a stream or lake to produce, grow, and hold wild trout (thereby following a pattern of revised regulations initiated in neighboring Wisconsin in 1990).

2. Modifications of hydroelectric operations to achieve better instream flow regimes as operator licenses are considered for renewal through the Federal Energy Regulatory Commission (FERC).

3. Incorporation of 100 foot-wide "no- cut" buffer zones along forested corridors bordering wild trout streams, a required mandate along streams bordered by publicly owned land (state and federal), and encouraged as a practice along privately owned reaches. A long-term goal of this policy is to increase natural recruitment of large woody debris to stream channels to enhance trout carrying capacity.

4. Increased efforts to improve free passage throughout wild trout stream systems by removing barriers or installing fish ladders.

5. Stepped-up measures to build and operate lamprey control barriers on streams.

6. More intensive efforts to reduce beaver populations where dams negatively impact trout carrying capacity.

7. Continuation of long-term research studies on wild trout streams and lakes, a tradition that has benefitted trout resource management in many states.

8. Annual updating of the list of designated trout streams and trout lakes so that the most protective water quality standards can be enforced.

9. Expansion of projects to improve trout habitat in streams, especially through reduction of sediment inputs and installation of sand traps to remove sand bedload.

10. Frequent dialogues, initiated by the Michigan DNR, with trout angling clientele to discuss mutual concerns regarding wild trout fisheries.

About 3.8 million domestic yearling and 445,000 domestic fingerling trout (excluding Great Lakes quotas) are presently stocked annually. A major agency effort is underway to develop wild brood stocks of brook, brown, and rainbow trout for stocking in streams. A strain of wild brook trout is presently in use to produce splake for stocking, primarily in lakes.

MINNESOTA

The Minnesota DNR presently classifies 3,3ll miles of streams and 180 lakes (13,500 acres) as trout water. Wild trout sustain the entire sport fisheries in 50% of the total mileage of trout streams. In another 20%, mixed stocks of wild and domestic trout are present. Domestic trout are stocked in all of the trout lakes.

The Minnesota DNR stresses perpetuation and enhancement of wild trout populations in several ways:

1. Experimental regulations that drastically restrict harvest apply to portions of 4 southeastern streams to improve angling quality for wild brown trout.

2. In 1992, the minimum size limit for wild steelhead was increased to 28 inches and the bag limit was reduced to 1/day.

3. Projects to apply field-tested techniques to improve trout habitat in streams holding wild trout are given top priority status.

4. Better intergovernmental agency cooperation is promoted to integrate beneficial watershed management activities.

5. Wild brook trout have been successfully reestablished in headwater reaches of several southeastern streams.

6. Support for wild trout management is promoted with angler clientele.

7. Professional fisheries management advice is supplied to organized angler groups that carry out projects to accomplish trout habitat improvements.

8. Fisheries managers periodically monitor standing stocks of wild trout to assess local and regional trends in abundance, and evaluate habitat improvement projects and experimental regulations.

9. A separate research unit of biologists, free from the constraints of day to day resource management demands, carries out in-depth field studies that increase knowledge about wild trout.

Three agency actions, still in the planning stage, will also benefit wild trout:

1. Revisions of the present trout stream classification system that will enhance the status of streams supporting wild trout populations.

2. Revisions of environmental laws to provide more protection of groundwater spring flows and small tributaries.

3. Completion of a statewide "status report" on wild brook trout.

In 1993, approximately 2.4 million hatchery-reared trout were stocked in Minnesota trout waters. Of these, 14% were stocked as fry, 70% as fingerlings, and 16% as yearlings. Species composition was 6% splake, 12% brook trout, 30% rainbow trout, and 52% brown trout. About 75% of these go into trout streams. No major changes are foreseen to alter the total number of trout stocked, but plans are underway to interbreed the present domestic strain of brown trout with wild brown trout to improve post-stocking survival until they are harvested. A recent trend in use of domestic trout has been an increase in stocking ponds and lakes in urban areas.

MISSOURI

Only 200 miles of stream, 1 large lake (reservoir), and a few urban area ponds provide trout fishing opportunities for anglers in Missouri. Management of these trout waters by the Missouri Department of Conservation (MDC) is very intensive and diverse, perhaps the most intensive to be found among midwest states.

Public access is available to 95% of the trout stream frontage, all the managed urban ponds, and to several sites around Lake Taneycomo (1,700 acres).

Despite the scarcity of trout streams in Missouri, which had no naturally present wild trout populations, fishing is now entirely dependent on self-sustaining wild stocks of rainbow trout in 14% of the total miles of trout streams. In another 16% of that total, wild trout also contribute to the fishery, along with stocked domestic brown and rainbow trout.

In 1982 the MDC implemented a program to specifically manage MDC-owned waters for wild trout fisheries and call attention of trout anglers to the unique values these fisheries offer. Included in this program are projects to expand the number of wild trout populations by stocking fry originating from eggs obtained from wild fish and by direct transfer of wild adult trout from one stream to another. One project has been successfully completed to date.

Angling regulations on most stream sections that have wild trout in them are very restrictive -- an 18-

inch minimum size limit, 3 trout/day bag limit, and artificial lures only.

Projects to enhance trout carrying capacity for wild trout via stream improvement have been modest to date but a low level of such effort will continue. Such projects involve stabilization of eroding stream banks with riprap and placement of boulder retards and rootwads in the channel to provide cover and greater habitat diversity favored by adult trout. A few projects have also been carried out to protect riparian zones and stabilize watersheds. Such management to indirectly benefit the quality of wild trout streams will continue, based on present long-range agency plans.

Trout fishing is likely to always remain heavily dependent on hatchery-reared domestic trout. Approximately 2,167,000 trout are now stocked annually. None are stocked where wild trout are present in adequate numbers to provide good fishing.

NEBRASKA

This state, like Missouri, had no native trout populations. Stocking of domestic trout eventually led to establishment of a few self-sustaining wild populations of brown trout and rainbow trout. About 30 miles (5%) of the 624 miles of streams presently managed for trout contain only wild trout. Another 60 miles provide fishing for a mix of wild and domestic trout. Hatchery-reared trout are also stocked in 2 reservoirs (30,600 acres) and 27 ponds (194 acres). No natural reproduction occurs in these bodies of standing water.

A 5-year (1993-97) fisheries management program is underway by the Nebraska Game and Parks Commission (NGPC) to reestablish a rainbow trout fishery in McConaughy Reservoir that will be based in part on natural reproduction in streams draining into the reservoir, a condition that existed for many years. To increase the present sparse annual spawning runs of McConaughy strain rainbow trout from the reservoir, approximately 25,000 of the 100,000 yearlings to be stocked annually in 1994-96 will be released into two streams where wild populations presently exist at low densities. Stocked yearlings will be fin-clipped prior to release. Long-term leases of riparian zones have also been negotiated along the two streams sustaining natural reproduction; leases that protect the zones from grazing by livestock.

The NGPC is gradually increasing its efforts to improve living conditions for trout in streams through acquisitions of instream flow rights, streambank stabilization projects, and enhancement of watershed quality. Planning is underway to develop a statewide trout stream management document that will identify management measures needed to improve spawning conditions for wild trout, increase carrying capacity for both juvenile and adult trout, and provide improved angler access.

About 525,000 legal-size domestic trout are stocked annually of which 40% are released into streams. Several lakes are stocked to provide fishing during the winter, lakes that become too warm for trout to survive during the summer.

WISCONSIN

Designated trout streams total 9,560 miles. Only wild trout are present in 37% of the total mileage. These streams and reaches of streams are designated as "Class I" by the Wisconsin DNR. Such Class I waters are not stocked with domestic trout and they receive the strongest protection available through enforcement of existing environmental laws.

Mixtures of wild trout and domestic trout are present in 44% of the total trout stream mileage. These waters are designated as Class II. Domestic trout are usually stocked annually in Class II waters to provide adequate fishing quality. Some "carryover" of stocked domestic trout is expected from year to year. Some of these survivors may spawn successfully as well as provide an opportunity to fish for larger trout.

The remaining 19% of trout stream mileage is designated as Class III. Living conditions for trout in these stream reaches usually approach marginal quality sometime during the year. Fisheries are maintained almost entirely by annual stocking of domestic trout.

A significant contribution to the trout fisheries in Wisconsin is provided by the wild trout populations present in approximately 500 spring ponds averaging about 2.4 surface acres. Most ponds are connected to trout streams via small outlet or inlet tributaries. Natural reproduction occurs in a majority of the ponds and trout are also recruited via movement from connecting streams.

Several spring ponds lacking natural recruitment and about 200 lakes are routinely stocked with domestic trout.

Two Wisconsin DNR management strategies to perpetuate and expand opportunities to fish for wild trout are especially noteworthy:

1. The most site-specific, biologically based set of trout fishing regulations in the nation (Wis. DNR, 1993). These regulations consist of 5 categories of size limits (some species-specific), bag limits, and bait type regulations. Local fisheries managers decide which category of regulations is likely to be most compatible to biological characteristics of a stream or reach of stream, especially the biological conditions for successful reproduction, subsequent growth and survival, and habitat factors determining carrying capacity. Three of 5 categories (1, 2, and 4) are applied primarily to wild trout populations. Category 3 (3 trout/day, 9-inch minimum size limit) is used primarily for streams and lakes that are highly dependent on domestic trout. Category 5 designates "special opportunity waters", some of which hold only wild trout and some a mixture of wild and domestic trout. This category includes a variety of fishing regulations that are all very harvest-restrictive. Thirty waters are designated for catch and release and 34 reaches of streams are managed with slot-size limits and low daily bag limits.

Among the several objectives of the 5 category paradigm, imposed in part of Wisconsin in 1990 and statewide in 1992, were high priority objectives to substantially reduce statewide harvest of wild trout and simultaneously increase angling quality based on catching more trout per trip (including trout released) and increasing the average size of trout creeled. For some anglers, their recreational satisfaction was also projected to increase by providing an 8-fold increase in the number of special opportunity fisheries where all or nearly all trout caught must be released.

2. The most innovative and effective trout habitat improvement program in the nation, a program that emphasizes enhancement of carrying capacity for wild trout in streams and spring ponds. Sufficient restoration of habitat quality is also achieved in some streams and spring ponds so that they can be removed from the list of waters stocked with domestic trout.

Licensed anglers (ages 16-65) in Wisconsin who fish for trout in inland waters must also purchase a trout stamp costing $7.25. All money from the sale of such stamps is allocated by the Wisconsin DNR for projects to improve trout habitat in streams and spring ponds. During fiscal 1993-94 about $721,000 derived from trout stamp sales was designated for such projects.

Several other fisheries management activities carried out by the Wisconsin DNR also benefit wild trout fisheries. These include:

1. Successful transfers of wild juvenile and adult trout from streams where they are abundant to streams where habitat is good for wild trout but they are absent or sparse. Receiving streams normally have potential for natural reproduction due to recently improved environmental conditions.

2. Successful stocking of hatchery-reared wild fry or fingerlings to establish self-sustained wild populations. This process is anticipated to gradually increase in popularity and application.

3. Implementation of forestry "best management practices" along perennial streams, practices which include 100-foot buffer zones within which little timber cutting is done, especially of long-lived tree species.

4. Recent implementation of stronger antidegradation laws that apply to all Class I streams. These laws require point source discharges of wastewater to at least match ambient stream conditions.

5. Recent implementation of publicly funded programs to protect and restore buffer strips of natural vegetation along privately owned stream corridors to reduce nonpoint inputs of harmful substances due to agricultural, forestry, or urban activities.

6. Stream-specific and watershed-specific programs to drastically reduce beaver populations where damage to streams is excessive. Removal involves state and federal cooperation and funds to hire professional trappers, liberalize public trapping seasons, and pay bounties in some counties where density of beavers is high.

7. First-priority allocation of funds for purchases of private land to such lands that border trout streams and spring ponds holding wild trout. Public ownership assures angler access and is required for the DNR to proceed with instream habitat improvement projects. During fiscal 1993-94 almost $1.4 million was designated for such acquisitions.

8. Funding to maintain a research team of fisheries biologists to work full-time on trout research projects, many of them of a long-term nature.

9. Increasing the minimum size limit for steelhead trout in tributary streams to Lake Superior from 12 inches to 26 inches in 1993 (matching the changes made in Minnesota), and encouraging anglers to practice catch and release of all steelhead hooked.

10. Field sampling surveys of portions of trout waters in each fisheries managers' region of responsibility to update waters inventory file data and assess management needs.

The most recent annual summary (1994) of statewide stocking quotas indicates that almost 1,970,000 domestic trout were released into Wisconsin trout waters. Approximately 67% of the total went into streams. Of these, 55% were stocked as "fingerlings" (age 0) and 45% were stocked as "holdovers" (age I or older). About 19% of the stream-stocked domestics were brook trout, 75% were brown trout, and 6% were rainbow trout. Fingerlings accounted for 37% of the domestic trout stocked in inland lakes and ponds in 1994. Species composition was 17% brook trout, 33% brown trout, and 46% rainbow trout.

A task force of DNR biologists and hatchery managers is presently working on a long-range plan to improve the health and post-stocking performance of domestic strains of trout. The plan will also include provisions for raising more trout using wild brood stocks as the source of fertilized eggs. Joint fisheries research and management teams of biologists will carry out field evaluations of post-stocking performances of paired wild and domestic lots stocked at the same time and place.

SUMMARY

Several activities by DNR agencies in the Midwest that focus on preservation and enhancement of the wild trout resources (both the fishes and their environments) are practiced in all or nearly all 6 states covered by my survey. These include:

1. Trout habitat improvements - at the watershed level, in riparian zones, and instream.

2. Applications of trout fishing regulations (often species-specific) that greatly restrict harvest, shift angling satisfaction to catching and releasing more trout, and take advantage of special biological characteristics of some waters to provide better fishing through site-specific regulations.

3. Reestablishment of self-sustaining wild trout populations through transfers of wild trout from one water to another and through collection of eggs from wild brood stocks.

4. Enforcement of new and stronger environmental protection laws.

5. Prohibition of stocking domestic trout where wild trout are capable of sustaining satisfactory fishing quality.

6. Periodic reclassification of waters to expand those managed for wild trout.

7. More agency promotion targeted at trout angling clientele regarding the goals of wild trout management and dialogue with angler clientele to discuss mutual concerns for even more emphasis on wild trout management.

8. Public acquisition of stream and lake frontage to assure future angler access and proceed with management activities to preserve or enhance environmental qualities that will benefit wild trout.

CONCLUSION

Although trout fisheries in the Midwest are primarily dependent on periodic stocking of domesticated trout in the majority of trout streams and trout lakes, natural resource agencies in the region are embarked on a common course that places higher

management and recreational values on wild trout fisheries than on fisheries dependent on domesticated trout. Through a variety of agency management initiatives a substantial shift in management operations has occurred during the past 15 years; a shift designed to give higher priority to preservation and/or enhancement of
wild trout populations, the environments in which they live, and the quality of recreation these wild stocks of trout provide. I believe these present trends will continue and hopefully accelerate. This shift in emphasis to favor management for wild trout is evident in three states (Michigan, Minnesota, and Wisconsin) having substantial natural resources of trout waters and in three states (Iowa, Missouri, and Nebraska) where such waters are much less abundant.

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Table 1.—A summary of the trout waters present in 6 Midwest states and the percentage of these waters that sustain wild trout only or mixed stocks of wild and domestic trout.

Item	Iowa	Michigan	Minnesota	Missouri	Nebraska	Wisconsin
Miles of Trout Stream	266	16,840	3,311	200	624	9,560
% all wild trout	5	11	50	14	5	37
% partly wild trout	1	20	20	16	10	44
Trout Lakes and Ponds:						
number	0	2,861 lakes	180 lakes	1 lake; sev. ponds	2 lakes; sev. ponds	200 lakes; 500 ponds
surface acres	0	157,600	13,500	17,000	30,800	lakes-unk. ponds-1,200

Wild Trout in North America — An Eastern Perspective

Delano R. Graff[1]

Abstract — In an effort to provide an Eastern Regional perspective on wild trout, fisheries chiefs in Eastern states and provinces were solicited for information on their programs and perspectives. Information from 14 states, 4 Canadian provinces, and the National Park Service form the basis for an Eastern perspective. Most agencies either have, or are in the process of developing, a formal policy on wild trout management. Resource inventory, habitat protection, regulations of harvest, protection from effects of stocking, and public education are viewed as key elements of wild trout management. Problems and opportunities are as varied as the social and geological variation across the region. It is evident wild trout management will play a significant role in Eastern fisheries management into the 21st Century.

Providing a regional perspective is a challenging assignment. Having been Director of the Pennsylvania Fish and Boat Commission's Bureau of Fisheries, or in an equivalent job, since the inception of Pennsylvania's wild trout management effort, I feel qualified and comfortable in offering our state perspective on wild trout. However, other Eastern states and provinces managing trout fisheries face differing circumstances, challenges and opportunities relative to wild trout. Recognizing that perceptions might differ slightly among Eastern agencies managing trout, I enlisted the aid of representatives of those agencies in an effort to offer a broader regional perception relative to managing wild trout into the 21st Century.

In order to identify threads of commonality and areas of difference among the various trout management agencies in the East, I contacted fisheries chiefs in Eastern states and provinces and requested their assistance. I posed four basic questions:

1. Do you have a wild trout policy and program?
2. What's involved in making that policy and program work?
3. What problem and opportunities have you encountered or see in the future?
4. What do you see as future role?

In addition, I requested everything and anything the respondent chose to provide in the way of information or professional opinion about wild trout management and the future of wild trout in their state or province.

Response to my request was gratifying. I received replies from 13 states (in addition to Pennsylvania), 4 Canadian provinces and the National Park Service. From those responses I have attempted to synthesize an Eastern regional perspective.

Since this is a perception paper rather than a data-driven technical presentation, I have generalized from specific responses. Every effort was made to accurately reflect agency responses. Any misinterpretations of the information provided are unintentional and entirely my fault. Agencies providing information include Arkansas, Georgia, Kentucky, Maine, Massachusetts, New Hampshire, New Jersey, New York, North Carolina,

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Pennsylvania, Tennessee, Vermont, Virginia, West Virginia, Quebec, Prince Edward Island, New Brunswick, Nova Scotia, and National Park Service, Great Smoky Mountains National Park.

DO YOU HAVE A WILD TROUT POLICY AND PROGRAM?

Wild trout are perceived as important enough for 12 of 19 agencies to have a formal policy or program statement directly related to wild trout management. The others all recognize the value of wild trout and most manage for protection of wild trout even without an explicit statement of policy or program. For example: The National Park Service manages for natural processes and native species as their policy and priority, but implicit in that is recognition of the validity of management of self-sustaining populations of naturalized (non-native) wild trout populations where appropriate. Maine has no formalized statewide policy on wild trout, but the agency intensively manages a truly impressive number of water areas specifically to protect wild trout. Tennessee has a basic but unwritten policy to recognize and protect wild trout. New Hampshire has developed a draft policy and resource classification system which recognizes wild trout as a management category. Georgia's policy and guiding document on trout management (including wild trout) is in its initial stages. Massachusetts has inventoried a substantial portion of its wild trout resources and is in the process of developing a comprehensive plan for trout management.

It would seem a safe generalization to say, as we move into the 21st Century, that all trout management agencies in the East will accord wild trout full and appropriate recognition and consideration through specific policies, plans and programs directed at protection and enhancement of wild trout populations.

WHAT'S INVOLVED IN MAKING THAT POLICY AND PROGRAM WORK?

Elements perceived as necessary for successful management of wild trout fisheries in the East include:

1. Resource inventory and classification.
2. Protection of habitat and water quality.
3. Regulations.
4. Protection of wild trout from the potentially harmful effects of stocking hatchery trout.
5. Public education and information.

Resource Inventory

Importance or priority attached to key elements involved in implementing wild trout management varies depending on circumstances in individual states or provinces. One area of agreement was that in order to management wild trout, it is essential to know the extent and status of wild trout within the management jurisdiction (what you have, where it is, and how well it is doing). A quote from the *Nova Scotia Recreational Fisheries Management Plan* is representative of the Eastern perception on this aspect of wild trout management: "Resource inventory data are required prior to the application of management strategies."

Habitat and Water Quality

Protection of habitat and water quality are perceived as important by all agencies managing wild trout. A statement from *Trout Management* in Prince Edward Island is typical of an Eastern perspective: "All efforts should be made to protect unspoiled trout habitat, while emphasis must be placed on restoring and enhancing degraded habitat." The urgency or priority assigned to this aspect of wild trout management varies depending on the degree of environmental degradation experienced in a state or province. New Jersey, Pennsylvania, or Massachusetts, for example, have a relatively high sense of urgency about habitat protection while more pristine areas, New Brunswick, for example, have had little impact on wild trout from habitat degradation and would rate other elements of management as more urgent.

There is a general perception that, in the East, wild trout populations are a reflection of a healthy ecosystem, a high level of environmental quality. The identification of a stream as wild trout water is often a positive and compelling factor in environmental regulation decisions that affect activities on watersheds, reservoir withdrawals or diversions or discharges. It would appear that having an inventory of wild trout water and specific management efforts for wild trout is in itself important in the protection and preservation of habitat and water quality. A quote from Virginia exemplifies this point: ". . .wild trout streams currently enjoy greater state mandated

environmental protection than endangered species waters."

Regulations

Regulations on harvest are perceived as the most powerful tools for managing individual wild trout populations. The frequency of application of highly restrictive harvest restrictions varies among agencies depending on biological and social circumstances, but all agencies view harvest regulations as an essential element of wild trout management. New Brunswick, for example, views regulations as their primary tool since overfishing, not habitat degradation, has had the largest influence on the state of wild trout populations.

Regulations applied to wild trout include (a) seasons, (b) sanctuary or refuge areas with no angling permitted, (c) size limits—minimum, maximum, and slot, (d) catch and release, and (f) tackle restrictions (primarily to exclude bait).

Stocking

Protection of wild trout from the potentially harmful effects of stocking hatchery trout is generally seen as a desirable objective in wild trout management. The degree of emphasis on this element of wild trout management varies widely as does the rationale for being concerned about the impact of hatchery fish. Wild trout in the East means self-sustaining populations, which may or may not be native species. Competition and genetic influences of hatchery fish are clearly concerns in the case of wild, native stocks. In instances where protection of native species from competition by introduced species is a concern—southern Appalachian brook trout—protection from hatchery stocking of brown or rainbow trout is essential. In cases where unique or pure wild strain gene pools are involved—possibly southern Appalachian brook trout in streams and areas such as Maine where something in the order of 432 wild trout populations exist in lakes that have never been stocked—protection from potential genetic impact of stocking is a key factor in management.

The genetic issue is given consideration in all Eastern areas, but the level of concern varies depending on the role of introduced species. In Pennsylvania, New York, New Jersey, and Arkansas, to mention a few, thriving wild brown trout populations are the result of hatchery stockings. In Pennsylvania and New York, streams were stocked for nearly 100 years and still supported healthy wild brown and brook trout populations. In Arkansas, home of arguably the premier trophy brown trout fishery in North America, there were no native trout species. Trout were established by hatchery stockings into tailwaters resulting from construction of dams in the 1940s. Wild does not have to mean native.

The protection of wild trout populations from the possible negative impacts of behavioral interaction with hatchery fish and/or from the effects of angling pressure attendant to stocking hatchery fish clearly enters into the decision not to stock. In Pennsylvania that is the fundamental basis for prohibition of stocking in Class A wild trout waters. In other cases the decision is simply that self-sustaining fisheries are most efficiently and economically managed through natural reproduction and expensive hatchery fish are used in waters where there is no wild trout fishery; i.e., West Virginia's observation that "It made no sense to stock hatchery trout if there was any other method to provide trout fishing opportunities."

The level of wild trout populations at which the no-stocking approach kicks in varies and the reason for not stocking varies. Social pressures may force compromise, but, overall, there is general agreement in the East that, wherever possible, wild trout should be managed with no introductions of hatchery fish.

Public Education and Information

Eastern states and provinces tend to view public education and information as a quite important element of wild trout management. The reasons for public education and information are many and tend to be universal across agencies. Public awareness of wild trout is seen as a key element in rallying angler support for management actions such as special regulations, habitat protection, or cessation of popular stocking programs. The long tradition of hatchery stockings and publicity related to stocking has created an overall impression among the general public that all trout come from hatcheries and virtually all trout fishing is created by stocking.

Wild trout management efforts have been, until relatively recent, not been well understood or acknowledged by the public. In contrast to the anglers

who don't realize the extent and value of wild trout are the wild trout advocates who are critical of but poorly informed on the efforts put forth by agencies to protect and manage wild trout.

Public education/information is viewed as important in three areas: (1) letting the public who are unaware know what is available in terms of wild trout, how valuable and special that resource is, and what management options are best applied, (2) letting people who are aware of the value of wild trout, but criticize agencies for not doing enough, know that the agency does know what's out there and has ongoing efforts to better protect and manage wild trout, and (3) taking our message to a "non-traditional" public, to build a long-term commitment among the non-angling public to support economic and land use decisions necessary to sustain wild trout populations through the 21st Century.

PROBLEMS AND OPPORTUNITIES

A problem extending across parts of the East is loss of public access to wild trout populations. The distribution of public land/private land in the East is quite different than might be the case for some of our Western counterparts. A substantial amount of Eastern wild trout habitat is on private land, some of which is under conservation easements or is simply open to public access due landowner courtesy. There has been a gradual, although accelerating, loss of public access to private lands in recent years. This is a problem and concern for resource management agencies.

Acid rain is seen as a major concern. From the perspective of those who have low production, poorly buffered waters, and who, due to weather patterns, receive atmospheric deposition of acid forming materials, acid rain is, and will continue to be, a threat to wild trout in the East. This is true from the Adirondacks to the Great Smoky Mountains.

Public perceptions are seen as a problem and a challenge. Education and information are the only response we have to this challenge. However, in much of the East, we have an increasing urban population who are a generation removed from any direct contact with hunting or fishing, whose values are not conservation oriented, who do not understand denial of use or discharge permits to protect wild trout. They may understand that some fishery agency is the reason water and sewer bills are higher or the new mall can't be built on a nice meadow outside of town, but they may not appreciate the value of wild trout.

A growing challenge involves a quite different segment of the public: those who are aware of native species and wild trout and take a preservationist/ environmentalist attitude that—at least in the East—is sometimes based more on emotion than reality. These are the people that would restrict all management options, including liming, in all situations involving a native species. Much of Eastern wild trout management focuses on introduced species. The mind set of extremists who would generalize to prevent all management intervention with introduced fishes (brown trout) is perceived as a concern because this mind set seems to be setting policy in the Department of Interior. Maybe a challenge for Eastern wild trout management is to assure the Fish and Wildlife Service has a balanced perspective on use and management of introduced salmonids.

Conflicting angler preferences and attitudes is a problem in Eastern wild trout management. Tackle restrictions invariably create conflict. Social pressure for regulations that are restrictive beyond what is necessary to achieve a biological objective create real problems for wild trout managers who are trying to build as broad a base as possible in support of wild trout fishermen. Restrictive regulations, such as catch-and-release, will not produce large trout if a stream is simply not capable of sustaining growth necessary for large fish or high standing stocks. Unfortunately, some anglers see the regulation as the end in itself rather than a tool to be applied at a fishery manager's discretion.

The whole issue of special regulations can be viewed as problematic. In the right situation, restrictive regulations are seen as an important component of wild trout management. In the low productivity of many Eastern wild trout waters, particularly wild brook trout streams, special regulations will not produce large trout. The challenge is to produce realistic angler expectations given the constraints of the environment. Typical of this problem is a comment from New Hampshire relative to protecting wild brook trout in small, softwater streams: "An 8 inch is a monster!" These fish are important. They're regulated and they will be protected, but anglers

will have to adjust their expectations to what nature provides—a tough challenge.

A common problem is, at what level of wild trout is management exclusively for wild fish with no stocking? Many Eastern streams with wild trout populations are still being stocked. Recreational demand is so high that, through stream classification, often only the very best wild trout streams are managed without stocking. Social traditions, a long history of stocking and public demand make it difficult to stop stocking in streams with, for lack of better description, moderate populations of wild trout. The challenge is to increase the scope of wild trout management and bring more of these waters under wild trout management, moving hatchery trout to other waters where wild trout aren't a factor.

The dispersed nature of wild trout streams and angler density often makes angler contact difficult. A challenge to Eastern agencies is to collect angler use and harvest data on wild trout streams. We know a great deal more about stocked trout catch rates and harvest than about wild trout. Good data is needed to support management initiatives. The problem is to strike a politically, socially, and biological acceptable balance between quantity and quality of recreation.

THE FUTURE

From an Eastern perspective, the future of wild trout management looks good, but it varies from jurisdiction to jurisdiction, influenced primarily by social traditions (a long history of stocking and the accompanying angler expectations) and by the extent of wild trout water available.

Maine, New Brunswick, Nova Scotia, and Quebec would appear, to me, to be examples of a wonderful future with exceptional opportunities for wild trout angling. Their resource base is large; wild fish seem, overall, much more important than hatchery plants. Inventory (including regulations and public information/education) would seem the key to a solid future of high quality angling sustained by wild fish.

New Jersey's response would seem the other extreme. Essentially, the future for wild trout management in New Jersey is resource limited. All candidate waters for wild trout management have been identified and are being appropriately managed. There is virtually no opportunity for expansion. The future is to safeguard and enhance those special few waters as an exceptional and valued part of the state's overall trout fishery.

Whether we have thousands of acres of wild trout water or a handful, there are some threads of common concern for the future, threads that I will presume to weave into an Eastern perspective. First and foremost, in the East, wild trout are viewed as something special, a resource deserving of exceptional recognition and management. We've come a long way since the first Wild Trout Symposium in 1974.

I think that everyone in the East perceives genetics as an important consideration in maintenance of distinct native trout strains and population, and I see the future in states with, for lack of a better term, heritage populations of brook trout beginning to test for genetic differences to determine if special protection for subpopulations is warranted. That same future holds the possibility of reclamation and reintroduction of native strains.

For all of the genetic concerns, the future of Eastern wild trout management in my view has to include introduced species, including rainbow and brown trout. There's a world of difference in the trout fisheries of Pennsylvania and Arkansas, but we are in total accord about the importance of introduced species: wild brown trout are the linchpin of our wild trout program. That perspective differs from others who have differing circumstances, but we hope that the future holds recognition of the validity of Eastern attitudes in dealing with there own wild trout management opportunities in their own way. Any national policy or attitude that overlooks the desires and concerns of recreational anglers for introduced but naturalized wild salmonid and focuses only on native species would not be appropriate in some of the altered environments of the East. Wild brown trout have a great future in the East as do wild populations of native brook and lake trout. We have room for both native and "naturalized"—both are appropriate.

Special regulations will remain a part of future management of Eastern wild trout, but there is growing appreciation of the social conflicts caused by exclusion of bait fishers from specially regulated, high quality wild trout fisheries. The future of specially regulated Eastern

wild trout fisheries may very well include bait fishing under highly restrictive harvest situations. Several Eastern states, including Pennsylvania, are evaluating specially regulated wild trout fisheries with harvest prohibited or restricted by a relatively high size and low creel limit, but there are no lure or bait restrictions. This does not meet with approval of all—at least not with some vocal fly fishers—but it is an attempt to achieve a biological objective with only the necessary minimum of restrictions on users. Angling pressure and resulting hooking mortality are a consideration and I don't see universal application of bait fishing in specially regulated wild trout fisheries, but it is on the mind of managers in more than a few Eastern states.

On the negative side, loss of habitat, particularly to acid rain, seems a part of Eastern wild trout management into the 21st Century. From New York's Adirondacks trout ponds, through West Virginia, south into the Great Smokies, acid rain continues to be a problem. It is reasonable to assume there will be losses or reductions of wild trout populations into the next century. Addition of buffer material (lime/limestone) appears to be a continuing interim effort where feasible.

The future of Eastern wild trout management means striking a balance between recreational demand and what the resource can provide. Some wild trout streams will continue to be stocked. We are faced with the challenge into the 21st Century of deciding at what level of population should stocking be terminated. The problem arises when a fishery manager is faced with high recreational demand on streams which support only a modest population of trout. Sometimes the decision is, stock hatchery fish. This is a dilemma that face many of us. There is no easy resolution.

Public education and information is seen as playing a big role in managing wild trout into the future. The responsibility goes both ways. One is making people aware that not all trout come from a hatchery. Many Eastern anglers do not realize the extent of wild trout populations in their own state. The other responsibility is to make certain those anglers who want and support wild trout do so with realistic expectations. A future responsibility is to provide sufficient information to assure angler expectations are consistent with the productivity and potential of the wild trout waters under consideration. Better information provides a start on a better relationship between angler and manager. Symposia such as this go a long way in building that information base. I think they will come to be equally valuable in the future.

SUMMARY

Overall, to synthesize information from others and from my own experience, I think the Eastern perspective on wild trout management into the 21st Century is one of confidence and optimism. Unlike the attitude of 20 years ago, we know that Eastern populations of wild trout can provide and sustain fisheries without stocking, there is growing angler support for wild trout, management styles have achieved a balance between fishing pressure and resource base recognizing the role of both wild and stocked trout, there are places where introduced species and effected growth are a concern, but south of Maine, wild populations of naturalized species—rainbow and brown trout—are key factors in many wild trout fisheries.

Wild trout are special. They are, for Pennsylvania, the last of the best and we had not special management for them until 1983. We intend to move into the 21st Century giving those fish the special consideration and attention that was for so long denied them. Wild trout are a solid part of Eastern trout management and will be even more so into the 21st Century.

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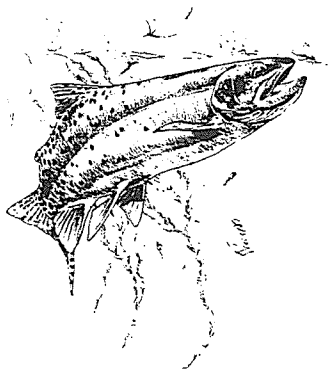

Wild Trout Management for the 21st Century - A Western State Fisheries Management Perspective

Jim Martin[1/]

Abstract -- The serious and widespread depletion of Pacific Northwest salmon and trout has created sufficient public and political attention to allow change. We must not let this opportunity escape. A real working partnership between Sportsmen, Tribes, and Federal/State agencies will be required. Protected species protection, the proper use of hatcheries, and watershed restoration are three major challenges. We must set aside minor disputes and "turf battles" in order to affect change before the public loses patience and our golden opportunity passes.

These are both the best of times and the worst of times for western salmonids, the people who fish for them, the people who manage them . . . . and for those who value the livability that the fish represent.

These are certainly the worst of times for the stocks, especially the anadromous salmonids of the Pacific Northwest. The combination of overharvest, habitat destruction, and the unprecedented combination of draught and El Niño, have brought the stocks to their knees. Across the west we have already weakened and fragmented stocks "winking out" of existence. Petitions to list fish stocks under the Endangered Species Act are appearing with alarming frequency. Clearly, these fish are at a crisis point.

These are the best of times because, right now, a number of events have coincided to create one of the most unique opportunities for positive change in fisheries management in a half century.

Oddly, this crisis of near extinction has caused an unprecedented level of public concern and attention. The concern for the sustainability of our natural heritage goes way beyond the concerns of fishermen to one of national concern.

[1/] Chief of Fisheries, Oregon Department of Fish & Wildlife

Also, this is a time of major advances in the science of stock definition, habitat restoration, and life history recognition. We are beginning to synthesize this new, better science into a stronger conceptual framework for management called ecosystem management.

Finally, we are currently blessed with a federal administration that actually cares deeply about natural resources and has courageously taken on the contentious and long-avoided battles of logging, grazing, mining, dam building, pollution and over-appropriation of our water.

However, we should never underestimate the strength of the opposition, especially as they work their strategies effectively in local and state governments across the west. The "wise use" movement is well funded and organized and will stop at nothing to portray advances in environmental protection/restoration as an anti-American plot by radical preservationists to deprive landowners (and extractive business) of their rights without fair compensation. Each advance in protection of the public trust is fuel in their quest to strike back. These are the best of times for positive federal court decisions reaffirming environmental protection laws but these are also the worst of times for

efforts to weaken state and local environmental protections.

One of our greatest challenges is communication and coordination between agencies . . . . and with the general public. The truth is that the working relationship between federal, state and tribal fish and wildlife agencies is more strained than anytime in the last quarter century and the situation is worsening rapidly. The very agencies that should be partners and natural allies are quarreling over heavy-handed tactics by federal agencies while state agencies are defending turf and status quo.

And if this wasn't hard enough, there is distrust and resentment building among the hunters and anglers of the country toward the "newly enlightened" federal biodiversity policies and the environmentalist who appear to have the ear and heart of federal leaders. Increasingly, the state and tribal agencies are joining anglers and hunters in defensiveness that is approaching "bunker mentality." The inability to explain concepts such as biodiversity and ecosystem management in tangible, clear terms, that match the values of the traditional constituents, is part of the problem. Another is the "we know best" attitude by some federal leaders that borders on big brother arrogance. The rush to change is outstripping our patience and ability to explain. The result is some key partners in the conservation movement are disenchanted and left behind, just when teamwork is needed most.

KEY ISSUES

Three key issues are currently dominating the fisheries management scene. Each important problem also represents a major opportunity for progress.

The first issue involves the balance between protecting rare and depleted species while maintaining benefits from stronger wild stocks and hatchery programs. Increasingly protected species measures are being mandated by federal agencies at the behest of well meaning environmental advocacy groups over the objections of state/tribal managers and fishermen. The Endangered Species Act in the Pacific Northwest has turned out to be a two-edged sword.

Managers and fishermen from highly altered ecosystems such as the Columbia, Colorado and Sacramento river systems are struggling to keep the "old promises" of mitigation and treaties in the face of strongly protectionist restrictions by the same federal government that promoted and accomplished the ecosystem alteration to start with!

Clearly, we need strategies that accomplish protection and rebuilding of listed and sensitive species <u>while</u> rebuilding ecosystem integrity and fisheries benefits. We need dialogue among the partners and support from fishermen and the public for sensible restoration programs.

A second major issue is the proper role of fish hatcheries in the programs of the future. The "hatchery bashers" and "hatchery defenders" have fully engaged one another in the popular media and the tone is becoming increasingly shrill. The public is confused, disillusioned and is losing patience as we argue emotion and philosophy, when scientifically based resource management strategies are what is needed. For example, in Oregon we have a wide diversity of healthy ecosystems and robust wild stocks. We collectively enjoy 8 million angler days per year. Over half of these angler days come from trout and 70% of that results from hatchery stocks.

By moving most of the hatchery fish from rivers to lakes and reservoirs, we have been able to maintain fisheries benefits with less risk to wild trout stocks. Currently we stock less than 5% of Oregon's streams and most wild stocks are further protected with restrictive angling regulations.

Anglers and the public support such balancing strategies because they make common sense and they show respect to wide ranges of values regarding wild stocks. Strong, sensible conservation strategies build coalitions rather than dividing natural allies into polarized extremes which neutralize one another, while the real opportunity to rebuild ecosystem integrity is lost.

Hatcheries must play a role in the fisheries of the future. Each program should have a clear management objective, must be cost effective and must

be biologically compatible with the other components of the biological community. Programs which fail this test must be changed in order to warrant public support.

The third major issue is whole-watershed restoration. Everyone would agree fish are the great integrators across the property boundaries of the watershed. Conservation strategies which are restricted to only one ownership within the watershed are bound to fail, especially with migratory stocks.

The "Pac Fish" strategy, to protect and rebuild anadromous salmonids of the Pacific Northwest on federal lands, is a good start. But where are the regulatory and/or incentive programs to involve state and private landowners? We need programs that tie economic flexibility for development to biological benchmarks. For systems that are biologically healthy, more flexibility for development may exist. For systems with biological "red lights" flashing, the flexibility for development must be constrained. Such a system of tax and zoning incentives/disincentives could be integrated into federal land management strategies that consider whole-watershed approaches to achieve restoration of system health.

SUMMARY

In order to meet the challenges of the next century, we not only will need to mobilize both the traditional hunting and fishing constituencies, but other non-consumptive wildlife enthusiasts as well. Our job as professionals is to synthesize the information on trends in stock health to demonstrate the problem to a broad cross-section of the public.

We also need to show people that there is a solution. We need to be "constructively discontent" with the status quo without being so critical we polarize our constituencies. The shrill debate on hatcheries within the profession is an example that may be hurting the consensus building process more than it is helping. Too often, we see environmental groups neutralizing fishing interest groups to the advantage of development interests. "Fish people" need to work together and stick together in order to accomplish the larger agenda.

Professionals need to set a good example in our communication style. We sometimes see professionals who are so consumed by their technical information they alienate the rest of the team (environmentalists, fishermen, the general public, and other professionals). Such techno-arrogance can be offensive and counter productive to consensus building.

The greatest challenge of the next century will be to combine the conservation and fisheries management missions into an integrated program that mobilizes a broad cross-section of the public that will push for change. Real stewardship and ecosystem restoration is the challenge for tomorrow. Today's stocks-at-risk status report is the wake-up call. The future is up to us.

Wild Trout: Key Indicators of Ecosystem Health

Harv Forsgren[1]

THE PAST

Trains thundered across America, demanding that 15 to 20 million acres of trees be cut each year just to replace railroad ties. Farmers cleared an average of 13.5 square miles of forest land a day, every day, to keep the burgeoning population fed. Wildfires burned out of control, scarring 40-50 million acres annually, causing flooding and damage to watersheds. Turn-of-the-century America was growing and thriving—and depleting and damaging its forests at an alarming rate.

By the end of the century, some vocal citizens were concerned at how quickly the forests were disappearing, and Congress responded by passing the Forest Reserve Act of 1891. The President could now designate forest reserves out of public domain lands. In 1895, the modern Forest Service was established and since that time, it has grown to manage 191 million acres of land in 44 states and Puerto Rico. Draining these lands are about 200,000 miles of perennial stream and more than 2 million acres of lakes, ponds and reservoirs - including perhaps as much as half of the nation's trout waters.

Management of these vast aquatic resources has been part of the agency's program from the very beginning. However, prior to the blossoming of environmental awareness during the 1960's and 1970's, fisheries was a very small program within the Forest Service. In regard to wild trout, our early management efforts were largely limited to small scale habitat improvement projects and assisting the states with their stocking programs.

Passage of landmark legislation, including the Multiple-Use Sustained-Yield Act of 1960, the National Environmental Policy Act of 1969, the Clean Water Act of 1972, the Endangered Species Act of 1973, and the National Forest Management Act of 1976, helped to clarify Forest Service responsibilities for management of aquatic resources. As a result the $1 million dedicated to fish habitat management grew until the early 1980's when it reached a plateau of about $10 million per year. The handful of fisheries "pioneers" were joined by a second cohort, swelling the ranks to about 100 fisheries biologists. During this era, wild trout management efforts focused on protecting habitat in the face of rapidly expanding commodity production. Investment in small scale habitat improvement projects also continued.

In 1985, the American Fisheries Society evaluated the Forest Service fisheries program. The review demonstrated a need to emphasize fish habitat protection and associated fisheries use opportunities. The Forest Service assembled a taskforce to outline a program that responded to the review findings. The taskforce, with representatives from state and federal agencies, the professional society, and the recreational fishing industry, developed specific goals, objectives and tasks for the Forest Service fisheries program that became known as "Rise to the Future."

Approved by the Chief of the Forest Service in March 1987, "Rise to the Future" helped to focus attention and emphasis on management of national forest aquatic resources. The change in agency emphasis, and the continued strong influence of recreational fisheries and conservation interest groups, are reflected in funding and staffing changes from 1986 to the present. Fisheries funding has increased from about $12 million to more than $50 million. A third cohort of fisheries biologists increased staffing from about 120 to more than 370. With this growth, wild trout management efforts on the national forests embraced new elements_aquatic education and interpretation and conservation of native aquatic communities, while holding fast to important elements of the past—habitat protection and improvement.

That past sets the stage for the present and future management of wild trout on public lands administered by the Forest Service.

THE PRESENT

In June of 1992, the Forest Service announced it was adopting a new ecological approach to management of public lands. For better or worse, this approach was dubbed

[1] *National Fisheries and Aquatic Ecology Program Leader, USDA Forest Service, Washington, D.C.*

"Ecosystem Management." Initial reaction to this announcement, both within and outside the agency, could be generously characterized as "critical skepticism." With the passage of two years and some operational experience, those feelings have largely evolved to "hopeful skepticism." It is to the advantage of wild trout that the perceptions - and reality - of ecosystem management continue to move in a positive direction.

Ecosystem management provides the context for Forest Service action to make a substantive contribution to the conservation, productivity, and use of wild trout. Indeed the Forest Service brand of ecosystem management reflects both components of our "Caring for the Land and Serving People" mission. It calls upon the agency to:

— promote the sustainability of ecosystems by ensuring their health, diversity, and productivity.

— provide multiple benefits for people within the capabilities of those ecosystems.

Many wild trout stocks in the United States are dependent on the success of ecosystem management. Public lands managed by the Forest Service (and Bureau of Land Management) represent a singular opportunity to conserve wild trout. These lands include the vast majority of the remaining "good" habitat, and probably the bulk of habitat for which we have the technologic, economic, and political potential to restore to support wild trout. These lands are open to, and within a few hours of, the vast majority of the public.

Four principles provide the key to ecosystem management implementation, if it is to contribute to conservation of wild trout.

First, land management decisions have to be scientifically based. As biologists we readily accept that premise but generally view it narrowly. Under ecosystem management, the Forest Service is committed to decisions that are based on good biological or ecological science; political science; and socio-economic science.

However, the biological or ecological science should be used to define the management decision space within which political and socio-economic considerations can be weighed.

Second, if we are to conserve wild trout our ecological approach to management must focus on the following:

— Sustainability of resources and uses.

— Understanding physical and biological processes and functions.

— Managing systems and communities rather than sites and species.

The overriding concern has to be the continued functioning of systems over millennia. This management approach focuses on the maintenance of the health of ecosystems; that is, restoring or maintaining a system's ability to absorb shock and yet retain long-term form, function, and productivity. Success is measured in a manner beyond today's profits and losses and beyond today's political desires.

Third, if we are to conserve wild trout, implementation of ecosystem management must be of an adaptive nature. Adaptive management recognizes the complexity of natural resource management and the gaps in our own knowledge. It places priority on appropriate monitoring and feedback to ensure experience based learning is applied to correct the management course.

Finally, if we are to conserve wild trout, ecosystem management must be designed, implemented, and evaluated in close partnership with other agencies, groups, and the public. As our Chief Jack Ward Thomas has said:

> "We...have the obligation to listen to the land wisdom of other people, other cultures, other ways of looking at lands and resources. We do this because of our respect for other sharp observers and thinkers who care about what we care about. We do this because they have invaluable insights to give us."[2]

OUTLOOK FOR THE FUTURE

The Forest Service has embraced those four principles, and others, to guide implementation of ecosystem

[2] *J.W. Thomas. This Time, Our Moment in History, Our Future. Speech delivered at the Forest Service Leadership Meeting, Houston, Texas, June 1994.*

management, but the question remains... "Will ecosystem management make a difference to the conservation of wild trout?" I am generally optimistic that it will! Let me share several reasons for that optimism in the forms of programs at the national, regional, and local levels.

At the national level:

— "Bring Back the Natives" was initiated in 1992 as a cooperative program among the Forest Service, Bureau of Land Management, and the National Fish and Wildlife Foundation to focus effort on watershed scale restoration to provide for conservation of native fish communities. Restoration efforts include adjustment of land management activities as well as structural and non-structural rehabilitation techniques. With the considerable help and financial contributions of state, industry, and private partners more than 40 comprehensive restoration efforts have been initiated in 14 states - targeting the health of nearly 2,000 stream miles. The top predators in nearly 90 percent of those systems are wild trout! A virtual who's who of wild trout stand to benefit from this ecosystem approach to management including: Apache, redband, Kern River rainbow, golden, steelhead, brook, and bull trout; Greenback, Colorado River, Yellowstone, Westslope, Bear Lake, Bonneville, Lahontan, Rio Grande and coastal cutthroat trout.

— In 1990, the "Every Species Counts" program was established to bring together the resources, enthusiasm, and commitment of the Forest Service, other agencies, private organizations, and individuals to ensure habitats of threatened, endangered and sensitive species on the national forests are managed to enhance species recovery and conservation. The program is particularly important in the context of aquatic species. Forest Service and Bureau of Land Management lands are home to almost 70 percent of the federally listed fish and more than half of those fish that are candidates for listing. Budget trends, emerging emphasis on aquatic systems, and accomplishments for this program are encouraging!

At the regional level:

— The Forest Service and Bureau of Land Management have developed a common strategy for management of public watersheds to provide habitat conditions that contribute to recovery and sustained natural production of Pacific salmon and steelhead throughout their natural range. This strategy, known as PACFISH, has been implemented as the "Aquatic Conservation Strategy" within the President's Forest Ecosystem Management Plan. We anticipate implementing PACFISH interim direction next month for anadromous fish producing watersheds in Eastern Oregon and Washington, Idaho, and California. Regional scale ecological assessments and Environmental Impact Statements are underway to provide longer term management direction for the Pacific anadromous salmonids and other fish inhabiting these areas. Forged through an interagency management/research partnership, PACFISH represents a credible, proactive, ecosystem approach to conservation of wild Pacific salmon and steelhead.

— Through a similar partnership Habitat Conservation Assessments (HCAs) are being developed for bull trout and interior cutthroat trout. These HCAs represent the most current and complete compilation of information on the habitat requirements and management needs of these wild trout over their entire geographical range. The completed bull trout HCA, and the draft cutthroat trout HCA both reflect the close collaborative efforts of the Forest Service, and other state, federal, and tribal fish management entities.

At the local level:

— There are numerous examples of watershed scale restoration efforts to restore the productivity of aquatic communities that support wild trout and salmon. Specific examples of local efforts include the following:

- Watershed Alliance (in the Puget Sound, Washington, area).
- Crooked River Ecosystem Enhancement Cooperative and Upper Grand Ronde River Watershed Restoration Project (both in eastern Oregon).
- Salmon River Watershed Restoration Project (in California's Klamath River drainage).

CONCLUSION

In closing, I'd like to quote a portion of a message Chief Jack Ward Thomas delivered to agency decision makers in Houston this past June:

> "This agency has been preparing for nearly a century for this critical time - whether we knew it or not. We are defining and setting our course to meet the challenges of the years ahead. And we know that we, as an agency, are not now as good as we need to be, we want to be, or - through our efforts and the support of our partners - as good as we will be. It is time to change and be revitalized, to set a course for the Forest Service as we move into the 21st Century."[3]

Conservation and enhanced opportunities for use and appreciation of wild trout have got to be an important part of that course!

The Forest Service is *uniquely* positioned geographically, and manages a suitably large land base to make a real difference in the conservation of wild trout. To not profile and capture that unique opportunity is to dash the agency's quest to be a world conservation leader. The health of wild trout and their habitats will be a highly visible indicator of the success of Forest Service ecosystem management. Given their immense social, cultural, ecological, and economic values, wild trout deserve nothing less than the Forest Service's best effort.

[3] *See footnote 2.*

Wild Trout Management in British Columbia

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In British Columbia, controversies about trout management rarely revolve around wild trout versus hatchery trout, as most fish caught are from indigenous wild stocks in natural waters. What trout we do stock are almost entirely direct progeny taken annually from the wild. The status of the trout resource and its use are outlined, as are the management philosophies and strategies employed today as compared to 15 years ago. Quality waters management is discussed using examples of two long evaluated trout fisheries with emphasis on the limited entry concept. For sustainable and quality wild trout fisheries to exist into the next century, attention will have to focus on at least improved habitat protection, quantification of habitat to produce fish, meeting First Nations expectations, establishing non-consumptive value of trout, increasing public awareness regarding biodiversity and the role of genetic variation, de-mystifying regulations, employing limited entry wisely, and finally "marketing" the biological, social, cultural and economic aspects of quality trout fisheries as a package, especially to the general public, other resource agencies and politicians.

INTRODUCTION

Much has been made about wild trout, their management including philosophy, "the product" itself and its utility in North America. In British Columbia, controversies regarding trout management rarely revolve around wild trout versus hatchery trout because what trout we do stock by practice are almost entirely direct progeny from the wild. Over 75 percent of all fish caught are wild stock in natural waters.

As a contribution to this panel, I will briefly summarize the status of the trout resource, its use, our management philosophy and the strategies we are now employing in anticipation of the years beyond 2000. I would like to give you some idea of what we have moved to in our management since I last spoke to many of you here at Trout II in 1979, and use two fisheries as examples of that management direction. There have been some down sides as well, and I will put them into perspective, having been connected with fisheries management for nearly 35 years.

Happily, I still revel in the wonder of wild trout. I am convinced more than ever that thinking about the continuance of fishing for them in wilderness surroundings is but one good reason to draw us together yet again today. Wild trout existing in natural waters, in my mind, should also be a confirmation of all that is good in human understanding of fairness, compassion

and self-discipline. Everyone would be better for knowing the goodness of wild trout -- there is more to these fish than just catching them! I believe there is room and time for enlightened wild trout management. Let me try to explain.

Status of the Trout Resource

Imagine an area 100 times larger than Yellowstone Park, one-third larger than Texas, three-fifths the size of Alaska, or an area equivalent to Washington, Idaho, Montana and Wyoming. Imagine an area with more than 25,000 lakes and 26 major river systems and 4,600 streams. Imagine a cruel Mother Nature who provided only the rainbow, the coastal cutthroat and the Westslope cutthroat trout. The brown trout was introduced, as was the brook "trout", the latter a char by another name. British Columbia has only 86 species of fish, one-quarter of which have been introduced through man's activities.

But trout in British Columbia are characterized by the Kamloops and the Gerrard rainbows as well as steelhead. The trout resource abounds generally in small interior lakes centering around Kamloops, while steelhead are mainly concentrated in 100 streams on Vancouver Island, and in the Fraser and Skeena watersheds.

Resident rainbow trout are very abundant in our nutrient rich dry interior lakes like Roche, White, Pinaus and Pass, and relatively spare in temperate west coast rain forest streams like the Nimpkish, Squamish and Chilliwack. Equally, coastal lakes are nutrient poor and usually only where salmon are consistent visitors do trout exist in any numbers in their outlet stream, for example on the Cowichan. There are relatively few good resident trout streams, but the Stellako, Blackwater, Horsefly, Thompson, Clearwater and St. Mary's are exceptions. The anadromous steelhead is widespread in coastal streams, has wildly fluctuating run sizes -- likely none over 10,000, a few over 5,000 and most in the low hundreds, but the Kispiox, Babine, Bulkley-Morice, Dean and Thompson continue to provide quality fishing. Cutthroat trout are perceived to be depressed province-wide and with only a few exceptions has their restoration been successful in streams. Marine fisheries are severely curtailed near urban centers and where spawning streams have been affected by industrial activity.

Use of the Trout Resource

Sport fishing is a popular recreational activity for both residents and tourists. Our last major survey in 1990 indicated that 400,000 licenced and 100,000 unlicenced juvenile anglers spent close to 5 million angler days fishing equally on lakes and streams. Non-residents from neighbouring Alberta, Washington, Oregon and California accounted for 0.5 million days. All anglers combined caught near 10 million fish and released 55 percent. Rainbow trout accounted for half the total catch of 18 classified game species. The total 1990 angler effort generated approximately 450 million dollars to the general economy of the province. The total number of anglers declined slightly throughout the 1980s, non-resident activity peaked and is declining markedly, whereas several regions of the province, most notably the central Cariboo and Chilcotin area, indicate a trend of continued increase in angler effort. In many northern areas sport fishing is a favoured outdoor activity and participation rate in the population is often over 25 percent. In rapidly growing urban areas the proportion of the population fishing has been continually declining.

Management Philosophy and Strategies

Management of freshwater fisheries, except for anadromous salmon, is the responsibility of the provincial government. The 5 species of Pacific salmon are under the management of the federal Department of Fisheries and Oceans. The provincial Fisheries Program is delivered by a central Fisheries Branch and 6 regional fisheries operational groups which, within the Ministry of Environment, Lands and Parks, have the responsibility for administering, conserving and developing the freshwater fisheries resources of the province.

In 1991, the Fisheries Program formally recognized its mandate to manage fish, fish habitat and sport fishing for the people of British columbia in a 5-year strategic plan. Basically, we took ownership of all fish in freshwater, other than anadromous salmon, and emphasized 4 main strategic objectives:

- conserve wild fish stocks,
- protect and manage fish habitat,

- serve the public interest, and
- practice strong corporate management.

We realized we had a responsibility to link our daily activities to issues of wild and stocked fish. With rapidly declining supply, the conservation of wild fish populations became a first priority commitment. The preservation of wild fish was based for the first time on identifying and monitoring both sport and non-game species. In reality, however, we currently actively manage less than 10 percent of an estimated 30,000 unique stocks of fish. Conducting inventory of wild fish populations is the highest priority of the Fisheries Program. Other wild fish priority management activities include monitoring the status of wild populations, setting rigid conditions for hatchery introductions and classifying systems based on stock status and use criteria. Our challenge is to "match-the-hatch", so to speak -- how much use, how many fish to experience and in what kind of settings?

At Trout II there was a lot of controversy over the definition of a wild trout. There were definitions biased toward hatchery bases and those that were toward the academic side. In British Columbia, fish culture is completely integrated into fisheries management delivery, and we have now agreed to the following:

- Wild stocks complete their life cycle without the direct assistance of man. This includes both indigenous and exotic species.
- Indigenous stocks reside in their original location and are naturally adapted to the local aquatic habitat.
- Exotic stocks include native species which have been transplanted to a new location or non-native species which have been introduced to the province.

The long term conservation of wild indigenous species and their habitats are the primary objectives of the ministry and the Fisheries Program.

In perspective we have shifted, over the last 15 years and particularly in the last 5 years, from a single species focus for game fish toward a holistic view of managing all fish. This may not sound very startling to an ecologically sensitive audience like Trout II. It is, however, a big step for many of our clients, senior executives and the politicians, particularly since we feel we have got the right approach, but currently there is little appreciation and less recognition for directed operational resources to do the job properly. The task now before most of us, in light of rapidly developing biodiversity issues, scarcity of resources, competing demand among land and water users, is to find new, innovative, flexible and adaptive ways to market the positive changes that can occur with ecosystem management. There has to be active promotion that healthy ecosystems, represented particularly by healthy fish stocks, are not luxuries but necessities. Sustainable environment and sustainable benefits, economic and otherwise, mean investment in proper habitat protection and meaningful restoration. The challenge will be to keep viable stocks in place while the presently unconverted begin to move from appreciation to recognition and finally to support for the value of all organisms and genetic variation and their importance to the diversity and stability of the ecosystem. An old theme for a few, a new theme for many!

I would now like to outline briefly some of the strategies we plan to act on to improve our management beyond 2000:

1. Implement a coordinated approach to assessing and managing wild fish populations
   - management policies and procedures;
   - classifying systems based on stock status;
   - establishing harvest levels; and,
   - setting conditions for cultured fish introductions.

2. Prevent over-harvesting by using conservative regulations.

3. Reduce commercial interception on non-target sport fish.

4. Mitigate the effects of environmental changes on fish.

5. Strengthen role of Fisheries Program in land and water use planning.

6. Improve the effectiveness of habitat protection work.

7. Involve the public in managing the fisheries resource.

8. Meet angler demand within limits of wild stock conservation.

9. Ensure appropriate allocation of the use of resource between resident anglers and sport fishing businesses.

10. Promote tidal trout sport fisheries and related businesses.

11. Develop cooperative fisheries management with First Nations.

12. Recognize and develop opportunities for the appreciative uses of fish.

13. Ensure the development of reliable and thorough information systems concerning natural resources.

14. Propose provincial legislation to cover all activities of the Fisheries Program.

In fifteen years the implementation of most management policies and procedures has been difficult at best. Because most regions were still living off the avails of adequate surplus stock, attention to policy was flexible and often non-conforming. Now, with freedom of information policy alignment is a necessity and Fisheries Program delivery can be expected to be more standardized across the province. With this approach should come improved public understanding and support. Regulations have certainly become much more complex and conservative. With more and better stock monitoring and capability studies on index waters there should be a move to better rationalizing and hopefully reducing complexity in the regulations. The likelihood of liberalizing limits now because of demand and supply is small. Catch and release is widely applied and practiced now. We likely will have to seriously look at the effects of multiple captures on some trout stocks and adjust regulations with more innovation. In British Columbia many of our world famous steelhead are intercepted by commercial and native net fisheries. Terminal fisheries are being encouraged; however, an entrenched 120-year commercial fishery is slow to change. More attention will have to be placed on long-term environmental changes affecting trout. Presently we are researching and developing cultured stocks that are tolerant to increasingly alkaline waters. Major emphasis by the government on land use planning augurs well for fisheries as forest removal and water extraction will not occur as unilateral resource activities. Similarly, new forest practice codes and major watershed restoration programs should stabilize and return over the next 3 decades presently degraded fish-bearing waters. There will be a concomitant move to involving the public in area resource boards and agency co-management agreements with First Nations. There will be a growing and shared responsibility for trout in the future and, through planning, allocations will be based on habitat capability to sustain stocks, conservation needs, rights of First Nations and angler demand and value of trout as an ecosystem member.

There will be good reason for the province to explore development of trout fisheries in marine waters, particularly near urban marine centers, many of which are the fastest growing areas in Canada. If ecosystem management is to be sold, it can be sold showing that fish also have a large capacity for appreciate use. We believe fish viewing and the knowledge that they are harbingers of a healthy environment for all, including humans, will be an important part of our public education program. Much more needs to be done in using fish as an educational tool in school curricula and industry operations. B.C. Hydro is going to educate its employees with environmental instruction and this is a good corporate signal to be emulated by many, we hope. Lastly, with large basic inventory systems being employed to service land use planning processes, the development of reliable and thorough fish-related information will help to support the drive to enact provincial legislation to cover off all activities of the Fisheries Program which now relies on tenets in other acts.

And yes, there have been some down sides in our delivery of fisheries management. There has been a long time appreciation, by a very few, for the world-class fisheries resources, but a long standing lack of political recognition. The Fisheries Program has been lumped into a large ministry including such other important sectors as water, waste, air, lands, parks, wildlife, pesticides and habitat. Fish most often get the last and least consideration. Key services to a well-run fisheries program are information, education, public consultation, planning, economics, public involvement and stewardship. These are all now centralized and we get little help unless it is an issue-oriented problem. Most of our present budget of $10 million goes mostly

to fixed costs. It has not increased in 10 years! Recent large funding from hydro compensation, Habitat Conservation Fund, Crown Resources Inventory Initiative, and the Watershed Restoration Program is not served adequately by our presently small and under-funded staff. These are all critically-needed programs, but our regional Fisheries staff are hard-pressed to survey the heavily-used waters, attend meetings with a public who want to be more involved and investigate complaints and new opportunities. Some are even having to worry about putting gas in their vehicles! All of this when our 1990 survey showed 540,000 anglers spent $455 million in direct expenditures to go fishing. We believe a 20, 50, 80 or 100 million dollar fisheries program is realistic and supportable by maintaining the quality of world-class fisheries, diversifying the fisheries, expanding the supporting tourism infrastructure and creating economic wealth at a very high benefit/cost ratio!

Two Examples of Trout Management Direction

I would now like to describe one quality resident rainbow trout fishery that some of you have experienced and what we have had to do to maintain wild stock even in a wilderness stream. I am speaking of the Stellako River. Secondly, I want to refer you to the world-famous summer steelhead stream -- the Dean River, in mid-coastal B.C., where we piloted and instituted limited entry fishing in a remote fishery.

Firstly, the Stellako is almost in the geographic center of the province in the sub-boreal forests. This nearly 15 km (9 mile) long stream is in a deeply-incised valley which has not been logged. It is lake moderated but is a typical cold northern stream, with May to August high water and low fall, winter and spring flows. Its fish assemblage is limited to small populations of rainbow trout, bull trout and whitefish and large populations of sockeye and kokanee salmon, chinook salmon and several species of undefined numbers of non-salmonids (e.g. burbot, suckers).

For 14 years monitoring has indicated a summer influx of 10-50 cm trout and for the last 7 years there has been a decline in 10-50 cm fish. From 1953 to 1983 the daily possession limit reduced from 15 to 5 and daily limits of over 50 cm was reduced from 3 to 1. A spring closure was also in effect. In 1980 it became obvious with only 1300-1800 angler days the stock could not sustain the harvest, and by 1991 the stock of 30 cm and greater catchables had declined by half.

Starting in 1985 a minimum catch size of 30 cm was imposed, a bait ban and single hook regulation was introduced, there was a near doubling of the fly-fishing zone, and a power boat ban and a winter to spring closure was placed on the fishery. I am happy to report that the latest stock assessments only a month ago indicate increases in all size classes. What we have described is a classical, very small (less than 3000 trout greater than 10 cm) but resilient trout stock that has to be managed understanding its likely dependence on salmon for nutrient enrichment of its stream habitat, the requirement for most sub-adults and adults to over-winter in lakes (NOTE: and not to be targeted in ice fisheries) and that zonation and fishing methods can lead to increasing fishing activity. Mandatory release of rainbow trout is now acceptable to the anglers in this fishery once it was explained that the stock dynamics could not support even a small harvest with the proficiency seen in 1300 angler days. A quality fishery lives on -- and yes, the average size is a respectable 42 cm (16.5 in) and several or more a day can usually be landed.

The second example of a management direction we have taken may not be new to most of you. However, imposing limited entry on what was becoming a gold rush steelhead fishery back in the mid-1980s was not a popular first time tactic in British Columbia where most anglers were naive about the possibility of quality fisheries disappearing in several fish cycles. The Dean River is not so curiously productive in its coastal portion as its headwaters are in the rich Chilcotin Plateau country to the east. The interior Dean River, in passing, provides one of our best headwater rainbow trout fisheries but very importantly its lower waters support the world famous Dean River summer steelhead fishery -- a dry fly-fishery, in particular.

Monitoring of angler effort and catch began in 1971 and by 1986 it became obvious we had the most acute problem of a constantly strong fish supply and a drastically increasing angler demand. Effort built from 1000 to 3000 angler days over the first 13 years and in 2 years leading up to 1986 went to 5200. Limited entry was proposed as a pilot for 1987 and continuance of a

quality fishery was rationalized, shopped around and instituted. This quality fishery had the following elements:

- wilderness setting;
- wild fish stocks;
- large fish available for catch;
- good catch success rate; and,
- compatible methods of fishing.

But it lacked the most critical element -- lack of angler crowding. We had to develop guidelines to establish daily entry level and the following were considered:

- physical characteristics of stream
  - number of runs
  - accessibility
  - water conditions;
- mobility of anglers;
- gear types -- compatible vs. competitive; and,
- guided vs. non-guided anglers.

With the historic use data, expectations of angling guides and the above guidelines, 0.5-1.0 anglers/km/day was calculated to allow a previous quality fishery to be re-established. Options for controlling angling entry were considered including:

- pricing;
- bidding;
- lottery;
- reservation (first come, first served); and,
- restrict particular user groups or user types.

Because of the origin of anglers who historically fished the river, the established guiding industry (mostly for non-Canadians) and the philosophy that the residents, particularly local residents, should have the majority of the opportunity, it soon became obvious that non-Canadian, non-guided anglers would receive lowest priority. The guides were given allocation, the resident demand was met (NOTE: it continued to be low and constant) and non-Canadian, non-guided anglers entered a lottery system. From 1987 to 1989, a constant price permit system was piloted and it ran efficiently and effectively but only caused a cessation in an increase of total angler days. In 1987 angler days dropped from 5200 to 4200 and in 1988 and 1989 regained to 5000.

In 1990, under a province-wide classified fisheries waters management system, a daily fee was added for all participants except residents on Class II portions of the Dean, except if guided. Angler days have now stabilized near 4000 days. As long as resident effort does not increase dramatically, non-guided non-Canadians still have annual access to the Dean but maybe not in the preferred 2 weeks in August. The general observation is that after 4 years of transition in the newest management system, with guided days intentionally capped at 40% and non-guided days at 60%, on average about 55 anglers per day fish the Class I portion of the river.

The angling guides, fishing associations, independent anglers and the regional fisheries management staff are responsible for developing and abiding by the Dean River management plan. This has been our longest monitored and intensively managed quality trout fishery. It is unique -- there are few Dean Rivers in the world. If limited entry for a quality fishery sounds foreign, consider that you can't make wild fish and wilderness -- you can only lose it forever. We're trying desperately to actively manage this stream into the future. It needs world attention and continuing support.

After 15 Years and the Future

Although we have world renowned trout fisheries we can not be complacent. We have seen unabated habitat loss, we have experienced demand and supply problems, we are witnessing multiple use interests in fish other than for fishing and there will be new forms of management as a result of First Nation treaties in this province.

For there to be sustainable and quality wild trout recreational fisheries into the next century, we are going to have to address at a minimum:

- Those Acts, guidelines and codes which ensure quality habitat is protected and restored under progressive land and water use strategies.

- The quantification of habitat and its fish-bearing capability in order to promote no "net" loss of trout habitat.

- Aboriginal expectations for trout in the context of

ceremonial, cultural, food and commercial activities (e.g. guiding).

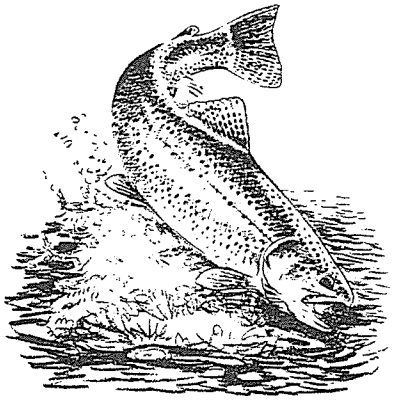
- Establishing the non-consumptive value of wild trout in the context of biodiversity and assuring genetic variation relative to the stability of ecosystems.

- Increasing dramatically the understanding by anglers, but not to the exclusion of other resource agencies, politicians, industry and First Nations, of the reasoning behind often complex regulation of fish use. Regulations must never be complicated and must be simplified only where there are good biological reasons and they are support socially and economically.

- Instituting limited entry only where management plans and operational monitoring can assure "matching-the-hatch" between fish supply and recreational use.

- The marketing of the biological, social, cultural and economic aspect of quality trout fisheries in a holistic manner to raise the goodness factor of fish.

Even the obvious challenges look formidable to us in British Columbia in our attempts to sustain quality trout fisheries. We've drifted into the 1990s with our management without strong government support. Even if we get some recognition from government the immediate future for quality trout fisheries management means we are going to have to form new partners and steward the resources in new ways. The constant, however, must be the policy to conserve wild fish for any management strategies that might be employed.



Habitat Protection and Restoration within a Watershed Context: A Generic Framework and Specific Application[1]

J.G. Imhof[2]

The protection and restoration of coldwater habitats will require better tools and processes in the future. Although we have developed sound techniques for restoring sites, changes in land management and landuse create major changes in processes that maintain the biophysical characteristics of watersheds, valleys and sites. An ecosystem based watershed framework is presented which aids in analysis of the causes of problems of aquatic habitat protection and restoration. The framework includes scoping the problem and issues, working closely with stakeholders, determining appropriate scales for analysis, conducting appropriate studies and recommending strategies for landuse management and protection and restoration of coldwater habitat. Application of this framework to the early stages of a watershed study on the Beaverkill/Willowemoc watershed in New York State is discussed.

INTRODUCTION

Are we making a difference? Are we protecting and restoring more coldwater systems then we are losing? These questions are central to determining the effectiveness of management actions. In the case of wild trout management, the answers vary depending upon your location in North America, but it is a safe assumption to state that in general, we are still losing many more coldwater systems throughout North America than we are protecting or restoring.

Pressures on wild trout fisheries and the aquatic ecosystems that maintain them are growing. Human populations, economic development and exploitation continue to expand as population growth continues. Never before has there been a greater need for determining strategically how to better manage, protect and restore the coldwater ecosystems of North America.

Ontario, like many other jurisdictions in North America has been wrestling with these management problems and questions. A major strategic planning process was

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undertaken by Ontario beginning in 1986 and culminating in 1992 with the release of the Strategic Plan for Ontario Fisheries (SPOF II)(OMNR 1992). The Ontario Ministry of Natural Resources (OMNR) along with other government ministries and agencies and with the help of 30-40 major stakeholder groups established that the long-term direction of fisheries resources in the lakes and streams of the province must be geared to an ecosystem approach in centring around the aquatic system as a whole (OMNR 1992). One of the major management strategies for riverine systems was the establishment of watersheds as a fundamental planning and analytical unit for aquatic systems.

This paper discusses the rationale, major elements and linkages necessary and a framework for undertaking ecosystem analyses in support of the protection and management of riverine aquatic habitat given various stressors and management questions. As well its preliminary application to a major study of the Beaverkill and Willowemoc systems in the Catskill mountains of New York is also discussed.

FROM SITE TO ECOSYSTEM

Over the last 20 years there has been a shift in management approaches for coldwater resources. More and more the realization that angler exploitation was only one component of fisheries management has evolved. Habitat has been identified in the last 10 years as an even more pressing issue given the strides and acceptance in harvest controls to reduce exploitation. However, habitat protection in the past has been to a large degree a site or reach level management activity, often focused on channel and in-channel manipulations . These manipulations have often worked, especially in regions where the overall state of the system was stable while attributes and features of the channel were damaged from past activities. Unfortunately this is not always the case. In many circumstances channel and in-channel techniques have failed because of the use of improper techniques for the type of river system and often because the system itself was in transition based upon changes in land management or landuse. Aquatic habitats and aquatic productivity are products of watershed and climatic characteristics. Therefore, it is not surprising that we often fail when we attempt to mitigate effects rather than treating the larger scale causes. These protection and restoration failures are not unique to the United States but also are occurring with alarming frequency in Canada as well.

It appears that in many circumstances we as policy makers, managers and researchers must re-think and expand our approaches to habitat protection. One reason is that we are still losing more habitat than we are regaining. Another reason is that given the pressures for increased efficiency in government, many jurisdictions will find resources more limited in the future (i.e. manpower and dollars). Given these circumstances it is essential to determine the causes of degradation and loss and to assess and develop management prescriptions at the appropriate scale of system stress and with the appropriate information. Any approach used should also provide information to allow other stakeholders to help with the protection and restoration of coldwater resources shared and enjoyed by all.

Various scales of analysis for planning and management of aquatic ecosystems and habitat appear in a number of papers over the last 10 years (Warren 1979; Lotspeich 1980; Lotspeich and Platts 1982; Frissell et al. 1986; Minshall 1988; Cupp 1989). Recommendations for an ecosystem approach to management of aquatic ecosystems is discussed in the report issued by the National Research Council (1992) and others (International Joint Commission 1978; SPOF II 1992; Allen and Hoekstra 1992; Allen et al. 1993). An

excellent review of various scale based approaches appears in Naiman et al. (1992).

Allen et al. (1993) suggests that the ecosystem approach,"...insists upon rigorous definitions of ecosystems. It also demands unambiguous linking of various ecosystem conceptions of different types and sizes, all explicitly defined. The ecosystem approach rejects the notion that there is one ecosystem conception that we can use for all purposes." As Allen et al. (1993) state, there are a variety of hierarchical systems that can be used to define ecosystems of various sizes, for example:

- Biotic - Landscape> community> species> genetic (Noss 1990)
- Biophysical - Ecoregion> ecodistrict> ecosite> ecoelement
- Physical - Landscape> watershed> subwatershed> valley/reach> site

All are relevant and any one may be appropriate for use given the types of issues to be addressed, the type of system at risk and the stressors created by different human uses or undertakings. What is universal about the ecosystem approach is that it recognizes the inherent hierarchical nested nature of ecosystems and attempts to examine quantifiable relationships and linkages amongst the components.

There is still an enormous amount to learn about the interactions of physical, chemical and biological characteristics of ecosystems. Use of definable linkages between various ecosystem attributes can provide us with a foundation of understanding of a system. In order for an analysis to be useful there is a need to define the linkages between ecosystem scales and those factors that condition the processes and the rates and modes of operation of those processes operating within and between scales.

The watershed hierarchy appears to be most appropriate approach for the purposes of management of water, aquatic ecosystems and land:water linkages (Imhof et al. 1991; National Research Council 1992). This approach allows us to study the land:water interactions in a clearly defined geographic setting. It also helps to place in context the major functional characteristics of the system at various scales and the potential effects of various human activities and natural disturbance on the system.

Different uses of land generate different responses in a watershed which in turn affect habitat. These responses occur through various pathways and at different scales. Ward and Stanford (1989) described five spatial interactive pathways within a stream (riverine-headwater; riverine-estuarine; riverine-floodplain; riverine-riparian; and riverine-groundwater). Imhof et al.(1991) suggested the need to examine two major interactive pathways within watersheds: the hydrologic pathway (water budget) and the valley system ecologic pathway based upon Ward and Stanford (1989) and modified from the River Continuum Concept of Vannote et al. (1980). These pathways provide a context, directionality and linkages between land and water, physical and biological elements within watersheds and valley systems. The hydrologic pathway operates at a watershed/subwatershed level whereas the valley system ecologic pathway operates at the reach level. These concepts were used to develop a hierarchical indicator model for watersheds and habitat (Fitzgibbon and Imhof 1994) at three major scales: watershed, valley/reach and site. The hierarchical indicator model is a based on elements of previous concepts (Warren 1979; Frissell et al. 1986; Cupp 1989; Naiman et al. 1992; Rosgen 1994).

Major elements of the hydrologic and ecologic pathways include the relationship of the hydrologic cycle to the characteristics of groundwater and surface water discharge and interactions within the watershed, the characteristics of the valley, floodplain and channel to the flow patten of the watershed and the linkages between the shallow watertable, riparian zone and channel system. These relationships and their modifications through various activities of

man or natural disturbances and change affect change on habitat in streams. In order to manage aquatic environments in the future, it is important to know what scale is appropriate for analysis to resolve issues that arise. Is the problem a site issue, a reach issue or a watershed issue should be a fundamental question.

Various uses of land have different impacts on conditions and processes within systems. In essence many of these activities modify various physical, biological and chemical characteristics of a system, often at a large scale difficult to discern at the site level. Table 1 provides an example of potential impacts of various human activities on aquatic processes and environments at three major scales. This information can be used as a first screening tool to determine in what direction and at what scale changes in functional elements of the aquatic ecosystem may occur. This can help to scope at what scale information must be collected in order to determine causal relationships and develop appropriate measures for protection and restoration. This can be used as a tool for watershed analysis.

Conflicts with habitat management in coldwater systems is often the long-term result of these changes. It is important therefore to understand how these activities and their impacts affect the various life history requirements and attributes of salmonids (Appendix 1)(modified from OMNR 1994) and build this analysis into an ecosystem based approach.

FRAMEWORK FOR A WATERSHED ECOSYSTEM APPROACH

In Ontario, a number of initiatives are being undertaken to determine the appropriate watershed scale, level of detail required and major human use issues to resolve. In part these initiatives have occurred as a result of planning and regulatory gridlock over various conflicting land uses such as water supply, irrigation, aggregate extraction, mining, urbanization, environmental protection, agricultural intensification/drainage/pasturage, dam construction and forestry practices. Some of the greatest pressures have been in southern Ontario where the major conflicts revolve around environmental protection, agriculture and rapid urban growth. From a wild trout standpoint, most of Ontario's most productive streams occur in southern Ontario (average biomass range 60-200 $kg.ha^{-1}$)(Imhof, unpublished data). The province is now developing a framework for watershed analysis and planning that will be flexible in scale, resolution and focus (Table 2). The initial approach, which is weighted to urbanizing watersheds is discussed in provincial guidelines (OMOEE/OMNR 1993a,b,c). Additional work has been done on making the framework more flexible for other land management issues (eg. agricultural management and environmental protection and rehabilitation).

The framework has four major phases (Table 3) with four essential components:

1. Scope problems and issues.
2. Determine suitable scales for analysis
3. Conduct appropriate studies using existing and new information.
4. Recommendation and implementation of strategies for management, planning, protection and restoration.

Embedded in the framework and essential to its success are the following sociological elements:

- Public participation and involvement process
- Agency participation and involvement process
- Political participation and involvement where required

Table 1: Major characteristics of change of selected land management/landuse activities related to three scales of analysis used in watershed planning.

Activity	Watershed/Headwater Tributaries[1]	Valley/Reach[1]	Site[1]
Forest Management - eg. clear cutting	*** ↑ water yield and run-off generation; ↓ infiltration; ↑ sediment discharge	** ↑ sediment loads; destabilization of planform and channel form; ↓ woody inputs	* degradation in riffle:pool sequencing; ↑ bank erosion; changes in substrate sorting; ↓ instream habitat complexity
Agriculture - drainage and crops	*** ↑ surface runoff; ↓ infiltration; ↑ sediment and nutrient loadings	*** ↑ drainage works; ↓ riparian zone and nutrient uptake; bank and riparian compaction; radical ↑ sediments and nutrients; ↓ water quality	* ↓ riffle:pool complexity; ↑ bank erosion; channel degradation; ↑ temperature; infilling of channel by sediments
Agriculture/Rangeland -grazing/pasturage	** ↑ annual peak flows; ↓ baseflows; ↓ saturated zones; ↑ nutrient inputs; ↑ bedload	*** ↓ meander geometry; ↑ channel width and ↓ depth; major reduction or elimination of riparian zone; ↑ bank erosion; ↑ fines in substrate; ↓ substrate sorting; ↓ water quality; impacts on herd health	*** ↓ riffle:pool complexity; wider/shallower cross-sections; ↓ coarse woody debris in channel; ↑ fines in substrate; ↓ habitat complexity and heterogeneity
Aggregate extraction - Gravels and sands adjacent to watercourses (depending upon extent and numbers)	** change in hydraulic gradients of shallow groundwater system; changes in low flow characteristics; changes in stream temperatures; potential ↑ sediments (washing)	*** potential ↓ distributional characteristics of groundwater discharge; potential change in volumes of groundwater discharge; ↓ floodplain storativity (if gravel extraction there); ↑ reach temperature	*** ↓ thermal refugia distributionally and volumetrically; ↓ potential for spawning of some species (eg. brook trout); alteration in distribution of baseflow contributions
Urban Development	*** ↑ impermeability of watershed; changes in water budget and ↑ water yield; change in drainage density; ↑ nutrients; ↑ fine sediment, ↓ coarse sediment inputs; ↓ water quality	*** ↑ surface runoff; ↓ infiltration; ↓ low flow; ↑ fine sediment discharges; ↑ frequency of severe floods; ↓ meander geometry; ↑ channel width; ↓ channel depth; abandonment of floodplain; ↑ water surface slope; ↑ temperatures	* channel armouring; ↓ habitat complexity and heterogeneity; ↓ riffle:pool complexity; wider/shallower cross-sections; ↑ fines in substrate; loss of riparian zone

[1]The relative importance of changes in state condition varies by activity and scale. The table attempts to differentiate relative importance of the changes observed either as: *** Major Causal agent; ** Moderate Causal agent; or * Effect; direction of change is noted as (↑) increase; (↓) decrease.

Pre-study Screening

Scoping the problems and issues within the system must be a public process. It is much more than simply public information meetings. The process can be variable depending upon time, budget and complexity of issues. The most successful watershed studies in Ontario have included public representatives on the overall study steering committee, stakeholder focus groups and public information dissemination through meetings, newsletters and an information hot-line. By far the most effective technique has been the use of a stakeholder focus group. The group is made up of individuals representing the diversity

Table 2: Scale and resolution of matrix of watershed analysis based upon desired management level.

Management Level	Resolution	Major Applications
Watershed analysis - Environmental /Ecological objectives (>100 km^2)	Low	Entire watershed with concurrent nesting of sub-basins. Sensitivity analysis and screening. Used as a tool for land management decisions for improvements in efficiencies and improvements in environmental protection.
Subwatershed analysis - Environmental /Ecological Targets (<100 km^2)	Medium	Emphasis on the sub-basin, ideally driven by objectives from the watershed study. Provides quantifiable information and relationships for threshold analysis in aid of landuse planning and restoration strategies
Valley segment/reach analysis - Protection standards (<5-10 KM^2)	High	Appropriate level for determination of empiric environmental measures used for management or protection
Site analysis - Design information (<100m)	Very High	Depending upon the problem, a great deal of site level information may be required including extensive survey and assessment techniques

Table 3: Matrix framework for watershed studies used in Ontario

Activity	Major elements
Pre-study screening	Determination of major management issues/problem/activities and most sensitive uses; Determination and involvement of partners, stakeholders and interested parties (government: federal, state/provincial, municipal; non-government organizations; professional organizations; interest groups; general public); Determination of appropriate upper watershed scale associated with the issue and its potential impacts on functions within the system; Determination of linkages and applications of information to scales below the scale of primary interest
Phase 1	Determination of relevant information for the study (based on the activity, the policy, planning or management component of interest); Capture of background information on the system; Development of a conceptual model of system function and characteristics; Determination of additional information to test relationships in the conceptual model and to provide a framework for integration of information
Phase 2	Collection of additional information to validate or modify conceptual model; Identification, if possible, of potential thresholds of biophysical and chemical change; Determination of functional relationships of the watershed and implications of issues to functional integrity of system; Development of options to resolve issues and maintain functional and structural elements of the system; Recommendation of most effective options with implications
Phase 3	Implementation plan identifying most appropriate lead amongst all the partners and stakeholders; Recommendations for monitoring, thresholds for management decisions and timetable for watershed review and amendments

of interest groups in the watershed. There is a major obligation to meet with the group at major decision points in the technical process, beginning with issues scoping and goal and objectives development (component 1). This ensures buy-in and support for the direction of the study. The process provides a forum for information and findings to be digested, questioned and reviewed by the focus group throughout the course of the study at important junctures in the process. Members of the group develop an understanding of the results of the findings and help with the determination of the recommendations and dissemination to members of their organizations. This public process diffuses a great deal of mistrust and

improves the chances of actually implementing recommendations through official plans, agency programs and interest group participation.

The least successful public processes in Ontario employed public information meetings and static displays only. At the end of this process, public groups were distrustful of the findings, information, goals and approaches. Needless to say the likelihood of rapid and effective implementation of the recommendations are poor.

The agency process includes the development of a steering committee with all the agencies that have a concern for the issues plaguing the watershed. In Ontario, two approaches to agency participation have occurred. In large scale watershed studies (>100 km^2) or where issues and concerns were not yet highly political, the agency steering committee is composed of decision-makers and technical specialists from the agencies. In politically sensitive watersheds, especially at the more detailed subwatershed studies (often <70 km^2), a steering committee composed of politicians, agency decision makers and public representatives is created with a technical steering committee struck that co-ordinates the day-to-day technical elements of the study.

The determination of scale and level of detail (resolution) is critical to the process (component 2)(Table 2). The level of information and scale of analysis needed to provide better management strategies for improved agricultural or forestry activities is different than the scale and resolution to address strategies to manage urban development. In the first instance, the general structure and major pathways may be or will be modified extensively rather than intensively. Therefore a larger scale and less detailed analysis may be required. In urbanizing watersheds, major, often permanent, structural and functional changes may occur and detailed quantifiable information is needed to direct protection, conservation and restoration strategies on the system. Engineers and planners, for example, will need to know how much water to infiltrate to ensure the protection of baseflows, maintain the integrity of channel systems and features within the watershed.

Where the protection and restoration of aquatic habitat requirements for salmonids is paramount, it is important to ensure that the appropriate information is collected at each scale to be able to determine cause from effect. This information is essential for the development of protection and restoration measures at the appropriate scale as part of the watershed study. The matrix outlined in Appendix 1 can be used as a way of sorting scale and controlling elements for each life history requirement.

Phase 1

Prior to initiating complicated, intensive and extensive studies, it is imperative that the study team determine what exists, what is relevant and what is useful. The scoping of issues provides a beginning to the determination of the appropriate scales for analysis and the potential processes and functions that have been or may be impaired. Background information of the watershed and for areas or sites within the watershed will provide a certain level of understanding of the general large scale characteristics of the system. Only after a synthesis of the existing information should the study team determine the additional studies required to provide the appropriate information on the functioning of the system as relates to the issues to be addressed. Where a reasonable amount of existing information occurs, the various disciplines involved can develop a conceptual model of the functions and characteristics of the watershed: in essence a state of the system analysis. This provides a tool for: determining potential relationships and linkages; determination of additional studies required to test the model construct; and a means of determining additional data collection needs and

methodologies that will aid in determining relationships and functional elements. Once the new studies are determined, then Phase 2 can proceed.

Phase 2

Phase 2 incorporates specific studies often conducted at stratified reaches and sites. Study reaches and sites are delineated using information generated in the pre-study screening and in Phase 1. Intensive study locations are stratified based upon: potential for change resulting from changes in land management or landuse; sensitivity or uniqueness; representative of the watershed.

The information at these representative or critical reaches and sites provide detailed information that links biophysical characteristics of these smaller scales to watershed processes. This information once collated and examined along with the conceptual model of the watershed provides a context for the determining resolutions to the issues identified in the pre-screening process. Suggested strategies for management, protection and restoration can then be developed based upon an understanding of the implications of various land management and landuse scenarios and practices.

This information is presented through the stakeholder/public process so that the public and stakeholders, along with agency staff can determine the suite of options, their implications and consequences for the management of the watershed. This information, along with what consensus does develop through the process, is then consolidated into a strategic series of recommendations.

Phase 3

Recommendations are presented through the appropriate political or bureaucratic process. In Ontario, where the stakeholder/public process has been used from start to finish, decision-making by politicians or senior agency staff is often straight forward. The contentious issues are addressed, objective information is available in support of strategic recommendations, the implications of various management options can be examined, costed out and weighed and the majority of the public and major stakeholders are usually in agreement. It often becomes a win-win situation for the decisionmakers.

One major requirement is the development of implementation plans that identified the agreed to recommendations and identify the lead agency or public group responsible for implementation. Timetables are devised and a standing committee or agency is struck that provides an audit function to the plan and recommendations. The committee and partners determine monitoring requirements, and the timetable for review of the plan and its success to date.

APPLICATION TO THE BEAMOC STUDY

The framework described above is being applied to a major watershed study on the Beaverkill/Willowemoc (Beamoc) rivers in the Catskill mountains of New York State.

The Beamoc watershed figures fundamentally in the 200 year history of American angling. It is heralded as the birthplace of the American fly fishing tradition. With its hundreds of miles of coldwater tributaries, two major tributaries and main stem, its watershed encompasses over 260 square miles in the Catskill Mountains of New York State. Over the last 50-60 years increases in recreational activities, major highway construction, agricultural and urban land use changes and water withdrawals have all played a part in the systems apparent slide in quality. In 1991 and again in 1993 the Beamoc system suffered severe droughts and high water

temperatures with concurrent low flows. Estimates suggest that in some pools up to 80% of the trout population perished (R. Fieldhouse NYDEC pers. comm.). It is uncertain if the actual loss of fish to high temperatures was as severe in other portions of the watershed. Nevertheless, the situation in 1991 and 1993 galvanized a number of individuals in Trout Unlimited at the local, state and national level to call for studies to seek ways in which the problems of the watershed could be identified and rectified.

A major purpose of the studies is to provide the government agency, New York Department of Environmental Conservation (NYDEC), and municipalities, responsible for the management of the Beamoc system and its fishery with useful information about the watershed's dynamics, its economic contributions locally and regionally and strategies for its protection and restoration. Given the purpose of the studies, there are two major components, a biophysical analysis and a socio-economic analysis.

Both studies are occurring concurrently and are meant to be considered one integrated study. For the purpose of this paper, however, I will be focusing primarily on the biophysical elements of the watershed study.

The goal of the study is to develop and provide practical information for the management of the trout fishery and other aquatic resources of the Beaverkill and Willowemoc watershed given the characteristics of the system and how people have modified or wish to modify the system. There are four major objectives of this study that are being presented to the public and to supported by agency representatives:

- construct a theoretical watershed model for the Beamoc System;
- conduct a series of specific trout studies using the model framework;
- use the model and study results to develop products and services that will aid in future management of the trout resources of the watershed;
- Provide a mechanism for public access to information and results of this study in an understandable form.

At present, the study is completing Pre-study screening and beginning Phase 1 of data capture. A number of discussions have been held with stakeholders, agency representatives (NYDEC), concerned citizens and scientists in order to scope the study, determine the appropriate upper scale of analysis and the logical secondary scales requiring information to resolve the issues.

Some of the issues that have been identified by the community, anglers and agency representatives include:

- point source and non-point source pollution problems;
- river channel widening, shallowing, loss of pools;
- limited critical thermal refuges during extreme conditions;
- possible alterations in low flow habitat;
- natural and man-made blockages of major tributaries;
- extent and importance of main stem vs tributary spawning;
- water abstraction from spring sources to the main stems;
- loss of riparian vegetation due to development;
- increases in fine sediment deposition in the channel;
- management of the fishery using wild trout vs hatchery product or both;

Based upon the issues expressed during various meetings and based upon the state purpose and goal of the study, it was determined that this study would use the full watershed analysis (Table 2) and then differentiate into important reach/valley sections. Information would also be collected and stratified between the three major components of the Beamoc system:

Willowemoc; Little Beaverkill; main stem Beaverkill. The watershed scale is selected because there is unlikely to be a major change in urban development in the next number years requiring extremely detailed measurements.

The issues suggest a need to understand watershed chemistry, hydrology, hydrogeology and geomorphology in order to determine how previous and present large scale land management practices may be contributing to problems and issues occurring at the valley/reach and site levels. For example, problems of tributary access, apparent pool infilling, riffle widening and floodplain erosion may be occurring as a result of changes in high flow patterns that may be land use or climatic and/or structural adjustments resulting from the building of a 4 lane highway down the lower valley of the system. These potential changes in hydrology and geomorphology would also manifest themselves in changes in trout usage of various pools, location and extent of thermal refuges and impaired reproduction. Attempts at using a site or even a reach as the scale of analysis may not determine the cause of the problems thereby leading to mitigative measures that may be ineffective.

A matrix has been developed in order identify the information required in Phase 1 of the study, to provide a means of sorting the existing information and to determine what is actually available. This is presented in Appendix 2. Once the available background information is collected and analyzed, a conceptual model of the watershed will be developed, the relevant studies required for Phase 2 will be determined and the study team and agencies will meet with the stakeholders and general public to discuss findings to date and the rationale for the next phase of the work. The public involvement at this point will also provide an opportunity for: the stakeholders to query the conceptual model of the watershed; identify issues that may have been missed; provide observations and information that may have been missed in Phase 1; and identify ways in which they can assist with data collections.

The Beamoc study was only initiated in June 1994. Pre-study screening and Phase 1 completion is expected by January 1995. At this point partnerships are being developed with the local community and stakeholder groups. Meetings have been held with agency staff from NYDEC and background information from various sources is being collected, collated and analyzed prior to the determination of more detailed and specific studies.

SUMMARY

Depending upon the type of human activity, the protection or restoration of wild trout populations and communities may not be possible if we manage primarily at a site or reach level. The use of watershed and subwatershed scaled analysis in conjunction with determination of site or reach issues may be one means of meeting our present and future management goals.

Watershed analysis in aid of ecosystem based planning and management is a relatively new process. In Ontario, 3 major full watershed studies using different approaches, and 15-20 subwatershed studies are completed or nearing completion. Lessons learned from Ontario's experience and the experience of others will help to develop the watershed analysis and framework as a useful tool for setting a common context for land management, land use and environmental planning and management. The general public in North America are coming to value what trout anglers have valued for many years: healthy, functional productive streams. The application of a watershed approach must include not only sound biophysical science but also a sociological process and analysis that ensures that those how live, work and recreate in a particular watershed have the opportunity to be fully involved and informed of the information and strategies

for better managing their environment.

Taking an ecosystemic approach to the management and restoration of the Beamoc system provides perhaps the best opportunity for people in the watershed to work together to restore the Beamoc system as a sustainable high quality environment that not only nourishes their souls but also provides them with a quality living environment, work place and some form of economic advantage. The end result will hopefully be a rejuvenated river system that can maintain its place as the birthplace of the American fly fishing tradition.

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Appendix 1: Relationship between life history requirements and biophysical attributes at three major watershed scales.

Habitat Attribute or Requirements	Watershed Level	Reach Level	Site Level
Baseflow habitat and thermal refugia	Groundwater (g.w.) discharge characteristics controlled by geology, physiography of watershed. G.w. influences baseflow patterns, fish community type and thermal patterns.	Define g.w. locations by volume and distribution. Moderate temperature extremes provide thermal refuges in summer & winter. Dispersed groundwater areas critical to population survival.	Baseflows control fish density at a site in combination with stream c/s, and channel complexity. G.w. discharges create local areas of reproduction potential and thermal refugia.
Migration	Migration controlled by relationship of timing, magnitude and duration of flood flows between main channel and related tributaries.	Relation of tributary accessability, and connectivity to main channel determines reproductive potential of various tributaries.	Local obstructions to migration may be permanent or seasonal often controlled by flows.
Reproduction -spawning & nursery Main channel	Skewed towards headwater zones where coarser substrates often exists. Occurs in larger stream portions where appropriate slopes, substrates and groundwater intrusions occur.	Require well sorted gravels in riffles ...especially B3,B4,C3,C4,E3,E4,F3,F4 channels (based on Rosgen 1994 classification). Wooded riparian zone contributes material for nursery habitat.	Spawning occurs at the transition points of the channel: head of riffles, tail of pools. Nursery habitat found in the margins of the riffles where woody debris distributed by spring floods.
Reproduction -spawning & nursery floodplain side channels	Large well forested watersheds generate large floodplains. Side channels developed by logjams and snags used by some Pacific salmon.	Floodplain complexity and connectivity important to immigration of adults and emigration of fry.	Side channels chosen by suitable substrate and active interflow areas. Nursery habitat along margins in amongst woody debris.
Food production	Invertebrates require allochtonous inputs from riparian sources in lower order streams. Active substrate sorting, bank stability, dynamic, stable channel profiles are essential. Autochthonous production more common in higher order streams but still require flow & sediment regimes that maintain well sorted substrates.	Riparian zone stability important to invertebrate communities in lower order streams for food sources and channel integrity. In larger streams rely upon substrate complexity, floodplain materials and primary production as sources of nutrients. Woody debris in fine textured streams important substrate for invertebrates.	Lower order systems, bank stability, riffle and pool complexity important. Woody material on the banks and inchannel very important. Higher order rivers floodplain connectivity and habitat heterogeneity important for invertebrate production
Shelter - refuges (environmental)	Flow and event regimes control form and complexity of channel for shelter. Vary as stream order increases. Physiography controls g.w. intrusions. In small streams g.w. intrusions are from shallow water tables: high potential for impact from adjacent landuse activities. In larger streams, groundwater intrusions may be regional rather than local.	Valley width and overburden control local shallow watertables and g.w. discharges. Knowledge of location of discharge points in larger streams important for protection of thermal refuges. Modification of the $_7Q_2$ in 1-2nd order streams may result in insufficient pool depth for shelter and reduction in groundwater for thermal refuge. In 3-5 Order streams critical flows may be the $_7Q_{10}$ and for larger rivers the $_7Q_{20}$.	Pool depth and channel complexity streams very important for determining quality of shelter refugia in relation to low flow volumes. G.w. discharge locations associated with pool areas and logjams create critical thermal refuges. Groundwater discharge areas in large pools often infrequent and critically important at site and watershed level.
Shelter - refuges (predators, etc.)	Structural complexity and quality generated by healthy, functional channels. Must link hydrology to stream classes. Flow and event regimes maintain the characteristics of the class.	Shelter habitat varies by life stage. Management of optimum hydraulic parameters by stream type will maintain shelter habitat over valley/reach.	In-channel complexity is very important (eg. 1-4 order streams combination of pool and edge quality, undercut banks, improved by woody debris). In larger streams, pool complexity, depth and characteristics of in-pool structure are very important as are side margins, side channels, anabranching channels and floodplain back bays.

Habitat Attribute or Requirements	Watershed Level	Reach Level	Site Level
Woody Debris	Forest structure within the watershed and riparian zone...relationships to hydrology, temperatures, food inputs (nutrient processing;variability of nutrient quality) and inputs of coarse woody material	Quality of forest structure...areal extent, community, health, roughness, density of stems	In-channel distribution, ideally no greater than approx. 10% by surface area for B,C,E,F,G channels...coarse material at outside bends, fine material in riffle margins. More than 10% in A and some B channels can enhance step:pool formation.
Floodplain Characteristics	Floodflow hydrograph generation, timing, duration and magnitude control floodplain width, timing of flows into floodplain and connectivity potential to channel.	Flood hydrograph duration, magnitude and timing linked to floodplain form, connection of floodplain to channel in relation to floodplain species migration period, reproduction period, incubation and early rearing duration.	Floodplain connections to main channel, location and connection to floodplain pools important in providing floodplain migration routes to and from main channel for adults and fry. Vegetation composition, proportion, patchiness and persistence important for side channel development, nutrient transformation and uptake.
Riparian Characteristics	Riparian zones are a function of watershed geology, topography and long-term climate. Specific to valley form and long-term watershed hydrology. Moderate flood flows, enhance low flow characteristics and manage upslope water quality through nutrient transformation. Riparian zone vegetative assemblages controlled by eocregion and a product of upslope vegetation assemblages, soil structure and water flow patterns.	Width of saturation zone and low flow elevation controls nutrient uptake and determine plant community opportunities. Will have variable control on channel form and characteristics based on stream order and location within watershed. Exert a major control on channel and reach characteristics in 1st and 2nd order streams. Have control on quality and quantity of organic material for nutrient cycle in stream.	Species composition determines relative rates and quality of woody debris inputs, storage and transport. Determines pool quality, shelter habitat and sediment transport/sorting efficiency between riffles and pools. Riparian width a first determinant of channel stability,width/depth ratio and relative nutrient uptake. Species composition, rooting depth and rooting density a major control on stability of banks in larger streams and control channel form in smaller streams.

Appendix 2: Matrix of attributes and elements to be considered in the Beamoc watershed study.

Attribute	Structural Elements	Functional Elements	Temporal Elements
WATER/SEDIMENT	Landform information: slope; overburden; infiltration/runoff potential and storage. Landcover vegetative systems: forest cover (areal) and type; agricultural; wetlands. Channel forms/types including floodplains. planform; meander pattern; meander belt; slope; etc. Cross-sectional information; maximum depths; substrate composition; bedload movement; Subwatersheds characterized and typed based upon the above information.	Water (hydrologic cycle) and sediment balance or at least runoff and erosion generation done distributionally and in total for main system and tributaries (event and regime)	Flow regimes, high and low (by 10 year periods?) Changes and distribution of suspended sediment and bedload in response to hydrologic changes by high/low events Changes in bedload movement between riffles and pools Change in morphological structures and distribution
NUTRIENTS	Loadings spatially and relative contribution: landuse, soil type, drainage, riparian/floodplain biota/vegetation (width of zone, characteristics and storativity/retention)	Indicator based invertebrate work used as a surrogate for nutrient cycling and inputs as well as water quality problems.	Changes in distribution and volumes of loadings
ENERGY	Channel and floodplain forms Riparian vegetative cover; wetlands; groundwater inputs - Thermal regimes and characteristics	Critical discharge events and flows Thermal properties in the stream	Changes in stream temperatures (high and low, daily, seasonally, extremes and event basis). Thermal responsiveness of the stream segments and diurnal ranges.
BIOTA	Channel habitat structure and riparian habitat structure Species composition and distribution	Invertebrate community, diversity and distribution Fish production/growth and recruitment (year class strength, reproductive success)	Changes in productivity, reproductive success and distributional changes.
LINKAGE DEFINERS	Land form and land cover characterize channel and floodplain form and composition. Link to nutrient and sediment discharges from various landuse activities. Channel and floodplain forms provide information on habitat structure in channel and the riparian zone in relation to temperature, groundwater inputs and the use of these areas over time by the coldwater community	Major definers for this system will include: landcover/use, sediments (bedload and suspended), floodplains, tributary systems (headwaters), groundwater recharge/discharge areas.	Changes over time in flow and sediment patterns, land uses, channel structure and fish use of main stem and tributaries will provide information on causes of systems problems allowing for strategic solutions.

West Coast Salmonid Habitat Restoration

Bill Shake

Abstract -- The West Coast watersheds are degraded and the wild fish they support are declining. In response, numerous programs and actions involving a broad array of fishery management strategies and techniques as well as restrictions on activities that contribute to the decline have been undertaken. Government agencies and Indian tribes with jurisdiction over these resources have been at the forefront of these efforts, but many other individuals and organizations must play an active role in trying to resolve these problems. Despite these repeated attempts to halt and reverse the decline of the fish stocks, an equitable solution that protects and restores fish habitat has eluded the interests involved.

In this context, we are proposing a multi-agency "Pacific Anadromous Fish Restoration Initiative" to enhance ecosystems and habitats for naturally spawning Pacific salmon, steelhead and cutthroat trout. This approach would bring together Federal, State, Tribal and local governments and the private sector in coordinated, watershed-based ecosystem restoration efforts and restore the natural habitat of West Coast fish, and provide environmental, economic, and cultural benefits for present and future generations.

Wild salmonid stocks are in serious trouble. At least 106 populations of west coast salmonids have been driven to extinction and at least 214 populations are at risk of extinction as identified by the American Fisheries Society article *Pacific Salmon at the Crossroads* (Nehlsen et al., 1991).

The Snake River populations of sockeye, spring/summer and fall chinook are listed as endangered. The Sacramento winter run of chinook are listed as endangered. Two weeks ago the National Marine Fisheries Service announced that the status of the west coast migratory salmon and trout will be reviewed for possible ESA listing. Petitions are being reviewed to consider coast wide listing of coho salmon and steelhead.

The well-being of the salmonids that inhabit these watersheds are the real indicators of the health of the environment. Their diversity and numbers are a true measure of the condition of not only the habitat but also of our political and social system's ability to prevent extinction of these magnificent creatures. So, they are more than symbols, they are the measure of our ability to protect, restore and enhance the very life-blood of the west coast - our watersheds.

But more than just fish are at risk. Our entire Pacific Northwest riparian habitat and the biodiversity it supports are in crisis. The west coast is facing an ecological disaster of unprecedented proportions.

In the past, salmon habitat was degraded by a combination of practices such as agriculture, urbanization, damming, timber harvesting, and road building. Mainstream dams have in the past been most frequently mentioned as the root cause of salmon population decline. However, there is increasing recognition that the loss of watershed ecosystems able to support healthy populations of trout and salmon is the single greatest contributor to their decline. This coupled with several years of drought and poor ocean survival have exacerbated the situation.

Immigration beginning in the 1850's brought increased settlement. These newcomers used the practices of diking and filling tidelands. Agriculture and logging increased erosion, sedimentation, water

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temperature, and reduced dissolved oxygen levels which decreased habitat diversity and water quality. The resulting loss of habitat reduced fish populations. Hatchery programs and extensive programs to remove woody debris from streams were believed to be the solution. The future of these watersheds, and the fish that they support and the quality of life in the region depends on our ability to develop a comprehensive approach to watershed restoration.

We must develop an ecosystem approach to watershed restoration that will insure we protect and enhance the biodiversity of that system.

As we move to implement an ecosystem approach to fish and wildlife conservation and habitat restoration we need a common language. I would suggest that the following definitions best describe the various terms I have been using:

Biodiversity: *The variety of life and its processes, including the variety of living organisms, the genetic differences among them, and the communities and ecosystems in which they occur.*

Ecosystem: *Dynamic and interrelating complex of plant and animal communities and their associated non-living environment.*

Ecosystem Approach: *Protecting or restoring the function, structure, and species composition of an ecosystem, recognizing that all components are interrelated.*

I would recommend that as restoration and restoration planning is being carried out that we try to use the same terms as we proceed. If we do, it will be one more way to insure coordination.

Now that I've talked about what we need to do in order to undertake watershed/salmon habitat restoration, let's spend some time discussing how we will accomplish this enormous task.

PRINCIPLES OF AN ECOSYSTEM APPROACH TO HABITAT RESTORATION

Adopting an ecosystem approach to habitat restoration as an underlying foundation will mean significantly changing the way we think, act, and solve problems. We must apply the concept of managing and protecting ecosystems to everthing we do from reviewing permits, managing land, stocking fish, and carrying out all of its activities. Common principles that will guide the adoption of an ecosystem approach are listed below.

Ecosytem Approach Principles

- An ecosystem approach is a critically important tool in promoting the conservation of biological diversity and an environmentally sustainable level of development.
- Environmental and socioeconomic factors and interests are considered.
- Natural resource goals must be established on an ecosystem-wide basis.
- Full participation of all partners (Federal, State, local, Tribal, public, and private) in setting and achieving resource goals is imperative.
- Resources and tools must be integrated and leveraged with all resource managers to achieve greater resource results.
- Strategies and implementation actions must be based on the best available science.
- Efforts must be focused on discrete units of the landscape, of varying but manageable size and with similar resource issues, to promote local action and involvement, i.e., watersheds.
- We must encourage flexibility and innovation to achieve greater resource results.
- Decisions must be delegated to the lowest appropriate level and employees must be given the maximum possible authority.
- Restoration means water quality and water quantity. It makes no sense to spend millions of dollars to stabilize stream banks, clean gravel beds or repair fish ladders and screens if there is no water in the creek or the water is too polluted or hot. Habitat restoration must include adequate instream flows and water quality.

The west coast habitat restoration process has been on-going for years - and we have many success stories of good projects completed and habitats being restored. One of these is the:

KLAMATH RIVER BASIN RESTORATION

For over thousands of years the fish of the Klamath River basin contributed to the wealth and sustenance of those who used them. However, the fish and their habitats have been greatly diminished over the past hundred years by dam construction, stream diversions, mining, logging, grazing and road development. As these practices took their toll on the fish and their habitat, concern for their welfare commanded ever-increasing amounts of time on local

state, tribal and federal administrative and legislative agendas.

Congress heard the public's concern for Klamath River conditions and took special note of the historic accord reached by the fishing groups for sharing the salmon harvest and rebuilding the river's salmon runs. On October 27, 1986 it adopted Public Law 99-552, an act to create a 20-year-long Federal-State cooperative "Klamath River Basin Conservation Area Restoration Program" for the rebuilding of the river's fish resources.

The Klamath River Basin Act creates a Klamath River Basin Fisheries Task Force and directs the U.S. Secretary of the Interior to cooperate with the Task Force in the creation and implementation of "a 20-year program to restore the anadromous fish populations of the [Klamath River Basin] Area to optimum levels and to maintain such levels." The Act also created the Klamath Fishery Management Council to assist the Secretary, and to coordinate with the Task Force in planning and carrying out the Restoration Program. The Secretary has assigned responsibility for the Program's day-to-day administration to the U.S. Fish and Wildlife Service.

Twelve populations of salmon and steelhead of the Klamath/Trinity ecosystem are considered at risk of extinction, (American Fisheries Society, *Fisheries Bulletin,* 1992) and two species of lakesuckers in the upper Klamath basin are listed as endangered. Two other species being considered for listing, the coho salmon and the bull trout, persist as remnant natural populations in the Klamath basin or in hatchery-supported runs. Several Klamath populations of anadromous fish and lakesuckers are extinct.

Operational Framework

Under the direction of two specific legislative initiatives, the U.S. Fish and Wildlife Service is implementing measures to restore the anadromous fishery resources of this important ecosystem. Restoration activities are guided by two Federal advisory committees, with members representing Tribal, State, county, Federal and private entities with an interest in restoration of depleted fish populations. The Trinity Restoration Task Force oversees fish and wildlife restoration in the Trinity River basin. The Klamath River Basin Fisheries Task Force guides the Klamath anadromous fishery restoration program, with an authorized twenty-year life, through 2006. This provides a realistic time frame for planning, implementing, and evaluating restoration measures. Restoration grant programs, and education and outreach efforts, provide for involvement of local communities in watershed restoration. Several grassroots restoration efforts are underway.

Watershed Restoration Planning

The Klamath fishery restoration program, first funded in 1989, is guided by a strategic plan emphasizing holistic watershed restoration -- as opposed to structural "fixes" -- and empowerment of local groups to restore their own watersheds through education, information-sharing, and funding. Three such local groups are now functioning. Education projects and information sharing are underway. A plan amendment dealing with the upper Klamath basin makes the connection between habitat needs of anadromous fish and the endangered Lost River and shortnosed lakesuckers. Correction of severe water pollution problems in the upper basin is critical to all these fishes.

Ecosystem restoration objectives include removal of endangered sucker species from listing, recovery of depleted salmon and steelhead stocks from at-risk status, and ultimately, restoration of sustainable fish harvests for tribal ceremonial subsistence use, sport angling, and commercial fisheries. Minimum targets include maintaining a natural spawning escapement of at least 35,000 adult fall chinook, and restoring lakesucker spawning populations to at least 500 adults per population. Numerical objectives remain to be identified for other fish runs.

The long range fishery restoration plan supports the State of California's water quality plan for inland surface waters of the north state, and is closely tied in concept to the watershed elements of the President's Forest Plan. The long range plan will be an element of a more comprehensive ecosystem restoration plan for the Klamath basin, now being facilitated by the Service. Finally, harvest management plans have been written that specifically protect depleted natural stocks of Klamath salmon.

The fishery restoration programs of the Klamath River basin, focused on key indicator species, can contribute to overall restoration of the watershed ecosystem. We have similar restoration programs ongoing in the Chehalis and Trinity River systems.

Although these programs are well on their way to save fish, the numbers of salmonids continue to

some macroinvertebrates but removing spawning gravels. Collector and grazer guilds of macroinvertebrates are most abundant.

From year 25 to year 100, riparian willows and aspen provide sufficient food for beaver. Beaver activity results in large, deep, dammed pools, and perhaps flow attenuation during spring and flow enhancement during summer and winter. Also, the ponds serve as refugia during these flow extremes, but tall dams intermittently block fish migrations. A few pieces of large woody debris derived from pre-fire riparian stands still influence channel structure. Nutrient retention by the stream increases, and this may produce an increase in aquatic macroinvertebrates. Spawning gravel becomes widely available.

One hundred to 150 years after the fire, conifers have overtaken the riparian zone but are still too small to contribute large woody debris. Nearly all of the pre-fire debris in the channel is gone. Beaver dams are decaying and collapsing, because food for beaver is absent. But riparian vegetation still stabilizes banks and the major sources of sediment for transport are the bed and banks of the stream.

After 200 years, the riparian vegetation is stabilizing the banks and contributing large woody debris, which is maximizing the channel complexity; trout cover is probably at a peak. Water quality is high, flashiness of the watershed is low, debris transport is low, and sediment delivery is low. Spawning gravel may be spottily distributed. The vegetative litter now entering the stream favors shredder guilds of macroinvertebrates, and nutrient retentiveness peaks. Primary productivity declines because light reaching the water surface is minimized. Overall productivity may be moderate to low, thus fish growth may decline.

Many of the aforementioned changes are speculative, and streams may follow different successional paths depending on the climate, geology, vegetation, and disturbance regime of the region. Nonetheless, sediment, water, and terrestrial vegetation interact to create this dynamic system, and leave us with two unanswered, and still unanswerable, questions: how do trout population size, structure, and distribution vary during this sequence? How should one rehabilitate degraded streams that follow this sequence? Though answers to all our questions may not be forthcoming, stream rehabilitation remains a popular management tool. Thus, a keen awareness of natural processes is essential in selecting appropriate rehabilitation techniques.

REHABILITATION

As stream channels, and thus trout populations, adjust to changes in the watershed over time, it is critical for us to recognize that structural rehabilitation projects do not permanently maintain habitat. Rosgen and Fittante (1986) evaluated the suitability of several types of fish habitat improvement structures for different channel types as identified by Rosgen's stream classification system. They determined that while there is probably no single correct solution to a problem, structural improvement projects that introduce features out of character with the natural tendencies of the river may be ineffective, short-lived, or further degrade the system the project was designed to improve. For example, Rosgen (1994) described a gabion check dam that was installed in a low gradient, meandering, gravel-bed stream to create a plunge pool for fish. Changes in channel morphology upstream of the gabion "dam" were predictable, but ignored. The bed material became finer as the competence of the stream to transport the available sediment was reduced; the width:depth ratio increased; and raising the base level of the stream reduced the gradient initiating an increase in sinuosity. As a result, lateral channel migration and bank erosion increased, and in 2 years the stream abandoned its channel and created a headcut gully with a gradient that was twice the valley slope. This has created a long-term problem that could have been avoided had the basic geomorphic principles governing river form and process been considered.

In contrast, working within the constraints of a particular system can be successful. A 3.2 km reach of the North Fork of the Colorado River between Shadow Mountain Reservoir and Lake Granby was targeted for habitat restoration by the State of Colorado and the USDA Forest Service (unpublished data). The operational hydrology of Shadow Mountain Reservoir has changed the annual flow regime in this reach to an extended period of baseflow for most of the year with large, flashy peaks during spring runoff and summer thunderstorms. The stream was wide and shallow with no defined thalweg, few pools, and very coarse substrate with no spawning gravels; all factors thought

to be limiting a trout fishery. The solution was to construct an active channel within the larger channel by building a series of alternating point bars that would decrease the width:depth ratio at low flows but allow the annual floods to spread out over the floodplain. The active channel was designed such that riffles were spaced 5-7 channel widths apart; overall gradient was maintained while the bed topography reflected the shallows and deeps of a pool-riffle stream; and where necessary, the banks were stabilized with boulders, vegetation, or both. Though 3 years is too short to evaluate the establishment of a trout fishery, the physical features of the stream are functioning as predicted. The bars have decreased the width:depth ratio at the low flows, spawning gravels are available at tails of pools and behind point bars, and the annual floods have come and gone without negatively affecting the flood and low-flow channel.

However, rehabilitation need not be structural. Sedell et al. (1989) equated salmonid abundance and stream channel complexity with vegetative complexity in the riparian zone. Consequently, the recovery of affected stream reaches in such watersheds will probably depend on the growth of large trees in the riparian zone in forested watersheds and their eventual recruitment into the streams. If natural succession is allowed to proceed, this may require well over 100 years. Silvicultural treatments of the riparian zone, such as creating gaps by removing small trees combined with planting of late-successional species, may accelerate the development of an uneven-aged stand capable of continually contributing large woody debris to the stream channel (Rainville et al. 1985). Other silvicultural treatments may also reestablish desirable habitats (Bisson et al. 1987).

A clear understanding of the variables leading to the deterioration of habitat may lead to the conclusion that wise land management practices may be more effective, because they address the cause of habitat degradation, than structural improvements that only address the symptoms of degradation. Failure to eliminate the cause of deterioration will negate any benefits of rehabilitation, often immediately (Frissell and Nawa 1992). Thus, identification of the causes of habitat degradation becomes critical and is the first step towards a solution. Insight into natural or unimpacted conditions can be provided by reference streams.

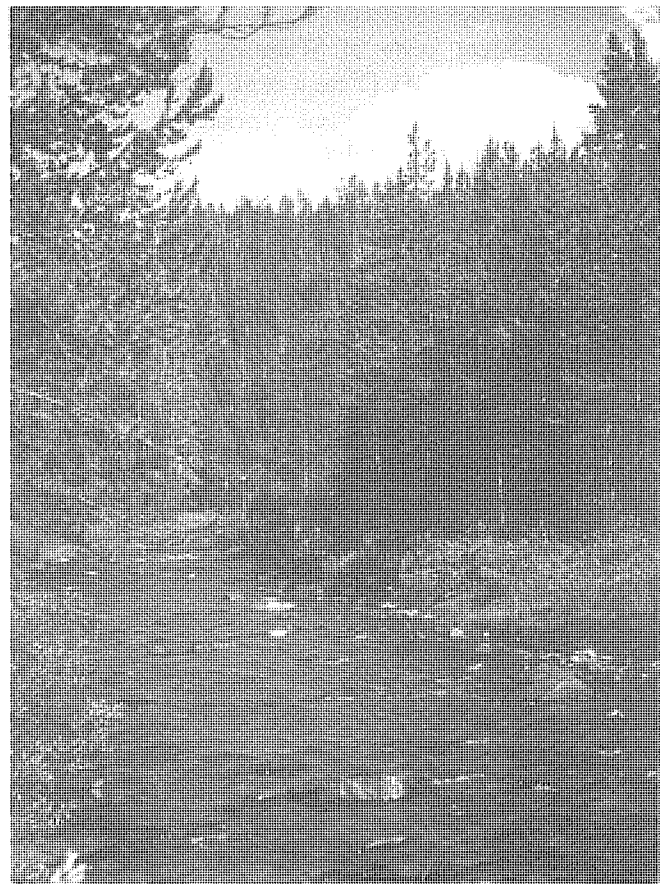

Figure 1.--East Fork of the Encampment River. Note lack of habitat diversity and large woody debris.

IDENTIFYING REFERENCE STREAMS

Reference streams or stream reaches from undisturbed watersheds are an excellent means of identifying the predisturbed condition of a channel, given that similar morphological characteristics exist between the reference and degraded stream. However, investigators must be aware that current management designations, such as wilderness, do not ensure that a watershed was spared from historic degradation. For example, the East Fork of the Encampment River watershed in south-central Wyoming was essentially roadless until recently (Figure 1), and could have been considered de facto wilderness. But note that the only habitat type for nearly 100 m is a riffle, large woody debris is nearly absent, and the riparian zone consists of a young stand of early successional lodgepole pine. These are symptoms of a tie-driven stream; tie driving

involved the transport of millions of rough-cut railroad ties and other lumber down streams during spring floods. A number of streams in designated wilderness areas in different parts of Wyoming were tie-driven between 1868 and 1941 (Young et al. in press). If such watersheds are considered pristine, erroneous conclusions about trout habitat and watershed function are inevitable.

MONITORING POPULATION RESPONSE

A neglected aspect of stream rehabilitation is verifying that the work was done, it was done correctly, and it produced the desired results. Though both managers and bureaucrats decry the lack of monitoring of rehabilitation (Forsgren and Loftus 1993), they have not redirected their efforts by funding more monitoring at the expense of fewer projects. Nonetheless, monitoring remains essential to any form of stream rehabilitation.

Kershner et al. (1991) identified three kinds of monitoring: implementation, effectiveness, and validation. Implementation monitoring evaluates whether a project was done correctly, e.g., whether a stream structure was installed according to specifications. Effectiveness monitoring determines whether the project worked, e.g., whether the structure increased local fish abundance. Validation monitoring assesses why a project worked or failed and has been considered the bailiwick of research. Thorough monitoring can lead to surprising results. Riley and Fausch (in press) noted that log drop structures tended to increase the abundance of trout in treated sections compared to control sections in six Colorado streams. They failed to observe a consistent difference in survival or growth between the treated and control sections but attributed the increase in abundance to the greater retention of mobile trout (Riley and Fausch in press).

Expanding the realm of monitoring to all aspects of stream rehabilitation (cf. Solomon 1989) is essential if we hope to assist fish populations and increase our understanding. Most fundamentally, was the funding designated for fisheries by agencies actually spent on fisheries work? Unfortunately, the answer has often been no (Forsgren and Loftus 1993). And before rehabilitation began, did the biologist correctly identify the factor limiting fish production? Shortages of refugia from high flows are probably not corrected by increasing summer pool habitat. Furthermore, if the habitat problem lies elsewhere, e.g., lack of stream connectivity for fishes with mobile life histories, habitat rehabilitation will be futile (Young in press[b]). If monitoring was done, what effect did local enhancement of habitat have on the entire population, i.e., did fish production increase, or were fish merely redistributed? Finally, was the source of degradation that created the need for rehabilitation remedied?

CONCLUSION

River restoration needs to be approached with an interdisciplinary understanding of not just the biological needs of the trout, but the geomorphic principles that form and maintain channels. Even when successful, structural rehabilitation of streams should be viewed as a temporary solution (Crispin et al. 1993). The eventual goal should be to reestablish the natural function and dynamics of streams and watersheds. Successful management of wild trout habitat and populations depends on our ability to read the river. Leopold (1989) said "Let the river teach all of us." Sage advice because, in the end, the river will have the final say.

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Ecosystem Protection Through the Endangered Species Act

Nancy M. Kaufman[1]

Abstract—Fish and other animals that live in North American waterways are disappearing faster than land-based fauna. The fish and Wildlife Service is working with a variety of agencies and organizations to move toward ecosystem management to better implement the objectives of the Endangered Species Act.

The best way to start is to read an excerpt from a New York Times article entitled: "Water-based Animals are Becoming Extinct Faster than Others"

"Fish and other animals that live in North American waterways are disappearing much faster than land-based fauna, survey data indicate. And without broad measures to protect water-dependent creatures from such threats as pollution,... the rate of aquatic extinctions is likely to accelerate... Indeed, while few were looking, many aquatic species recently disappeared, sometimes leaving gaping holes in the food chain and always diminishing forever the biological diversity that keeps the earth genetically healthy..."

Let's take a look at the trends of aquatic species versus birds and mammals. According to the Nature Conservancy, 7% of US mammals and birds are extinct or imperiled compared to 20% of fishes, 55% of freshwater mussels and 36% of crayfish being extinct or imperiled.

Let's look at fish specifically. This box score was compiled by the American Fisheries Society for all of North America. The data include Federal, State and Foreign sources. Of 1,061 species of native freshwater fishes in North America, 364 species are listed as endangered, threatened or are of special concern, 40 species are extinct of these 16 have become extinct since 1964. The primary documented cause is the widespread degradation of aquatic habitats.

Not all of this dismal picture is due to pollution, but a significant portion is. Although more than one factor may be responsible for each extinction, water pollution is identified as a factor in 38% of the extinctions detailed here.

Based on documented declines of species and loss of biodiversity the Congress passed the Endangered Species Act of 1973. It has been amended numerous times since then but it remains substantially the same. The Act embodies a fairly comprehensive approach to maintaining species diversity.

You might be asking yourself at this point: Okay, so we are losing species, so what! The dinosaurs went extinct and we're doing great without them.

But endangered species do have values to society which led to our elected representatives passing the Endangered Species Act. What are those values?

Here are 10 to think about:

1. Endangered species are an integral part of our nation's heritage. Their very existence is part of our country's history and should be preserved.

2. Endangered species are our environmental barometers—"or canaries in the coal mine"—warning us of environmental situations which could also affect us. The loss of the Bruneau hot springs snail may not seem like a large problem but the decline in the snail is the signal that the aquifer which provides water for drinking and irrigation is badly depleted. Areas which contain eight legged

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salamanders may not be great places to bring up our children. Water which cannot support life forms such as fish and mussels may not be healthy enough for us either.

3. Endangered species have utilitarian value for a range of human enterprises such as agriculture, medicine, hunting, fishing, and wildlife watching. The old axiom about the cure for cancer being out there is no longer a myth. Taxol from the Pacific yew tree is showing promise for its pharmacological properties. The possible extinction of the "bintangor" tree in Borneo has ended promising research into a cure for AIDS. The secretions of the Houston Toad has a strong analgesic effect. As biodiversity is diminished so are our options.

4. Endangered species have scientific value. We can learn much about the life that sustains us by studying endangered species in their habitats. Endangered species are often non-generalists, they tend to be species which have specific habitat requirements and therefore have developed very specialized mechanisms to survive and reproduce. Studying these specialized mechanisms can lead to greater understanding of our interaction with our universe.

5. Endangered species have spiritual and aesthetic value for some. They are, for many people, a source of personal and emotional fulfillment, appreciated for their beauty or complexity or rarity.

6. Endangered species have intrinsic value for some people. Meaning that the simple right to exist is respected.

7. Endangered species have value for the survival of other species with which they are interconnected (including humans). They have evolutionary value, in the contribution they make to the global gene pool.

8. Endangered species have educational value. The plight of these organisms can raise public awareness about the nature of environmental problems. And success in saving one species can serve as a model for strategies that would save others.

9. Endangered species have value by virtue of their legal status. They are a legal force for conservation and protection of the environment that sustains our natural environment.

10. Endangered species are the "bottom line" reminder that the continued health of the planet depends on the wisdom of our stewardship and that we have an ethical and practical responsibility to protect and conserve nature of which we are a part.

Does everyone believe that the benefits of preventing the extinction of a species are worth the cost to society? No. Hardly. Look at the Spotted Owl controversy. This situation and others like it have lead to a great National debate as the U.S. Congress considers the reauthorization of the Endangered Species Act.

This Administration has taken the position that the goals of the Act are sound, that the Act, as currently written contains greater flexibility then past Administrations have wanted to exercise and that changes in the implementation of the Act can and will ameliorate some of the strongest criticisms made of the Act today. On July 1, 1994 the Secretarys of Commerce and Interior published new policies to explain some of these changes to the public.

The purpose of the Act is to provide a means whereby the ecosystems upon which endangered and threatened species depend may be conserved. To foster an "ecosystem approach" to the conservation of species the Services are encouraged by policy to produce multiple species listings and recovery plans.

Recovery teams will be expanded to include non-scientific personnel, people who are stake holders in the issues surrounding the species listing and who's skills may contribute to more practical plans. Where multiple avenues to recovery exist the Services have committed to using the path with the least socio-economic impacts to the public.

There are 5 criteria for determining whether a species qualifies for listing. The criteria are: 1) habitat loss, 2) direct taking, 3) disease, 4) inadequacy of existing regulatory mechanisms and 5) other natural or manmade factors.

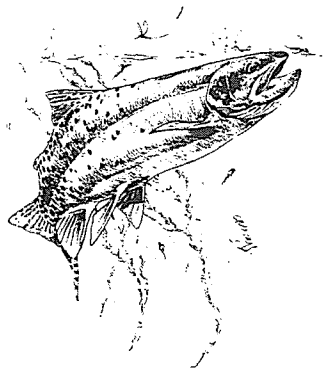
The Act provides that the Secretary shall make listing decisions "solely on the basis of the best scientific and commercial data available.

Public confidence in the use of the best scientific and commercial data available should be bolstered by the new policy of specifically seeking peer review of listing packages. Another policy states that the Services will include additional information on activities which will not constitute "Take" under the Act. That is to the extent possible at the time of listing we will discuss activities which are not likely to affect the newly listed species. While we will never be able to discuss the universe of activities which someone may wish to undertake I believe that the policy will go a long way to reassure many members of the public that listing will not have the devastating effects they fear.

The Service has worked with other Federal Agencies and the International Association of Fish and Wildlife Agencies to expand an agreement among the Fish and Wildlife Service, the National Park Service, the Bureau of Land Management, the National Marine Fisheries Service and the Forest Service for candidate conservation. The agreement states that the Federal family will take positive actions to reduce threats to candidate species. The hope is that threats can be reduced to the point where the protection of the Endangered Species Act are no longer needed. New policies on cooperation and coordination with the States will also improve partnerships with the governments which are largely responsible for candidate management.

All this is being done in anticipation of reauthorization. This year's legislative calendar included attempts to reauthorize the Clean Drinking Water Act and the Clean Water Act; it appears that no real progress was made in these arenas. Will the Endangered Species Act fair better in the next Congress? I don't know. What I do know is that the Fish and Wildlife Service and the National Marine Fisheries Service will continue their work on joint implementation policies on petition management, consultations and Habitat Conservation Planning to make the Act more "user friendly." The ESA will continue to provide the valuable mandate to conserve ecosystems and resources which will in the final analysis be the conservation of sustainable economies, and the preservation of a variety of lifestyles which will not otherwise be maintained.

I therefore argue strongly that the Endangered Species Act is not the major impediment to progress that some would like us to believe. Is our administration of the Act perfect in every way? No. Hardly. But we are constantly looking for ways to improve and have developed a number of initiatives aimed at streamlining the requirements of the Act and reducing economic impact while maintaining species protection. These and other internal efforts will lead to improved administration of the Endangered Species Act.



Impacts of Limiting Pacific Salmon on Fishery Management

Steven M. Huffaker[1]

Listing of Snake River salmon under the Endangered Species Act has had both positive and negative effects on fish management in Idaho. On the positive side, fish habitat protection on federal land within critical habitat is better protected, ocean and in-river harvest regulation processes are more closely scrutinized, and hatchery practices are being examined. On the negative side, intense lobbying by special interest groups has thwarted meaningful changes in the operation of the federal dams and reservoirs that are by far the largest problem for Snake River stocks. The result is a breech in public and state agency trust brought about by massive inconsistency in the way the Endangered Species Act is administered.

The listing of Snake River salmon has had many effects on fishery management in Idaho. Some have been beneficial, some have not.

On the positive side, the ability of federal agency biologists to protect fish habitat and water quality on federal land has been enhanced. Constraints have been established on harvest of some chronically over-fished stocks. The role of hatchery production in both producing fish for harvest and enhancing depressed populations is being reviewed. Most importantly, in my view, the fact that the Snake River system is developed and operated to the extreme detriment of aquatic species has finally come to national attention.

On the other side of the coin, tremendous amounts of time and money have been wasted on process. We have been forced to work extensively on a number of peripheral issues. While we toiled on unimportant problems, we have failed to address the major cause of the decline of the fish. Our ineptitude and inability to administer public policy that makes sense to those being affected has created unprecedented polarization. Public unrest is a forum ripe for politicians and special interest groups to exploit. They have capitalized by pitting agriculture against recreation, resident fish against anadromous fish, and peoples' rights against fish conservation.

Listing of Snake River salmon was, like most Endangered Species Act listing petitions, an act of frustration. It was a desperate response to force federal agencies to deal with the failure of other federal laws to stop the decline of a species. Many times in the last three years, I have regretted the day I stood before the Idaho Fish and Game Commission and recommended they endorse that petition as warranted and necessary. When I made that recommendation, I thought it would finally focus the attention of the region on the problem that biologists had been unable to overcome for decades, the operation of the Snake and Columbia rivers for hydropower at the direct expense of the salmon. How in the world, I reasoned, could anyone reach any conclusion other than to fix the dams so they would pass fish. After all, the problem was obvious. Dams and water release operations had completely changed the natural migration corridor. Spring floods on which the

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salmon migrated to and from the ocean were impounded and stored for release in the winter when the power was worth more. The decline of the runs could be clearly charted by the construction of the dams. Everyone who studied the problem agreed the dams and river operations were far larger problems than any of the others.

We greatly underestimated the ability of heavily subsidized industries to influence politicians and public opinion! We also forgot the First Rule Of Money: "The one with the money makes the rules."

I guess we should have anticipated what would happen. The Northwest had bought off on the Northwest Power Planning Council as an alternative to listing these fish in 1980. The Council was given a mandate to balance the needs of fish and hydropower. In ten years all this group of political appointees did was to create a process that consumed the time and attention of the fish agencies and tribes. Bound by uncertainty, enticed by money, and tethered to a maypole designed to keep them from treading on the sacred grass of mainstem operations, the agencies and tribes could not stop the decline of the salmon.

Bonneville Power Administration, a three billion dollar a year quasi-government puppet for northwest utilities, is in charge of the budget. Those utilities do not want changes in how water is managed. Please remember the First Rule of Money.

The Corps of Engineers is in charge of the dams. If there is a more autonomous entity in the world than the Corps, I would like to know who it is.

The response to the listing of Snake River salmon was predictable. Everyone did exactly what they had done in the past:

1. Deny the problem exists;
2. Blame everyone else;
3. Confuse the real issue;
4. Lobby intensely to maintain the status quo.

I am sorry to have to stand here today and tell you that the confusion and lobbying are working. The only way Idaho has been able to address the real issue, that of improving mainstem operation for migrating salmon and steelhead, is through the federal courts.

National Marine Fisheries Service has demonstrated remarkable ineptitude at dealing with political pressure or administering the Endangered Species Act. They have been unable to provide the federal leadership needed to induce other federal agencies to make significant changes critical for salmon recovery.

In fairness, this listing has had a few beneficial effects. Unfortunately, most of them will not contribute much to saving salmon in the Snake River. It is a fact that some production habitat for Idaho salmon can and should be improved. It is also a fact that salmon are going extinct in wilderness habitat that is essentially unaltered by the activities of man. Does that mean we should not use this opportunity to make things better? Absolutely not. It just means we must not be fooled into spending all our energy on habitat issues, or harvest issues, or hatchery issues.

If you are a hammer, everything looks like a nail. The Endangered Species Act is regarded as the ultimate environmental hammer. This hammer is currently being swung by a variety of people. Some of those people have a broad background and an appreciation for decisions that make a difference. They administer the Endangered Species Act with a measure of common sense. Logical decisions based in sound biology are generally accepted. When logical, biologically-based decisions are challenged, they are defended by most resource professionals.

The same hammer is also wielded by some who are long on ambition and theory, but short on expertise and field experience. They tend to swing full force at every nail they see. This group has been suppressed by the two previous administrations. Suddenly they are empowered to deal with all the forces of evil, be they real or perceived. The result is a battle being fought on all fronts without regard for casualties or the status of the war.

In the later cases, the biology is speculative. For example, a stocked fish might compete with a wild one; a boat might disturb a spawning salmon. Campgrounds are closed to keep people from trampling the river banks based on the logic that unless human activity is restricted, livestock activity cannot also be restricted. The sole justification for restricting the activities of people is sometimes just that they are relatively easy to administer. At the local level, local threats to individual fish or their habitat can be dealt with. Things that are politically tougher are usually left

to a higher authority. Higher authorities are more politically constrained.

The problem with administering the Endangered Species Act that way is it does not take people long to see the "little guy" getting restricted while the big problems are swept under the rug. The little guy can still vote. If we do this to enough people, the little guys are likely to take away the big hammer!

The listing of Idaho salmon has done good things and bad ones. Fish habitat has benefited, and water quality may be enhanced. Tightened processes to regulate commercial fishing are being used. A review of the role of hatcheries and their procedures with regard to genetics and disease is underway.

Unfortunately, the way the Endangered Species Act has been administered has polarized many people against the salmon and against the Endangered Species Act itself. It has made it very difficult for my agency to work for needed reform on state and private land. State agencies and private citizens are frustrated because they are not allowed to bring local expertise and common sense into the process. Once federal processes take over, the process sometimes becomes more important than the result.

The Endangered Species Act is a two-edged sword, and one that is a lot easier to take out of the sheath than to put back in. Its track record is not all that impressive.

As of 1989, 495 United States species had been listed. Of those, 16 were recovering, 18 were probably extinct, and 15 had been "delisted," but only five were "delisted" due to recovery (Reffalt).

By 1992, 711 species had been listed. In a 1994 news release, U.S. Fish and Wildlife Service (USFWS) claimed 10% of those to be improving and 28% stable, leaving 62% still in decline (USFWS).

Part of the problem may lie with the recovery planning process. A review of the 314 recovery plans found that recovery goals were frequently set at levels lower than current population estimates (Tear et al. 1993). My point is not to criticize the federal agencies or the Endangered Species Act, but to emphasize that listing a species may not be of much use in saving it, primarily because species are not usually listed until most of the damage is done.

Nowhere is this more clear than in the case of Snake River salmon. Sixty years of dam building for flood control, hydroelectric generation, navigation, and irrigation changed the salmon's migration corridor from a river to a series of dams and reservoirs. Recovery measures can help with ongoing threats to nursery habitat, but they are apparently powerless to change the primary cause of salmon decline!

Some federal agencies and the environmental community are currently scrambling to show success stories in time for reauthorization. Others are capitalizing on the horror stories of economic upheaval to prevent reauthorization. Meanwhile nobody has repealed the first rule of money.

Our objective should not be to list species. As conservationists and anglers concerned about wild trout and their environment, we should all regard a listing petition as a failure on our part to take those actions needed to prevent listings. We need to look at what is happening earlier, and to get involved more effectively with addressing the real problems. We must be very careful not to allow ourselves to get caught up in the religious aspects of genetic purity or catch and release to the point where we disenfranchise others we must have as partners to resolve the big issues.

Conservation is the alternative to extinction. Conservation Agreements are a preferable alternative to listing under the Endangered Species Act. A Conservation Agreement binding on the signatories to do whatever is agreed upon. They can be done at the lowest level by those with the best knowledge and experience as to what is realistic and sufficient to get the job done. Conservation agreements can be done on private lands or public, without National Environmental Policy Act (NEPA) process, and with or without any new state, federal or private funds. They are the exemplification of the term "partnership" that so many talk about and so few do anything about.

I will close with pleas for common sense and action:

1. Don't get caught up in the little issues that will not make a difference. Before you launch a campaign to eliminate hatchery fish from spot X or change the regulations in area Y, be sure your action will have a net beneficial effect on the BIG PICTURE.

2. See if you can reach your goal without taking something away from another user. Don't

alienate people we all may need as allies when it's time to do something important.

3. Talk to people who may have different views, not just those of like mind. Talk to the professionals, and strive for objectivity and accuracy.

4. When you get to a big picture issue, get INVOLVED. The Snake River salmon issue would be a perfect one with which to start. The fish runs clearly show the problem is real. Write the people elected to represent you in Congress. Demand that they become partners in salmon conservation. Tell them to stop the denial, quit the disinformation, and focus on the real issues. Tell them the salmon problem in the Snake River is a perfect example of failure of the federal government to act in partnership for conservation of these fish. Tell them you want the federal actions that imperil the fish corrected. The salmon can be recovered and fisheries restored as soon as the federal dams are fixed so the little fish can get to the ocean and the big ones can get back.

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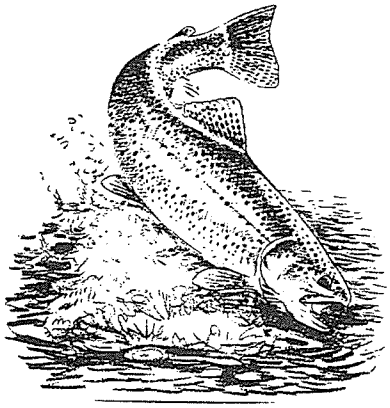

Listing the Atlantic Salmon A Case History

Jerry Marancik[1] and Paul Nickerson[2]

Abstract—During the colonial period, it is estimated that between 300,000 and 1.1 million adult Atlantic salmon returned to 28 rivers in New England. Decades of abuse from dam construction, pollution and over harvesting eventually caused the demise of Atlantic salmon populations in nearly all of the major rivers. Restoration programs begun in the 1960's in three major New England rivers have achieved varied successes over the last 25 years, such as the Penobscot River in Maine, which has a return of 2,000 to 4,000 adult Atlantic salmon annually.

There are seven small coastal rivers in Maine which are thought to contain the last remaining native stocks of Atlantic salmon in the U.S. Declining returns through the 1980's and 1990's prompted the U.S. Fish & Wildlife Service to designate these river stocks as Category 2 candidate species under the Endangered Species Act in 1991. In October, 1993, the U.S. Fish & Wildlife Service and National Marine Fisheries Service were petitioned to list the Atlantic Salmon as Endangered throughout their historic range. A proposed rule is expected to be published in the Federal Register on or about October 1, 1994, with a final rule expected October, 1995. The Category 2 designation and Petition have created a great deal of activity and interest in the Atlantic salmon, including increased funding to identify and reverse the causes for the declining runs.

BACKGROUND

The following description was taken from Haines, 1992:

"The Atlantic salmon (Salmo salar) is an anadromous fish native to the north Atlantic region. Adults feed and grow in the Davis Straits between Labrador and Greenland (Mills 1989), and migrate to coastal rivers between about 40 degrees and 70 degrees latitude for reproduction (Netboy 1974). In the United States of America, Atlantic salmon originally occurred in at least 28 rivers from the St. Croix on the Maine-New Brunswick border to at least the Housitonic in Connecticut, and probaby as far as the Hudson River in New York (Dunfield 1985). Estimates of populations range from 300,000 (USFWS 1984) to 1.1 million fish (Dunfield 1985)."

Anadromous fish, such as the Atlantic salmon, striped bass, American shad and river herring were an important food source for the colonists and native people.

Dams built across the lower portions of many of these rivers in the 18th and early 19th centuries usually had poorly built fishways or no fishways at all and effectively blocked the spawning migration of anadromous fish. Within a few years, the salmon runs in many of the great rivers such as the Connecticut, Merrimack and most of the Kennebec were destroyed. Pollution during and after the Industrial Revolution, coupled with continued dam construction and overharvesting, caused the extinction of nearly all of the remaining major salmon populations in New England. By the mid-19th century, the last remaining significant salmon

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populations in the United States were found only in Maine.

In 1947, when known returns were only about 1,500 adults, the Maine Atlantic Sea Run Salmon Commission (MASRSC) was established in an effort to reverse the decline. The MASRSC is the only state resource agency solely responsible for management of Atlantic salmon.

In the 1960's, the marine feeding grounds for North American and European stocks of salmon were found off Greenland by the commercial fleets, and exploitation grew rapidly. The few remaining Maine stocks continued to dwindle and through the 1950's the Penobscot River stock virtually disappeared.

In 1965, the passage of the Anadromous Fish Conservation Act stimulated the New England states to pursue salmon restoration once again. Improvements in water quality, installation of fish passage facilities, and increased public awareness created an atmosphere of hope that restoration could succeed throughout New England, and more partners joined the effort. Restoration projects were undertaken for the Penobscot, Merrimack and Connecticut rivers.

During the 1970's and early 1980's, returns increased and recreational fishing success in Maine was high. The recreational fishery harvested 15-25% of the returning spawners in some rivers. However; Atlantic salmon continued to be exploited at sea with Canadian and West Greenland fisheries taking a heavy toll, which contributed to reduced spawning escapement. Those factors, coupled with what are assumed to be worsening natural conditions at sea, drastically reduced Atlantic salmon abundance in many U.S. rivers during the past decade.

PRESENT STATUS

Restoration programs on the major rivers that had lost their salmon populations, such as the Connecticut, Merrimack, and Penobscot have shown some successes since they began in the mid-1960's. The Penobscot River, for example, nearly devoid of salmon in the 1950's, now shows a return of 2,000 to 4,000 adults annually. Natural reproduction has roughly doubled with each generation over the last five generations and is estimated to comprise between 10 and 20% of the annual run. The majority of returning adults for these restoration rivers originate from hatchery reared fry and smolts.

Today, there are seven rivers in Maine which are thought to contain the last remaining native populations of Atlantic salmon in the U.S. Five rivers (Dennys, East Machias, Machias, Narraguagus and Pleasant) are located in eastern (Washington County) Maine; and two others (Ducktrap and Sheepscot) are located in mid-coastal Maine. These are small coastal rivers ranging between 9 and 60 miles in length with drainage areas of 35 to 460 square miles.

A maximum of 2,500 adults may be expected to return in total to these seven rivers, based upon available habitat.

Adult returns over the last 25 years peaked in the late 1970's and early 1980's when the total angler harvest reached 300 wild origin salmon. During this period, adult returns have been estimated from angler catch, redd counts and the intermittent use of trapping facilities. The run size has declined through the 1980's and continued into the 1990's with record lows being reported. The reasons for this decline are not well understood, and the possible causes are numerous, such as sea-surface temperatures, commercial and recreational harvest, poaching, predation, past stocking practices, etc.

In 1990, the Maine Atlantic Sea Run Salmon Commission and the National Marine Fisherie Service undertook a comprehensive study on the Narraguagus River to examine issues concerning the Atlantic salmon populations in eastern Maine, including the capacity of the habitat to produce smolts. The five-year study examined adult returns; juvenile abundance; habitat types, quality and quantity; contaminants; and macroinvertebrates. Although depressed, relative to historic levels, the juvenile population levels are commensurate with the adult returns, and habitat capability indicating that problems exist with post-smolt survival in the marine environment.

In November, 1991, the U.S. Fish & Wildlife Service designated salmon populations in the five Washington County rivers, and in 1994, the two mid-coast rivers, as Category 2 candidates under the Endangered Species Act. Although there are no regulatory authorities mandated for candidate species, the designation prompted some major program changes, support and criticisms. In order to address the Category 2 concerns, the U.S. Fish and Wildlife Service and Maine Atlantic Sea Run Salmon Commission developed a Prelisting Recovery Plan in 1992. The goals of the plan are: to increase adult returns to the point where listing as threatened or endangered is not necessary; in the event that the stocks are listed, recovery can proceed without further delay; prelisting recovery ef-

forts and planning would defray public controversy.

Activities called for in the plan are:

1) Develop river-specific broodstock for augmenting juvenile populations with emphasis on fry releases.

2) Determine genetic characteristics of all Atlantic salmon stocks in Maine.

3) Establish weirs and traps to obtain annual information on the number, origin, age structure, run timing and biological characteristics of existing adult returns.

4) Identify, monitor and reduce or eliminate threats.

5) Inventory and summarize the current status of Atlantic salmon habitat.

6) Summarize information on the status of Atlantic salmon stocks annually and assess recovery progress.

In order to implement the Atlantic Salmon Prelisting Recovery Plan, the U.S. Congress earmarked a special appropriation of Fish & Wildlife Service Endangered Species funds for the MASRSC in 1993, 1994 and proposed again in 1995. This enabled the State of Maine to conduct habitat surveys, identify obstructions to migration and other factors which may limit production of juvenile salmon, and to establish weirs and traps on two of the seven rivers in order to collect broodstock and enumerate adult returns. Temporary weirs were used to collect adult broodstock from the Dennys River during 1992, 1993 and 1994 and from the Machias River in 1993. Also, weirs were installed on the Pleasant and Sheepscot Rivers to enumerate the adult runs in 1994.

Development of river-specific broodstock began in 1991 with the conversion of the Craig Brook National Fish Hatchery in East Orland, Maine from a Penobscot River broodstock and smolt production facility to a river-specific broodstock and fry production facility. The program began with replumbing of the water supply and discharge, and the collection of adult salmon from the Dennys and Machias rivers. The collection of adult salmon for broodstock from the Category 2 rivers is a temporary measure, for the purpose of obtaining an "instant" source of eggs. The primary source for developing river-specific broodstocks comes from the capture and rearing of wild parr. The first collections of age 1+ parr were made from the Machias, Narraguagus and Dennys rivers in 1992. The first eggs are anticipated to be taken from these fish in the fall of 1994 as three-year-old adults. An interesting aspect of the captive wild broodstock program involved training the parr to adapt from feeding in the wild to feeding on prepared hatchery feed. Several diets were attempted and rejected by the fish. An offering of freeze-dried krill was finally successful in getting the fish eating in the hatchery, and they could be weaned onto prepared dry hatchery diet (King, 1993, 1994).

Beginning in 1990, samples of fish flesh and blood were collected from rivers in Maine and Canada to determine the genetic composition and differentiation of Atlantic salmon stocks. Various techniques were applied to examine the mitochondrial and nuclear DNA, allozymes, and meristic and morphometric measurements. The purpose of the genetic work is to determine if the native stocks differ from each other and from fish in the Penobscot River. Results to date are not definitive and it is anticipated that this work will continue for several more years.

In 1994, the U.S. Fish and Wildlife Service provided funding under a Stewardship Program to conduct a series of activities in Maine's Category 2 rivers. Funding for FY's 94, 95 and 96 was earmarked to protect the genetic character of native stocks; measure impact of sport harvest; survey habitat to characterize and quantify the various habitat types using GIS; identify and remove, if possible, barriers to migration such as beaver dams and log jams; increase stocking of river-specific stocks, and measure impact of stocked fry on native populations.

In October, 1993, the USFWS and NMFS received a petition from Restore: The North Woods, Biodiversity Legal Foundation and Jeffrey Eliot to list the Atlantic salmon as endangered throughout its historic range in New England. Since the USFWS and NMFS share federal responsibility for the Atlantic salmon under Cooperative Agreements, the decision was made to respond jointly to the Petition. The Services published a notice on January 20, 1994 that the petition presented substantial scientific information indicating that a listing may be warranted, and requested information from the public. Personnel from the two agencies and National Biological Survey at the field and regional levels formed working groups to address such issues as the present and historical status of the individual river stocks, and the genetic characterization of the stocks in Maine. The ESA review

broodstock. The majority (65%) indicated that the F_1 progeny would still be wild, but only 50% believed the F_2 generation would be wild. However, when asked the open-ended question "When would you consider the progeny of wild broodfish to become domesticated?", some indicated it would take up to ten generations, but the majority (65%) would expect the progeny of wild fish to become domesticated within five generations (Figure 2).

The qualifiers added to questions 5, 6, and 7 by the respondees included decisions based on electrophoretic analysis of proteins, behavioral changes, conditions under which successive generations were maintained, and strains of trout. Some respondees pointed out that domestication

SURVEY - What is a wild trout?

1. With the national controversy between hatchery-reared fish and wild fish, can wild trout be produced in hatcheries? ___ Yes ___ No
2. Wild trout become domesticated after 1 day to 1 month in captivity. ___ Yes ___ No
3. Wild trout become domesticated after 1 month to 1 year in captivity. ___ Yes ___ No
4. Wild trout become domesticated after more than 1 year in captivity. ___ Yes ___ No
5. The F_1 generation taken from wild broodstock would be considered as wild trout?
   ___ True ___ False
6. The F_2 generation taken from wild broodfish would be considered as wild trout.
   ___ True ___ False
7. When would you consider the progeny of wild broodfish to become domesticated (give the F_1, F_2, F_3, etc generation) _____.
8. Have you recognized behavioral differences among trout taken from the wild?
   ___ Yes ___ No
9. Do some trout taken from the "wild" appear more docile than others? ___ Yes ___ No
10. In your own words, how do you describe a wild trout?
11. How can hatcheries support wild trout programs?
12. How could hatchery procedures, diets, etc. be modified to produce fish more similar to wild trout?

Information on person completing the survey:

Name:
Hatchery:
Address:
City, State, Zip:
Phone: FAX:

Please return to the address below by September 15, 1994.

Nick C. Parker
Texas Cooperative Fish and Wildlife Research Unit
Texas Tech University
Lubbock, TX 79409-2125
Phone 806/742-2851 FAX 806/742-2280

Figure 1 .—The survey sent to managers of 76 National Fish Hatcheries of the U.S. Fish and Wildlife Service to solicit their views on wild trout.

was not an all or none process, but a gradual cline. Others argued that anything man does to a wild fish, even catching and releasing it in the wild, alters its behavior and therefore renders it less naive, therefore less wild.

Is one wild trout the same as every other wild trout? Are there behavioral differences among wild trout? Seventy percent of the respondees have recognized behavioral differences within or among strains of wild trout (question 8) and 45% indicated that some "wild" trout appeared more docile than others (questions 9). Some wild trout, when moved into captivity, were judged to be "more flighty", to "run from people", "difficult to feed", "do not transport well", and some show "more signs of stress during handling."

Most fish culturists tended to describe wild trout based on the fish's behavior when placed in captivity. The range of definitions included the following:

1. An endemic population of trout in a natural setting with no history of domestication or stocking.
2. A fish that will adapt to the wild environment within 60 days.
3. A fish with genetic characteristics similar to its wild counterparts and a fish whose behavior has not be significantly modified by time in the hatchery -- at least not irreversibly.
4. Any trout originating from a wild parent stock that retains wild characteristics when stocked.
5. A fish that has not become domesticated after years of selection in the hatchery.

It is worth noting that of the 39 definitions for "wild trout" provided by the 41 respondents, 51% used a definition that would not preclude fish from being produced in a hatchery. Conversely, 16 of 39 (41%) expressively excluded use of hatcheries or any type of management action in their definition of wild trout. Only 5% included genetic composition as part of their definition. The views expressed in all 39 definitions were included in one of the five definitions in the examples given.

When asked "How can hatcheries support wild trout programs?" (question 11) the responses ranged from positive recommendations for hatching programs to keeping hatchery-produced fish away from waters with wild trout. Individual responses indicated that 26 of 30 (87%) respondees believed that hatcheries could be used to produce fish that were "wilder" than domestic stocks. However, most indicated that programs must shift their emphasis from quantity to quality. Gametes taken from wild broodstock could be used to produce F_1 wild progeny. Most respondees supported the position of the U.S. Fish and Wildlife Service guidelines for producing wild trout -- wild trout are those with no more than two generations in a hatchery environment.

Conversely, 16% of respondees indicated their belief that hatcheries could not produce wild fish. A minority held the position that hatchery fish should never be stocked in streams designated for wild fish. However, others pointed out that many restoration programs were dependent upon protecting and propagating threatened and endangered stocks in hatcheries to produce progeny for release in the wild.

The final question on the survey was to solicit recommendations on how hatchery procedures could be modified to produce fish more similar to wild trout. Thirty-seven of the 41 respondees (90%) answered this question. To produce wild trout, or at least fish more similar to wild trout, most fish culturists agreed on several major points. They would: (1) reduce stocking densities in raceways and ponds; (2) provide diets similar to that available to wild fish; (3) greatly reduce quantity and type of fat in the diets; (4) cease using prophylactic treatments for suppression of disease; (5) increase flow rates; (6) avoid human contact; (7) minimize stress; (8) supply shade; (9) design tanks or ponds to simulate environmental conditions similar to those found in natural habitats with earthen banks, trees, roots, and gravel bottoms; (10) paint tanks a dark color and reduce light intensities in hatchery buildings. Another suggestion was to routinely infuse genes from wild stocks into hatchery stocks. Some culturists would defy anyone to distinguish between a wild trout and a hatchery-reared trout 6 months after stocking. At the other extreme, one culturist declared it impossible to modify hatcheries or procedures to produce wild trout.

DISCUSSION

Not all fish culturists hold the same views regarding wild trout or the role of hatcheries in wild trout programs. However, given the opportunity, almost all culturists would like to produce fish of a quality equal to that of wild trout (some apparently now believe that they do so). Major obstacles recognized by most respondees were inadequate budgets, excessively high production quotas, and compliance with established procedures for control of selected fish diseases. Hatcheries were seen as an aid to

manage and maintain populations of wild trout. Culturists recognized the importance of proper habitat to

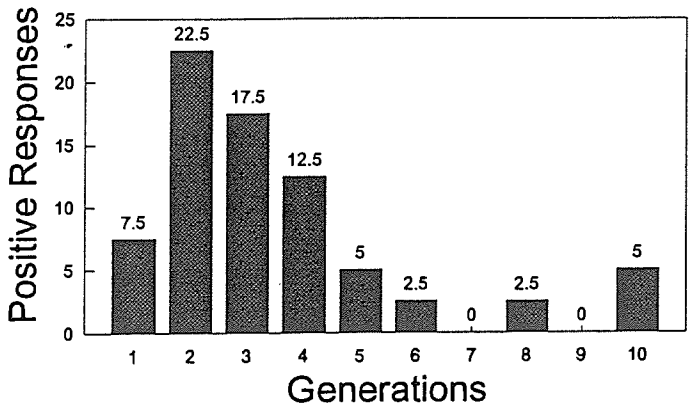

Figure 2.—Percent of fish culturists responding positively that wild trout would become domesticated after one to ten generations of captivity.

maintain healthy populations of wild trout and other aquatic species. They also recognized that the growth of the human population and the increasing demands of anglers can not be met by wild trout alone. There is a recognized need for put-and-take fisheries in urban environments and the need to use hatchery-reared fish to restore stocks in areas where habitat has been degraded.

As beauty is in the eye of the beholder, so may wild trout be in the eye of the angler, culturist, or manager. No fish culturist wants to produce fish without fins or those described as "swimming sausages with scales." However, they do want to use hatcheries as appropriate to support programs for restoration of wild trout and to provide angling opportunities for those unable to fish for wild trout. Maybe as in the case of pornography, wild trout are hard to define, but we all know them when we see them. I believe that we can all appreciate and admire wild trout regardless of their source.

ACKNOWLEDGEMENTS

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What Is A Wild Trout? A Population Geneticist's Perspective

Kenneth P. Currens[1]

Genetic ideas for valuing wild trout fall into two categories of ideas with ancient origins: the sacred and the utilitarian. Genetic ideas in the sacred tradition include the tight adaptation of wild fish to their environment, genetic integrity, pure lines, and wild-type alleles. Utilitarian genetic ideas include the uses of native races as source for domesticated strains, as raw material for genetic improvement programs, and as a resource for genetic engineering. The best aspects of the sacred and utilitarian traditions can be combined in a framework for assessing genetic risks to wild trout populations. Without such a framework, anglers, biologists, and managers of the future may not be debating what a wild trout is. They will be asking what wild trout were.

> Thinking back across the years, holding such beauty in my hands, I know that it was not really a fish - it was a poem...beauty is more complicated than we know, perhaps more complicated than it is fully possible to know. But we are not merely in the science and technology business, not when our science is focused on protecting the beauty of trout rivers and their watersheds, and the beautiful species that thrive in such places - we are in the poetry business.
>
> - Ernest Schwiebert, 1989, "Elegies and Epilogues"

It has been nearly a generation since Wild Trout I when Dr. Willis King asked in the keynote statement, "What is a wild trout?" In the twenty years that have followed, population geneticists and systematists have done much to put meat on the bones of his answer: "There are all kinds of wild trout. Some of them wilder than others, for different reasons." Some population geneticists have worked to describe the kinds of wild trout; others have wondered what makes a trout wild. But few of us have wondered how our science became part of the poetry business in the first place. Poems, I am told, have a life before they are written. Ideas live again and again. What are the origins of population genetic ideas in valuing wild trout and what do they mean for keeping the poetry alive?

ORIGINS OF GENETIC IDEAS

The four volumes of the proceedings of Wild Trout I-IV, like many other writings about wild trout management, indicate that population genetic ideas have been part of the justification for managing wild trout since at least 1974. Reference to these ideas has evolved as sophistication about genetic theory, management of genetically different populations, and knowledge of genetic diversity of wild trout have expanded. In general, however, these ideas fall into two traditions: the sacred and the utilitarian. Genetic ideas in each add to the richness of understanding about what wild trout are, but

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the sources of these ideas rest many years, centuries, or even millennia in the past. To use these ideas to manage wild trout in the twenty-first century, we need to understand their history and limitations.

The Sacred Tradition

The tradition in conservation and ecology that emphasizes the importance of balance, order, and hierarchy in nature is what I call the sacred tradition. Its influence in Western science is usually attributed to the natural philosophies of idealism and essentialism developed by Plato and Aristotle nearly 2400 years ago (Mason 1962). Natural order, balance and hierarchy, as well as the belief that organisms are imperfect representations of an ideal form or essence, are recognizable in the religious metaphor of a Great Chain of Being during the 17th and 18th Centuries (Pope 1733), in ecological studies of Frederic Clements at the beginning of this century, in the more recent Gaia hypothesis, and in the "type" system used by taxonomists when describing new species.

But what about population genetics? The modern synthesis of principles of inheritance and theory of evolution began by Dobzhansky (1937) ushered in an area that challenged many parts of the sacred tradition but not others. Mayr (1942) rejected the Platonic and Aristotelian views of species as typological, because they emphasized ideal, unchanging forms, and introduced the modern "biological" concept of species based on genetic variation and change. However, many of the genetic reasons that have been used for valuing wild trout management - the tight adaptation of the fish to their environment, genetic integrity, pure lines, "mongrelization" of interbreeding lines, and dominance of wild-type alleles - entered genetics before the modern synthesis and as part of the sacred tradition. For example, many early geneticists at the beginning of this century were typologists who were interested in the mechanisms of inheritance, not differences among individuals or populations (Dobzhansky 1977). To make inferences about the transmission of genes, they had to use highly inbred populations of domesticated organisms that consistently bred pure ("pure lines") or were homozygous for a desired characteristic (Carlson 1989). To ensure purity, many chose characteristics that were not observed in wild populations. Because the wild characteristic reappeared in the offspring of inbred and wild matings, "wild-type" alleles were considered normal and often dominant.

Their experiences led to the classical view of genetic diversity, in which individuals in wild populations were thought to be homozygous for wild-type alleles, just as laboratory strains were for mutant alleles. Under this view, natural selection acted as a strong purifying agent that quickly recovered the genetic integrity of the population by removing harmful genetic variation from the genome. Because differences among individuals within a population were thought to be very small, when differences were discovered between populations they were thought to have enormous adaptive significance. When different "types" were found in a population, they were thought to be the result of "mongrelization" between different pure lines (Dobzhansky 1977), a disruption of the natural order and a loss of fitness.

Similar vocabulary is sometimes incorporated into valuing wild trout. But how well does genetic variation in wild trout populations fit this view of nature? In the last 25 years, different evolutionary races of wild trout have become increasingly well-recognized (Behnke 1992). However, genetic studies also indicate that significant genetic differences exist among individuals within populations as well as among populations and races. Estimates of the proportion of genetic variation found within populations (as opposed to among populations) for trout range from 55.5% in Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*) to 96.3% in Yellowstone cutthroat trout (*O. c. bouvieri*). Average heterozygosity (the proportion of loci with more than one allele) in the populations ranged from 9.5% in coastal cutthroat trout (*O. c. clarki*) to 1.3% in Yellowstone cutthroat trout (Allendorf and Leary 1988). Variation within populations is also important.

The Utilitarian Tradition

The utilitarian tradition is deeply rooted in agriculture. Farmers have long recognized the importance of variation within populations. The history of exploiting quantitative genetic variation of wild animals to select for specialized domestic strains covers thousands years (Hale 1969). Just as it is an old axiom among farmers "not to eat the seed corn," wild trout are valued as the raw material for "genetic improvement" programs. Dr. Behnke's persistent plea to exploit different native trout genotypes rather than domesticated hatchery strains in creative fishery management represents a very different application of genetic ideas in the utilitarian tradition (Behnke 1989). Most recently, genetic engineers have recognized wild

populations as reservoirs of raw material that can be tapped for economic benefit.

Compared to the sacred tradition, short-term empirical results, rather than genetic theory, have been the corner stone of genetic ideas in the utilitarian tradition. Although many of the early pioneers of evolutionary theory emphasized quantitative genetic traits, they believed that "the problem of animal evolution is essentially a statistical problem" (Weldon 1893). Change of more than one trait was difficult to study except through correlation. Geneticists and animal breeders readily quantified the importance of the physical environment on a desired outcome - the phenotype, or visible expression of a trait - but they did much less to understand the "genetic environment" of the organism. Genetic assumptions, made to simplify the statistics, gained credibility with little empirical support (Barton and Turelli 1989). Consequently, as molecular biologists continue to develop tools to dissect small portions of the genome for practical purposes, we still know very little about interaction within the genome and its effect on the evolutionary response of populations.

Advise for the Present

To those who use genetic ideas to value wild trout, I offer this simple advice: avoid typological thinking and be humble. The traditions in which genetic ideas have developed provide both rewards and dangers to valuing wild trout. The sacred tradition provides an esthetic of order, balance, and hierarchy in nature that is important for understanding the poetry as well as the biology of wild fish. However, it can also lead seductively to typological thinking. Fish and wildlife managers, for example, are sometimes seduced by the notion that if we knew more about genetic diversity among fish populations, we might be able to identify a universal "genetic distance value" that would tell us whether samples from different locations were the same genetic stock. Although we might not recognize it, this is Aristotle's essence applied to stock identification. On the other hand, the utilitarian tradition offers practicality but without a warranty on the product. Dr. Fred Allendorf once noted, "The genome is more like a jig-saw puzzle than a box of Legos." It is bold to piece together a jig-saw puzzle without knowing what the picture is or what pieces have been lost. It is also humbling.

THE RISKY FUTURE

The two traditions that have given genetic value to wild trout are also the traditions that will take us into the future. One tradition provides order, balance, and diversity. The other provides opportunity - but with a risk. As we become more embroiled in Endangered Species Act considerations, needs for tribal and traditional fisheries, and the changing attitudes of urban America, how will we make decisions for wild trout? We need a framework for managing wild trout that combines the best of these traditions.

One way is to ask over and over again, "What are the risks? How vulnerable are the populations?" Genetic risk assessment is the systematic identification and characterization of vulnerability to losses of genetic diversity. I have explained detailed descriptions of genetic risk assessment elsewhere in the fisheries literature. In general, we can recognize four basic genetic hazards to populations: 1) extinction, 2) loss of within-population genetic diversity, 3) loss of between-population genetic diversity, and 4) domestication, or the loss of fitness in the wild of fish bred or reared in an artificial environment or their offspring. We also know that with every management action, however well intended, comes a probability (or risk), however small, of each of these hazards. Vulnerability is the product of these two: risk and hazard.

A very simple system for managing and assessing risk has five parts (Figure 1). Identifying sources of hazards is critical for assessing and managing risks to wild trout populations. Sources of hazards are usually human interventions (however well intended) into a natural system. These may include fishing, collecting fish for hatchery brood stock, releasing hatchery fish, and activities that alter the habitat. They may have an effect at different endpoints. These might be a target population (such as a threatened population in a recovery program) or non-targeted fish of the same or different species. For each source of hazard and each possible endpoint, there is a risk of some loss from the hazards already described.

However, vulnerability can be managed. Two important pieces of the system are the proximate and ultimate control mechanisms. The proximate control mechanisms provide reliability. Reliability is the potential success of the protective measures that are in place against hazards. In natural resource management, the ways in which we **minimize** the conditions for unwanted genetic change during our intervention are our only proximate

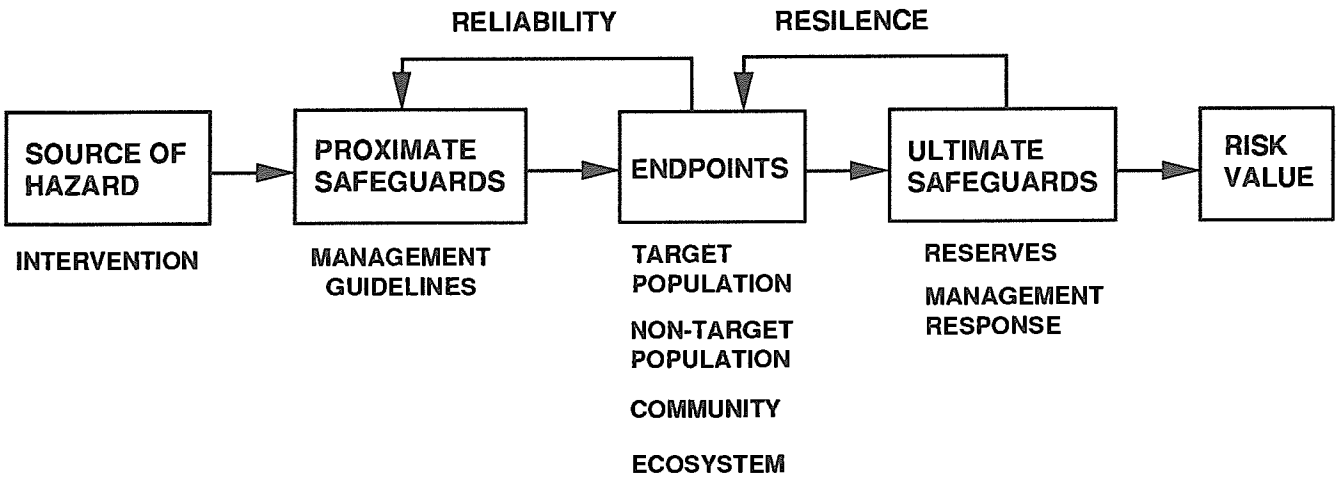

Figure 1. - A framework for assessing and managing vulnerability of wild populations to losses of genetic diversity.

safeguards. On the other hand, ultimate safeguards increase resilience. Resilience is the potential rate of recovery from failure of the proximate safeguards. Resilience comes from two different sources: 1) natural, genetic reserves and 2) the ability of managers to quickly identify and respond appropriately to a failure of other safeguards. Stringent standards for proximate and ultimate safeguards must be set before managers intervene in a natural system.

Based on this simple system, when anglers, conservationists, or biologists ask, "What are the risks? How vulnerable are the populations?" they should expect two kinds of information. First, they should expect that all sources of hazards, possible endpoints, and the risks have been identified and ranked, or estimated, no matter how small. Second, they should expect an honest evaluation of how well the safeguards that are actually being used meet the set standards.

Genetic risk assessment, as I imagine it, combines both the sacred and utilitarian traditions. On the one hand, it recognizes the need to maintain order, balance, diversity, and resilience in wild trout populations; on the other hand, it allows for opportunity and the risks and hazards that come with it. We will know it is working, if it keeps us humble.

CONCLUSIONS

What are wild trout? It all depends on history - theirs and ours - and what we make of it. As S.J. Gould (1989) wrote, our interpretation

> "does not rest on direct deductions from laws of nature, but on an unpredictable sequence of antecedent states, where any major change in any step of the sequence would have altered the final result. This final result is therefore dependent, or contingent, upon everything that came before - the unerasable and determining signature of history."

We are not only in poetry business - we are in history business.

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Fish Culture and Wild Trout: A Fish Manager's View

Ron Remmick[1]

Abstract.-Fish culture provides fisheries managers a tool to create and maintain fishing opportunities when wild trout are not available. Wild trout are considered wild if they have spent their entire life in the natural environment despite their parent's origins. Wild trout can be exotic or native species. Cultured fish can be used to re-introduce native or exotic species that may develop wild populations. Habitat defines a wild trout as much as its origins. Habitat structures should be used when poor habitat jeopardizes a wild population. Habitat protection, fishing regulations, and education are important tools for wild trout management.

Fish culture provides a management tool for fisheries management biologists. Cultured fish are used to create and maintain fishing opportunities. Many fishermen are not concerned about a fish's pedigree so these stocked fish can take pressure away from wild trout waters. Cultured fish are also used to re-establish wild and native trout populations after natural or man caused disturbances. Basically, fish culture provides fish when wild trout are not available. It then follows that management biologists need to define a wild trout.

This is a wild trout.... A symbol of strength, self-reliance and the ability to survive the harsh realities of a natural environment.

This is NOT a wild trout.... This fish symbolizes a reliance on man to guide him through a part or all of his life.

These caricatures provide a symbolic definition and imply wild trout require no help from man. This is not always true. Wild trout require varying degrees of management to remain wild under fishing pressure, development activities, agricultural uses, and general recreational uses. Management may be light in remote under-utilized areas or intense in easily accessible, popular waters. Remote areas may only require an occasional survey to make sure man has not done anything to hurt the population. Heavily used areas may require constant vigilance including creel surveys, population estimations, habitat surveys, and cooperative efforts with other resource agencies to make sure wild trout are heard from and protected.

Wild trout management requires a knowledge of what makes a trout wild (besides the opening caricatures). All of us here probably have similar ideas although skewed by our educational, professional, and recreational backgrounds. You will be hearing from these various backgrounds in this session as well as throughout the symposium.

I asked Wyoming Game and Fish Department fisheries biologist to define a wild trout. A synthesis of the biologist's definitions can be stated, "Any trout that spends its entire life in the wild regardless of the parent's origins". Wild trout will complete a life cycle on their

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own. Stocked fish may survive and eventually spawn but they still are not wild. Surviving eggs from stocked fish which hatch, mature, and finish their life in the natural environment ARE wild.

Some people mistakenly think wild trout and native trout are synonymous. Wild trout ARE NOT necessarily native trout. Wyoming has many good wild rainbow, brook, brown, and lake trout populations even though cutthroat trout are our only native trout. In the Bridger Wilderness Area alone we have about 500 lakes supporting trout populations last stocked between the 1920's and 1950's. Although not native, these species are wild.

Our department's fish culture system hatch and rear native trout for re-introduction into their native range. These native's are not wild trout. An example; two plants, one in 1979 and the other in 1987, provided native cutthroat trout to Sunrise Lake. These fish survived but because they originated in the hatchery they were not wild. These stocked cutthroat eventually spawned and the resulting off-spring survived to spawn and provide another generation. Surviving progeny of the original hatchery fish would be considered wild from a fish manager's view point.

To summarize, a fish manager considers a wild trout one that has completed an entire life cycle in its natural environment from egg until death. A wild trout's parents can be wild or stocked, native or exotic but able to survive and successfully reproduce in the natural world. A fish manager's job it to make sure wild trout remain wild in their natural environment. This means wild trout also need to be defined by their habitat.

This is a wild trout... (good habitat picture). This is NOT... (bad habitat picture). This may seem obvious to all of us here. But as a fish manager we deal with many publics that think as long as there is water in a stream or lake then trout will survive and reproduce.

A healthy riparian zone, good spawning areas, slack water and aquatic vegetation for fry habitat, undercut banks and deep pools for older trout, and unpolluted water are necessary for wild trout habitat. There are waters with a low wild trout population because they are limited by one or more of these features. This type of water usually requires stocking to support recreational fishing. Sometimes one or more limiting factors can be identified and "fixed" using habitat structures.

Limiting habitat features were identified on the upper Green River within the Bridger-Teton National Forest. Through a cooperative effort by the United States Forest Service, Wyoming Game and Fish Department, and Trout Unlimited approximately six river miles had structures placed in a area abused by tie-hacking activities. This activity was used by railroad companies to provide railroad ties to a destination approximately 100 miles downstream. Massive quantities of ties were collected during the winter months then flushed down the Green River during spring runoff. This left the river wide and shallow with little trout cover especially important bank cover areas. Good spawning sites were available but limited habitat allowed little natural recruitment. Stocking was necessary as fishing pressure increased.

The habitat improvement project consisted of boulder funnels, boulder clusters, and log and rock revetments. By far the most successful structure has been the log and rock revetments. Our population estimates have shown increases of 118 trout per mile to 463 trout per mile just 3 years after construction started. In fact some structures had only been completed one year prior to sampling. During our sampling we also observed an increase in aquatic vegetation along the back-water areas created by the log structures. Associated with this vegetation we observed an increase in young-of-the-year rainbow trout. As stated earlier there had always been good spawning areas, but the lack of good cover area for young trout restricted how many could stay in the area. When these structures become more established more young trout habitat should develop. The result should be less dependence on stocked trout and more on wild trout.

There are on-going discussions about the value, costs, and overall need for habitat structures. Structures can be misused. They are sometimes used to fix a problem created by poor habitat management practices. Proper resource management could allow a water to repair itself naturally in just a few years. Structures would not be necessary. But habitat can be so damaged from man's past activities (like tie-hacking on the Green River) that decades could go by before natural improvements occur. In the mean time we could lose a valuable wild trout fishery that may have existed with a little structure work. Manager's have to decide between structures and their associated costs to perpetuate a wild trout fishery, or no structures and the need to routinely stock fish. Budget limitations, man-power needs, and other management

issues may dictate the direction we go but helping a wild trout population should be chosen when possible.

Increased fishermen demands for wild trout has required special fishing regulations. Wild trout contribute to what many consider a quality experience. Fishermen will spend a lot of time and money to catch a wild trout. Special regulations can limit harvest and protect wild trout under increased fishing pressure. Some remote or under-utilized wild trout waters may not need special regulations since harvest does not affect the populations. Easily accessible and popular waters may need special regulations to maintain a viable wild population. As a management biologist it is our job to find out when regulations are necessary to maintain a wild population without additional stocking.

To make sure wild trout remain wild requires a broad educational program. As a fish manager we need to make sure people know what a wild trout is and its value. We have to show people that wild trout exist because of good quality habitat and protection of that habitat.

Stocked fish can create an illusion of stability in a natural system. Many fishermen using stocked waters have come to expect fish populations to remain the same from year to year. Climatic changes, erosional processes, and human disturbances affect wild trout recruitment. Wild trout populations may be high after a series of good water years but suddenly drop during the inevitable drought years. Everyone here probably accepts these fluctuations as a part of the natural system. But fish managers deal with many fisherman who find these fluctuations unacceptable. An educational program can explain a wild trout's value to these fishermen. Hopefully they will then accept the population swings. Education should also include the contribution of wild trout and their habitat to a quality fishing experience and a wild trout's importance as a water quality indicator.

To conclude, a fish manager's wild trout is wild because it lived its entire life in a natural environment. A wild trout can be an exotic or a native trout. A native trout is not wild if it came from a hatchery.

Fish culture can be used to supply fish to a water with little or no recruitment. This will provide fishing opportunities where none would have existed. Stocked waters can also take pressure away from wild trout waters. Fish culture can also be used to stock fish that will survive to spawn and produce off-spring which become wild trout.

Habitat defines a wild trout. Good habitat for all a trout's life stages is required. Managers should not balk at using structures if they can restore or perpetuate a wild population. Structures should only be used when natural recovery is slow and a wild population is jeopardized.

Wild trout require management. This may be minimal in remote areas or intensive in accessible and popular waters under a threat from a multitude of development activities. Management includes habitat protection, fishing regulations, and education.

For a fisheries manager THIS is a wild trout (picture of a wild trout in good habitat caught by a happy fisherman).

Why Wild Trout Matter

Ray J. White[1], Willa Nehlsen[2], and James R. Karr[3]

Abstract -- Fishery agencies increasingly manage for wild trout. Such management emphasizes habitat protection, tailors angling regulations to the productive capacities of waters, and isolates hatchery programs from wild trout populations. In quality stream environments, locally adapted wild trout survive and reproduce better than hatchery-produced trout because the hatchery environment selects for anatomical, physiological, and behavioral traits that are maladaptive when those fish are released. Hatchery trout can increase mortality of wild trout, and hatchery operations can degrade waters that harbor wild fish. Hatchery programs also often lead people to believe that causes of fishery decline have been averted. Thus, hatchery programs are justified only in carefully defined circumstances; for example, stocking usually should be viewed as a short-term option to restore extirpated populations or to create populations in new waters or where reproductive habitat is lacking. The energies of agencies will be more effective if focused to manage in broad ecological contexts rather than merely adjusting hatchery programs.

INTRODUCTION

A wild trout completes its life cycle without direct help from humans after hatching in a largely natural environment from eggs deposited there by its mother. Wild fish rear to maturity, spawn, and have offspring to produce the next generation of wild fish. Basically, wild trout matter because they are of far higher quality than trout that are bred and raised by humans.

Managing fisheries for fishers is a related reason why wild trout matter. Trout anglers, especially experienced trout anglers, hold wild fish in high esteem (Jackson 1989). At Wild Trout IV, Robert M. Jackson, Professor of Psychology at the University of Wisconsin–LaCrosse, sketched the results of his studies on trout anglers' motivations and satisfactions. The anglers value naturalness of setting more than catching fish, and as their experience grows, they place less value on harvest and more on the skills involved, the natural beauty of the trout, and the escape provided by water bodies that support wild trout. Tragically, we did not learn more from Jackson's insight because leukemia cut short his life and work in 1993. We dedicate this paper to the memory of Bob Jackson.

Jackson (1989) defined good management in part as "giving people what they want to the extent that the ecosystem can support it." He further sensed that experienced trout anglers would subscribe to a Leopold (1933) theorem that may incorporate economic as well as esthetic logic--"The recreational value of a head of game is inverse to the artificiality of its origin, and hence in a broad way to the intensiveness of the system of game management which produced it." A wild trout is the opposite of artificial.

The reasons for concern about wild trout go beyond the pleasure and economics of fishing. More than fishers benefit from the presence of

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wild trout. Hikers, birdwatchers, nature photographers, similar recreationists, and rural property owners also value wild trout at least indirectly because their pleasures in wild environments are not protected if the trout are not protected. Also, the connections between wild trout, watershed health, and water supply make wild trout important to all citizens.

Many human actions threaten the well-being of wild trout and their waters. Early efforts to solve the problem of declining fish populations centered on artificially rearing fish in hatcheries for release into the wild--rather than addressing the causative human actions. Huge stocking programs ensued, many of which persisted without evaluation. In the last decade or so scientists have increasingly scrutinized the soundness of stocking and the possibility that these programs constitute another of the human threats to wild fish. In 1992, the Oregon Trout organization sponsored a review of such studies to analyze influences of hatchery programs on wild trout and salmon; here we summarize components of that review as presented in a report to Oregon Trout (White et. al 1994).

SOME HISTORY

For most of the 130-some years of freshwater fishery management in North America, artificial fish breeding and stocking have dominated agency operations and philosophies. A shift toward managing for wild trout began perhaps 40 years ago when Alberta found low survival of hatchery cutthroat trout (*Oncorhynchus clarki*) in streams that had substantial wild populations (Miller 1954). That province ceased stream stocking and devoted hatchery production to lakes and reservoirs, where survival was generally better than in streams. In 1956, Yellowstone National Park halted its 60 years of massive stocking, therefter planting only in limited situations to restore native fishes (Varley 1981). In the 1970s, the Park set special angling regulations, allowing size and age structures of wild trout populations to improve. Wild-fish policies spread to other national parks.

In the 1960s, midwestern states such as Michigan and Wisconsin limited use of hatchery trout in streams that supported wild populations. They also increased efforts to improve habitat, and the opportunity for wild trout fishing expanded under these programs. Montana found in the 1970s that wild trout increased in streams where stocking was stopped (Vincent 1975, 1987). That state began stocking still waters only, thus establishing in its streams the largest wild trout program in the lower 48 states. In the 1980s, Pennsylvania and Maryland combined cessation of stocking with carefully formulated fishing regulations to produce increased populations of wild trout in many streams (White 1992b; Bachman 1994). Many other states and provinces undertook wild trout programs during the 1980s and early 1990s.

The increasingly restricted use of hatchery trout in streams did not necessarily reduce amounts produced in hatcheries; often they were put instead into lakes and reservoirs where reproductive habitat was poor or non-existent. Hatchery output increased in Maryland, even as many streams were converted to wild trout fisheries (Bachman 1994). Only 3.3% of Idaho's trout stream miles (850 of 26,000) are now stocked, whereas, three-fourths of "catchable" trout and almost all hatchery fry and fingerlings are released into lakes, ponds, and reservoirs (Van Vooren 1994). Only 135 of 4,694 Wyoming trout streams, including seven tailwaters, are stocked, and 85% of planted trout (a lesser percentage by weight) go into still waters (Wiley et al. 1993; Fowden 1994).

Despite the trend toward managing for wild trout, hatchery programs may still consume the lion's share of budgets in most fishery agencies. Stocking is a way for managers "in the trenches" to assuage demands for fishing in the short run, and in the West it is the only way to provide for fishing in many reservoirs and lakes (not that all naturally fishless lakes *should* have fish).

Strong concerns about the utility of hatchery programs have existed for over 100 years. The U.S. Fish Commission published a French communication forecasting that fish culturists "will expend a hundred millions of francs to obtain with difficulty a result which should be reached immediately and almost 'free of cost,' requiring merely some employees to execute the laws which are now little more regarded than

scarecrows" (Anonymous 1884). Later, John N. Cobb (1917), a federal scientist who was in 1919 to become first director of America's first fishery college at the University of Washington, warned that "[i]n some sections an almost idolatrous faith in the efficacy of artificial culture of fish for replenishing the ravages of man and animals is manifested, and nothing has done more harm than the prevalence of such an idea. . ." He repeated the warning in 1921 and 1930. As the numbers of agency biologists swelled in the 1950s, doubts about hatchery-based management grew. Especially in light of modern ecology and genetics, the questioning has recently increased from scientists, anglers, and others concerned about long-term maintenance of fish resources.

Why the longstanding doubt, the intensified criticism, and the change toward managing for wild fish? Below, we bring together in brief the findings of many studies that help explain the poor post-stocking performance of hatchery fish and the harm that stocking programs cause to wild fish. Not all or even most of the problems we describe are likely to apply simultaneously in a given situation. They should be regarded as things that *can* happen--also as things that *cannot* be completely avoided, no matter how hard we try to improve fish culture.

HOW HATCHERIES INFLUENCE HATCHERY TROUT

The physical, chemical, and biological environment in hatcheries differs markedly from the environments of wild fish. Trout that do well in hatcheries typically perform poorly after release into wild environments, especially streams. Inevitably, the artificial surroundings and experiences in a hatchery alter trout unfavorably for post-stocking survival and reproduction, although this domestication may improve them for fish farming. The disparity between wild and hatchery fish results from the biological phenomenon, adaptation (White 1992a)[4]. Hatchery trout are ill-adapted to perform in the wild because, in addition to the intentional and inadvertent selection that fish culturists do, the hatchery environment itself selects for *anatomical, physiological,* and *behavioral* features that make the fish especially suited to survive and reproduce in hatcheries. In contrast, wild trout have been naturally selected for survival and reproduction in a particular water body and are uniquely adapted to that local environment.

Anatomical Features

At least four forms of anatomical problems are known to arise in hatchery fish: inappropriate gross body proportions; malformed body parts (crippled fins, etc. from the nipping and disease infections in crowded hatchery containers); discoloration; and hyperbuoyancy. Hyperbuoyancy derives from obesity and gas bladder abnormalities. It accounts in part for the disadvantageous tendency of stocked trout to hover near the water surface. Other, more subtle anatomical problems likely remain to be discovered.

Physiological Features

Hatchery fish are less successful than wild fish in wild environments in at least nine ways relating to their physiology. They show poor traits of stamina, temperature tolerance, and stress resistance. They experience rapid decline in energy stores and high incidence of disease. Hatchery fish tend to have reduced abilities for coping with the normal variation in natural environments and with the infrequent natural catastrophes, such as droughts and cold snaps. For some species, delayed breeding in hatchery females occurs. Traditionally, fish culturists have paid most attention to the physiological problems, seeking solutions in disease control and nutrition.

Behavioral Features

The behavioral category encompasses some 10 to 15 problems, depending on how one lumps or splits them. Each of the problems involves a group of interrelated behaviors. Eight of the problem groups are well documented; the rest are probable but still speculative. Especially important are the complexes of aberrant behaviors

[4] *In a series entitled "Why Wild Fish Matter," obviously prompting the assignment to give the present, even more trout-focused paper.*

causing high vulnerability to predators; inept foraging; inappropriate habitat occupation; and breeding failure. Hatchery fish also have been found to waste energy in fast water, lack appropriate social behavior, have weak territorial behavior, exhibit social disorientation, and undergo much stress when placed in unfamiliar surroundings. Other complications involve abnormal tameness toward humans (and other predators?), hyperaggressiveness toward their own kind, and inappropriate timing of migrations. They cope poorly with changing seasons, especially winter, and are more vulnerable to angling than wild conspecifics.

Although the behavioral category of problems is apparently the largest, and although its components are severe and closely intertwined with the physiological and anatomical problems, post-stocking behavior has received little attention from hatchery personnel. The problems manifest themselves in natural waters--where fish culturists seldom venture--and can be hard to measure. Even when detected, behavioral problems are bothersome to solve, so may be ignored and left to play themselves out, hidden in streams, lakes, and oceans.

The anatomical, physiological, and behavioral differences of hatchery from wild trout can arise by genetic divergence (Currens, this volume) and can also be non-heritably induced by the hatchery environment (Swain et al. 1991). Genetics has been described as the ecological memory of a population--the way it fits itself into (adapts to) its environment better and better in each generation via heritable traits. Significant genetic divergence can occur in hatchery-produced populations just one generation removed from the wild (Reisenbichler and McIntyre 1977). A major cause is the act of selecting parent fish from the wild population to provide eggs and sperm. Because capturing wild fish in natural waters is difficult, taking practical numbers at practical times and places fails to encompass the full genetic variation of the wild, adapted population. Thus, variation in the hatchery stock will be narrower than in parent wild stock, and the hatchery stock will be less well adapted to withstanding or properly performing in a naturally diverse range of environmental conditions. Other aspects of hatchery operations cause further genetic divergence. If trout are hatchery-bred and -reared for repeated generations as "broodstocks," the divergence increases.

Some aberrant behavioral traits undoubtedly are based in genetics, but many must be of non-heritable kinds; that is, differently *learned* under wild and hatchery conditions. Learning, in contrast to inheritance, is a shorter-term, individual kind of response. Removing trout from their natural waters and placing them in the highly abnormal environments of hatcheries immediately disrupts learning processes essential to life in the wild, thus may be a major way that fish culture adversely changes trout. Learning ability itself has a genetic foundation and is probably changed by selection under hatchery conditions. Put simply, hatchery trout, among their other shortcomings, do not know how to behave properly in natural environments. This works to their own disadvantage and that of wild trout populations into which they are stocked.

HOW HATCHERY PROGRAMS AFFECT WILD TROUT

Programs of artificial propagation and stocking can affect wild populations in three major ways: hatchery fish interact, often negatively, with wild fish; hatchery facilities and operations can degrade waters that harbor wild fish; and hatchery programs influence people and human institutions.

Effects of Hatchery Fish on Wild Fish

The post-stocking influences of hatchery trout on wild trout are largely behavioral and are related to the traits that make them different. A positive effect of stocked fish buffering wild populations from harvest by absorbing fishing pressure is often hypothesized but can apply only if the stocking does not stimulate increased harvest of wild fish, as it often does (see mixed-stock harvest, below). The positive effect is usually overshadowed by negative influences.

Exotic introductions.--In the last 120 years or so, massive programs of artificial breeding and stocking created populations of wild exotic (non–

indigenous) fish in much of North America, many of them trout. The introductions were generally viewed as "improving" on nature to benefit people. If the transplantations resulted in self–reproducing populations, they were usually regarded as "successful" and advantageous, but some were soon recognized as detrimental.

The early fishery workers spread many North American fishes beyond their pre-Columbian ranges within the continent. However, transfers from overseas seldom took hold. Of many Old World fishes imported in the late 1800s, only two became permanently established as major populations. The Asian common carp (*Cyprinus carpio*), introduced in 1831 but not widely distributed until 1879, then rapidly attained pest status and became disastrous for many aquatic ecosystems. European brown trout (*Salmo trutta*), introduced in the 1880s, spread extensively and became a valued sport fish. However, it often supplanted indigenous brook trout (*Salvelinus fontinalis*) in eastern steams and did likewise with cutthroat and other trout in the West. Since the 1960s, intentional and accidental introductions from abroad have increased (Courtenay and Kohler 1986).

Intracontinental transplants also had ill effects. Brook trout ousted cutthroat trout from many western streams. Rainbow trout (*Oncorhynchus mykiss*), brought east from Pacific drainages, bred with cutthroat trout, hybridizing some kinds out of existence. Rainbow trout also probably competed with cutthroat trout, and they supplanted some brook trout populations in the East. Widespread planting of the Yellowstone cutthroat trout subspecies in the West led to decline of other forms of that fish. Recently, concern has risen about ineffectiveness and detriments from "outplanting" or "interbasin transfers," especially of anadromous salmonids, a form of exotic introduction (Reisenbichler 1984, 1988). Clearly, stocking exotic fishes can serve short–term ends but cause grief in the long run.

Genetic contamination and loss.--Excessive gene flow occurs by hybridization between species, as mentioned above. Also, interbreeding between hatchery and wild conspecifics transfers undesirable traits that arise in hatcheries from selection and from loss of genetic variation, or that derive from distant stocks used to provide eggs or sperm for hatcheries.

Predation.--Hatchery trout can eat wild ones if they are stocked at or grow to sufficient size. But it is uncertain whether predation by recently-stocked salmonids often occurs, even where the capacity for it seems to exist (e.g., yearlings or 2-year-olds imposed on age-0 wild trout). Predation studies are difficult and seldom done. Much speculation about severe predation by newly-stocked salmonids is based on just one study (Sholes and Hallock 1979). Obviously, stocking northern pike (*Esox lucius*) and other large piscivores in trout waters is a mistake. Predation by hatchery trout may be a lesser problem than their competition with and social disruption of wild trout.

Competition.--Organisms compete when a resource that each needs is in short supply relative to the combined needs of the organisms. The needed resource might be space per se, food, mates, or sites for feeding, resting, reproduction, or refuge from enemies. In a trout stream, hiding cover, food, and space can be in very short supply for the population during low flow periods, especially those occurring in the growing season, the time of high demand for resources.

The more alike two animals (or kinds of animals) are, the more similar their needs, and the stiffer the competition between them is likely to be. Thus, intraspecific competition may often be more intense than interspecific competition. Closely related species that evolved together (after the isolation that made them different), such as coho salmon (*Oncorhynchus kisutch*) and steelhead (*O. mykiss*) in west coast streams, both thrive in the same water body by using different microhabitats and/or foods, especially during times of short supply. Because salmonids as a group tend (with exceptions) to have similar needs, stocking hatchery salmonids among wild ones risks adverse results. And because conspecifics are likely to have almost identical needs, the risk of ineffectiveness or harm is especially high when we try to bolster a population by stocking more of the same species.

Thus, strong intraspecific competition may explain differential success between the three

general types of stocking: *Introduction* of new kinds of fish has been the most effective (re immediate objectives of creating fisheries); *maintenance* of populations by repeated stocking where no natural reproduction can occur has been of intermediate efficacy, and *supplementation* of self-reproducing populations by injecting conspecifics has been least successful (Laarman 1978). Supplementation is often unneeded and can intensify intraspecific competition, decreasing the wild populations it is intended to augment (Vincent 1987; Evans and Willox 1991). It can particularly disadvantage wild trout when hatchery stock of the same or a more aggressive species is interplanted at the same or larger size.

Maladaptive social disruption.--Hatchery trout stocked into wild populations can cause chaos simply by inadvertently moving around in bothersome ways and being in inappropriate places. This could be called the new-freshman-on-campus syndrome. It is not really competition because the stocked fish are probably more confused than purposefully seeking a resource. In one study, newly-planted hatchery brown trout ventured aimlessly into established territories of wild brown trout, and the territory holders wasted energy chasing them away (Bachman 1984). Also, hatchery salmonids exert excessive (Moyle 1969; Swain and Riddell 1990, 1991; Mesa 1991) and misdirected (Bachman 1984) aggression, which must adversely affect wild trout among which they are stocked.

The "Pied-Piper" effect.--In wild migratory populations, the injection of hatchery young that migrate downstream before the wild young are biologically ready to do so can induce detrimentally premature migration (Hansen and Jonsson 1985).

Suppression of normal behavior.--Hatchery fish are usually stocked at local densities far exceeding those in nature. Such crowding can suppress the normal behavior of other fishes (Stringer 1952, cited in Fraser 1969).

Mixed-stock harvest.--When many hatchery fish mix with far fewer wild fish, and fishing regulations are set for harvest at rates suited to the relatively strong hatchery stock (or to the combined stock), harvest is likely to be excessive on the weaker wild stock. This is common in the Pacific Northwest's commercial salmon fisheries but can be a risk wherever hatchery and wild stocks mix and fishing pressure is intense.

Predator attraction.--Stocking hatchery fish in abnormal density provides an increased prey abundance that can attract abnormal numbers of predators, and the hyperaggressive behavior of hatchery fish can be a further attraction. As in the mixed-stock fishery problem, this can cause excessive predation on wild fish (reviewed by Rosenau and McPhail 1987).

Disease transmission.--The crowded, stressful conditions of hatcheries make them ideal places for fish diseases to thrive. Diseases brought to natural waters by stocking can certainly affect wild trout.

Effects of Facilities and Operations

Reduced water quality.--Effluent water from hatcheries can contain harmful chemicals and may adversely change the temperature of receiving waters.

Disease contamination.--Hatchery effluents may often contain disease organisms.

Diminished stream flow.--Diversions to supply hatcheries with water can reduce flow in the tapped streams.

Other habitat destruction.--If, for hatcheries and their operations, streams are dammed or channelized, or riparian zones are built upon or otherwise disrupted, habitat for wild trout may be harmed.

Interference with wild fish movement and spawning.--Hatchery water diversion structures can hamper migrations and other movement of wild fish, as can weirs built to trap hatchery adults for spawning. At some anadromous salmonid hatcheries, wild spawners are deliberately blocked from upstream migration beyond the water intake for fear they will contaminate the water supply with pathogens.

Up-river nutrient depletion.--Impeding adult salmon migration at hatcheries can also prevent upstream fertilization by their carcasses, thus reducing natural productive capacity of streams for trout and salmon.

Robbing of wild spawners.--Taking wild spawners for hatchery egg supplies can reduce

wild populations in streams. This problem is common in Pacific salmon culture and can occur in similar operations with other salmonids.

Effects on People and Institutions

False sense of security.--Presence of hatchery programs can falsely lead the public and decision-makers to believe that healthy fisheries exist, that everything is OK when it is not (Goodman 1990). This promotes complacency about protecting habitat and controlling harvest.

Diversion of funds from activities that benefit wild trout.--The long-term payoff from addressing habitat destruction and overfishing, which are the core causes of wild fish decline would be far greater than from stocking. But inertia and short-term pressures are great, so hatchery programs still probably outcompete habitat programs for funding in most fishery agencies.

REFORM TOWARD WILD TROUT EMPHASIS

Righting the problems of the long overemphasis of stocking will require revamping overall fishery management to focus on managing ecologically for wild fish, not mere reengineering of hatchery facilities and operations. This will mean managing human activities more than managing fish. Some states and provinces are already well along in such reorientation. For example, British Columbia has adopted conservation of wild fish and maintenance of their habitat as its fishery program's top priorities and has strategies for meeting those objectives (Taylor, this volume). Others are moving strongly in that direction, as reviewed above. Still, some agencies seem more concerned with perpetuating hatcheries than with managing ecologically for the integrity of aquatic ecosystems (Karr 1991).

Managing for wild trout is necessarily habitat-based. Protection of existing good habitat from human abuse is the first priority. Protecting against overharvest and harm from hatchery programs is fundamental, as well. *Restoring* degraded habitat can also be important.

Much of the public does not realize the potential that exists for repairing damaged trout streams. It is best done by reducing the causative human problems, then letting nature regenerate normal stream features via plant regrowth, water current, and sediment redistribution. In many situations, major benefits happen naturally in one to five years. Under some conditions, however, natural recovery is much slower, and human rebuilding of stream structure may be warranted. For example, channelized streams often show little improvement after many decades and must be diverted back into their previous meanders--or new meandering courses must be dug--if they are again to support healthy trout populations. Other streams have not healed from log or railroad tie drives after more than a century and need special treatment. Such restoration can become a priority in endangered-species situations, where fast recovery is essential. Stream restoration should never be undertaken without guidance of well-qualified professionals.

BETTER USES OF HATCHERIES AND STOCKING

Examining the many adverse effects of fish hatcheries and stocking helps to define their proper uses. Given certain local conditions, management objectives, and willingness of beneficiaries to bear the expense, some kinds of hatchery program are appropriate. One type is the "rescue hatchery" for endangered species; indigenous fishes are saved from imminent extirpation by capturing and breeding them artificially, then recolonizing offspring into the waters from which human activities threatened to eliminate them--after significantly reducing the abuse. (This limited hatchery function justifies neither human actions that endanger species nor hatchery programs in general.)

Three other kinds of stocking, usually to provide for fishing in waters where none would otherwise exist, will not directly harm wild trout if done such that the hatchery fish cannot mix with them: (1) colonizing self-reproducing trout populations into newly-constructed waters, such as reservoirs; (2) "put-and-*grow*" planting with young trout which in several months or a year will reach desirable size (and appearance) for fishing in artificial or irreparably damaged waters that lack spawning habitat but have substantial

productive capacity; and (3) "put-and-*take*" stocking of harvestable-sized trout for quick recreation. Put-and-take is often uneconomical (Johnson et al. in press). It is also low in desirability because the trout and the situation are highly unnatural, and the recently-stocked trout caught in such programs still have the shabby appearance (dull color, misshapen fins) acquired in the hatchery.

All stocking, but put-and-take in particular, can send illusory messages that hatcheries are *the* source of trout, thus influence public attitudes unfavorably toward ecologically sound management. Therefore, education about wild fish should counterbalance the stocking message. Even a hatchery run for beneficial purposes presents danger of misuse as long as the facility exists. Like a loaded gun lying on a park bench, it offers tremendous potential for abuse. Temptations will be strong to use it in politically expedient (or simply convenient) but ecologically irresponsible ways. Unauthorized stocking by overzealous hatchery personnel is one form of this that has created problems.

SEPARATION OF WILD AND HATCHERY PROGRAMS

A key to success in the movement of state and provincial agencies toward greater emphasis on wild fish is *geographic separation* of stocking pro-grams from management for wild fish. This is much easier with salmonids that stay in small areas than with those that range widely. Simultaneously managing for wild and hatchery "resident" trout in different nearby but isolated water bodies, such as lakes or small streams protected from immigrant fish by waterfalls or other barriers can be simple. But to segregate wild and hatchery *migratory* salmonids in extensive, contiguous coldwater river–and–sea systems is almost impossible. By virtue of the complexity and geographic extensiveness of their life cycles, managing for sea-run salmon is very difficult (White in press).

That life-cycle complexity is central to the salmon dilemma in the Pacific Northwest--and to the 200-year-old one for Atlantic salmon. In the Northwest, the world's most massive system of hatcheries was erected in an effort to offset drastic decline in the world's once most magnificent assemblage of migratory salmonid stocks--a decline caused mainly by the many things people do to alter original landscapes and the streams that drain them. In Washington state, over 120 major state, federal, and tribal hatcheries exist, and the number is rising. Most of these are intended to compensate for the destruction of runs by the Columbia River's system of hydroelectric dams and reservoirs. Over 150 smaller facilities, operated mainly by volunteer groups, augment the main hatcheries. Major salmon hatchery programs exist in all the other Northwest states, and all operate essentially by stocking in waters that are home to wild salmon.

As that system grew, greatly expanding its production in the 1960s and -70s, and plateauing in the 1980s--at an annual output in Washington alone far exceeding by weight that of the entire U.S. federal hatchery system--the worst salmon crisis in the Northwest's history developed. Runs of hatchery-produced salmon are generally depressed, and many locally adapted wild anadromous salmonid stocks are at all-time lows, not counting over 100 already extirpated (Nehlsen et al. 1991). Four stocks have come under Endangered Species Act protection, and more are candidates for it. As a result, almost the entire commercial and sport fishery for salmon along the Oregon-Washington coast was closed during 1994 for the first time in history. That's what we got for betting on hatcheries and injecting their fish into wild populations--instead of attending to habitat matters and proper harvest control.

The Northeast also greatly expanded its Atlantic salmon hatchery system in the last 20 years to try to restore long-defunct runs. Results have been dismal, and some biologists and conservationists point out that, although some stocking is needed to recolonize rivers, most hatchery funds would be better spent to increase the habitat restoration component of the recovery program, importantly by alleviating problems that some of the region's 10,000 dams cause.

CONCLUSION

The Northeast and Northwest salmon crises vividly illustrate the consequences of inattention to wild salmonids. In contrast, rebounding wild

trout resources resulting from enlightened management in the East (Graff, this volume), Midwest (Hunt, this volume) and Northern Rocky Mountain (Vincent 1991; VanVooren 1994) regions are beacons of success. The examples at both extremes should spur us to expand wild salmonid programs. The main approach must be protection and restoration of healthy ecosystems (Doppelt at al. 1993). The outcome should be better preservation of what we have left and--given adequate control of human population and technology--wider opportunity to enjoy wild trout in natural settings.

Wild trout matter not just biologically and economically, they matter also culturally: for the values and outlooks that many anglers and others hold concerning nature and what constitutes worthwhile recreation. Wild trout represent what nature really is. To fish for them and among them, or simply to observe them, is to have a genuine experience in and with nature--which, in this era so characterized by lack of genuineness, matters. And that's a *big* reason why wild trout matter. We think Bob Jackson would agree.

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Angler Satisfaction with the Number and Size of Trout Caught at Hot Creek, California

John M. Deinstadt[1] and M. Ralph Carpenter[2]

Relationships between angler satisfaction with the number and size of trout and the catch were evaluated. Voluntarily returned survey forms, collected over a 10-year period at Hot Creek, a popular catch-and-release wild trout stream, served as the database. Anglers highly satisfied with the number of trout caught at Hot Creek averaged 10.7 trout/day (2.52 trout/hour). The mean length of trout landed by anglers highly satisfied with the size caught was 12.1 inches. When the number caught was an independent variable, the number of trout/day required to satisfy anglers remained fairly constant over the 10 seasons. Mean lengths associated with a high satisfaction for size increased during the first half of the study and then stabilized. Trends in satisfaction with the overall angling experience were more closely related to satisfaction with the number of trout caught than with the size caught. Potential uses of the findings included improving the basis for selecting bag and size limits and developing satisfaction indexes for various classes of trout waters.

INTRODUCTION

When anglers fish one of their favorite waters they usually arrive with expectations of the fishing conditions and success they will experience. These expectations may vary with the time of year, an angler's prior experiences, and the type of water fished. If their expectations are fulfilled, anglers are satisfied with their time on the water (Carpenter, Deinstadt, and Bowlus 1977). If not, they may express differing degrees of dissatisfaction. Fisheries biologists have measured satisfaction levels, usually in conjunction with creel censuses, to gain insights into the success of their management programs.

California is currently monitoring angling success and satisfaction on about 40 designated "wild trout waters" with voluntary response forms distributed through angler survey boxes. The survey instrument closely parallels the angler survey card used for many years in Yellowstone National Park (Carty 1994). Included on the forms are three questions regarding satisfaction with the number of trout caught, size of trout caught, and overall angling experience.

At the outset of the angler survey box program, we thought that questions on angler satisfaction should provide more than just general insights into the success of management programs. One of the studies underway to examine this possibility is an evaluation of the relationships between the number and sizes of trout caught and their accompanying satisfaction ratings. The largest database available in California for this evaluation was from Hot Creek. This report covers part of that evaluation. Specific objectives research: (1) the number and sizes of trout needed to produce moderate to

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high satisfaction ratings; (2) how variable these ratings were during the study period; and (3) how these ratings may be used to complement other survey data.

DESCRIPTION OF THE STUDY AREA

Hot Creek, one of California's best known wild trout fisheries, is located in the east-central Sierra Nevada area about 10 miles east of the community of Mammoth Lakes. The study area, flowing through a shallow gorge, is just under one mile in length and has an average width of 33 feet. The study section is a relatively low gradient, shallow reach with few pools. A combination of spring flow, cover provided by extensive beds of rooted aquatic plants, and ice-free winter conditions creates one of the most productive trout streams in California. Though rainbow trout often comprise a significant part of the catch, brown trout comprise most of the stream's fish population. Angling is restricted to flies-only.

Since 1973, Hot Creek has been used as an experimental wild trout stream by the California Department of Fish and Game. Current studies center around a long-term evaluation of changes resulting from establishing a catch-and-release only (zero-limit) fishery. From the third to the seventh year after these studies began in 1982, the portion of the catch comprised of trout ≥12 inches increased from 19% to 45% (Figure 1). The size structure of the catch remained fairly stable from 1989 through 1991 (Figure 2). In 1992, following the almost total loss of the 1991 brown trout year class, the percentage of ≥12 inch trout in the catch increased to a high of 65% (Figure 1). In 1993 the percentage of

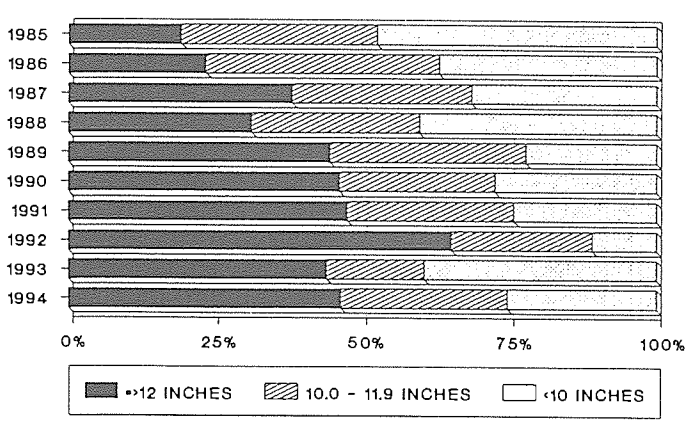

Figure 1.——Lengths of trout caught in Hot Creek during the 1985-1994 seasons based on volunteer surveys.

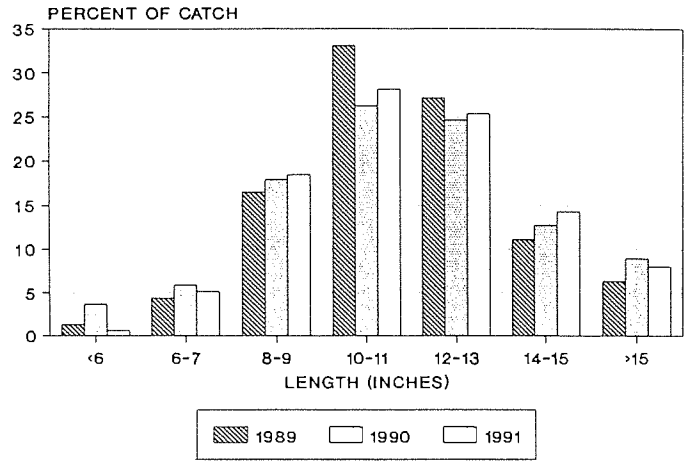

Figure 2.——Length frequencies of the trout caught at Hot Creek during the 1989-1991 seasons based on volunteer surveys.

trout <10 inches increased to a six-year high and the percentage of trout 10.0 to 11.9 decreased to a 10-year low. In 1994 the overall size structure of the catch returned to about that present during 1989 through 1991 seasons.

The mean number of trout/angler day decreased from a high of 10.7 in 1985 to 5.4 in 1989 (Figure 3). Trout/

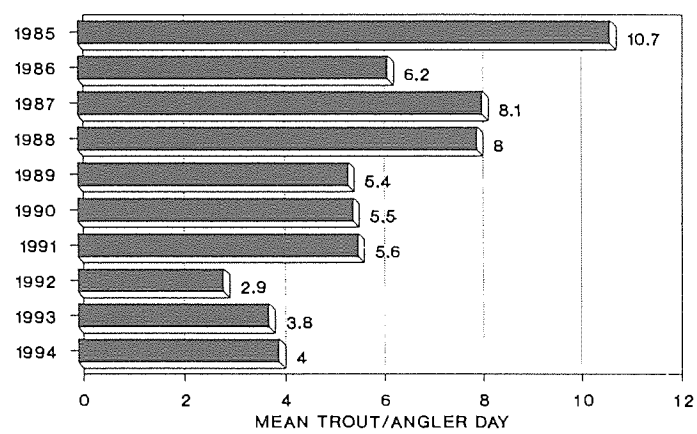

Figure 3.——Mean number of trout/angler day caught at Hot Creek during the 1985-1994 seasons based on volunteer surveys.

angler day remained almost stable from 1989 through 1991, then decreased in association with the loss of the 1991 brown trout year class. In 1993 and 1994, there was a partial recovery in the number of trout/angler day. Mean catch rates during the study followed a similar pattern decreasing from 2.50 trout/hour in 1985 to 0.94 trout/hour in 1992, then recovering to 1.31 trout/hour in 1994. During the more stable 1989 to 1991 seasons, catch rates ranged from 1.30 to 1.36 trout/hour.

STUDY METHODS

Information collected from voluntarily returned forms distributed at Hot Creek either as mail-in surveys placed on the windshields of angler vehicles or as angler box surveys provided the database for this study. Anglers completed 4,035 forms (230 to 703/season) during the 10-year study period ending on August 31, 1994. Information received from individual anglers at the end of their fishing day included the date, hours fished, number and lengths of brown and rainbow trout released, and ratings for satisfaction with their overall angling experience, size of trout, and number of trout. Ratings were scaled -2 and -1 (not satisfied), 0 (neutral), and +1 and +2 (satisfied) (Deinstadt, Lentz, Sibbald, and Murphy 1993). In this report, +1 is considered moderately satisfied and +2 highly satisfied. Results on angler satisfaction with the number of trout caught/day are based on an average of the annual mean values over the 10-year study period.

Lengths of trout released were reported as <6 inches, 6.0 to 7.9, 8.0 to 9.9, etc. up to 17 inches, and then ≥18 inches. Mean lengths for the ratings on satisfaction with size were calculated using 5 inches as the mid-point for trout <6 inches, 19 inches as the mid-point for trout ≥18 inches, and the actual mid-points of each 2-inch group. Results presented on satisfaction for the size of trout caught are limited to successful anglers only.

SATISFACTION WITH THE NUMBER OF TROUT CAUGHT

Anglers rating their satisfaction low (-2) for the number of trout caught averaged 1.4 fish/day (Figure 4).

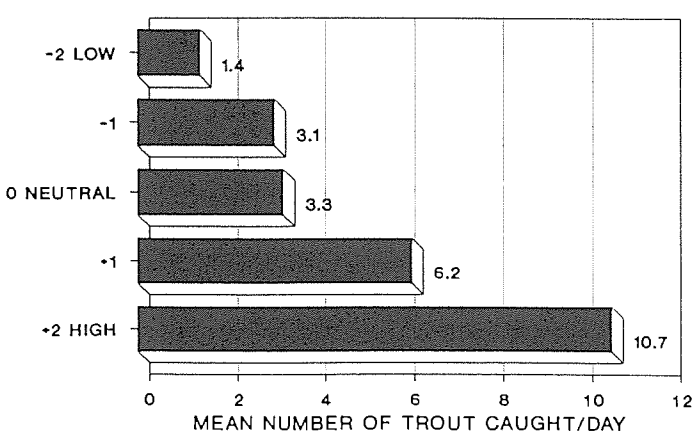

Figure 4.——Satisfaction with the number of trout caught vs. the mean number of trout landed/day at Hot Creek over 10 seasons.

Anglers rating their satisfaction high (+2) averaged 10.7 trout/day. Corresponding low and high values for catch rates were 0.38 and 2.52 trout/hour. Anglers fished an average of 3.9 hours/day during the study.

Comparing the satisfaction levels for anglers who caught and released from zero to five trout/day, the majority of the unsuccessful anglers reported their satisfaction for the number of trout caught with a minus value (Figure 5). Forty-two percent of these anglers

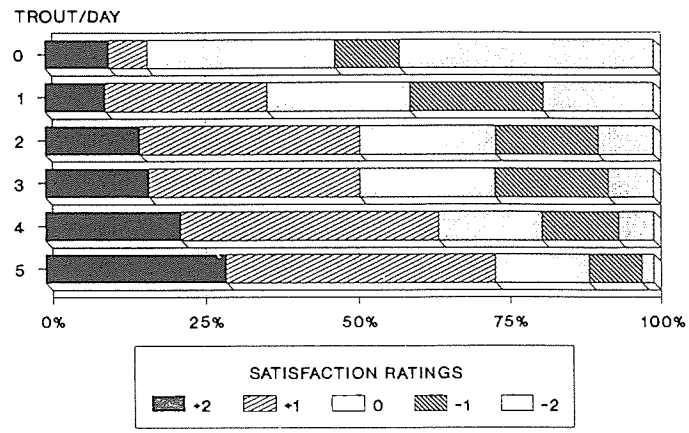

Figure 5.——Satisfaction ratings for the number of trout (zero to five) vs. the number of trout caught/angler day at Hot Creek over 10 seasons.

responded with a -2 rating, while 11%, despite their failure to land any trout, responded with a +2 rating. For anglers landing one trout the -2 ratings decreased to 18%, but the +2 ratings remain unchanged. There was little difference between satisfaction ratings for anglers landing two or three trout. Slightly more than 50% of these anglers, however, gave their satisfaction with the number of trout caught a plus rating. When anglers landed five trout, very few responded with a -2 rating. The +2 rating increased to about 25% and the combined +1 and +2 ratings increased to just under 75%.

In an effort to identify when the majority of Hot Creek anglers gave satisfaction with the number of trout caught/day a +2 rating, catch data were combined into five fish groups (Figure 6). When the values for catches of one to five trout/day were combined, the +2 rating was 17%. With six to 10 trout, the +2 rating increased to 36%. At 11 to 15 trout/day, a +2 rating reached a little over 50%. Slightly less than 75% of the anglers responded with a +2 rating when they caught over 15 trout/day.

When +1 and +2 ratings are combined, about 50% of the anglers are satisfied with catches of one to five

trout/day (Figure 6). Over 75% of the anglers were satisfied when they caught six to 10 trout. Even a catch of over 15 trout/day did not, however, satisfy all of the Hot Creek anglers.

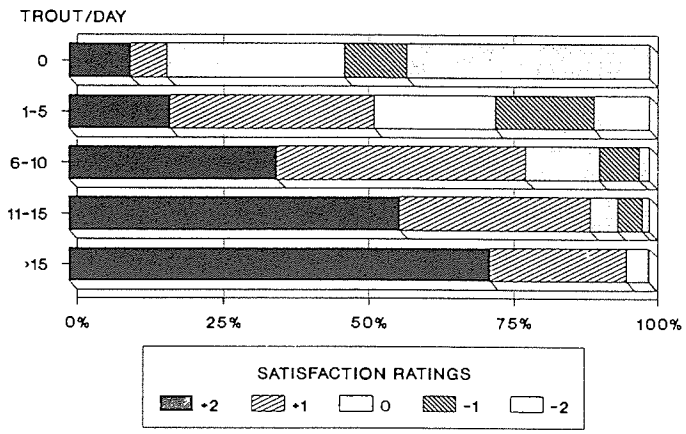

Figure 6.——Satisfaction ratings for the number of trout (zero to >15) vs. the number of trout caught/angler day at Hot Creek over 10 season.

In evaluating potential variability in the ratings over the 10 seasons, data on the relationship between satisfaction with the number caught and the number caught were examined. When the number of trout caught was the independent variable, trends in the five ratings (based on their means/season) showed little upward or downward movement (Figure 7). The crossing over of values which occurred for catches of 11 to 15 trout/day and >15 trout/day in 1993 and 1994 is attributable more to sample size than an actual change in angler expectations.

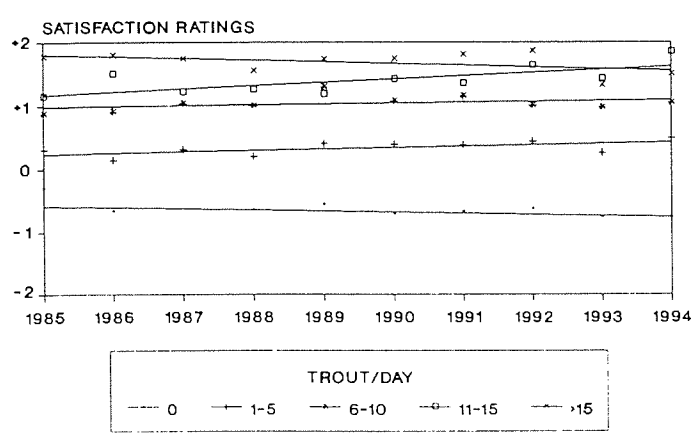

Figure 7.——Trends in the satisfaction ratings for the number of trout caught/day at Hot Creek during the 1985-1994 seasons.

SATISFACTION WITH THE SIZE OF TROUT CAUGHT

Over the 10 seasons, the average length of trout released by anglers giving satisfaction with the size of trout caught a -2 rating was calculated at 9.6 inches (Figure 8). The average length of trout reported by those rating their satisfaction with size a +2 was 12.1 inches.

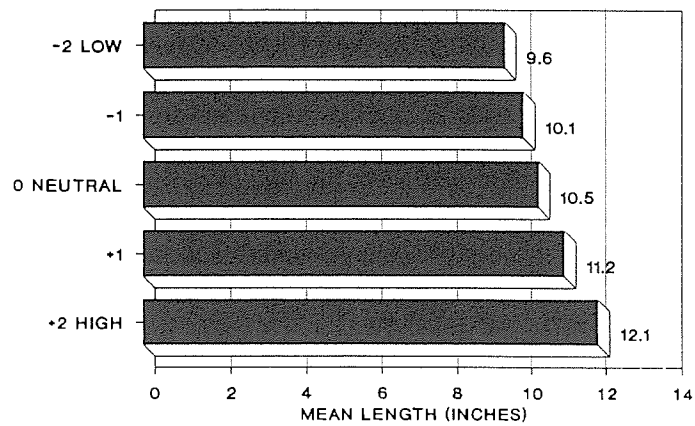

Figure 8.——Satisfaction with the size of trout caught vs. the mean lengths of trout Hot Creek anglers reported catching over 10 seasons.

The mean lengths of trout reported by anglers giving satisfaction with size a +2 rating increased from 10.8 inches in 1985 to 12.4 inches in 1989 (Figure 9). These

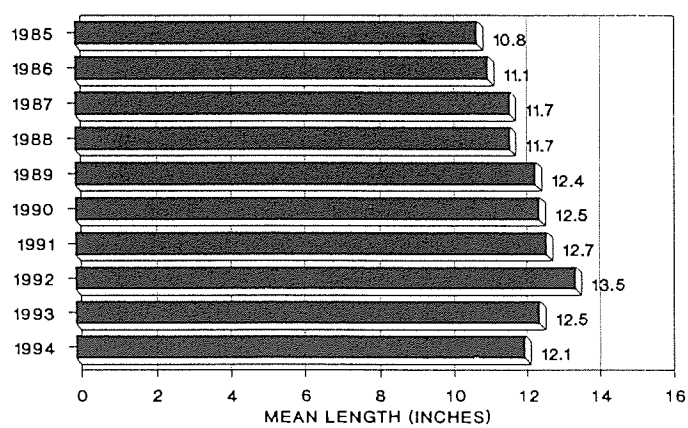

Figure 9.——Mean lengths of trout reported by Hot Creek anglers rating their satisfaction with size a +2 during the 1985-1994 seasons.

data strongly indicate that during the first five years of the study, the mean length of trout associated with +2 ratings was not constant, but increased as the percentage of larger trout in the catch increased (Figure 1). However, this trend, with one exception, changed sharply

during the last half of the study. The mean lengths of trout in the +2 category, with that one exception, varied only 0.6 inches in length from 1989 to 1994. That exception, in 1992, was produced by the absence of the age 1 year class which artificially shifted the mean size for trout upward.

As an alternative method of studying the relationship between satisfaction with size and the catch, the number of ≥12-inch trout caught by successful anglers was examined. When anglers caught one trout ≥12 inches, +2 ratings increased from 10% to 27% (Figure 10). If

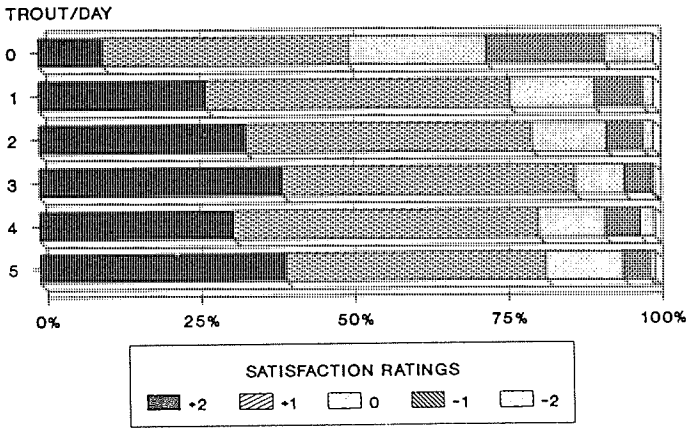

Figure 10.——Satisfaction with the size of trout landed vs. the number of trout ≥12 inches caught/day at Hot Creek over 10 seasons.

+1 and +2 ratings are combined for this group of anglers, the ratings increase from about 50% to 75%. When the number of ≥12-inch trout caught increased from one to five, +2 ratings increased irregularly to 40%. The combined +1 and +2 ratings for the increase from one to five trout, however, gained little. Therefore, landing one ≥12-inch trout made an appreciable difference which was not greatly enhanced by two to five additional large trout.

NUMBER, SIZE, AND OVERALL ANGLING EXPERIENCE

The relationship between satisfaction with the number and size of trout caught and the overall angling experience was examined to determine if Hot Creek anglers considered number or size more important. During the first half of the study there was a steady upward trend in angler satisfaction with the size of trout landed (Figure 11). There did not appear, between 1985 and 1989, to be any major upward or downward trend in

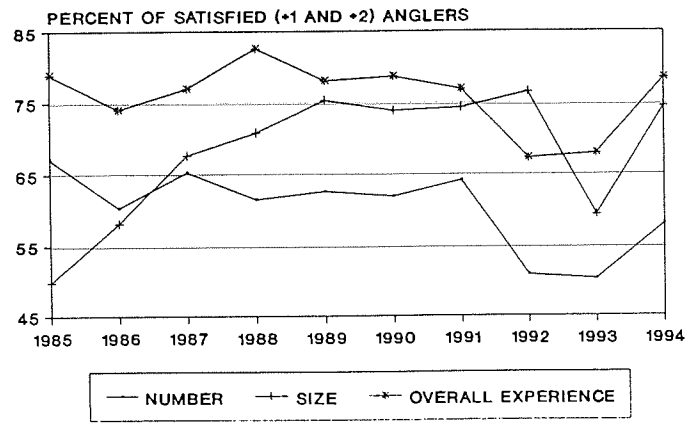

Figure 11.——Relationship between satisfaction with the number and size of trout caught and the overall angling experience at Hot Creek during the 1985-1994 seasons.

satisfaction with the number of trout caught or in the overall angling experience. From 1989 through 1991, all three satisfaction factors appeared to be in equilibrium.

Satisfaction with the number of trout caught, due to the failure of the 1991 brown trout year class, decreased sharply in 1992 (Figure 11). Due to the highest percentage of ≥12-inch trout recorded in the catch during the study, satisfaction with the size caught remained high in 1992 (Figures 9 and 11). Overall satisfaction with the angling experience was not, however, maintained by the greater percentage of large fish in 1992, but followed the sharp decrease recorded for satisfaction with the number caught. With the higher percentage of <10-inch trout entering the fishery in 1993, satisfaction with size also declined sharply (Figure 1). During the 1993 season, satisfaction with the number caught and overall angling experience remained almost unchanged. With an improvement in catch rates in 1994, both of these ratings increased.

Based primarily on the changes that occurred following the failure of the 1991 year class and, secondarily, to the apparent lack of a strong response to five years of steady increases in satisfaction with size, the number rather than the size of trout caught was concluded to have been more important to Hot Creek anglers.

DISCUSSION

Two variables occurring during this study were considered important. First, is the already described

change in the fishery. Accompanying the experimental catch-and-release angling regulation, there was a major change in both the number and size of trout caught. Second, there was a change in the anglers being sampled. Though data were not collected to support this observation, it is recognized that many of the anglers now fishing Hot Creek were not fishing the stream a decade ago. Though not a variable, it is also recognized that there was an exceptionally wide range in the expectations of Hot Creek anglers. Some were not satisfied with 15 or better trout days. Others, not landing a single trout, reported a high level of satisfaction with the number of trout caught. Despite these variables and differences, Hot Creek anglers, as a group, were consistent in the number of trout they expected to catch/day during the past decade.

The sliding scale observed for a high satisfaction rating with the size of trout caught may not have occurred if the study had been conducted after the trout population had stabilized. Most fisheries do not undergo such major shifts in size structure. Data from five of the last six years of the study show that, in the absence of this shift, Hot Creek anglers also had consistent standards for the size of trout they expected to catch (Figures 1 and 9).

Though the relationship was not examined during the study, it seems probable that satisfaction with the size and number of trout caught are not independent. When larger trout are available, anglers are probably satisfied with fewer landings. However, based on the sharp drop which occurred in satisfaction with the number of trout caught in 1992, there appear to be limits on how few fish, despite their size, anglers will accept.

MANAGEMENT APPLICATIONS OF SATISFACTION RATINGS

In California, the special angling regulations used on wild trout waters have been established using a combination of biological data (growth and survival rates) and angling data (projected effort or catch). Satisfaction ratings, or something similar, have not been used. If the findings at other waters are similar to those at Hot Creek, a 12-inch minimum size limit may be not only biologically desirable, but also a socially sound criteria. If the slight difference between satisfaction with two and three trout landed/day is common to other fisheries, the choice of a two-trout limit, now used on many California wild trout waters, gains some added credibility. Recognizing again that, to some degree, angler expectations for each water are unique, it is anticipated that useful "satisfaction indexes" will emerge with further analysis of available databases.

ACKNOWLEDGEMENTS

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Impacts of Historic Land Use on Trout Habitat in the Southern Appalachians

C. Andrew Dolloff[1]

Land use has had a major impact on habitat structure in the Southern Appalachians. One of the most conspicuous changes has been the loss of large woody debris (LWD). Human use has so changed the structure and composition of most forested watersheds that it is difficult for average citizens to understand why LWD matters. Research is underway to determine the effect of adding LWD on trout,trout habitat, and macroinvertebrates in two southwest Virginia streams.

Trout in the Southeast depend upon the continuous supply of high quality water and habitat provided by streams originating in the Appalachian Mountains. Historically, much of the land over which many Appalachian streams flow has been used for a variety of purposes including timber production, livestock grazing and other agricultural activities, mining, and recreation (Mastran and Lowerre 1983). During the past 100 years in particular, the combination of intensive land use, exploitive fishing, and deliberate introduction of exotic species has greatly altered stream ecosystems.

The most direct way to determine the structure and function of undisturbed trout habitats is to locate and survey habitat types and the sequencing of habitat units in pristine streams. Unfortunately, few streams in the eastern United States are in a pristine condition. As an alternative, a conceptual model of undisturbed streams can be constructed from careful analysis of the historical record. Coupled with present day descriptions of land use and habitat condition, knowledge of the probable undisturbed condition gained through a historical reconstruction should enable managers to suggest appropriate rehabilitative or enhancement measures.

Limited available historical evidence suggests that stream habitats in the Southeast, like those in other parts of the country (Sedell and Luchessa 1981), were structurally more complex than at present. Larger stream channels were cleared to provide corridors for transportation, and the demand for homesteads, agriculture, and mining lead to the clearing of forests and abuse of small streams in the southern Appalachians (Mastran and Lowerre 1983). Although most of the easily exploited forest in the southeastern U.S. had already been cut by 1880, vast reserves of high quality timber remained deep in the southern mountains. Over 20,000 square miles of forest lay mostly untouched in Kentucky alone, all within easy reach of the Mississippi and its numerous tributaries (Sargent 1884). Early loggers depended on streams to expedite transportation of logs to sawmills (Anonymous 1912; Scalf 1966). As timber supplies from readily accessible lowlands adjacent to larger rivers were exploited, lumber companies pushed into the mountains where they "improved" numerous streams for log transportation (Clark 1981).

Splash dams were built across many Appalachian mountain streams (Figure 1).

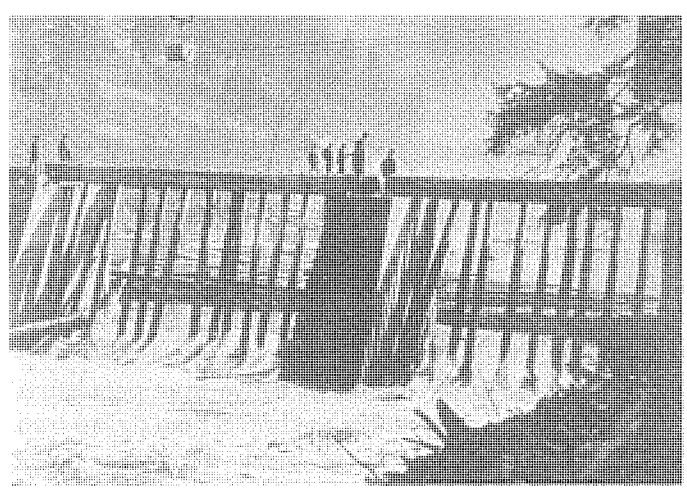

Figure 1. - Splash dam erected about 1910 on the Russell Fork Big Sandy River, Southwest Virginia.

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Logs were piled in the stream and when sufficient volumes of water were backed up, the dams were breached. Logs and anything else in the channel were flushed downstream with the ensuing torrent. In later years, railroad grades and roads were constructed along the contours of hillslopes and all too often in the stream channels where they displaced riparian vegetation, contributed excessive amounts of sediments, removed stable accumulations of woody debris, and ultimately decreased the complexity of habitat structure (Figure 2).

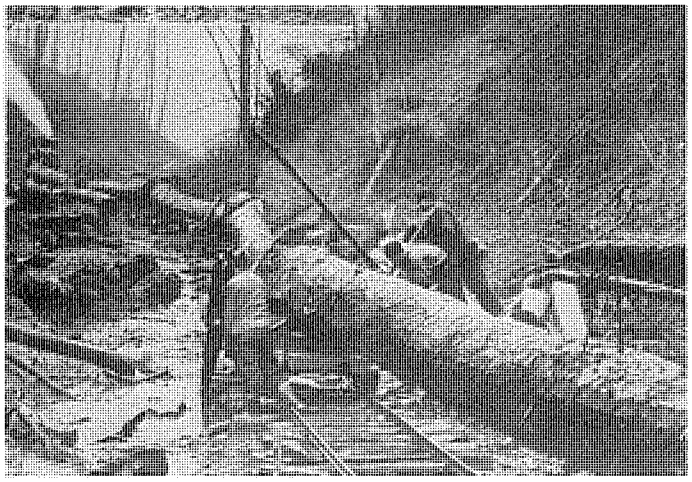

Figure 2. -- Appalachian stream corridor used for log transportation.

Although published reports are rare, there is widespread agreement that the distribution of native brook trout *Salvelinus fontinalis* in the southeastern United States began to decline around the turn of the century (Larson and Moore 1985), coincident with the era of intensive logging and land clearing. Anecdotal accounts tell of catching "20 or more brook trout up to 13 inches long in under 15 minutes" in the days preceding logging (Clarkson 1964). Early surveys by Burrows (1934) in the Nantahala National Forest (an area occupied by the present day Nantahala and Chatahoochee National Forests) and King (1937) in the Great Smoky Mountains National Park suggest that exploitive fishing combined with loss of habitat caused by destructive farming, logging, and mining practices resulted in the loss of trout from much of their former range.

In response to the decline of native trout populations, rainbow *Oncorhynchus mykiss* and brown trout *Salmo trutta* and nonindigenous stocks of brook trout were widely introduced to supplement existing trout stocks and to provide trout in waters thought to be unsuited to production of native fishes (King 1937). After nearly a century of stocking, trout populations in many southeastern streams are composed of at least two of these three species.

Today trout populations in the southeastern United States are largely confined to headwater streams in the Appalachian Mountains. Strictly enforced regulations and heightened public awareness now prevent most of the destructive fishing practices (dynamite, nets, etc.) once common in the Appalachians (Kelly et al. 1980). Trout populations, however, have not returned to former levels of abundance. Many streams still exhibit the effects of past land and water use practices such as splash damming (Anon. 1912; Sedell and Duvall 1985), stream "improvement" for transportation of logs (Brown 1936), and erosion associated with roads and the removal of streamside vegetation. Although habitats in most streams on public lands are protected from these types of activities, rehabilitation or enhancement of trout stocks remains hampered by a lack of information on the historical condition (pre-disturbance) of trout habitats in Southern Appalachian streams.

EXPERIMENTAL ADDITION OF LARGE WOODY DEBRIS TO APPALACHIAN MOUNTAIN WATERSHEDS

One of the most conspicuous changes in southern Appalachian watersheds has been the loss of large woody debris (LWD) (e.g. trees, large branches, and root wads) from riparian zones and stream channels (Dolloff 1994). Woody debris accumulates naturally in forest streams where it strongly influences the storage and movement of sediments, increases stream channel stability, and provides cover for fish and living places for other aquatic species. Despite the growing awareness of its importance, the relationship of LWD, macroinvertebrates, and fish has received little attention in the southeast. The specific amount, type, and function of LWD and the distribution of fish populations and macroinvertebrates relative to LWD and sediment accumulations are largely unknown in the forested streams of the southern Appalachians. The need for research linking LWD, fish, and macroinvertebrates is clear; restoration and protection of fish habitats depend on our ability to understand and eventually manipulate factors such as LWD that both directly and indirectly influence stream biota.

In 1993, researchers from the Southeastern Station and Virginia Tech began a series of experiments to document the amount, probable role, and relation of LWD to fish and macroinvertebrates in southern Appalachian streams. The specific objectives are to: inventory and characterize LWD and associated physical habitat components and fish and

macroinvertebrate communities in southern Appalachian watersheds, evaluate changes in stream channel configuration and habitat resulting from addition of LWD, and describe influences of LWD on fish and macroinvertebrate natural history and populations.

Approach

LWD debris loading, physical habitat features, and fish and macroinvertebrate distribution and abundance were inventoried in North Fork Big Stony and North Fork Barbours Creek, two small streams on the Jefferson National Forest. All habitat units (e.g. pools, riffles) were identified and mapped (plan-view map). Woody debris was tallied by size (length, diameter), approximate location (bridging the channel, partially submerged, compass orientation, etc.), and dominant function (cover, habitat formation, or channel stability) in streams of sufficient size to support wild trout. Sediment accumulations associated with LWD were characterized (particle size, probable geologic origin) and measured (area, depth). Fish abundance and biomass were assessed by diver counts and electrofishing. Macroinvertebrates were sampled with portable invertebrate box samplers (PIBS) in both riffle and pool habitats.

Information from the initial surveys was used to develop field experiments involving selected additions of key LWD to influence channel formation processes (e.g. changes in habitat characteristics, sediment dynamics). In each of two streams, three reaches of about 250 m (each separated by a "control zone" of 50 m) were established. Proceeding from upstream to downstream, the first reach functions as a reference; no LWD was added but habitat and biota, and "phantom" logs (places in the stream measured as if a log had been placed) is being monitored concurrent with monitoring in the two experimental reaches. The middle 250 m reaches received pieces of LWD (diameter at least 20 cm and length at least 1.5 times channel width) placed according to the judgement of at least two resource professionals experienced in the manipulation of stream habitats. The downstream-most reach received logs of similar size but placed randomly. Logs were not "keyed' or otherwise pinned to the stream banks. North Fork Big Stony received 50 logs per section and North Fork Barbours 25 logs per section. All logs were manufactured from live trees of eight species, located at least 15 m from either stream bank, to prevent the confounding influence of opening the streamside canopy (Table 1). Data are being analyzed with a Geographic Information System to better understand spatial relations at both local (individual pools and riffles) and stream reach scales and to account for natural variation related to stream size and location.

Table 1. -- Species and number of pieces of large woody debris added to two Southwest Virginia streams.

Tree Species	Big Stony	Barbours
Poplar	3	5
Red oak	2	22
White oak	1	6
Chestnut oak		12
Scarlet oak		2
Sugar maple		3
Cherry	4	
Hemlock	16	
White pine	27	
Yellow pine	47	
Total	100	50

All sites were labeled and serve as the foundation for long-term monitoring of interactions among LWD inputs, channel mechanics, and stream biota.

One year after adding LWD, the sequence of pools and riffles changed substantially (Figure 3.).

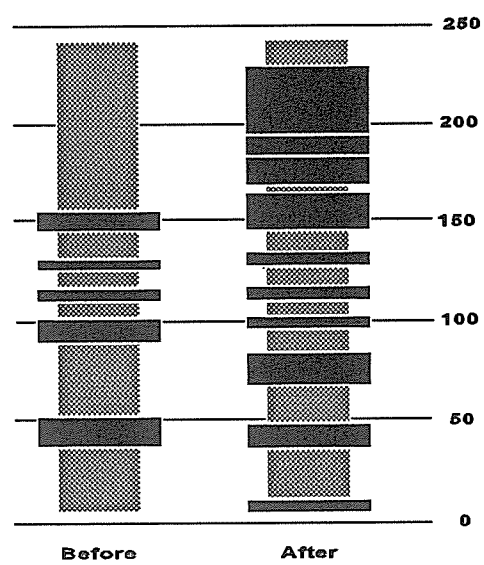

Figure 3. - Pool (dark rectangles) -riffle (light rectangles) sequence in the controlled placement section of a Southwest Virginia stream before and after addition of LWD.

The number and surface area of individual pools increased while that of riffles decreased. Preliminary results indicate that brook trout use a greater proportion of the total available habitat (Kelly Harpster, personnel communication) and that the macroinvertebrate community composition has shifted from pool to mostly riffle-oriented species (Robert Hilderbrand, personal communication). The results of this study will give managers a more complete understanding of the amounts, distribution, inputs and relations to fish and other stream biota of LWD and associated habitat features in southern Appalachian streams.

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The Use of DNA to Identify Geographical Isolation in Trout Stocks

Dennis K. Shiozawa[1] and R. Paul Evans[2]

We used mitochondrial DNA to determine the phylogenetic associations of 26 cutthroat trout populations from Utah. The fish fell into three distinct clades representing the Yellowstone Cutthroat trout, the Colorado River Cutthroat trout, and the Bonneville Cutthroat trout. Cutthroat trout from the Bear River drainage of the Bonneville Basin were part of the Yellowstone Cutthroat clade rather than the Bonneville Cutthroat clade, implying a polyphyletic origin of the Bonneville Cutthroat trout. Considerable within subspecies genetic diversity was also documented for all three subspecies indicating that no single population can be expected to represent the genetic diversity of an entire subspecies. In maintaining genetic diversity of the native cutthroat, managers will need to focus on preserving as many isolated populations as possible.

INTRODUCTION

The cutthroat trout, *Oncorhynchus clarki*, of western North America are a diverse assemblage of subspecies. Behnke (1988) recognizes four main lineages or major subspecies of these fish; the Coastal Cutthroat, the Westslope Cutthroat, the Lahontan Cutthroat, and the Yellowstone Cutthroat. Both the Westslope and Coastal Cutthroats have one recognized extant subspecies across their entire range, although regional variations exist. The Lahontan Cutthroat complex consists of two recognized minor sub-species, the Lahontan and the Paiute Cutthroats, and evidence points to as many as three additional undescribed subspecies (Behnke 1992; Williams, Proebstel, and Shiozawa, unpublished data). The Yellowstone Cutthroat complex is the most diverse, having five extant minor subspecies, the Yellowstone (*O. c. bouvieri*), the Colorado River (*O. c. pleuriticus*), the Bonneville (*O. c. utah*), the Greenback (*O. c. stomis*), and the Rio Grande (*O. c. virginalis*) and one or two undescribed subspecies (Behnke 1992; Shiozawa, Evans, Williams, and Proebstel unpublished data). The four major subspecies can be readily separated both meristically (Behnke 1988, 1992) and biochemically (Loudenslager and Gull 1980; Leary et. al. 1987). However the minor subspecies have been more difficult to separate, especially those of the Yellowstone complex. Knowledge of basin of origin in combination with meristics allows separation of these fish, but introgression with non-native subspecies has complicated systematics. Museum specimens have significantly facilitated the meristic and morphological study of these trout (Behnke 1992), however even with museum specimens some of the subspecies, for example the Bonneville Cutthroat and the Yellowstone Cutthroat, can not be clearly separated. Biochemical analyses, which have largely focused on allozyme studies (Loudenslager and Gull 1980; Martin et. al. 1985; Leary et. al. 1987), have identified few diagnostic loci (ie. unique to each subspecies of interest) and generally must rely on informative loci (ie. occurring in different proportions in the various subspecies) to separate the minor subspecies.

We have focused on the examination of DNA, specifically mitochondrial DNA (mtDNA). This has several advantages over other techniques. DNA can be extracted from a small sample while protein electrophoresis has often required the sacrifice of the fish. We now routinely utilize fin clips in our lab. Tissues for DNA extraction can be field preserved in a number of buffers (e.g. Proebstel et. al. 1993) and even

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transported and stored without refrigeration. We have also successfully extracted DNA from museum specimens (Shiozawa et. al. 1992). Mitochondrial DNA is a maternally inherited DNA located within the mitochondria of the cell. Unlike nuclear DNA which undergoes recombination with every generation, mtDNA gives unambiguous information on maternal lines. Populations that have multiple mtDNA haplotypes due to introgression events are readily distinguished by the haplotypes which are diagnostic. Because mitochondrial DNA is essentially a single locus screen, more fish must be examined to detect low frequency introgression than may be required with protein electrophoresis where multiple loci are evaluated. One must also assume that females from both subspecies were involved in any hybridization event. That is, no assortative mating takes place where, for example, the males of one subspecies only breed with females of another. Therefore the results of mtDNA analysis must be interpreted with proper caution.

OBJECTIVES

The native cutthroat trout in Utah include three recognized subspecies of the Yellowstone complex: the Yellowstone Cutthroat Trout, *O. c. bouvieri*, native in the Raft River drainage of the extreme north-western part of the state; the Colorado River Cutthroat Trout (*O. c. pleuriticus*) in the Colorado River drainages; and the Bonneville Cutthroat Trout (*O. c. utah*) in the Bonneville Basin (Behnke 1992). Fishery managers are concerned with identifying Utah's native subspecies since the emphasis on management of native stocks includes maintaining genetic diversity. Part of the present dilemma with the Yellowstone complex developed from early fishery management practices. At that time little understanding of the range of genetic diversity between populations or even subspecies existed. The main criteria in trout management appears to have been the ease in which the fish could be adapted to hatchery operations. Cutthroat were more difficult to rear than rainbow trout so rather than establishing brood stocks, eggs were collected from fish in the field. This limited most egg taking operations to lake systems where high numbers of eggs could be easily collected and then shipped considerable distances. Between 1915 and the early 1950's about 45% of 112 million cutthroat trout planted in the state of Utah were from imported eggs, mostly from just one source: Yellowstone Lake in Yellowstone National Park (Cope 1955). The result of this stocking was widespread introgression of the native Bonneville and Colorado River Cutthroat trout with the Yellowstone Cutthroat. This introgression made the identification of the remaining pure populations difficult, especially given the close genetic relationships among these three subspecies. Now managers are attempting to locate populations of native trout that have not introgressed with introduced trout so that the some degree of preservation of the original genetic diversity within each subspecies is possible.

Previous studies in our laboratory used mitochondrial DNA based markers to identify and separate the extant cutthroat trout subspecies. In particular, a cladistic analysis of mtDNA restriction fragment length polymorphisms (RFLPs) from representatives of the three Utah subspecies (Table 1) suggested that the technique would allow us to decipher phylogenetic relationships among them (Figure 1). The cutthroat from the Bear

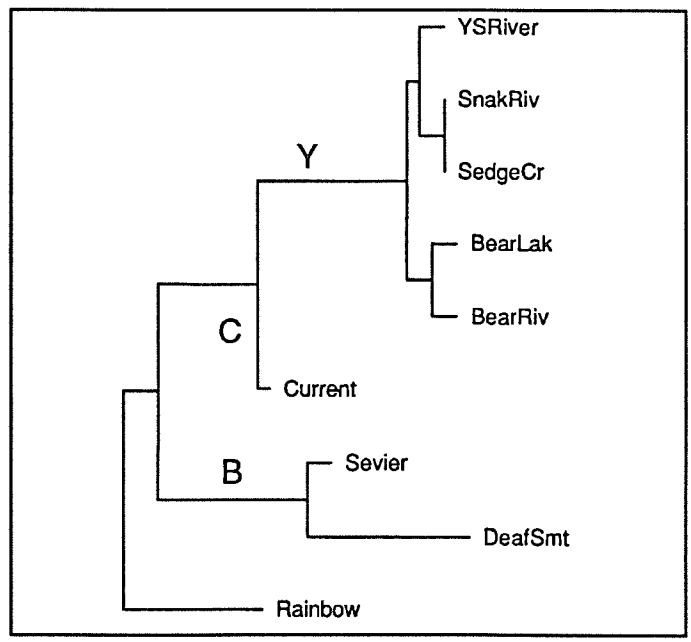

Figure 1.–Relationships of *O. clarki* subspecies estimated from bootstrap analysis of mitochondrial haplotypes. Eight populations from distinct geographic regions were used for this initial analysis. Major clades are marked for Yellowstone (Y), Colorado (C), and Bonneville (B) subspecies.

River and Bear Lake are classified as Bonneville Cutthroat trout because the Bear River is a part of the Bonneville Basin . However electrophoretic evidence points to their having a genetic association with the Yellowstone subspecies rather than the Bonneville Cutthroat trout (Loudenslager and Gull 1980; Martin et. al. 1985). The mtDNA cladogram reinforces this conclusion, but it is also apparent that both the Bear

Table 1.--Cutthroat trout populations used to project initial phylogenetic relationships among the Yellowstone, Colorado River, and Bonneville Cutthroat Trout.

Population	Location	Drainage	Subspecies
YSRiver	Yellowstone Nat'l Park	Yellowstone River	Yellowstone
SnakeRiv	Teton Nat'l Park	Snake River	Yellowstone
SedgeCr	Yellowstone Nat'l Park	Yellowstone River	Yellowstone
BearLak	Rich Co. UT	Bear River	Bonneville
BearRiv	Rich Co. UT	Bear River	Bonneville
Current	Wasatch Co. UT	Green River	Colorado River
Sevier	Millard Co. UT	Bonneville Basin	Bonneville
DeafSmt	Salt Lake Co. UT	Bonneville Basin	Bonneville
Rainbow	Hatchery Stock	----------	----------

Table 2.--Streams examined for the presence of Colorado River Cutthroat Trout.

Stream	Location	County	Drainage
North Fork, Sheep Creek[c]	Uinta Mts	Dagget	Green River
South Fork, Sheep Creek[c]	Uinta Mts	Dagget	Green River
Dry Fork Creek[c]	Uinta Mts	Uinta	Ashley Creek
Race Track Creek[c]	Current Cr.	Wasatch	Strawberry River
Reader Creek[c]	Uinta Mts	Duchesne	Whiterocks River
West fork, Duchesne River[c]	Uinta Mts	Wasatch	Duchesne River
Willow Creek,[a,b,c]	Wasatch Plateau	Wasatch	Duchesne River
Yellowstone River, UT[c]	Uinta Mts	Duchesne	Duchesne River
Spring Creek[b]	Wasatch Plateau	Sanpete	San Rafael River
Upper La Sal Creek[a]	La Sal Mts	San Juan	Colorado River
Geyser Creek[a,b,c]	La Sal Mts	San Juan	Colorado River
Beaver Creek[c]	La Sal Mts	San Juan	Colorado River
East Fork, Boulder Creek[c]	Boulder Mts	Garfield	Escalante River
West Fork, Boulder Creek[c]	Boulder Mts	Garfield	Escalante River

[a] = *Yellowstone Cutthroat Trout haplotypes*
[b] = *Bonneville Cutthroat Trout haplotypes*
[c] = *Colorado River Cutthroat Trout haplotypes*

Table 3.--Streams examined for the presence of Bonneville Cutthroat Trout.

Population	Location	County	Drainage
Birch Creek[b]	Deep Creek Mts	Juab	Great Salt Lake
Lower Trout Creek[b]	Deep Creek Mts	Juab	Great Salt Lake
Trout Creek[b]	Deep Creek Mts	Juab	Great Salt Lake
Birch Creek[b]	Tushar Mts	Beaver	Beaver River
South Fork, San Pitch River[a]	Wasatch Plateau	Sanpete	Sevier River
Reservoir Fork[b]	Pine Valley Mts	Washington	Virgin River
Bear Canyon Creek[a,b]	Monte Cristo	Weber	Ogden River
Wheeler Creek[a,b]	Snow Basin	Weber	Ogden River
Three/Two Mile Creek[a]	Wasatch Mts	Summit	Weber River
Main Creek[b]	Wasatch Mts	Wasatch	Provo River
Carter Creek[a]	Uinta Mts	Summit	Bear River
Deadman Creek[a]	Uinta Mts	Summit	Bear River

[a] = *Yellowstone Cutthroat Trout haplotypes*
[b] = *Bonneville Cutthroat Trout haplotypes*
[c] = *Colorado River Cutthroat Trout haplotypes*

River and Bear Lake fish that we examined were slightly divergent from the Yellowstone populations examined. The mtDNA RFLP analysis clearly separated the remaining Bonneville Cutthroat and the Colorado River Cutthroat from the Yellowstone clade.

Our objective was to apply these mtDNA techniques to Utah cutthroat populations suspected to be Bonneville and Colorado River Cutthroat. The restriction data for these populations would be added to our initial phylogram (Figure 1) to determine subspecies classification. This would also allow us to evaluate haplotype variation within subspecies.

METHODS

Specimens were collected from 26 locations in Utah by biologists with the Utah Department of Wildlife Resources and the U. S. Forest Service between 1990 and 1994 (Table 2 and Table 3). Whole fish or tissue samples were preserved by freezing or alcohol and were brought to BYU for analysis. At BYU the specimens were assigned population and individual museum catalog numbers for tracking purposes. This allows the direct association of the results of DNA analysis with the individual specimens from which the sample was taken.

The whole specimens are archived in the fish collection of the Monte L. Bean Life Science Museum at BYU. The tissues were archived with our frozen tissue collection in an ultracold freezer and a portion was later used for DNA isolation.

Total DNA was extracted from ground liver, muscle, or fin tissues by digestion in a solution of 10 mM Tris-HCl, pH 8.0/ 25 mM EDTA/ 100 mM NaCl/ 0.5% SDS/ proteinase K (0.5 μg/ml) for 8-10 hours at 55°C. The DNA was purified by two extractions with phenol/chloroform/isoamyl alcohol (25:24:1; vol/vol/vol) and DNA was precipitated in two volumes of 100% ethanol after making the solution 300 mM in sodium acetate, pH 5.4. The DNA was resuspended in 10 mM Tris and 1.0 mM EDTA (pH 7.2, TE buffer) or sterile distilled water. DNA concentration was determined by absorbance at 260 nm and by estimations from ethidium bromide-stained gels.

Polymerase chain reaction was used to amplify the ND1, ND2, ND5/6, CytB regions of the mitochondrial genome from each individual. The sequences of the ND1 and ND5/6 primers were according to Cronin et. al. (1993). The ND2 primers were obtained from LGL Ecological Genetics, Inc (Bryan, Texas). The cytochrome B primer sequences are available from this lab. The ND1 primers, 1311 and 1312, amplify a mtDNA fragment of 2.0 kb; the ND2 primers, 452 and 562, generate a 2.2 kb fragment; the ND5/6 primers, 1313 and 1314, generate a 2.4 kb fragment; and the CytB primers, 1425 and 1426, amplify a 1.3 kb fragment. In total, 45% of the mtDNA genome was sampled with these 4 primer sets. Amplification was performed in a 40 μl reaction containing: 100 ng of total DNA, 8 pmol of each primer, 4 μl of a 10 mM dNTP mix, 4 μl of 10X reaction buffer (Perkin-Elmer), and 0.1 μl of Taq polymerase (Perkin-Elmer). Each PCR cycle (Ericomp or Perkin-Elmer thermal cycler) consisted of denaturation for 50 seconds at 94°C, annealing for 55 seconds at 55°C, and elongation for 2.5 minutes at 72°C. This cycle was repeated 38 times.

Aliquots of each amplified fragment were digested separately with each of ten restriction endonucleases: *Alu*I, *Cfo*I, *Dde*I, *Hae*III, *Hin*fI, *Hpa*II, *Mbo*I, *Msp*I, *Rsa*I, and *Sau*3AI. *Dde*I and *Hin*fI are pentanucleotide sequence endonucleases while the remainder are tetranucleotide sequence endonucleases. Restriction digests were performed in 10 μl reaction volumes according to protocols from the supplier (Promega). Restriction fragments were electrophoretically separated in 3% agarose gels in 40 mM TAE buffer (pH 8) and the DNA was stained with ethidium bromide and visualized by UV transillumination. Alphabetic designations were assigned to each unique band pattern generated by each restriction endonuclease digest of the amplified mtDNA fragments. REAP (Restriction Enzyme Analysis Program; McElroy et. al., 1991) converted the band pattern information into binary code (presence or absence of individual restriction fragments) that was used to estimate Nei's evolutionary distance. The binary data set generated by REAP was also utilized for maximum-parsimony analysis using PAUP (Swofford 1993). The phylogenetic relationships of the taxa were then calculated using an exhaustive heuristic search with bootstrapping (100 replications).

RESULTS and DISCUSSION

Our preliminary analysis (Figure 1) of the three subspecies led us to expect to find the fish from these 26 populations falling into the three distinct clades (Figure 2). The Yellowstone Cutthroat subspecies is bounded by a Yellowstone River (Yellowstone National Park;

YSRiver) haplotype through Geyser 2, the second haplotype found in Geyser Creek in the La Sal Mountains. The Colorado River Cutthroat trout are in the clade beginning with Current Creek and ending with Geyser 1. The Bonneville Cutthroat trout comprise the clade beginning with Willow 3 and ending with Geyser 3. Rainbow trout was used as the outgroup. The actual subspecies classifications of each population are also noted with superscripts in Tables 2 and 3. Populations that were introgressed contained multiple haplotypes that fell into multiple clades. The majority of the populations examined were mitochondrially pure Bonneville or Colorado River Cutthroat trout. Four of the populations from the Colorado River drainages were either introgressed or had mtDNA haplotypes that were not expected in the Colorado River basin. These were Upper La Sal Creek, Willow Creek, Spring Creek, and Geyser Creek. The Upper La Sal haplotype was of Yellowstone Cutthroat origin while both Geyser and Willow Creeks were introgressed with a Yellowstone haplotype. All of the Spring Creek trout had a Bonneville Cutthroat haplotype. Willow Creek's confluence with the Strawberry River is just below Strawberry Reservoir and the Yellowstone Cutthroat haplotype likely came from the introgressed Yellowstone-Colorado River Cutthroat population that was managed in Strawberry Reservoir until the early 1990's. The headwaters of Willow Creek is also adjacent to the Bonneville Basin and a stream transfer event may have allowed the Bonneville Cutthroat haplotype into the stream or one of the nearby drainages. Conversely the Bonneville Cutthroat could have been stocked by man. The Geyser Creek population in the La Sal mountains near Moab, Utah also may have had Bonneville Cutthroat trout introduced by man or may have retained the Bonneville haplotype from a prehistoric stream capture event. It also contained mtDNA from the Yellowstone Cutthroat clade. The Spring Creek population is also adjacent to the Bonneville Basin and these fish may represent a naturally invading population.

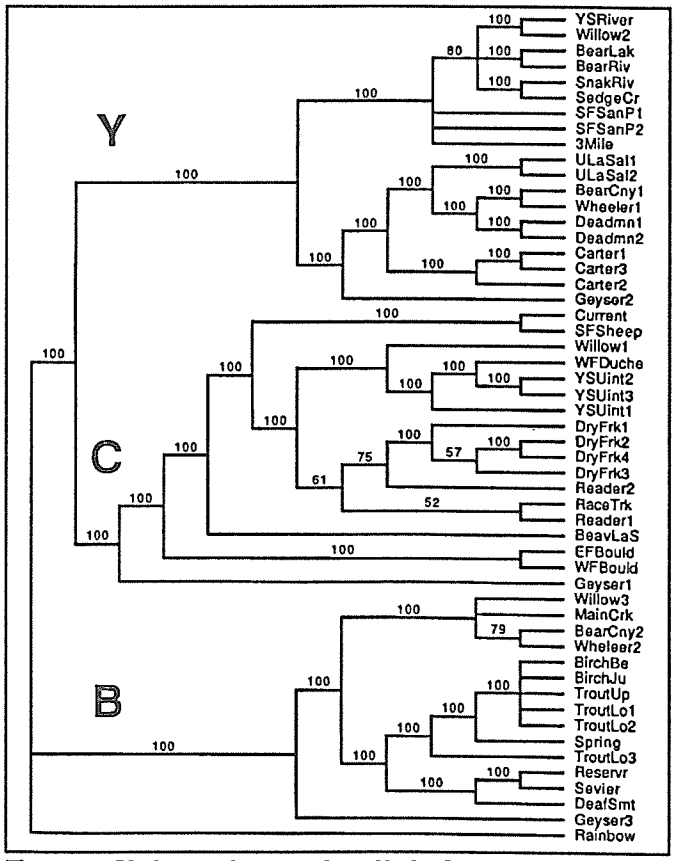

Figure 2.--Phylogenetic tree of 26 Utah *O. clarki* populations. The relationships of *O.clarki* subspecies and populations were estimated from a 50%-majority- rule consensus tree after heuristic search using maximum parsimony. The numbers indicate the fraction of instances for which branches were joined under bootstrap analysis. The Yellowstone, Colorado and Bonneville subspecies clades are marked as Y, C, and B, respectively.

Six of the Bonneville Basin populations were pure Bonneville Cutthroat trout (Figure 2, Table 3). Two populations, Bear Canyon Creek and Wheeler Creek, were introgressed with Yellowstone Cutthroat mtDNA. The remaining four populations contained Yellowstone haplotypes. A Yellowstone haplotype was expected in Carter Creek and Deadman Creek in the Bear River drainage basin (see above), but both Three Mile Creek and the South Fork of the San Pitch River have been stocked with cutthroat from outside of the Bonneville Basin.

These general classifications from the analysis of mtDNA RFLPs are useful for general management decisions, but additional insights can be gained from the cladogram. First is the general adherence of the haplotypes to the three basic clades that we expected to find. The cladistic analysis supports separate lineages for each of the major subspecies, with the exception of the Bear River drainage component of the Bonneville Cutthroat Trout. This particular group falls consistently within the Yellowstone clade. Of the three subspecies the Bonneville are the most divergent group. The Colorado River and Yellowstone are more similar.

Second, the Bear River fish fell within the Yellowstone clade as was expected based on evidence from allozyme studies (Loudenslager and Gull 1980, Martin et al 1985). This is consistent with the Bonneville Cutthroat trout being polyphyletic in origin. Under this hypothesis, a cutthroat trout occupied the main Bonneville Basin prior

to the diversion of the Bear River into the Bonneville Basin in the late Pleistocene (Bright 1963). The Bear River transfer then brought a Yellowstone Cutthroat line into contact with the main basin Bonneville Cutthroat. Conversely, given the widespread stocking of cutthroat trout in Utah, especially Yellowstone Cutthroat trout, the presence of Yellowstone haplotypes does not conclusively prove a polyphyletic origin. We initially assumed that the separation of the Bear Lake and Bear River Bonneville Cutthroat from the Yellowstone Cutthroat in our preliminary study (Figure 1) represented the degree of divergence to be expected between the two subspecies. However our expanded data set has shown that the Yellowstone clade (Figure 2) is separated into two lines. One contains the fish that we examined from the Greater Yellowstone region (YS River, Sedge Creek, Snake River) and the Bear River and Bear Lake samples, and the second includes fish from several streams in the upper Bear River (Carter Creek and Deadman Creek) as well as several non-Bear River drainage streams contain populations introduced by man. Carter Creek and Deadman Creek each contain closely related multiple haplotypes. Such haplotype clades are characteristic of endemic populations (Billington and Herbert 1991; Bermingham and Avise 1986). It is possible that the haplotype we initially utilized to define the Bear River form of the Bonneville Cutthroat trout is actually a Yellowstone haplotype and the Carter Creek and Deadman Creek haplotypes more correctly define the original Bear River haplotype pattern. We currently have several projects under way to resolve this issue.

Third, as is obvious from the branching of the phylogenetic tree (Figure 2), the three subspecies are made up of a diverse range of haplotypes. This is perhaps the most important message of our study. Genetic diversity is a function of all of the populations. No single population is representative of a subspecies. If we are to conserve genetic diversity we cannot simply preserve a few populations and stock them elsewhere throughout the subspecies' native range. This would deplete genetic diversity as much as has the introduction of rainbow trout and Yellowstone cutthroat throughout the west. Instead we must conserve as many native populations over as wide a geographical range as possible. Transplants of pure native populations should be kept within the same general drainage basins from which they originated. Many of the populations we examined contained haplotype clades indicating low vagility (Heggens et. al 1991). This could mean that less gene flow has historically occurred between basins than may have been expected from the stream interconnections existing prior to water development by man, thus emphasizing the uniqueness of the remaining populations.

This is not to suggest that we should eliminate hatchery based fisheries, that non-native salmonids should be removed from our lakes and streams, or that unique traits of native trout can not be enhanced for sport fisheries. But where appropriate and where pure forms of our native fishes still remain we should protect and enhance the integrity of those populations.

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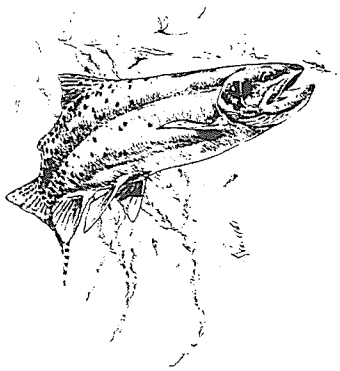

Conflicts in Allocation of Wild Trout Resources: An Idaho Case History[1]

Russell F. Thurow[2] and Daniel J. Schill[3]

Abstract.--Fisheries resources are finite and conflicts may arise when several groups compete for the same resource. Diverse groups of anglers often derive different benefits and possess different preferences concerning the way a resource should be managed. This paper examines the conflict which arose when new regulations were proposed for reaches of Idaho's Big Wood River. One organized group of anglers lobbied for specific restrictive regulations. Another group of anglers responded and successfully challenged the new regulations in court. We describe factors contributing to the controversy and discuss aspects of the conflict that may be instructive for anglers and management agencies. We examine philosophical questions concerning future management of wild trout streams.

INTRODUCTION

Although effective wild trout management remains ecologically based, attitudes of resource users have assumed an increasing role in the management process. Modern fishery managers are faced with the challenge of allocating a limited and often shrinking resource to a wide variety of users. As Jackson (1989) observed, people who fish for trout may have the broadest range of individual differences of any known group of anglers. These diverse anglers derive different benefits and possess very different preferences concerning the way the resource should be managed (Orbach 1980, Voiland and Duttweiler 1984).

Conflicts may arise if decision makers fail to understand the effect of management decisions on diverse user groups. Few recreational activities create the emotional commitment and intensity found in trout fishing (Wingate 1988). In response to the question, If for some reason you could not go trout fishing, more than 25% of all Wisconsin stream anglers and nearly 40% of all members of Trout Unlimited answered that they would miss it more than all other activities (Jackson et. al 1988). Trout anglers also tend to be defensive of their right to practice preferred fishing methods. Peyton and Gigliotti (1988) observed that the extreme levels of specialization, intense feelings about fishing, and associated ethics of trout anglers on the Au Sable River cultivated an intolerance of alternative recreational choices.

Associated with the increased involvement of the public in the decision making process has been an increase in organized special interest groups. Organizations range from groups focused on restoring specific reaches of local rivers such as Friends of the Payette River, to national organizations such as Trout Unlimited and the Federation of Fly Fishers who are cosponsers of this Symposium. Gigliotti and Peyton (1993) suggest that as angling groups gain political influence, they sometimes use that influence to gain regulations favoring their interests and restricting entry of competing users.

The increase in politically active special interest groups provides added challenges to fisheries agencies charged with allocating limited wild trout resources. To avoid conflicts and public rejection of regulation proposals, it is important for managers to understand the extent to which organized angler groups represent all anglers using the resource (Gigliotti and Peyton 1993).

This paper describes the conflict which arose when the Idaho Fish and Game Commission attempted to implement new angling regulations on the Big Wood River. In Idaho, the ultimate decision-maker in any angling regulation-setting process is the Commission, six individuals politically appointed by the governor. The Commission's task is to weigh input from their biological staff, the Idaho Department of Fish and Game (IDFG), with public input to make sound resource decisions.

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[1]*Paper presented at the Wild Trout V Symposium. (Yellowstone National Park, Wyoming. September 26-27, 1994)*
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A local angling group comprised primarily of fly anglers, the Friends of the Big Wood River (FBW), supported and lobbied for expansion of restrictive regulations including prohibition of bait. A less organized group of anglers comprised of bait, lure, and some fly anglers, opposed the more restrictive regulations and challenged them in court. We describe biological capabilities of the river and sociological aspects of the fishery and review factors contributing to the conflict. We discussed aspects of the dispute that may be instructive for fisheries managers and anglers.

STUDY AREA

The Big Wood River (BWR) is regarded as one of Idaho's most productive wild trout streams. From its origin near Galena Summit north of Ketchum, the river flows south-southwest 99 km[4] to its confluence with Magic Reservoir. Thurow (1987) provides a detailed description of the study area including climate, geology, water quality and the unique endemic fish fauna in the drainage.

The BWR and tributaries comprise the largest complex of trout waters in south central Idaho. Silver Creek, an internationally renowned spring creek, is tributary to the BWR. The BWR contains a wild, self-sustaining population of rainbow trout Oncorhynchus mykiss and has a history of producing large trout in excess of 2.5 kg, with accurate records of fish exceeding 5 kg. Rainbow trout have provided a popular and valuable fishery since settlement of the drainage.

As the valley became settled, both agricultural and residential development of the floodplain altered the BWR drainage. Concurrent with the habitat disturbance was a large increase in the human population. From 1960 to 1992, the population of the upper Wood River valley increased by 225% as compared to a statewide increase of 60% (U.S. Department of Commerce 1994). As habitat disturbance and angler effort increased, the sport fishery in the drainage declined.

RESEARCH RESULTS

As a result of concerns about the status of the fishery, fisheries managers requested more information about fish populations in the drainage. In 1986 IDFG initiated an intensive research project on the BWR to gather information to guide future management. The research was designed to evaluate the current status of trout populations, define factors limiting the population, and provide recommendations to improve the fishery. Research was conducted from 1986 to 1988 and evaluated both biological and sociological aspects of the fish population and fishery (Thurow 1990).

The Existing Trout Population

Research results illustrated that the BWR sustained an excellent wild trout population. In the most productive areas, summer densities of age 2 and older trout exceeded 400 fish per km. More than 20% of the fish exceeded 300 mm and nearly 5% exceeded 400 mm.

The wild rainbow trout stock in the river had sufficient growth potential and longevity to produce large trout exceeding 500 mm. Growth rates in the most productive reaches of the BWR were comparable to rates in other productive Idaho streams including the Henry's Fork Snake River and Silver Creek.

Biological capabilities of the BWR differed among reaches. As a result of differences in stream productivity and habitat quality, trout populations were not evenly distributed spacially. Productive reaches supported more than three times the density of trout as less productive areas, regardless of the type of angling regulation. For example, an existing catch-and-release area supported less than one third the density of both age 2 and older trout and trout larger than 400 mm as compared to a more productive reach with higher habitat quality with a six fish limit.

Habitat quality profoundly effected fish abundance. We observed 8 to 10 times fewer trout in altered stream reaches as compared to reaches with complex habitat. Fish population density was positively correlated to the abundance of cover, particularly large woody debris.

Natural mortality rates in the BWR were very high. In the catch-and-release area, about 65% of the fish died of natural causes each year. Mortality estimates suggested that compensatory mortality was occurring in the drainage. As exploitation decreased in various river segments, natural mortality increased.

The Existing Sport Fishery

The BWR also sustained a very popular and quality sport fishery. Angler effort exceeded 60,000 hours, averaged more than 800 hours per km, and exceeded 2,000 hours per km in a few reaches. Catch rates averaged more than one trout per hour and more than 50% of the creeled fish exceeded 300 mm.

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[4]*Metric units conversions: 1 km = 1.609 miles, 100 mm = 3.94 inches, 1 kg = 2.2 lbs.*

A large proportion (65%) of the catch was voluntarily released. Anglers of all types released fish, regardless of their preferred angling method. Anglers released small trout and selectively harvested larger fish, especially those from 300 to 400 mm.

Most anglers used bait (46%) or flys (41%) and smaller proportions used lures or multiple methods. Angler types were not evenly distributed along the river. Bait anglers frequented certain reaches and fly anglers others. Most anglers (81%) that fished the BWR under the general statewide bag limit of 6 fish rated the fishing good to excellent. Although levels of satisfaction were high, most anglers (89%) said they would support more restrictive angling regulations if the regulations increased the abundance of large trout. Bait (88%), lure (100%), and fly (93%) anglers all favored more restrictive angling regulations.

Although anglers on the BWR favored more restrictive regulations, the opportunity to keep fish remained important for many. Nearly sixty percent of the anglers responded that the opportunity to keep fish was at least "somewhat important" as a reason to fish. Forty percent of the anglers said they would stop fishing the BWR if forced to release all trout.

While the quality of the BWR fishery had declined from historical levels, we documented a productive stock with adequate recruitment in most sections. The fishery was sustainable with existing levels of effort and harvest. With public support, fish managers had an opportunity to balance natural mortality with harvest to improve the population size structure.

CASE HISTORY

Widely disparate views of the most appropriate regulations for the BWR had been discussed among anglers for many seasons. The stream attracted a constituency of anglers who considered special regulations which limit harvest and the method of take as essential to quality fishing. Five commercial fishing guide services that employed more than 75 individual guides were licensed on the BWR and Silver Creek. Many of their clients fished exclusively with flys and preferred to release most of their catch.

The stream also attracted a constituency of anglers for whom the right to keep fish was essential. This second group was comprised of predominantly bait anglers but also included individuals who preferred to fish with lures and flys.

Polarization between the two angling groups was in place at the onset of the research project in 1986. Many proponents of special regulations blamed harvest-oriented anglers as the reason for the demise of historically better fisheries. Many harvest oriented anglers labeled advocates of highly restrictive regulations as out-of-staters who sought to reserve waters for an elite few.

At the onset of the research program, the IDFG goal was to complete field research and a final report in 1989. Any proposals for regulation changes were targeted for the 1990 biennial regulation cycle. Although informed of this schedule, special regulation advocates pressed for immediate change. In 1988, two years into the research project, members of FBW met with IDFG staff to express concern over a second consecutive year of drought. FBW members feared overharvest of trout and sought an emergency regulation consisting of a slot limit with bait prohibited. IDFG staff responded that the ongoing research enabled them to evaluate the fish population and in the event of an emergency, immediate action would be taken.

Within one week of the meeting, members of FBW developed a petition outlining their concerns about the drought and the need for emergency regulations. A three page flyer soliciting supporting letters and containing a suggested list of points, was sent to a list of potential petition supporters. The closing statement of the flyer suggested that the drought was only part of the reason for the lobbying effort: "If you feel as we do, that the Big Wood River should be managed permanently as a wild trout fishery which protects fish in the 12" to 20" range, please indicate this in your letter."

The lobbying effort was very effective, more than 1,000 signatures and 40 letters were sent to IDFG and the Commission. As a result of the lobbying, the Commission considered emergency regulations for the BWR at its May 1988 session. At Commission direction, IDFG staff developed a "monitoring program" in cooperation with FBW to monitor the effects of the drought. A sampling schedule was designed and parameters agreed upon as indicators of potential emergency conditions. IDFG results demonstrated that the population of wild trout in the river was equal to or greater than it had been prior to the drought in 1986. FBW agreed that no emergency existed.

Proponents of special regulations, however, continued to lobby for immediate changes in regulations. The efforts culminated at the October 1988 Commission meeting, when members of FBW and a Sun Valley fly shop owner were asked by the Commission to testify on the need for special regulations on the BWR and Silver Creek. The invited speakers requested elimination of bait angling on several miles of both streams and installation of expanded catch-and-release and a slot limit. IDFG staff responded to the Commission and cited the need to complete the current research program and obtain broad-based public input prior to implementing new regulations. The Commission directed

IDFG staff to implement new angling regulations on the BWR and Silver Creek by the general season opener in May, 1989, one year earlier than anticipated. News releases describing the Commission meeting generated negative responses from anglers who were not proponents of bait restrictions. A conflict was brewing.

Development of Regulation Options

In response to the Commission directive, IDFG staff summarized existing biological data to describe the dynamics of the wild trout population in the BWR. A simple modeling approach was used to evaluate the response of the existing trout population to various levels of angler exploitation under different angling regulations. Simulations were based on empiracle estimates and best available literature. We used MOCPOP, a generalized population model designed to simulate age-structured populations in modeling exercises (Beamesderfer 1988). The model is an adaption of one presented by Taylor (1981) except that recruitment can be stock-dependent and described by Beverton-Holt or Ricker functions, or held constant (Ricker 1975). Inputs included size-specific exploitation, growth (von Bertalanffy coefficients), age-specific maturity, age-specific mortality, length-weight coefficients, and recruitment-function coefficients. A sensitivity analysis was used to describe the influence of key population parameters. Model outputs provided annual estimates of total numbers of trout of specific sizes and ages, total harvest, and yield under various regulation scenarios. Thurow (1990) provides a detailed description of the modeling approach.

We examined the response of the BWR population to eight regulations. We tested four slot limits which allowed harvest of fish less than or larger than specified lengths, three minimum size limits, and catch-and-release. Creel data was used to estimate the theoretical reduction in harvest from various bag limits. The effects of bait hooking mortality were tested under various restrictive regulations. Literature suggests that a mean of 25% of the trout hooked with bait and released die with a range of 5% to 60% (Wydoski 1977, Mongillo 1984). A "worst case scenario" was applied by assuming 60% of the trout caught and released with bait would die. We tested the sensitivity of the fish population to compensatory mortality (Ricker 1975) by varying conditional mortality with exploitation.

Because of differences in growth and mortality, results of population simulations varied between upper, less productive areas of the BWR and lower, more productive areas. Regulations had a minor influence on the total abundance of trout unless nearly all harvest was eliminated (Figure 1). Regulations had a major influence on the size structure of the population, however. Catch-and-release regulations provided the largest predicted increase in percentages of trout larger than 300 mm and 400 mm. A 2-fish bag limit coupled with various size limits was effective in increasing the size structure of the population. Although the response of the population to regulations with bait allowed was reduced from that where bait was prohibited, the size structure of the population was still enhanced (Figure 2). If hooking mortality rates with bait proved less than the 60% mortality we modeled, the population response with bait would be improved.

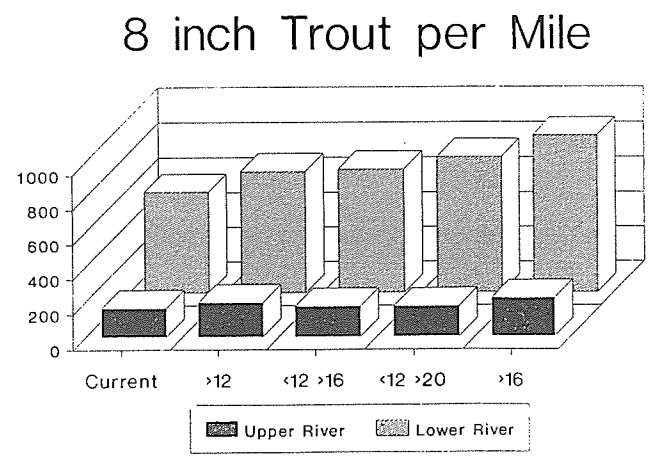

Figure 1. The predicted number of trout per mile larger than 203 mm (8 inches) resulting from varying size limits (in inches) on the Big Wood River, upper and lower reaches.

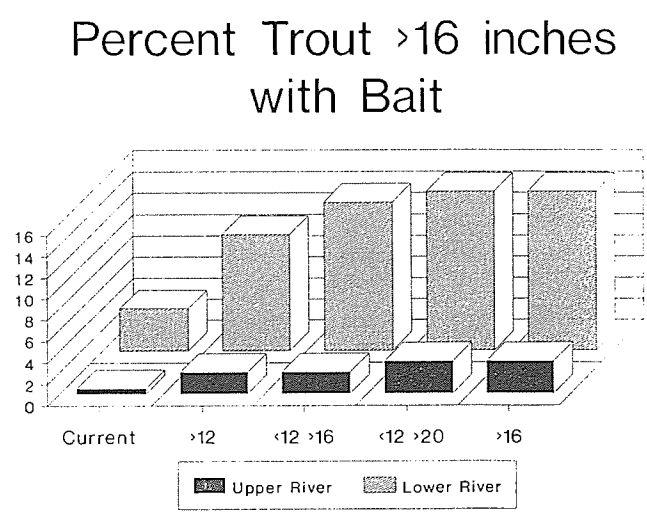

Figure 2. The predicted percent of the trout population larger than 406 mm (16 inches) resulting from varying size limits (in inches) on the Big Wood River, upper and lower reaches.

In January, IDFG staff scheduled a series of public meetings. Four public meeting locations were selected on the basis of residency of Idaho anglers who listed the BWR as a water they most frequently fished in response to a random

sample of license buyers (Reid 1989). IDFG made a concerted effort to publicize the meetings via news releases and radio spots. A discussion of potential proposals was included in most correspondence in an attempt to encourage participation of a broad cross section of anglers.

In response to the scheduling of public meetings, proponents of special regulations mounted a second, intensive lobbying effort directing letters to the Commission. More than 300 letters were received by the Commission requesting special regulations.

In March, IDFG staff finalized regulation options and held the four public meetings. At each meeting, IDFG described the biological potential of the river, its sport fishery, angler profiles, and angler opinions. Modeling results were presented to outline the predicted response of the trout populations to various regulation options. The public was given an opportunity to comment verbally or in writing. IDFG also solicited written comments from a random sample of anglers who had listed the Big Wood as a stream they fished most often. In an unprecedented public response to a local fishery, more than 3,000 comments were received on the proposals.

IDFG staff compiled the results of the comments and applied them in developing a preferred alternative. A majority of the commentors favored some change in the existing angling regulations. Most respondents to the mail survey and those testifying at the public meetings were divided between restrictions prohibiting bait or restrictions allowing bait (Figure 3). Few commentors preferred large increases in catch-and-release regulations. Unsolicited letters favored either no change or bait prohibitions.

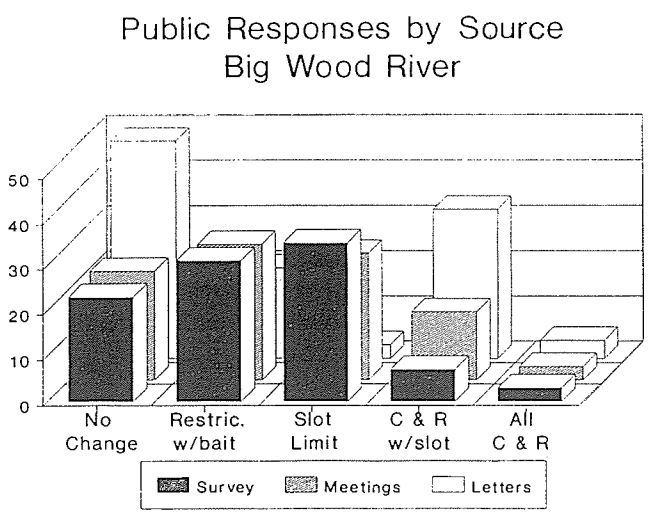

Figure 3. Public responses to proposals for new angling regulations on the Big Wood River, by public meeting attendees, a random mail survey, and unsolicited letters. Restric. w/bait = size and bag limits with bait allowed, Slot limit = with bait prohibited, C & R w/slot = combination of catch-and-release and slot limits with bait prohibited, All C & R = all catch-and-release.

IDFG staff utilized the results of the public hearings and established two goals for the preferred alternative: 1) to enhance the size structure of the wild trout population and 2) to maintain diverse angling experiences and displace as few anglers as possible. The preferred alternative considered both the biological capabilities of the river and the preferences of anglers. IDFG proposed zoning the BWR into reaches based on the biological potential and the existing distribution of anglers using different terminal gear. Four zones were selected: general regulations (6 fish bag limit and no size limit), a slot limit with bait allowed, a slot limit with bait prohibited, and adding approximately 6 km of catch-and-release. Highway bridges were selected as permanent landmarks.

The preferred alternative was presented to the IDFG Commission in April. Citing the complexity of the IDFG staff proposal, the Commission rejected it and approved a proposal which expanded catch-and-release on the BWR from 6 to 32 km. The Commission placed a slot limit on the remainder of the river that allowed bait and required single, barbless hooks.

Immediately following the Commission meeting, opponents of the expanded catch-and-release regulations began to organize and voice their opposition. What began in May 1989 as a local opposition group named the "Wood River and Silver Creek Sportsman's Association" soon evolved into a larger regional group renamed the "Idaho Sportfishing Association" (ISA). The group claimed 3,000-4,000 members and retained an attorney. Within weeks ISA submitted a petition to the Governor of Idaho with nearly 3,000 signatures opposing the new regulations.

On May 24, 1989, three days prior to the general angling season opener, ISA successfully filed a temporary restraining order to prevent the new regulations from being implemented. In the complaint, ISA charged the Commission with acting arbitrarily and capriciously and with not basing their decisions upon competent and substantive evidence. The complaint also charged the Commission with acting "in excess of the statutory authority and purposes" granted them. Judge Phillip Becker concurred and wrote "the Court finds the plaintiffs and others similarly situated will suffer irreparable harm if they are prohibited from fishing in those stretches of the Big Wood River and Silver Creek in which they have traditionally fished.." A June hearing was set to allow attorneys from both sides to present arguments concerning the filing of a preliminary injunction.

In June, the judge dissolved the temporary restraining order and issued a stay to the enactment of new regulations. The judge ordered the stay and gave the Commission until September to respond to the ISA complaint and demonstrate that it used proper findings of fact in arriving at the decision.

The judge also took under advisement a motion of intervention by FBW, the Henry's Fork Foundation, and the Nature Conservancy in support of the Commission ruling. In July, the judge denied the motion to intervene.

In August, the Commission modified its earlier court-blocked ruling. In its new decision, the Commission added 13 km of catch-and-release to the BWR. The new regulations were to be effective on October 1. In response, the ISA filed an amended complaint and successfully blocked enactment of the amended regulations. In January 1990, Judge Becker granted the ISA further hearing on the amended complaint.

In April 1990, after more than a year of litigation and just weeks prior to the angling season opener, a compromise was reached. The new regulations for the BWR maintained some areas with general angling regulations, added a new regulation with a slot limit and 2 fish bag limit allowing bait, and added 13 km of catch-and-release.

DISCUSSION

The controversy over angling regulations on the BWR is a classic example of the difficulty of allocating a finite resource among competing user groups. A number of factors contributed to the conflict and resulted in the legal challenge. Some of these factors may have been unique to the geographic area while others may be common to trout streams across the U. S. An examination of these factors may be instructive for anglers and fisheries management agencies.

Understanding User Groups

The polarization which developed between the two groups intensified the conflict and reduced the potential for reasonable compromise. Much of that polarization was unnecessary because angler interviews on the BWR and the statewide angler opinion survey illustrate many of the basic views of both groups were indistinguishable. Both groups were unfairly labeled and inaccurately described. Members of the FBW were labeled as fly only anglers who released all of their trout when many used flys and lures and occasionally killed trout. Members of ISA were labeled as bait anglers who harvested every trout hooked when members used flys, lures, and bait and many released a majority of the trout they caught. Anglers from both groups were willing to accept more restrictions on harvest if these regulations would increase the size of trout and both groups favored wild trout and believed protection and enhancement of wild trout should receive more emphasis. The major difference between the two groups was the right to fish with their preferred method and the right to harvest some trout. In a similar case on Michigan's Au Sable River, extreme stereotypes were drawn yet the two groups of anglers were indistinguishable on all measured characteristics except two: where they lived, and whether they placed a priority on the right to harvest a fish (Peyton and Gigliotti 1988).

Fishery managers need information to assist them in understanding the impact of management decisions on user groups. In cases such as the BWR, where conservation of trout stocks is not at issue, optimum angling regulations can be based on the biological capabilities of the system and the social preferences of anglers. Management agencies need sociological information to help allocate finite resources among competing user groups and to understand the impact of management decisions on resource users (Orbach 1980). Research is needed to evaluate changes in angler participation and satisfaction after new regulations are implemented. While studies have demonstrated that catch-and-release and other restrictive regulations attract anglers (Hunt 1987, Wells 1987), little attention has been given to anglers that formerly fished waters with more liberal regulations. Important questions remain about the risks of displacing anglers and the fate of those displaced anglers.

Politics and Regulations

Members of FBW were much more organized and effective in lobbying for regulations that met their definition of quality fishing and restricted other types of trout anglers. FBW began its efforts in April 1988, more than a year before ISA was conceived. The group was well organized, established a large network of supporters to solicit support from, and focused its lobbying on the decision makers. Members of the group enthusiastically committed time and as Jackson (1989) observed, became almost evangelistic in bringing their desired regulations to the streams. Despite data to the contrary, FBW members lobbied that the fishery was in jeopardy and the only solution was to implement restrictive regulations that eliminated most bait angling. The group also emphasized that they had worked hard to acquire habitat and restore degraded areas in contrast to bait anglers who they depicted as not working to maintain habitat. FBW also argued that specialized fly anglers contributed substantial amounts of money to the local economy and that special regulations as they advocated would enhance the economic value of the fisheries resource. Members of organized groups as FBW may "capture" agencies and decision makers and exert a disproportionate amount of influence on the decision making process (Gigliotti and Peyton 1993).

Just as Gigliotti and Peyton (1993) observed on the Au Sable River, anglers on the BWR who opposed large

increases in catch-and-release regulations felt alienated from the decision making process. This group did not become organized until after the regulations had been approved. This may have been partially due to their belief that the public meetings provided ample opportunity to influence the decision. As Peyton (1987) observed, citizens who agree with a proposal may fail to take action. The group ultimately chose litigation as the only action available to counter the political influence of the more effective group (Gigliotti and Peyton 1993).

The public backlash generated by the regulations originally adopted by the Commission illustrates the risk of attempting to influence regulations through direct political lobbying. Subsequent to the controversy, two members of the Commission received large opposition to their reappointments. Petitions with nearly 10,000 signatures were submitted in opposition. Much of the testimony before the Senate Resources and Environment Committee, both for and against reappointment centered around the controversial angling regulations the two Commissioners voted for. Within one year, political pressure was successfully applied to add a Commission member from south central Idaho to better represent the views of people in that area.

At the same legislative session, a bill was introduced in the Idaho Senate to limit IDFG authority to enact regulations restricting angling methods. Although the bill remained in committee, it seized the attention of anglers, biologists and managers who recognized the risk of state legislatures dictating fisheries management programs.

Goal Setting

Specific goals need to be established for future fisheries management programs. The recent use of litigation to thwart implementation of special regulations should alert anglers and agencies that goals must be well defined and decisions to implement regulations must be based on facts. In both the BWR and Au Sable River case histories, the presiding judges initially agreed with plaintiffs that regulation implementation was "arbitrary and capricious". To avoid such litigation, it is imperative that goals are clearly established and biological and sociological data supports decisions.

Lewynsky (1986) suggested that continual elimination of bait anglers from special regulation fisheries may be the result of poor goal definition by regulating agencies. Should the goal of special regulations always be to maximize the numbers and size of large trout? Where continued viability of a stock is not an issue, goals for improving the fishery without achieving the "maximum" response may be more acceptable to a larger segment of the anglers. Future trout management will depend on our ability to give people what they want to the extent that the resource can support it (Jackson 1988). Research will play a key role in providing accurate biological and sociological information to assist in setting goals. Once numeric goals have been established (e.g. 20% of the population exceeding 400 mm, catch rates of 1 fish/hr) simulations can be used to predict which management strategies can achieve the goal. Depending on several factors, bait restrictions may or may not prove necessary to achieve such goals.

Bait Restrictions

As more trout waters are closed to bait angling, displaced anglers may be compelled to contest restrictive regulations as they did on the BWR. Prior to the controversy over new regulations, the BWR was one of the few streams in south central Idaho where bait anglers could fish for large wild trout. Currently, more than 1800 miles of Idaho's finest trout streams are managed under restrictive regulations prohibiting bait. The state supports a large group of bait anglers. Eighty-seven percent of active Idaho anglers use bait (Sanyal and McLaughlin 1994) and 42% of active anglers prefer to use bait (Reid 1989).

Additional research is needed to evaluate bait hooking mortality. Supporters of special regulations and many biologists believe hooking mortality from bait is always unacceptable where size limits are implemented and a large portion of the catch must be released. Gear limitations are supported by literature that suggests hooking mortality is substantially reduced with artificial flys and lures (Wydoski 1977, Mongillo 1984). Depending on management goals and other factors however, hooking mortality from bait may be acceptable.

In recent years, several studies have appeared in the fisheries literature documenting the success of size limits or catch-and-release regulations without bait prohibited. In Idaho's South Fork Snake River, a slot limit without bait restrictions has resulted in an 80% increase in the abundance of Yellowstone cutthroat trout and a four-fold increase in the percent of trout larger than 406 mm (Thurow et. al 1988). In Pennsylvania, a no harvest regulation was enacted without bait restrictions. Although bait anglers comprised 38% of the anglers, densities of trout increased and catch rates increased by six-fold (Carline et. al 1991). In Connecticut, catch rates more than doubled after a harvest ban without bait restrictions (Orciari and Phillips 1986, cited in Carline et. al 1991). Turner (1986) reported the use of a size limit without bait restrictions in Missouri's North Fork White River. Although 37% of the angler used bait, after six years, both catch rates and the fall abundance of trout more than doubled. On the Yellowstone River in Montana, the trout

population in two reaches with the same size limit responded similarly although one reach allowed bait and the other reach prohibited bait (personal communication, B. Shepard, Montana Department of Fish, Wildlife, and Parks, 1994).

Several factors including system productivity, natural mortality rates, the ratio of bait anglers, and the location of hooking may influence the importance of bait hooking mortality. In many Idaho streams, conditional natural mortality rates typically range from 30-65% for wild trout stocks (Schill 1991). Consequently many of the trout "saved" by bait restrictions in waters with high natural mortality will not survive and contribute to the next years fishery. Highly productive waters with fast growth rates may be inherently more resilient to hooking mortality. On the BWR, our simulations suggested that even with a "worst case scenario" of 60% bait hooking mortality and 60% participation by bait anglers, management goals for increasing the proportion of large wild trout could be attained. Our simulations on the BWR, and the studies cited above suggest that prohibition of bait angling in restricted harvest and no-harvest fisheries merits reexamination (Carline et. al 1991).

The successful use of restrictive regulations with bait would have widespread application to restoring wild trout fisheries. Such regulations might increase angler acceptance of restrictive regulations and could build support for wild trout management. To achieve the broadest base of support for special regulations, unnecessary restrictions should be avoided (Behnke 1989).

Habitat Issues

Although a compromise was finally attained, the controversy over regulations diverted attention from habitat protection and restoration, the real issue threatening the long term viability of the BWR fish populations. Human induced changes, especially since 1940, have extensively altered channel morphology, instream habitat, and riparian vegetative communities. Most disturbance has been associated with residential and agricultural development of floodplain areas, attempts to control flooding, and road and bridge construction. Studies conducted on the BWR in 1967 and 1968 found more than 22% of the channel had been physically altered (Irizarry 1969). Although legislation restricts activities in stream channels, extensive alterations of all types continue today. Our research documented over 8 times more trout in unaltered reaches supporting complex habitat as compared to altered reaches. Concurrent with floodplain development has been extensive diversion of water for agricultural and domestic uses. Had the energy, time, and finances used during the regulation controversy been applied to protect and restore habitat by strengthening county zoning ordinances, creating protected river corridors, or obtaining water rights, the long term persistence of the fishery would have benefited.

CONCLUSION

Conflicts over wild trout resources could increase in the future as a growing human population with more leisure time competes for dwindling natural resources. Case histories as we observed on the BWR and the Au Sable River raise some important philosophical questions concerning our attempts to manage for the necessary level of diversity (Peyton and Gigliotti 1988):

1. Are agencies responsible for representing less specialized and unorganized anglers who do not effectively lobby for their preferences?

2. How important are the preferences and ethics of traditional user groups in determining management programs?

3. To what degree should agencies consider economics in allocating resources among anglers?

4. Will departments and the public accept the degree of complication necessary to balance the resource and public needs?

These questions must be addressed if resources are to be equitably allocated among user groups. If agencies are unable to mediate conflicts in allocation, the courts and perhaps State Legislative bodies will ultimately decide the fate of wild trout resources.

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growth in the West will continue to place increased demands on the region's natural resources.

This significant population growth has not been matched with comparable growth in trout anglers. Angler numbers for trout, salmon and steelhead have increased slightly during the past decade. This has happened in spite of the droughts and severe habitat problems in many areas. There were about 9.1 million trout anglers in 1991 according to the Fish and Wildlife Service's National Survey of Fishing, Hunting and Wildlife Associated Recreation report. Adding salmon and steelhead anglers results in a combined total of about 10 million. Trout, salmon, and steelhead anglers accounted for over 110 million days fishing in 1991 and spent about $5.3 billion in local economies.

Most of the growth in trout angling has come from a dramatic increase in fly fishing. About 44% of all trout anglers now fish with a fly and spend 27 million days (or about one-third of their fishing days) casting bugs. Fly anglers spend about $1.3 billion annually on their trout fishing.

Trout fishing is no longer a sport practiced predominantly by rural residents. The vast majority of trout anglers now come from the cities. Further, the contemporary fly angler has a relatively short history of fishing. Most new fly fishing buffs started fishing during their 30's and 40's, and surprisingly, a relatively large percentage, about 35%, are female. Waders are no longer being designed only for men with stumpy legs and big feet.

THE PUBLIC INTEREST IN WILD TROUT

Trout anglers, both new and old, are the primary constituents for wild trout. Yet we note that only a small percentage, much less than 10 percent, belong to any type of organized fishing or conservation organization. River-related organizations have recently begun to use endangered fish and decimated fish habitat as a means to accomplish their primary goal of protecting free-flowing and scenic river corridors. This turn of events is much-needed. We can use the help from any quarter. The members of these organizations are predominantly urban-based and will help expand the constituency for protecting and enhancing wild trout populations.

As the nation's population continues to grow and rapidly expand in the west, impacts associated with population growth, industrial and commercial development, agriculture, grazing, mining, and even sport fishing will continue to alter the face of the landscape as public and private land managers respond to special interests and the political will of state and federal politicians who supposedly represent the "public interest."

But, is it in the public interest to allow our watersheds to become so degraded that fish and other wildlife become extirpated? Is it in the public interest to allow special interests to dictate natural resource use and management policy as has occurred for over a century? Is it in the public interest to favor short-term interests for a few over the long-term interests of the many? I think not!

COMPETITORS

Fish and fish habitat are but two concerns across a broad landscape with literally hundreds of other constituent groups vying for recognition and attention; from loggers, mountain bikers, developers and ranchers to fly anglers. The interests of fish, and those who care about them, are but one constituent group. Frequently, the folks within this broad constituent group cannot agree on a course of action to protect and enhance fisheries resources. Further, even when fish constituents are united, they face a formidable array of well-heeled and politically-connected interests constantly trying to undo or counter advances made to protect fish and fish habitats. Conservation is being flanked by small property owners wrapped up in land battles; the building, mining, logging and farming industries; and conservatives seeking to limit the sphere of government influence as a matter of principle.

Recent state and federal court decisions have upheld individual property owner's rights and are redefining "takings" and compensation under the ESA. For the second year, there will be no major environmental legislation passed by the Congress. Mining and grazing reforms are languishing, elevating the EPA to Cabinet-level status is on the back burner, and the Magnusson Fisheries Conservation Act reauthorization is pitifully mired down. In the face of this, there are over 20 bills before congress which would expand or protect private landowner rights from "takings" under current legislation. The Clinton administration is sending mixed messages on the environment and appears to have taken a purely

defensive stance on most issues. With the prospect of extensive changes in the Congress this fall, and with numerous gubernatorial changes as well, the next few years appear to be an uncertain period for the environment.

Logging, mining, agriculture and development interests have their roots firmly planted in legislation and the political process. The Western congressional delegation is not likely to change appreciably in its stance on water rights, range, forestry and agriculture issues. We have witnessed their positions on range and mining reform. Industry has a firm hold on decision making and decision makers. Their organizations are some of the most powerful in the country.

Likewise, entrenched bureaucracies have programs and personnel whose missions support the status quo. Some of these are legislatively mandated, others are regulatory. The actions of the Bonneville Power Administration (BPA) and Forest Service are examples. BPA has been sweeping salmon issues under the dam for decades. Its reluctance to become part of the process for generating solutions has only recently been transformed by the Endangered Species Act and the listing of several runs of salmon as endangered or threatened. Recent Forest Service decisions on instream flows for fish and aquatic life in the intermountain region have sided with water user-wishes and against legal mandates and forest plans dictating protection.

CHANGE AND CONFLICT

Fisheries and other conservation organizations are striving to change the culture of state and federal agencies and the will of politicians. But the social and economic forces at work in states and nationally are well-entrenched and formidable. The greater environmental consciousness of Americans and the shifting of population from rural to urban areas in the West are slowly beginning to have effects on the body politic. In other words, we may have a large constituency for wild trout, but we have been unable to adequately harness the political and economic capabilities of this constituency to work on behalf of wild trout and fisheries in general. In Washington, DC there are few fisheries conservation organizations and of those that exist, the number of issues that can be tackled in the short or long term are extremely limited. Local and regional organizations do not fare much better.

As we have seen recently, wild trout and wild trout habitat are not only besieged by development, agricultural, and industrial and municipal interests, but by traditional supporters of trout conservation. Anglers are at odds with each other over several issues. Some of these program constituents feel management objectives should focus on natural systems and natural system production. Stocking is seen by some factions as a severe detriment to wild trout populations. Other anglers argue that while restoration of natural systems is a laudable goal, it is impossible to accomplish. Further, some systems are generally low in productivity and without active management to enhance productivity, the benefits derived from wild trout streams would be severely curtailed. Other anglers advocate supplemental stocking of local fish reared and grown out in hatcheries. Still others are quibbling over the role of endangered species and the value of razorback suckers versus trout.

Coming up with common-sense solutions, that are scientifically based, is the challenge of trout fishery managers. In some areas, the national Endangered Species Act and local derivations, also conflicts with wild trout management. The mandates from these laws, and attendant regulations, often focuses the attention of new constituencies on wild trout management, particularly when wild trout management adversely affects the recovery effort of an endangered species dear to their hearts. Common sense and logical reasoning is often lost by agencies, organizations, and individuals in the ensuing debate and process over balancing the needs of a single species or all species with the legitimate desires of the public.

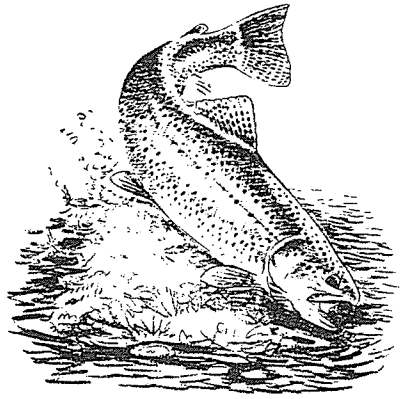
A NEED FOR ACTION

For wild trout to flourish in the 21st Century, the fisheries and conservation communities will need to become much more organized and cooperative in their efforts to protect and enhance fish populations and fish habitat. A broader network of organizations needs to be developed and a mechanism for timely coordination on issues devised. There also must be a concerted effort by fisheries agencies to better educate the urban public about the value of fisheries and fish habitat and the implications of various agricultural, forestry, development, and water-related issues on those values. While these recommendations are being practiced now, a much better job needs to be done in utilizing the meager resources available for competing in the natural resource conservation, use and management arena. Ways need to

be devised for the disenfranchised conservation-oriented public to have their viewpoints expressed to national, state and local elected officials. The will of the public also needs elevating so agency policy makers will know that they will be held accountable for their actions or inactions. It is incumbent upon all of us assembled here to initiate and facilitate the partnerships among individuals, agencies, and organizations to ensure that the changing social, political, and economic structure fosters an environment that allows wild trout to flourish in the 21st century.

In conclusion, I would like to leave you with two thoughts. First, attendees at this meeting and countless others need to be commended for the hard work and great progress on wild trout management. If you step back and look at the record from Wild Trout I through what we have heard here at Wild Trout V, you should be rightfully impressed by: the sophistication and results of the research that has been conducted over the past 20 years; at the changes in management that have protected and enhanced wild trout populations; and yes, at the political gains we have made.

My second thought reflects a very real concern that we are going to be beaten in the political arena where top notch science and management programs often count for little. The ESA has been view as the safety net for the environment. We were wrong in this assumption. It is the courts which are holding the bottom line on the environment. It is truly a grim state of affairs when we have to sue agencies to uphold the laws of the land. We are deteriorating to where we are managing by suits. This is clearly not acceptable.



British vs. American Spending Patterns and Attitudes Toward Wild Trout

Perk Perkins[1]

Abstract — The Orvis Company surveyed its American fly fishing customers who fall among the higher socioeconomic brackets of the trout fishing public. The results confirmed popular notions that the preferences for wild trout rise with the angler's commitment in time and money to the sport. However, it is felt that an angler's enthusiasm for the sport is not dependent on the availability of wild trout and it is the enthusiasm that generates the economic activity. For example, the stillwater market in England (mostly stocked fish) is considered more prosperous than the stream fishing market where wild trout represent a greater share of the quarry.

The American fly fishers' preference for wild trout contrast strongly with the relative indifference of the British and this disparity may be attributable to the contrasting fishing environments. The American trout fishing environment is much more wild and unmanaged than the British and the American preference for wild trout runs much stronger than the British.

The Orvis Company and other businesses that share its niche in the trout fishing industry would like to bias their customers to wild trout fisheries. However the economic reality is that these businesses will pursue the commerce generated by the most active fishery.

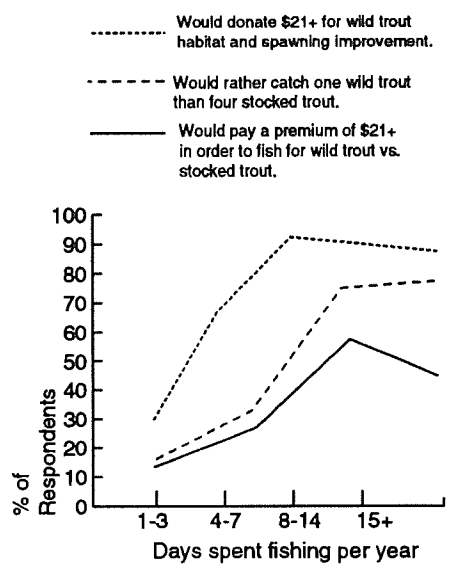
THE SURVEY AND ITS BIAS

The survey was published in a newsletter that goes to The Orvis Company's best fishing customers. These customers are all fly fishers and not a cross section of trout fishers but rather a group from the higher socioeconomic brackets of the market. Those responding to the survey were likely to be motivated by high enthusiasm for the sport and the quality of its fisheries.

ENTHUSIASM, WILD TROUT PREFERENCE AND SPENDING PATTERNS

Respondents to the survey showed a strong preference for wild trout: 42% said they would pay a daily premium of $21+ in order to fish for wild trout over stocked trout; 61% said they would rather catch one wild trout to four stocked trout; while only 28% said they would donate $21+ to support a stocking program, 81% said they would donate that amount to support wild trout habitat and spawning improvements.

Figure 1 — The more active the angler, the more the angler valued wild trout.



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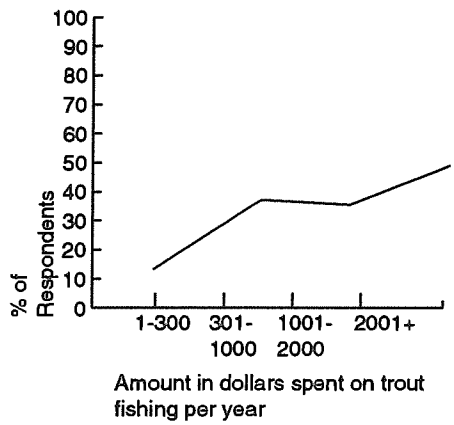

Figure 2 — The more an angler spent on fishing, the more the angler valued wild trout.

THE BRITISH CONTRAST

While a survey was not run among similar British anglers, for two years the author lived in England and fished on many waters with numerous different anglers. Additionally, the author had three ghillies who guided clients on water where catch and release was promoted for the explicit purpose of diminishing the reliance on stocked trout. In general, British anglers much preferred the certainty of taking a brace of trout home to the possibility of building a wild trout fishery. Most of the trout caught were stocked and while visiting Americans usually commented negatively on this aspect of the fishing, the British rarely did.

Much of the trout fishing in England occurs on reservoirs where nearly all of the trout are stocked. It is this stillwater market that is most prized by the fly fishing industry, not just because it represents larger numbers of customers, but because the stillwater anglers are very enthusiastic and inclined to spend as much, if not more money, on their sport than the stream anglers who are more likely to encounter wild trout. It should be noted that the stocked trout observed in England were much healthier and better looking fish than those seen in many parts of the United States, particularly the Southeast.

CONCLUSION

The conclusion drawn is that spending is driven by enthusiasm and enthusiasm is not necessarily driven by the availability of wild trout, though perhaps it is driven by quality trout. Certainly among some of the higher socioeconomic groups of trout fishers in the United States the promise of wild trout can be correlated to higher spending on the sport, but this bias may be influenced by the natural or sporting environment. In the United States, when one goes trout fishing, one conjures images of mountains, wilderness, and the untamed outdoors—this may be the image but not always the reality. However, in England, one imagines well groomed streambanks or pastoral lakeshores. In England, one cannot ignore the careful management that man has had on the trout fishing surroundings and perhaps as a result, wild things are not expected.

Beyond the Pocketbook: Held and Intrinsic Values Associated With Wild Trout

Barbara A. Knuth[1]

Abstract — A variety of values are associated with wild trout. Held and intrinsic values differ from assigned values, which include the worth of trout compared to other organisms or objects. Held values reflect human ideas; intrinsic values reflect the unique worth of the organism itself. Each of these three types of values is part of the environment shaping trout management and research processes. Held and intrinsic values include aesthetic, spiritual, philosophical, educational, ecological, social, psychological, and physiological values associated with wild trout. Understanding the dimensions of each of these values is the first step in understanding more completely the forces shaping wild trout management.

THE IMPORTANCE OF VALUES

What does it mean to value wild trout? Do we value trout because of their importance relative to other fish or other organisms? Do we value them because of the opportunities they provide to people, opportunities for recreation, food, artistic expression, or economic profit? Do we value trout because of the images conjured in our minds when we think about a wild trout in a pristine mountain lake? Do we value trout because of the inherent contribution they make to functioning ecological systems? Do we value trout simply because they exist?

Wild Trout Values Defined

Each of these notions of value is legitimate, relating to one or more of three basic categories of values. Brown (1984) distinguished between "held values" and "assigned values." He and other authors have defined held values as ideas, perceptions, and attitudes about objects.

Assigned values contrast with held values. Assigned values are defined as the worth of an object in relation to other objects (Brown and Manfredo 1987). Assigned values are typically represented with economic parameters. Held values are related more strongly to ideas, behaviors, and experiences, whereas assigned values are more closely related to goods and services (Weithman 1993). Held values may be transformed into statements of preference or relative importance, thus becoming assigned values.

A third type of value is intrinsic value. Such values are not assigned by, nor necessarily perceived by, people. Rather, objects or organisms have value apart from people (Rolston 1983).

The values of wild trout, then, are the qualities that render them desirable or useful, either relative to human perceptions and judgments or as unique organisms unto themselves. The range of values associated with wild trout is part of the environment in which research and management of trout occur. This environment is characterized by the political, economic, sociocultural, and ecological factors influencing how decisions are made (Krueger and Decker 1993). Just as a range of values associated with wild trout exists, the ways in which these values enter into management and research processes will

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vary greatly. Management and research decisions may be driven by maximizing economic return from a particular trout fishery; or by fostering genetic diversity as manifested in certain trout populations; or by providing recreational opportunities for people to experience trout fishing or observation. Each of these desired outcomes reflect values associated with wild trout.

People differ in the extent to which they recognize the various values associated with wild trout. Some may see only assigned values as legitimate, working within a paradigm that views economic transactions as being the ultimate indicator of societal good. Others place great importance on held and intrinsic values. No matter which value orientations are present in the management environment, each has implications for the types of management goals, objectives, and strategies that will be judged acceptable and appropriate.

In this paper, I focus on held and intrinsic values and leave the discussion of assigned values to other authors. Held and intrinsic values that are recognized in management decisions help define the desired human relationship with wild trout, and thus identify appropriate management approaches.

TYPES OF HELD AND INTRINSIC VALUES

A variety of held and intrinsic values are associated with wild trout. Some of these values pertain more strongly to communities and groups within society (e.g., spiritual, aesthetic), whereas others pertain more strongly to individual humans (e.g., psychological, physiological) or trout (e.g., ecological). Each of these values is described in greater detail below.

Aesthetic Values

Aesthetic values associated with wild trout are strongly related to the symbols of characteristics we value as humans (Rolston 1987). Aesthetic values may derive from trout in nature or in natural systems, or trout in art and literature. Wild trout are symbols of pristine environments, of grace in motion, of freedom or excitement to some. Trout have served as inspiration for various forms of art, such as Franz Schubert's musical piece "Trout Quintet." Aesthetic appreciation reflects social values common to a particular culture, and helps build a common language and symbolic system.

Spiritual Values

Spiritual values associated with trout are a type of cultural value that reflect the spiritual and sacred ideas characteristic of a particular group. These values represent a collective feeling toward trout (Weithman 1993). Spiritual values may include ethical beliefs about the treatment of animals, or the culturally-ingrained fear or adulation of trout. Trout may be valued as objects of worship, either because of inherent qualities, or because they reflect the goodness of a greater being. Spiritual values of trout may be manifested in totems, in cultural stories focusing on spiritual concepts, or in worship customs centered around trout or aquatic systems. Those who find spiritual value in wild trout usually identify such benefits as better or more important than other, more material, benefits, such as recreational or educational values (Callicott 1987).

Ecological Values

Ecological values associated with wild trout are related to the role of trout in ecological processes. Intrinsic ecological values refer to the worth of trout simply as a part of the ecological system. Trout may also be valued, however, because of the importance of functioning ecological systems to human well-being (Talbot 1987). Under this conceptualization, the value of wild trout is their contribution to keeping ecosystems functioning well and thus supporting humans. Trout may also be valued ecologically because of their role as indicator species, the "canary" of the aquatic world that warn humans of impending ecological disaster.

Recreational Values

A variety of held values are associated with the benefits perceived from trout-related recreation. These include social values that are concerned with fostering relationships among people, and individual values related to psychological or physiological benefits.

Social Values

Family or community cohesion may be fostered by activities associated with wild trout, for example, fishing, observing trout, or maintaining habitat. Trout may be the main objects that contribute to community

togetherness, pride, or camaraderie by providing a focal point for activities or communication. Social group cohesion may be enhanced through exchange of stories and tales focusing on trout and/or trout fishing.

Trout-related subcultures have arisen within human society, evolving around the use of specific methods for catching trout. These include groups who advocate catch-and-release fishing, flyfishing, lure fishing, or bait-fishing. Social support for management options, such as no-kill zones, may be critical if proposed management programs are to succeed. For example, no-kill regulations in Yellowstone National Park have been effective in extending the catch-related benefits of individual trout to many fishers (Schill et al. 1986). Such regulations would be untenable if a subculture did not exist that values catch-and-release fishing opportunities.

Psychological Values

Psychological values relate to the satisfaction, motives, or attitudes associated with use or knowledge of a fishery (Weithman 1993). Psychological values associated with trout-related recreation include the personal satisfaction provided by interacting with trout, effects on attitude or personality, or cognitive attributes such as deriving pleasure from knowing about trout life history or behavior (Brown and Manfredo 1987; Shaw 1987). The satisfactions gained from trout may include skill development or demonstrating prowess, gaining a sense of self-sufficiency or greater understanding of the natural world, or being able to escape the pressures of the rest of life through fishing for or observing trout.

Physiological Values

Physiological benefits are derived if trout-related experiences lead to improved health or functioning of the human body (Brown and Manfredo 1987). These benefits may include overall conditioning through exercise, or stress reduction provided by the escape from daily routine and associated stressors.

Educational Values

Trout engage our thinking, our fascination, our curiosity about the natural world. The educational values spawned from this engagement are many (Hair and Pomerantz 1987). Trout may have value in educating youth and adults about ecological processes. Fly fishers will be quite unsuccessful if they lack an understanding of the variation in trout feeding habits, and the nuances of insect hatches throughout the year. Trout are an ideal organism for stimulating understanding of ecological relationships across temporal and spatial scales.

Trout have educational value related to acculturation and socialization skills. As noted earlier, various subcultures have arisen associated with trout and trout fishing. Each of these subcultures has associated with it its own social rules. Introducing a novice to the trout fishing experience includes introducing the rules and norms of the subculture. These may be norms associated with human relationships and respect, or norms associated with environmental stewardship and ethics toward fish and the systems in which they live.

Philosophical Values

Philosophical values represent the continuum of held and intrinsic values. Many philosophers would relabel held value as instrumental value, the utility of trout as a means to some end (e.g., physiological benefits to individual humans, aesthetic symbols to human cultures).

Instrumental value, to a philosopher, is contrasted with intrinsic value, the inherent worth of trout as an end in itself (Callicott 1987). Intrinsic value of trout is related to ecological value, reflecting the importance of trout as a part of the biotic community. Intrinsic value, however, is separated from any human perception of worth, and does not require any particular contribution of the organism to the ecological system except that it exists.

CONSIDERING VALUES IN MANAGEMENT

The relative influence of any of these values within a management or research process will depend on the people involved and the decisions proposed. The values people hold within management debates will control which resources receive priority for funding and management, what management objectives and outcomes will be supported, which management actions will be acceptable, and what types of behavior people will exhibit relative to wild trout. If wild trout management is to succeed into the future, all involved with wild trout research, management, appreciation, and use should have tolerance and understanding for

the variety of values associated with the resource they share.

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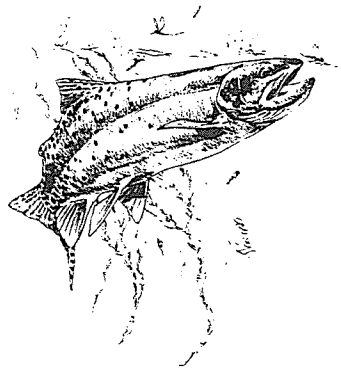

Effects of the "Animal Rights" Movement on the Future of Fishing

Steve Quinn[1]

The modern "animal rights" movement stems from philosophies dating to the 17th and 18th centuries that questioned many standard beliefs of western civilization, based on the Old Testament and ancient Greek philosophers. Peter Singer's book *Animal Liberation* crystallized earlier philosophies and ignited the exponential expansion of this movement today. Animal rights fundamentalists in the United States have commonly attacked animal experimentation, animal husbandry, trapping, and the fur industry. Hunting, circuses, zoos, and aquariums also have been frequently targeted, with fishing receiving far less attention due in part to lack of empathy of humans with scaly poikilotherms. Opposition to use and killing of "sentient" beings means, however, that activists will heighten campaigns against fishing if and when they succeed in restricting activities higher on their agenda. The organization, People for the Ethical Treatment of Animals has been the most vocal in opposing fishing, using demonstrations, articles, and youth education. Other potential threats include legal challenges to management policies of state and federal agencies; formation of "unholy alliances" between animal rights groups and environmental preservation groups or other groups; and indoctrinating youth through formal education and the media.

HISTORICAL PERSPECTIVE

Some of the philosophies espoused by the "animal rights" movement can be traced to the writings of the Duchess of Newcastle, who condemned the human tendency to tyrannize other species in the middle of the 17th century (Jasper and Nelkin 1992). In an essay written in 1789, British philosopher Jeremy Bentham wrote, "The question is not, Can they reason?, nor Can they talk?, but Can they suffer?" in comparing the rights of imprisoned animals with black slaves recently freed by the French government (Singer 1975). Such essays did not gain widespread support during an era when the rights of women, children, and non-whites were much debated.

Scientific discoveries and changing attitudes during the 19th century gave rise to new philosophies and societies for animal welfare. Darwin's theories of natural selection and evolution found support in Victorian England and reduced in the minds of many the barrier between man and animal. Growing popularity of pets led people to view animals anthropomorphically and to treat them better than many humans fared. In the United States, exposes of animal treatment in slaughter houses and in biomedical labs led to the formation of societies like the American Humane Association, which was organized in 1877 as "a national federation of individuals and agencies for the prevention of cruelty, especially to children and animals."

Groups remained focused on animal welfare and the prevention of unnecessary cruelty into the 1970s, when Dr. Tom Regan, a philosophy professor at North Carolina State University published the book *The Case for Animal Rights* in 1973, and Peter Singer, director of the Centre for Human Bioethics at Monash University in Australia published *Animal Liberation* in 1975. They expressed the position that because animals are sentient, that is they experience pain and enjoyment, they deserve the same consideration given to humans. People who deny these rights are called "speciesists," analogous to racists or sexists. Their philosophies have spawned the modern animal rights or animal liberation movement.

Central to this movement is the philosophy that repudiates the dominion of humans over animals.

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This dominion is stated in the Book of Genesis of the Old Testament and was discussed by the Greek philosopher Aristotle in the 4th century B.C. He wrote, "Plants exist for the sake of animals, and brute beasts for the sake of man—domestic animals for his use and food, wild ones for food and other accessories of life, such as clothing and various tools." Rene Descartes, a 17th-century French thinker, often called the father of modern philosophy, expounded on the superiority of humans over animals, citing their immortal soul, conscience, feelings, and capacity for language.

Peter Singer (1975) disparages these philosophies in the opening chapter of *Animal Liberation*, arguing that people are speciesist when they fail to treat all sentient beings with equal consideration. He parallels the battle for equality of species with those for equality of human sexes and races. Animal rights fundamentalists or extremists believe that people should never use animals for their own pleasures or interests, regardless of benefits. Another faction of the animal rights movement, labeled pragmatists (Jasper and Nelkin 1992), believes certain species deserve greater consideration than others, and would allow humans to use animals when the benefits from their use outweigh the animals' suffering. A third faction, the welfarists, accepts most current uses of animals but seek to minimize their suffering (Jasper and Nelkin 1992). Their position, advocated through public education and lobbying has gained strong public support. Societies for the prevention of cruelty to animals are examples. Boundaries blur, however, as the Humane Society of the United States was founded as an animal welfare group in 1954 but now contains animal rights fundamentalists in leadership positions. Most members of the society probably remain welfarists who may not support the radical philosophies of the leaders but continue to provide financial support to the organization.

ANIMAL RIGHTS ORGANIZATIONS

The Wildlife Legislative Fund of America, a non-profit group that promotes hunting and fishing through lobbying, legal defense, and public relations, lists more than 200 groups as anti-hunting (Parsons 1994). The Humane Society of the United States claims about 850,000 members and a budget of about 13.5 million dollars, followed by People for the Ethical Treatment of Animals (PETA) with a 10 million dollar budget in 1992 (Kumar 1993), Friends of Animals 4.1 million, The Fund for Animals 1.2 million and the Animal Welfare Institute at about half a million dollars in 1989, to name several examples (Rempel 1992). PETA has shown dramatic growth in membership since it was founded in the early 1980s by Alex Pacheco and Ingrid Newkirk, increasing from 8,000 members in 1984, to 84,000 in 1987, 300,000 in 1990, and almost 500,000 in 1993. This group, the first one to profess strong opposition to fishing and harvest of aquatic animals, epitomizes the current animal rights movement, with its combination of the old animal welfare tradition and the recent environmental ideology.

ANIMAL RIGHTS AGENDAS

In *Animal Liberation*, Singer rebuked two primary uses of animals—biomedical and psychological research using animals, and animal husbandry. These remain the primary causes of animal rights activists and extremists, though the fur industry including trapping and ranching of fur bearers, and use of animals in testing cosmetics have been placed high on the agenda (Richards and Krannich 1991). Hunting, circuses, zoos, and aquariums have more recently come under attack, and fishing has received far less attention from activists. Animal rights proponents empathize with animals and the degree of empathy seems to increase with similarity to humans. Biomedical research using rats faces less opposition than research on dogs, and that less than experiments on primates. This bias suggests that animal rights activists are themselves speciesist, despite the philosophical positions of movement leaders. Scaly poikilotherms endear themselves little to the general public though the millions of tropical fish hobbyists obviously appreciate the appearance and behavior of fish. For this reason alone, fishing has not and will not attract vehement attack from animal rights extremists, unless they succeed in eliminating practices they find more objectionable, and then turn to fishing. Fundamentalist or extremist animal rights supporters theoretically should oppose even activities like driving a car, in which hundreds of insects may be smashed during an evening drive, since these creatures qualify as sentient under some definitions. Their platforms rarely are consistent, however, and interviewers of animal rights apologists often are amused to report that the interviewee swatted a mosquito.

ATTACKS ON ANGLING

Threats to sportfishing by the animal rights movement stem from the aggressive and multifaceted approach used by these groups in stopping what they consider the immoral and unethical

treatment of nonhuman animals. Activists in this movement, like those in the abortion debate, are emotional, highly motivated, and willing to sacrifice much to shape the law to suit their interests. Animal rights activists have won victories in virtually all battles they have engaged in. The use of animals in laboratories has declined dramatically and is under much greater scrutiny by public and private agencies. The fur industry has taken a severe financial hit and trappers across the country have quit due to low fur value. Zoos and even public aquariums have renovated old exhibits to provide more freedom of movement and more natural conditions. In the farm animal arena, slaughterhouse standards have been imposed and vegetarianism has increased, though major victories have eluded the movement here, likely because of the tremendous fondness of North Americans for meat. Efforts to stop hunting also have met with less success, again due to the strong hunting tradition on this continent, as opposed to the situation in Europe. Yet participation in hunting continues to slide as animal rights activists have made it seem more brutal and less natural, especially to young people and urban residents.

The Animal Liberation Front (ALF) is the most violent of animal rights organizations, and they're credited with over 100 clandestine break-ins and acts of vandalism, since crossing the Atlantic from England in 1979 (Jasper and Nelkin 1992). The media has highlighted raids on labs but targets have included meat markets, taxidermists, fur retailers, and Kentucky Fried Chicken outlets. A bait shop in England was bombed last year.

PETA has been the most vocal animal rights organization in opposing fishing, suggesting that as sentient beings, fish should not be cut off from their furry, warm-blooded brethren in the animal kingdom (Cline 1991; Kumar 1993; Montgomery 1993). "Don't eat sea animals or anyone else with a face," recommends an article about abuse of aquatic life in *PETA News* (Jackson 1993). Although the Humane Society of the United States has no official position on fishing, Dr. Michael Fox, whose title is Scientific Director of the Society, has been a most vocal opponent for over a decade. In an article in *The Animal's Agenda*, he argued that if fish could scream, we'd be less likely to torture them with our sportfishing techniques. And as a veterinarian, he used his knowledge of neurophysiology to suggest that fish not only feel pain but experience fear. As sentient beings, he suggests that fish should have the same rights to a painless existence as cats or chimpanzees (Fox 1987). As for convincing anglers, Dr. Fox needn't have bothered because observant anglers recognize that fish experience pain and fear, though its similarity to human feelings of those names are unknown. A greater threat to the future of fishing is that Fox, Newkirk, and others are attempting to convince the nonfishing public that fishing causes needless pain to animals and that this activity should be restricted or banned.

In England, activists often confront anglers, much as hunters in some areas face protests on opening day of deer season. Last year, for example, protesters on the Avon River attempted to scare fish during a fishing match by creating waves and banging trash can lids underwater, and even emptied keep sacks of competitive anglers. This event was organized by a group called the Campaign for the Abolition of Angling (Anon. 1993a). English protesters also stage "feeding raids" in which they throw bait into fishing waters to make fish too full to bite. Last year, an Englishman was charged with cruelty to tropical fish after leaving them unattended for three days while he was away. The court cleared him of the charges only after he produced a book written by a member of the the Royal Society for the Prevention of Cruelty to Animals, which stated that it was safe to leave fish home alone for up to two weeks (Vincent 1993). At the Maryland Governor's Fishing Tournament two years ago, protesters objected to the "Hooked on Fishing, Not on Drugs" program that seeks to involve youth in fishing and other outdoor activities as an alternative to drug use. The protesters charged that replacing drug abuse with animal abuse is not a viable solution (Cline 1991). In Michigan, protesters attempted to disrupt fisheries surveys on sections of three rivers that used rotenone

In England, as in America, tournament anglers typically release fish after a weigh-in. The fact that fish are not killed in no way assuages the animal rights extremists. PETA urges members to protest at tournaments, suggesting that "Sportfishing entertains at the expense of innocent animals." In Germany, animal rights extremists succeeded in getting a law passed that forbids releasing fish. Apparently, their philosophy is that harvesting fish for food is okay but fishing for sport is wrong (Lindner 1992). A similar movement is underway in Holland (Moquette 1990). These legal challenges are more likely where anglers have become a small non-vocal minority. In most European countries, angling is now practiced by only a small percentage of citizens, due to factors including pollution, difficult fishing conditions, and feudal traditions. The bulk of casual anglers have been lost and with them political clout. Opinions of opposing groups can be

enacted as law unless provisions are made for the rights of minorities. In this country, we must work to sustain interest in fishing by maintaining good fish habitat and fishing opportunities, and through education. Moreover, we must continue to uphold the rights of minorities, including trappers, anglers, and hunters to pursue these pastimes in a regulated manner.

THREATS TO SPORTFISHING

A few members of the outdoor press have been aware of potential threats to fishing from animal rights extremists for over 15 years. In 1978 and 1979, W. Horace Carter wrote a three-part article for *Bassmaster* magazine that outlined the threats to fishing from animal extremists, and the methods they use to change America's outdoor ethic (Carter 1978a; Carter 1978b; Carter 1979). A catalyst for this early concern about the anti-fishing movement was the statement by Jacques Cousteau during a television interview that, "If one enjoys the act of catching fish—sport fishing—then he is suffering a perversion." Efforts to decipher this statement by Carter and *In-Fisherman* publisher Ron Lindner revealed that indeed, Cousteau and his society opposed all recreational fishing though they admitted that in some situations it might be proper to catch and eat a fish. The Cousteau Society emerged as strongly humanist, seeking to alter man's relationships to humans and nature through what they called "values clarification." Their use of grade school curricula to retrain the values of children was particularly unsettling.

Indeed, leaders of the the animal rights movement seem to realize that older generations are entrenched in the traditional bloodsports of hunting and fishing and any plans to ban activities would be strongly opposed. By influencing the next generations away from these activities, however, animal extremists reduce the influence of spokespersons for hunting and fishing, and may be able to restrict these activities. For example, efforts to pass Proposition 200 in Arizona in 1992 finally awoke the sleeping giant. Information efforts by the Arizona Game and Fish Department, Wildlife Legislative Fund of America, American Fishing Tackle Manufacturers of America, and other groups led to defeat by a substantial margin of a bill that could have been manipulated to outlaw hunting and sportfishing, as well as trapping throughout Arizona (Anon. 1993b).

Animal rights groups have sought to remove wildlife management from the province of state natural resource management agencies through the ballot box, since they view management agencies as catering to anglers and hunters (Decker and Brown 1987). By restricting management agencies, they threaten all consumptive uses of resources and many nonconsumptive uses, because these activities depend on management, often intensive management. Agencies have established procedures to prepare environmental impact statements to justify hunting seasons, which should head off most challenges. These defensive efforts have come at a price of time, money, and manpower that hasn't been available to manage wildlife and fish populations. And the democratic process still allows further usurpation of agency authority.

Animal rights activists have expanded the breadth of their attack on hunting, fishing and resource management by using the court system to delay or stymie traditional management on federal lands as well, again sapping the funds of management agencies. Recent suits by the Defenders of Wildlife and environmental groups challenged the compatibility of various uses of wildlife refuges with their intended purpose. As a result, the U. S. Fish & Wildlife Service will conduct a review of all uses and stop those that are incompatible or too expensive. Although hunting and fishing opportunities are not threatened this year, agency officials admit closures are possible. Recent responses to animal rights initiatives by the American Fisheries Society also suggest that biologists are taking the threat of the animal rights movement seriously. Actions include an editorial by the society president (Fetterolf 1993), a panel discussion at a chapter meeting (Kehmeier 1994), and formation of a committee charged with drafting a policy statement for the society (Don Jackson, Mississippi State Univ., personal communication). Several years ago, the American Society of Ichthyologists and Herpetologists approved a document titled, "Guidelines for Use of Fishes in Field Research." It contains some sensible recommendations about collecting and holding fish, but many of its phrases have a rather defensive tone. And I suspect it was prepared, at least in part to head off attacks by animal extremists.

Quinn (1992) noted that animal use standards and other conciliatory gestures may erode the historic license to use animals and serve to strengthen the position of groups that wish to eventually stop all use of animals.

Another threat to the future of sportfishing is formation of "unholy alliances" between animal rights activists and groups within the environmental or wildlife management mantle. Richards and Krannich (1991) found animal rights activists to be

highly involved in the environmental movement and that activists strongly favored protecting wildlife habitat. The temptation may exist for resource managers to enlist the political and financial clout of some groups to accomplish mutual goals for wildlife or fishery habitat. Such alliances will erode the conservation and management philosophy of public agencies and alienate most supporters of management agencies. Some advocates for endangered species might consider cooperating with animal activists on a campaign. Other examples of dangerous alliances are opponents of fishing tournaments aligning with animal rights groups to challenge the ethical or legal aspects of this type of fishing, or harvest oriented angler groups aligning with activists to oppose catch-and-release regulations.

Perhaps the greatest threat to recreational fishing posed by the animal rights movement is the "values clarification" program suggested by Jacques Cousteau more than 15 years ago and now enacted by several animal rights organizations. As I researched this topic in the local library I was surprised to find most titles relating to animal rights, animal welfare, and animal liberation in the section labeled "juvenile nonfiction." Most were efforts to persuade grade-school children and high-school students that traditional uses of animals are wrong. Experiments on lab animals and testing of cosmetics headed the list of targets, since they can be made to seem shocking even to seasoned adults. Authors also take potshots at trapping, hunting, and fishing, and encourage kids to stop eating meat to save animals. Ingrid Newkirk's book *Kids Can Save The Animals! 101 Easy Things To Do* contains an anti-fishing chapter, along with others about saving rain forests, stopping pollution, and other environmental messages (Newkirk 1991). Many nature shows on television also have an anti-hunting bias, which may inspire opposition to other sports that take animals for food and recreation, like fishing. But most insidious is the fact that school curricula have allowed animal rights literature to be presented to children in books, pamphlets, and presentations. Teachers also may convey this message either blatantly or subtly, perhaps even subconsciously. These efforts have eroded participation by youth in hunting and fishing and they will continue to do so, although the recent increase in wildlife and fishery management education efforts and programs to introduce fishing like Project WILD and WILD Aquatic, Pathway to Fishing, Casting Kids, Hooked On Fishing, Not On Drugs, Future Fisherman Foundation and others may help stem the tide. Without new year-classes of anglers and hunters, these traditional uses of wildlife and fish will face further and more effective threats in the 21st century.

In-Fisherman publisher Ron Lindner and Editor-in-Chief Doug Stange coined the term "Selective Harvest" as a fishing philosophy for the future. Selective harvest emphasizes the choice that must be made of whether to harvest or release each fish caught. The decision is based on fish species and size, status of the species in a body of water, and regulations (Stange 1989; Quinn and Reinert 1991). This philosophy strikes a balance between the tradition of harvesting fish for food and the recent realization that we must release most large fish, and fish of certain species in certain water bodies, to sustain good fishing into the future. The harvest component of selective harvest also blunts some charges from animal rights activists that anglers abuse and then release fish for fun. Animal rights extremists, however, oppose killing of fish for any reason and tormenting them with hooks. Indeed, articles in PETA publications ask children to urge angling parents to refrain from tormenting animals used for bait, if they won't forego fishing altogether. Thus selective harvest may lessen or eliminate attacks on fishing by the pragmatist and welfarist segments of the animal rights movement. Fundamentalists will continue their assault, however, if and when issues of greater urgency to them are resolved in their favor.

The key to ensuring that these extremists do not infringe on the rights of anglers, hunters, and other stakeholders is informing the public about threats to traditional conservation philosophies. The perception exists that animal rights activists are loony bunny huggers or old ladies with too many cats. Instead, most are young to middle-age, dynamic, well educated, articulate, affluent, and deadly serious about changing the way society operates, including the way we use animals. The angling public and the public at large must become more familiar with the history of the animal rights movement, its changing philosophies and agendas, sociological and demographic aspects of activists (Decker and Brown 1987; Sperling 1988; Richards and Krannich 1991), and its methods of values clarification. With this knowledge, people with other philosophies or beliefs will rally to prevent this small minority from forcing their will on us all.

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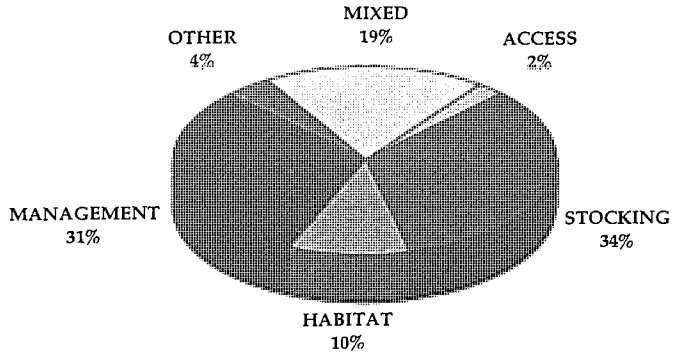
funding, so long as it is substantial in character and design. "Substantial in character" generally means that the state must demonstrate a substantial need to undertake the project. "Substantial in design" generally means that a project must be technically sound and competently designed. If a proposed project meets these criteria, and passes through an array of minor tests related to other federal laws such as the Endangered Species Act and the National Environmental Policy Act, the Division of Federal Aid will likely approve it.

Sport fisheries research and management, boating access development and maintenance, aquatic resources education, habitat enhancement, technical assistance, hatchery construction and operation, and land acquisition are all allowable types of projects. Some activities (aquatic resources education, boating access) have mandatory expenditure guidelines. Other types of expenditures (law enforcement, public relations) are prohibited. Generally, states have wide latitude to undertake projects that address their sport fish priorities.

Coldwater Expenditures Under Wallop-Breaux



Within the fish management community, the Wallop-Breaux program has enjoyed widespread support. Its most ardent defenders have strived mightily to prevent changes in the program or redirection of its funds for other purposes. Nonetheless, some changes have been made. New funds were added and dedicated to wetlands conservation. Money was reserved for pumpout facilities in coastal states. Now, debate over the tradeoffs between stocking and wild trout management have assumed a higher profile in the fisheries community. State and federal fisheries managers recently discussed this issue last spring at a "Wild Trout, Planted Trout" workshop in Denver. The use of hatchery stock, native and wild trout, genetic purity and fish health were all key issues discussed by attendees. Managers at the workshop felt that a better balance was needed between hatchery stocking and wild trout, with habitat loss and genetic loss identified as the problems of the greatest importance. As managers confront these issues, there has been increasing concern about the role of the Wallop-Breaux program in balancing wild and stocked fish, and on the emphasis given to the immediate creation of fishing opportunities as opposed to long term fisheries restoration programs.

These debates have also begun to attract interest from beyond the traditional Wallop-Breaux constituency in the fisheries management community. The public, Congress, and the outdoor press have all begun to take a closer look at Wallop-Breaux. Those expressing opinions on program priorities have ranged from Ted Williams of *Fly Rod and Reel*, who wrote that "biodiversity . . . is crumbling all around us while we do things like build fish cleaning stations," to the Sport Fishing Institute, which argued, "the Wallop-Breaux program has been an undeniable success in providing more fishing opportunities . . . [it] is not specifically designed to protect biodiversity."

As a sport fish "restoration" program, one can argue that Wallop-Breaux should place greater emphasis on the restoration of wild sport fish and their habitats, as opposed to providing short-term recreational opportunities through hatchery production for put-and-take stocking. Before entering the debate about program emphasis, however, we felt the need for a better assessment of the current balance between program activities.

WALLOP-BREAUX ACCOUNTABILITY STUDIES

Today, ten years after the passage of the Wallop-Breaux amendments, sport fish restoration apportionments to the states total nearly $200 million annually. The amount of funding has raised a great deal of interest from the public, Congress, and internally at the FWS.

In response the tremendous growth in the Sport Fish Restoration Program and the increased public emphasis on managing habitats for diversity in fisheries, the Division of Federal Aid released a Draft Supplemental Environmental Impact Statement on the program. The draft EIS included baseline data on program expenditures from 1985

to 1991. The report showed 14.5% of expenditures directed to hatchery and stocking programs, 37% to research and surveys, and 3.9% to habitat management. Habitat was a small piece of the picture compared to hatchery funding, while the largest investment was in research and survey work. The Division did not attempt in its review to highlight hatchery and habitat emphasis within categories such as research and surveys, area and facility maintenance, and technical guidance.

Congressional interest also resulted in an independent review of the program. In February of 1992, members of the House Committee on Merchant Marine and Fisheries requested that the General Accounting Office (GAO) examine the administration of the Wallop-Breaux program. One area in which the committee members expressed particular interest was program expenditures for native freshwater fish and for protecting and restoring fish habitat. The GAO reviewed five states (California, Florida, North Carolina, Texas, and Washington) and indicated that between 3 and 24 percent of the total program funds had been spent on habitat projects. The GAO would not offer more precise estimates because the Sport Fish Restoration record keeping system made it difficult to determine the amount of funds used for habitat, hatchery or any other types of projects.

Following the GAO effort, Trout Unlimited initiated a study of salmonid restoration activities from 1989 to 1993 (McGurrin et al., 1994). The TU study revealed a major emphasis on hatchery and stocking-related activities. These activities accounted for 40% of projects reported and 42% of funds reported for salmonid restoration. While some of the expenditures for hatcheries were dedicated to native trout and salmon restoration, this component of hatchery work was relatively small (less than 10% of the total hatchery projects and expenditures). The study also noted the need for more and better information on program expenditures in assessing program emphasis.

The GAO report and earlier TU study highlighted the difficulty of assessing the complex array of activities funded under the Sport Fish Restoration program. We experienced many of the same problems in our analysis, made even more difficult by our more specific focus on coldwater resources. Given the difficulty of trying to determine what managers intended to do with Wallop-Breaux, we did not even attempt to look at the program's unintended effects—negative impacts on wild and native fish from stocking and other activities funded under Wallop-Breaux. Several authors have documented the adverse effects of improperly planted fish on native biodiversity (Williams et al. 1989, Miller et al. 1989). Others have suggested that activities funded through Dingell-Johnson (such as introduction of sport fish species outside their native ranges and the release of hatchery fish in habitats supporting wild fish) have exacerbated the loss of freshwater biodiversity (Wilcove et al., 1992). While our analysis does not examine negative impacts of Wallop-Breaux activities on wild trout populations, they should be kept in mind as part of the overall picture.

SPORT FISH RESTORATION EXPENDITURES ON COLDWATER ACTIVITIES

In an effort to build upon the Division of Federal Aid, GAO, and earlier TU reports, the authors of this paper reviewed coldwater Sport Fish Restoration projects listed under the Federal Aid Information Reporting System (FAIRS). The Division of Federal Aid established FAIRS in order to provide better information on program activities on a national level. The FAIRS database includes information such as project goals and benefits, project costs, and target species. The quality of project data available in FAIRS varies widely between and within states, but it provides the best national picture of Wallop-Breaux available.

Using FAIRS, the authors assessed grants and studies from the past three years (FY 1992 to FY 1994) that predominantly addressed coldwater fisheries. Boating access grants were not included in the review, as those funds are dedicated under law (12.5% of allocations are to be spent on boating access). Our interest was in the use of discretionary funding. In all, over 1,100 projects from 40 states were included in the review. Total expenditures on these projects exceeded $150 million.

Using the project descriptions offered in FAIRS, projects were classified according to their area of emphasis. The categories used were:

1. habitat projects (including such activities as habitat assessment; stream enhancement; land acquisition for habitat protection; and land use reviews);

2. hatchery activities (including rearing and stocking of fish; assessments of stocking success; techniques development; and associated genetics and fish health research);

3. management projects (including general biological research; development of regulations; and population and utilization surveys not directed specifically toward assessing habitat or hatchery activities);

4. public access, not including boating access funds (including facilities maintenance and land acquisition for fishing access); and

5. other projects such as aquatic resource education and general program administration.

Many projects contained multiple components. Where one component was clearly the primary focus of a grant or study, the project was assigned to that category. Where no primary focus could be identified, the project was assigned to a sixth, "mixed" project category. Nearly 15 percent of projects (representing 19 percent of funds) were classified as "mixed."

Ultimately, healthy and abundant wild trout populations depend upon good habitat. Meeting a growing demand for high-quality wild trout fisheries will require significant efforts in protecting healthy habitats and rehabilitating degraded ecosystems. As a result, we hoped to observe relatively high levels of expenditure on habitat projects, consistent with the program goal of sport fish restoration. Our results, however, reflected a national emphasis on stocking and hatchery-related activities rather than habitat management.

Hatchery-related activities received approximately 34 percent of funds allocated to coldwater restoration. Some of these expenditures were dedicated to native trout and salmon restoration (for example, rebuilding stocks of Arctic grayling, lake trout, and Atlantic salmon). Other funds supported studies on the genetic interactions of hatchery fish with wild trout. However, despite ambiguities in the FAIRS data, it was apparent that the largest share of coldwater hatchery funds was directed to maintenance stocking.

By contrast, only 10 percent of coldwater restoration funds were directed to habitat-related activities. General management activities received 31 percent of coldwater funds. Fishing access and other activities accounted for a relatively small part of coldwater expenditures (two and four percent, respectively). As noted earlier, 19 percent of coldwater funds were dedicated to projects that could not be assigned to a category of primary emphasis.

The results of the coldwater assessment are consistent with the data on overall habitat expenditures presented in the GAO review; the GAO did not assess the level of hatchery-related expenditures. The FWS review of overall expenditures indicated lower levels of funding for both habitat and hatchery-related activities. This is likely due to two major factors. First, the FWS did not attempt to categorize research and survey work, land acquisition, or facility development and maintenance done in support of hatchery or habitat activities. Secondly, the FWS review included boating access funds, resulting in lower percentages for all non-access activities. The ratio of habitat to hatchery funds is very close for the FWS and TU reviews (3.7 to 1 compared to 3.4 to 1). The results of both reviews suggest that there is a much greater emphasis on hatchery work than on habitat improvement in Wallop-Breaux expenditures. There are several possible reasons for that observed emphasis.

First, salmonids are extremely popular game fish and are often brought into areas where they cannot be self-sustaining—for example, in seasonal fisheries in southern states or in tailwater releases from reservoirs. In those situations, coldwater anglers depend on hatcheries for their recreation.

Further, salmonids require high-quality water and habitats in order to thrive. Most historical salmonid habitat has been altered and degraded to the point that it can no longer support wild production, or can only support much reduced levels of production. In the face of such obstacles, recreational fisheries may come to depend upon the hatchery product to provide plentiful angling opportunities. In some areas, habitat degradation may be so severe that restoration sufficient to support fishable wild salmonid populations may be beyond ecological or political possibility, at least in the short term. In those situations, hatchery production may be viewed as the only option for maintaining coldwater recreational fisheries. However, the continued use of hatchery production to address a habitat management problem remains a "band-aid" approach, focusing on the symptoms of the problem and not the causes. It should not be viewed as a long-term solution.

Angler perceptions may also support a greater emphasis on hatcheries than habitat. In a hatchery, anglers can see the fish being added to a system; the benefits (in terms of catchable fish) are clearly visible and immediately available. Increasing fish numbers through habitat restoration requires greater patience and may be more a matter of faith—"if you build it, they will come." Unfortu-

nately, many involved in habitat restoration (including TU) have paid too little attention to evaluating the success of habitat projects in increasing fish populations and fishing opportunities, aggravating this perception problem.

Finally, inertia is a powerful force supporting a continued hatchery emphasis. "That's the way we've always done it" is often the reason things get done in a given way. It is more difficult to generate change than to maintain the status quo.

WILD TROUT MANAGEMENT IN THE SPORT FISH RESTORATION PROGRAM

While hatchery-related activities have been a major focus of the Wallop-Breaux program, many states have supported valuable wild trout management and restoration activities through Sport Fish Restoration. For the three years examined, we found 19 states that used Federal Aid funds to finance projects specifically designated for wild trout management (out of 40 states that funded some coldwater activities). These and other states also used Sport Fish Restoration funds for a variety of other habitat and management activities that benefit wild trout populations. The following projects illustrate the range of benefits the Wallop-Breaux program can offer for wild trout, when states dedicate resources to that purpose.

Back from the Brink

Some members of the angling community have expressed concern that endangered species protection and recreational fishing are coming in conflict. This need not be the case. There are several examples where managers have brought at-risk species back to levels where they can provide outstanding recreational fishing opportunities. The Wallop-Breaux partnership can play a valuable role in such recoveries, as demonstrated by California's work on the threatened Little Kern golden trout.

As a result of introductions of non-native trout, pure forms of golden trout were reduced to five remnant stocks occupying only ten miles of streams in the Little Kern drainage and one stream outside the drainage. Hybridization with introduced rainbow trout constituted the main threat to the continued existence of Little Kern golden trout. Habitat in the Little Kern watershed remained suitable for this native fish.

The California Department of Fish and Game, funded in part through Sport Fish Restoration, implemented a strategy of chemical treatment. Barriers to fish passage (sometimes artificially constructed) were used to separate areas containing pure golden trout and downstream areas retaining introduced trout. Working downstream section by section, state employees treated the stream segments between barriers with rotenone to remove the non-native fish. Pure golden trout from endemic or restored populations were transplanted into the treated sections. Hatchery production was sometimes used to provide additional golden trout for reintroduction. Usually, naturally reproducing populations were reestablished within three years of treatment.

Little Kern golden trout are well on the road to recovery. With help from Wallop-Breaux, golden trout have been restored to over 70 percent of their critical habitat, and should be ready for delisting before the turn of the century (Christenson 1994). California anglers are already enjoying the unique opportunity to catch this attractive fish in its natural habitat.

Public Access and Wild Trout

Many recreational anglers place high value on wild trout fishing opportunities, and Wallop-Breaux can provide funds to ensure that productive wild trout fisheries are available for pubic enjoyment. Access projects are often costly, and the enhancement of state funding through Wallop-Breaux can make such projects possible in many areas where they would not be otherwise. Pennsylvania's recent acquisition of lands along Spring Creek is a case in point.

Spring Creek is a high-quality limestone stream running through central Pennsylvania, near State College. The creek became a truly outstanding wild trout fishery after Pennsylvania eliminated stocking and instituted a no-harvest policy for the stream in 1982. A local entrepreneur purchased and consolidated significant sections of streamfront property along the popular trout stream. Then, those sections were posted and public use was eliminated on nearly two miles of the stream. A couple of years later, a local TU member noticed a for sale sign on the streamfront property. The Pennsylvania Fish Commission quickly began to investigate the possibility of purchasing the land to ensure public access. After negotiating with the seller, the Commission sought approval from the state legislature to purchase the land for $1.3 million. Time was of the essence, as private fishing

groups were already looking into buying the land for themselves.

The Commission persevered and, using Sport Fish Restoration to supplement state funds, purchased 130 acres of land to provide access and protect this stretch of outstanding wild trout waters. As a result, anglers can (and do, in large numbers) enjoy public access to one of the most productive trout waters in the region.

Volunteers for Wild Trout

The angling and conservation constituencies that support protection and restoration of fisheries resources are a valuable asset that state agencies should tap. Using volunt eers not only reduces labor costs, it builds a more active and informed constituency for fisheries conservation. Moreover, under the Wallop-Breaux program, volunteer labor can be used as in-kind match for federal dollars—a valuable bonus in small states that may be pressed to come up with matching funds. Although Oregon does not need to use volunteer labor as match, they have used Wallop-Breaux funds to establish an outstanding statewide volunteer program, the Salmon and Trout Enhancement Program (STEP).

The Oregon legislature established the STEP program in 1981, with the goal of restoring native stocks of trout and salmon to historic levels of abundance. Wallop-Breaux and state dollars provide core funding for the program. Ten regional STEP biologists work around the state to coordinate volunteer activities in support of salmonid conservation. Volunteers are trained and given technical assistance for activities such as population surveys, habitat improvement, and streamside incubation. Interested teachers are trained to educate students about fisheries conservation and lead them through on the ground activities benefiting trout and salmon. Throughout the state, the program has raised awareness of the value of restoring and conserving native salmonids.

While many states use volunteers with specific Wallop-Breaux projects, the STEP program has the advantage of providing a central, visible coordinating point for volunteer efforts. STEP enhances public awareness of volunteer opportunities and how to get involved. The popular program also provides a place for corporations and other donors to direct monetary and in-kind donations for salmonid restoration.

Public interest in STEP has been tremendous. From October 1992 to September 1993, 16,992 people participated in STEP projects, donating 98,862 hours of time. Volunteers surveyed 416 miles of stream. Using volunteers made Oregon's Wallop-Breaux dollars stretch further for fisheries conservation, and helped build a stronger constituency for the restoration of native trout and salmon.

Partnerships for Habitat Enhancement

Those of us who work with fisheries often talk about the need for watershed approaches to fisheries conservation and restoration. However, addressing the issues critical to restoration of large sections of stream and their watersheds requires partnerships among a wide range of parties that have a stake in watershed management. Sport Fish Restoration dollars have helped launch such a partnership on the Upper Manistee River in Michigan.

The Michigan Department of Natural Resources teamed up with the State Department of Military Affairs (who owns land along the river), the Soil Conservation Service, local soil and water conservation districts, county road commissions, Michigan Trout Unlimited, the Huron Pines Resource Conservation and Development Area Council, and the Manistee and Upper Manistee River Associations. These groups formed the Upper Manistee River Restoration Committee, dedicated to restoring the Manistee's fishery and recreational potential. The Committee has supported activities to curb streambank erosion, remove excessive streambed sediment, improve public access, enhance streamside vegetation and repair previously installed habitat structures that were in need of maintenance.

Excessive sediment input has been a major problem for the Manistee. The Committee has used a variety of approaches to address this obstacle to wild trout productivity. Rock structures and revegetation have been used to shore up unstable banks at more than three-quarters of the problem sites inventoried. Six instream catch-basins have been installed to capture excess sediment. A new timber bridge was constructed to replace the existing, erosion-prone bridge crossing. Over 600 stream structures have been inspected and repaired where necessary.

The results have been gratifying. Electrofishing counts for 1993 showed brook trout levels of 881 lbs/acre, up from 585 lbs/acre in 1988. Catch rates have climbed from 84 trout/100 hrs to 158 trout/100 hrs. Sport Fish Restoration dollars played a central role in making this successful partnership possible.

Urban Wild Trout Fisheries

For many people, urban fisheries means catching hatchery-produced fish stocked in an environment where natural reproduction is probably impossible. The people of Rapid City, South Dakota, however, enjoy a tremendous wild trout fishery running through the heart of town. Sport Fish Restoration helped finance the habitat improvement activities that made this unusual urban fishing experience possible.

Channelization of Rapid Creek in the city had reduced the length from 42 km to 12 km (Glover 1994). In the wake of a devastating 1972 flood, Rapid City established a greenbelt along Rapid Creek through the city. In subsequent years, the South Dakota Department of Game Fish and Parks and its partners have conducted a series of ten stream improvement projects along 19.3 km of Rapid Creek, in order to enhance habitat for the wild brown trout that resided in the stream. Sport Fish Restoration funds contributed to several of the more recent of these projects. The following two projects, while conducted earlier than those funded through Wallop-Breaux, are indicative of the types of activities completed through the cooperative effort, and tremendous fishery results obtained.

A variety of techniques were used to narrow the stream channel, restore some of its natural curvature, and provide greater habitat diversity for trout. In the Sioux Park area, nine wing deflectors, five bank covers and three riprap areas were used, with sod placed over the structures to hasten the revegetation and restore a more natural appearance. Brown trout populations along this stretch increased 43% from 1978 to 1990 (Glover 1994).

In the Baken Park area, a 1978 Corps of Engineers project had increased stream width from 9-11 m to 27-39 m. Using wing deflectors and riprap, South Dakota Game, Fish and Parks restored the stream to its natural width and enhanced habitat diversity in the stream. Revegetation helped restore a natural appearance. The results were even more marked than in Sioux Park: increases in brown trout populations of 200% from 1978 to 1993 (Glover 1994).

Sport Fish Restoration funded additional projects along Rapid Creek that have helped build upon these successes. Rapid City now enjoys a first-rate urban trout fishery—without the use of stocking.

These projects reflect the good news: many states are using Sport Fish Restoration dollars in innovative ways to enhance wild trout and salmon resources. The bad news, however, is that such efforts remain far too rare. As the FAIRS data shows, hatchery activities retain a *position of primacy in coldwater Wallop-Breaux expenditures.

THE FUTURE OF WILD TROUT AND SPORT FISH RESTORATION

There has been a great deal of talk about trout management "going wild," with an increased emphasis on activities to benefit natural production. Actions, however, have changed more slowly than words when it comes to the Sport Fish Restoration program, and hatchery production continues to receive far more attention than long-term habitat restoration work. Further change is needed to shift the emphasis from hatchery production to projects like those just described, empowering wild trout management under Wallop-Breaux to achieve its potential.

A two-pronged approach is needed. First, we should strive to reduce the negative impacts of ongoing hatchery activities on wild fish—ensuring that short-term solutions are not undercutting long-term restoration. At the same time, we should invest in wild trout management and habitat protection and restoration so that coldwater fisheries are less dependent on hatchery production. A greater emphasis on wild trout management will provide enhanced angling opportunities into the future, and in the case of native trout, conserve the unique genotypes of salmonids adapted to specific aquatic systems. The authors offer several recommendations which we believe offer potential for accomplishing those objectives.

- Hatchery programs funded by Wallop-Breaux should operate under a state hatchery plan which would undergo programmatic environmental assessment to determine overall impacts on wild fish and cost-effectiveness compared to non-hatchery restoration activities. Hatcheries, when they are carefully used in restoration programs and in recreational fishing programs that avoid impacts on wild and native fish, can be a valuable management tool and work in partnership with wild trout management. Environmental assessment would highlight potential problems and provide the basis for an improved understanding of the role of hatcheries and stocking programs in aquatic ecosystems.

- Scientifically-credible standards and guidelines for sound hatchery management should be integrated into hatchery programs funded through Wallop-Breaux. The guidelines on the use of cultured fish in aquatic ecosystems that are currently being developed by the American Fisheries Society may offer an appropriate starting point for such Wallop-Breaux stocking guidelines.

- Wild trout professionals and advocates should continue to educate anglers and managers on the opportunities for and benefits of wild trout fisheries. Changing attitudes is the surest way of changing management activities, both under Wallop-Breaux and through other programs.

- Dedicated funds should be provided for state habitat conservation activities. A program requirement that dedicates existing Sport Fish Restoration funds for habitat projects seems unlikely, as state agencies would resist new funding earmarks that could reduce funding for ongoing state activities. However, the development of *new* Wallop-Breaux funds dedicated to aquatic habitat activities would increase the visibility of such projects and ensure a stable source of funding for habitat conservation. Funding could be apportioned among all states, or a portion could be allocated through competitive grants with an emphasis on watershed approaches to habitat conservation.

These recommendations offer some means through which the Sport Fish Restoration program can support an increased emphasis on habitat conservation, wild fish management and responsible use of hatcheries in appropriate situations. Attaining these goals will depend on the insights and contributions of fisheries professionals, political leaders, and most of all, the angling public. We can make a bright future for wild trout under Wallop-Breaux, if we accept the challenge.

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The Future of Native Trout Fishing in the U.S.

If These Are "Our Good 'Ole Days" Then We Are In A Heap of Trouble

David A. Nolte

Will there be native trout fishing in the United States (U.S.) in our future? The author examines his own fishing roots and discusses some of the broader issues regarding native trout species. The future is now. The decisions we make today will determine our immediate resource future and the future of other generations. Through innovative fishery management, cultural and economic change and involvement by a spectrum of citizens will we ensure the integrity of native salmonids in the future.

Since the beginning of Wild Trout Management (Wild Trout I) in 1979, resource managers, anglers and non-anglers alike have awakened to the importance of native salmonids in our ecosystems. **We know that native fish are valuable for more than just fishing. Native fish hold a myriad of values, some yet to be discovered, which serves to remind us of the power, complexity and beauty of our natural world.** In a way it may seem self-serving to discuss the future of native trout fishing in the U.S. But this discussion is not just about fishing. It is about preserving native trout for those who prefer to observe fish, rather than catch them. It is about protecting the watersheds' health and enhancing water quality.

The future of native trout fishing in the U.S. lies in our past experiences, our vision for the future and our actions of the present. It is only through our ability to adapt to the changing needs of our environment that future generations will also learn of the power, complexity and beauty of the natural world. I believe my experiences as an angler and as a participant in affecting change to my environment are important in reflecting upon the future of a sport fishery for native salmonids.

THE AGE OF DISCOVERY

When I was 11 years old and living in Southern California, I discovered the joys of fishing, thanks to an aunt and uncle who took my brother and I to Ft. Bragg, California, on their annual salmon fishing trip. I caught my first huge silver salmon there. It was a real awakening. I was hooked.

After that trip, I sensed that my father, born and raised in Pennsylvania, missed those outdoor experiences while trying to provide for his family in a rapidly growing urban environment called greater Los Angeles. It was time for us to share this together. And so we did...the best kinds of memories anyone can have about their father.

I remember the first fishing outfit that I purchased with my summer job lawn mowing money—a Sears closed faced reel and fiberglass pole. I remember seeing the hatchery truck move up the road on the West Fork of the San Gabriel River, watching those youngsters and adults yarding trout out of a poor excuse of a river before artificial fish had a chance to breathe the remaining wildness of a river. A river that was physically challenged by man's greedy resource habits. I knew then that the picture I saw before my eyes was wrong.

At age 14, I remember discovering the joys of fly fishing and catching my first native rainbow trout on the West Fork of the San Gabriel River above Bear Creek, a mighty 5-incher that took a drowned dry fly fished downstream. Holding that living jewel in my hand, while trying to capture its beauty in a "Kodak Moment" memory, I wasn't aware of the biology of the being as much as thinking what a damn fine fish it was and that all was well with the world if I could find rivers with trout in them.

By sweet 16, fishing was better (or so I thought) than sex. I told my older brother that I'd still have that favorite flyrod long after he lost his favorite girlfriend. I guess back then I was naive enough to think that high quality trout waters filled with native fishes—like virgins, would always be in demand.

[1] Bring Back the Natives Program Coordinator, Trout Unlimited, Redmond, Oregon.

By 18 I was thrust into the realities of school, jobs and life in the urban fast lanes off and on for fifteen years. Work and travels took me away from those meandering slow lanes of life we call trout streams During that time, I visited many countries and experienced many cultures. Yet, the vastness, the openness and the beauty of the American landscape was always on my mind. And I often wondered, "Will it still be there when I return? Will there be native trout on the West Fork of the San Gabriel River?"

Now, involved as a grassroots volunteer with Trout Unlimited and as program coordinator for the National Fish and Wildlife Foundation (NFWF), U.S. Forest Service (USFS), Bureau of Land Management (BLM) and Trout Unlimited (TU) Bring Back the Natives Program (BBN), I am in a position to find out.

BACK TO THE FUTURE

Remember the movie with Michael J. Fox as Marty and Christopher Lloyd as Doc titled, "Back to the Future?" It seems only they are aware of a mistake in time. Things are really screwed up. Together they used "best science" to tinker with time in order to correct the problems and "set the clock back." I don't think they really completely knew what needed fixing or how to fix it, yet in the end, and after three movies, they succeed. Sound familiar?

In a way, we are trying to set the clock back for our environment through a variety of actions, including implementation of several important concepts—biodiversity and ecosystem management. It is a very centric attitude to think that we have all of the abilities and plenty of time to tinker with planet Earth in order to correct the abuse we continue to heap on it. It shouldn't take a rocket scientist or a member of Congress to figure out that we do not.

So, how do we set that clock back? It will take a longer term vision than the next political election. From our experiences to date, we cannot just rely on the government to always do what is right. Marshall McLuhan once said, "Politics offers yesterday's answers to today's problems." If we are to have a future for native trout fishing we must require government land managers to take a higher road in natural resource management. That road should include quite an innovative thought—how about us all erring on the side of the resource for a change? It should include a better understanding of natural processes that include us as part of the process, not as the dominant user. In addition, we need innovation not just in the areas of biological science, but in natural resource administrative management. Such innovation must be pervasive. In Federal agencies like the USFS and the BLM, administrators, accountants, and support staff must understand new concepts such as ecosystem management and biodiversity and apply them to how they do their job. They should be part of the process of change, not just the 'ologists. Collectively, public resource staff must set the example. They mus prove to the public that biological diversity and ecosystem management are not just the current fashionable buzz words but a path for true human sustainability.

This will take long-term vision and capable planning. Peter Drucker, futurist in his own right, reminds us that "Long-range planning does not deal with future decisions, but with the future of present decisions." The future is now. The decisions we make regarding our ecosystem are everyone's future.

And make decisions, make them now! Decision making involves risks. It won't be easy, but look at the alternatives. The landmark paper by Willa Nehlsen, Jack E. Williams and James A. Lichatowich, "Stocks At Risk From California, Oregon, Idaho and Washington" includes 214 naturally spawning stocks in which 101 are at high risk of extinction, 58 at moderate risk of extinction, 54 of special concern and 1 classified as threatened under the Endangered Species Act of 1973. And we haven't even considered resident salmonids and important non-game species such as sculpins, suckers, minnows and darters. By this type of grim estimate, I'd better do my retirement fishing now. How do we distinguish our needs from our greeds?

One process that can help identify our needs is direct and meaningful involvement in the process of resource restoration by a biodiversity of partners—local government, concerned citizens, organizations, state agencies, private businesses and other federal agencies.

Reforms are needed in many areas of natural resource management. Like reinventing government, we have to reinvent our public land resource institutions to better serve the biological needs of all creatures.

We cannot continue to permit the short-term vision of consumptive greed to drive the ecological locomotive. That is one huge train wreck waiting to happen!

GREED

"Then the Americans came—more greedy because there were more of them. They took the lands, remade the laws to make their titles good. And farmholds spread over the land, first in the valleys and then up the foothill slopes..."

John Steinbeck, "East of Eden."

"The canneries themselves fought the war [World War II] *by getting the limit taken off fish and catching them all. It was done for patriotic reasons, but that didn't bring the fish back. As with the oysters in Alice, 'They'd eaten every one.' It was the same noble impulse that stripped the forests of the West and right now is pumping water out of California's earth faster than it can rain back in. When the desert comes, people will be sad;"*

John Steinbeck, "Sweet Thursday"

These two excerpts from one of my favorite authors reminds me of a concept quite alien to most Americans—that we are living far beyond our means when it comes to use and sustainability of our natural resources. So what are we going to do about it? One way to address this issue was recently shared by Andy Kerr, Executive Director of the Oregon Natural Resources Council (ONRC). Their mission: to aggressively defend Oregon's wild lands.

In a recent speech marking the 22nd ONRC Conference, Mr. Kerr talked about a 100-year plan for Oregon. He emphasized the importance of biological diversity. He stressed the importance of all of us living within our ecological and economic means (note which one is first). He talks about sustainable population—is it quantity of humans or quality of life? He stresses family values, societal change. He mentions the fact that we all seem to work more but really we need to work less—worker productivity has increased but workers have not measurably benefited. I could not agree more. I'd love to have a bit more time to go fishing! Mr. Kerr's most important statement describes our evolutionary challenge:

"The evolutionary challenge is whether we, as a species, will evolve to have the wisdom to practice, something no other species has ever done or had to do, that is to practice willful self-restraint. We must learn to live within our means, both economic and environmental. We must be concerned about the quality of our people, not the quantity of people."

According to Vicki Robin, co-author of "Your Money or Your Life," the U.S. represents 5 percent of the world's population but consumes 30 percent of the world's resources. Each of us uses energy equal on the average to that of 6 Mexicans, 14 Chinese or 38 people in India. We continue to hope for that scientific or technological fix, but it may not happen.

What we need to do for a start is what just happened on September 9, 1994 when the U.S. 9th Circuit Court gave an opinion that elevates salmon and fishery interests. It ordered that fishery interests be given as much weight as dam operations and industrial users. The Pacific Northwest power and industrial base are crying foul. Fishery supporters are cautious but pleased.

"I think the federal courts are interpreting the law with an eye toward higher principles. Those higher principles are, quite frankly, the laws of nature, what it is a species like salmon really need and what the power act was really intended to do."—Ted Strong, Director of the Columbia River Inter-tribal Fish Commission

As a ratepayer for NW power, I won't mind a rate increase if it preserves anadromous fisheries. Increased rates will spur conservation, new technologies and new business opportunities.

THE RULES HAVE CHANGED

"As the last forests are felled in the forest strongholds like the Philippines and Ecuador, the decline of species will accelerate even more. In the world as a whole, extinction rates are already hundreds or thousands of times higher than before the coming of man. They cannot be balanced by new evolution in any period of time that has meaning for the human race"

E.O. Wilson, "The Diversity of Life," 1992.

Clearly, the rules have changed. The rules that the U.S. has used to manage its resources is affected by international-level actions. American societal values are clearly changing. Humankind's penchant for modifying its environment in a not so sustainable manner is well documented. As Issac Asimov stated, "Things do change. The only question is that since things are deteriorating so quickly, will society and man's habits change quickly enough?" So like it or not, we are stuck with ourselves. This is really at the heart of the matter. If we are to preserve native fish for the future, whether for fishing, viewing or non-use, we must recognize, as Lewis Thomas stated, that "We are in fact the masters—like it or not."

We have to live with ourselves and what we make of Planet Earth. It will take a radical departure, as Mr. Kerr suggests, in order to make change happen. It will take all of us to do it. We have to find new mechanisms to provide opportunity to implement new resource management concepts on the ground, restoring entire watersheds and riverine areas while coalescing a broad spectrum of partners.

BRING BACK THE NATIVES

One program, now in its third year, is attempting to do so. Bring Back the Natives is an initiative funded by the National Fish and Wildlife Foundation, Washington, D.C. This key national aquatic program is the first national campaign combining two major federal agencies, the USDA-Forest Service and USDI-Bureau of Land Management, with partnerships including state agencies, local organizations, private businesses, citizens and Trout Unlimited. The program focuses on restoring the health of riverine systems and the repopulation of native freshwater species. Currently there are 27 projects being funded, with a projected FY95 grant of $500,000+.

The National Fish and Wildlife Foundation's interest and support of *Bring Back the Natives* lies in the program's integration across administrative and functional boundaries to restore ecosystem health. Almost 69 percent of the threatened and endangered fishes in the U.S., more than one-half of the fishes that are candidates for Federal listing, and many vulnerable aquatic invertebrates reside on multiple-use lands managed by the USFS and BLM.

Project criteria includes:

- An ecological approach to stream and watershed restoration and or cooperative efforts with state agencies to reintroduce native aquatic species, coupled with revised land management practices that eliminate the cause(s) of degradation.

- A major segment of the habitat of a species stock or community complex so as to have a significant impact on the overall status of the species and the ecosystems on which they depend.

- The participation of partners (e.g. state, local, tribal and non-governmental organizations, businesses and individuals; particularly those who can contribute non-Federal dollars and non-Federal professional services and or materials to assist with matching the NFWF grant.

- Watersheds managed by USFS and BLM Contact the author at (503) 923-3344 or facsimile (503) 548-FISH; or Andy Martin, BBN Program Administrator, NFWF (202) 857-5690, for more information regarding the BBN program.

Is the program meeting its goals? Well, we haven't fixed it all yet. There are many federal land managers out there that have not yet embraced these new philosophies. There are federal land managers out there who just don't get it! Sometimes local land managers need to be reminded that actions speak louder than words! We often times than not, are still out there employing multiple use with a dominant use flavor. We are not yet "erring" on the side of the resource.

Our state fish and game agencies do not provide sterling examples of attitude supportive of wild fish management either. How many have a wild fish management plan, and are attempting to implement it? However, as Dr. Ray White, fisheries consultant pointed out in a presentation at the 1990 Trout Unlimited National Convention, things are looking up. He sees three major trends at work in fisheries management:

- increased willingness to change in resource agencies

- increased guidance from basic sciences in stream fishery management.

- increased recognition of recreational values by managers and agencies.

Just this year, a broad spectrum of state, federal agency, private consultants and other fishery experts met in Denver, Colorado, to discuss wild trout versus planted trout. Some of the issues described in the Proceedings of the Workshop, Wild Trout and Planted Trout—Balancing the Scale:

- The effects of stocking on native varieties of salmonids are inconsequential.

- Are native trout preserves, reserves, or refugia for recovery of interior western cutthroat a realistic fisheries management option?

- The future of the resource is most important, not who has the primary authority for its management. State, federal and private interests must work together. How can this best happen?

Programs such as Bring Back the Natives do provide federal land managers with low-risk opportunities to implement ecosystem management, to view management at a watershed level, to incorporate new partners including private businesses, landowners and citizens.

And what about the rest of the American society? The burden of change does not just rest on scientists, biologists and resource managers. The jury is still out on the American public. Yet, when Southern California was in a severe drought several years ago, the surburbanites responded far better to water conservation measures than the agricultural interests. So there is hope.

Change scares the hell out of people because it almost always requires doing something new. But the consequences of continuing our old Earth habits are even scarier. As Margaret Mead reminds us, "We won't have a society if we destroy the environment."

THE FUTURE IS NOW...

It will take more than the biologists and scientists to ensure that we have native fish around for the 21st century. And it won't be easy. In our society we still have Generation X, the wayward souls of today, Yuppies who still think we are living in the "Me Generation," the Baby Boomers who might be more concerned with the status of Social Security than native trout, the Respected Elders who believe they have paid for it already and are more interested in their next RV stop, and sundry other "Type-A" personalities that identify with fast-lane concrete and towering cityscapes rather than wilderness landscapes and clean, flowing rivers. When pondering about the modern generation, sage Bill Vaughn noted, "It's hard for the modern generation to understand Thoreau, who lived beside a pond but didn't own water skis or a snorkel."

Yet, the future is now. The leadership shown in the tackle industry by the Orvis Company is an excellent example. We should all be familiar with the generous support Orvis has given recently for the Blackfoot River. Orvis now has committed to raising $150,000 to restore the Henry's Fork Outlet, a significant headwaters reach of the Upper Henry's Fork. They'll be working with The Nature Conservancy, the Henry's Fork Foundation and the National Fish and Wildlife Foundation.

For information regarding this important restoration project, or other Orvis-supported efforts, write Orvis at The Nature Conservancy and Henry's Fork Fund, Orvis, Dept. L.R., Rte. 7A, Manchester, VT 05254.

The Coors Brewing Company has, through its national Pure Water 2000 program, provided funding to support the wise stewardship of our natural resources. Since its inception in 1990, the Coors Pure Water 2000 program has provided more than $1.5 million to more than 600 water resource protection projects. Many of these projects include support for Bring Back the Natives projects. For information regarding the Coors Pure Water 2000 program, call 1-800-TO-COORS.

There is also a relatively new program that promotes watershed-level restoration. The National Fish and Wildlife Foundation, in partnership with the U.S. Fish and Wildlife Service (USFWS), has a new initiative, "Fisheries Across America." This national fisheries program is providing the means to establish partnerships between the USFWS, NFWF and the private sector to restore and protect naturally functioning aquatic ecosystems and the organisms that exist there. It focuses on the restoration and protection of native aquatic species and their natural habitats. Contact Gris Batchelder, Program Coordinator at NFWF, (202) 857-0166 or Doug Alcorn, USFWS, (703) 358-1718 for further information or grant application.

And lest we forget, our future lies in the grassroots membership typical of organizations like Trout Unlimited. It's 75,000+ members contribute their time, resources, knowledge and cash towards restoration, protection and enhancement of our coldwater resources. Trout Unlimited provides its members with over $100,000 annually through its Embrace-A-Stream grant program, which supports projects on research, education and restoration of coldwater fisheries. It also provides a mechanism for corporate sponsorship of fisheries restoration through the Coldwater Conservation Fund.

...IF WE JUST DO IT

Change at the local level is powerful. Through education of the community and the future recipients of our resource "trust fund" lies the future of trout fishing in the United States.

So, will we have a future where fishing for native salmonids are possible? I believe so. It will take time. It will take money. It will take a national will to change. The value of native salmonids lie deeply rooted in Native American culture and far beyond what we, as Americans, envision. We too can launch upon our own Age of Discovery to enhance our understanding of these species and their relationship with the natural world. Surely such enlightenment will benefit our society.

We must be innovative! Through initiatives like Bring Back the Natives and Fisheries Across America, Government can provide the spark. But it will take other private and public partnership involvement if it is to truly succeed.

Finally, we must remind ourselves not to be driven by crisis. Our future is in our hands now. Our generosity to ourselves will determine whether we exist beyond the 21st century.

I hope that, in the not so distant future, I will return to Southern California and walk the eight miles or so up the West Fork of the San Gabriel River to see those native rainbow trout still there, still serving as a mirror of the quality of life that we all seek.

ACKNOWLEDGMENTS

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A State Perspective On The Future of Fishing For Wild Trout

Larry G. Peterman

Wild Trout, as a management philosophy, has been active in Montana for over 20 years and has produced some remarkable fisheries. The angling experience has also changed, largely due to overcrowding on many of the more popular waters. The fisheries management program of the future will need to be diverse and dynamic in order to continue to provide the opportunity for Wild Trout. It will require a strong habitat and native fish management component. It will also need to provide a diversity of angling opportunities for the angling public. Finally, we need to learn to manage overcrowding and social conflict on our Wild Trout waters.

Wild Trout, as a management philosophy, has been active in Montana for over 20 years. During those 20 plus years, we have seen some remarkable fisheries develop; fisheries that have received national attention and attract anglers from across the continent as well as international anglers. We have also seen some equally significant changes in the individual fishing experience itself on those Wild Trout waters.

It's probably safe to say that there will be equally dramatic changes in the future. So, what does the future for Wild Trout hold? What will it look like when we get there? More importantly, how do we get there in the first place?

I will begin by stating the premise that we know how to develop and manage for Wild Trout populations. That should be obvious from the last two days' presentations. We talked about what a Wild Trout is, the importance of habitat to Wild Trout and the economic aspect of Wild Trout. We know, for instance, that Wild Trout populations are absolutely dependent on quality habitat and to manage for Wild Trout fisheries one needs to spend most of the time concentrating on maintaining or restoring that habitat. That habitat consists of good physical streambank and streambed conditions, adequate instream flows, cold water temperatures, and clean water. We know that the watershed and the condition of that watershed play a vital part in maintaining quality stream conditions; so we recognize the need to look beyond just the immediate bed and banks of the stream.

But, we know how to do that. We may not always have adequate statutes to protect the habitat, and there will always be opposing interests that will have to be dealt with, and sometimes we will lose. But, more often, we will win, and I think that if we look down the road, the optimist in me says we will see that the changes in habitat conditions will probably be for the better. The realist in me says that it will be an uphill battle in the face of increased demands for our resources and increased population pressures. For purposes of this discussion, I will be the optimist. As such, I believe you will see, although very slowly, traditional users of our rivers and watersheds becoming more sensitive to the river's values. You will see more efforts going into restoring damaged watersheds in order to have the kind of values that Wild Trout bring to an area. And you will see a greater recognition of the values of a healthy aquatic ecosystem from society in general. Probably one of the more significant habitat concerns in the future will be not from the

traditional agriculture and timber uses, although they will always be major players, but from the new influx of people who purchase this land for the natural amenities it provides. Home development, subdivision and the like will be a major challenge because they are attracted to the river bottoms and have a significant potential to damage the very resources that attracted them there in the first place.

These are things that we already know about managing Wild Trout populations. While there are significant challenges to be overcome in this arena of habitat preservation and restoration, it probably contains no real surprises. We pretty much know what needs to be done, and the arena we are working in, whether it be stream protection laws, water quality laws, instream flows or hydropower regulation. Most of us are knowledgeable and comfortable working in these settings.

While we know how to manage for Wild Trout populations, I am not so sure that we know, or are very adept at, managing the Wild Trout fisheries themselves. I use the term fisheries to include - angling pressure, the overcrowding situation on many of our streams, angler etiquette, and motorized watercraft conflicts. Since Wild Trout management began in the early '70's in Montana, the experience of Wild Trout fishing on many of our major rivers has changed dramatically. That change is largely due to the extremely crowded conditions we now find on rivers like the Madison, Big Horn and Missouri. While there is a fairly large and reasonably competent body of information available on the management of Wild Trout populations, we are only now beginning to struggle with the management of the angler component of the fisheries and the problems associated with increasing popularity of flyfishing and wild trout fishing on western rivers.

In order for a state to have an enduring Wild Trout program, the focus needs to be broader than just Wild Trout. Let me give you some thoughts on several aspects of what I think an overall state fishery management program needs to have in order to perpetuate the quality Wild Trout fishing experience in the future.

First, and we have alluded to it before, you need a strong habitat component in the program. It is absolutely essential to maintain and enhance cold water stream fishery habitat if we are to preserve these fisheries in the future; and I think there is growing support for that.

Second, we as managers and anglers, need to address the issue of overcrowding and lack of fishing etiquette on our major Wild Trout waters. We have seen, just recently, fishing pressure quadruple on some of our more popular streams over a period of only a few short years. A decrease in angler satisfaction is directly correlated with increased crowding. Much of this may be inevitable. However, we need to collectively, on our more crowded rivers, determine what type of angling experience for Wild Trout we wish to have and how much regulation or lost opportunity we are willing to accept to have that experience. It is one thing to fish for 18 inch trout on the Missouri River with the sun going down and the caddis flies hatching, looking up at the canyon walls and watching the river go by on some warm July evening, yet it is quite another to be in that same spot in that same place and struggling to find a spot to get off the bank and down the river just to fish. It is one thing to fish the Big Hole River some fall morning watching the mist rise from the river and having the sun peek over the canyon walls; it is quite another to sit on the bank of the Big Hole during the salmon fly hatch and try to time your casts so they fall in between some of the 150+ boats that are going to float by your spot in a matter of a day's fishing. Those are two entirely different experiences in the same place fishing the same fish population. We can predict that the future

will hold Wild Trout fishing opportunities, perhaps even more than it holds now. We also can predict, however, that that experience may not be anything like it is today, unless we make a combined effort to address the social aspect of a wild trout fishery.

Another aspect of a fishery program which has a strong Wild Trout component is that the fishery program must offer a diversity of fishing opportunities. We have heard that Wild Trout fishing is akin to almost a religious experience; that there is something spiritual about being on the river in the early morning, watching the mist rise and floating your fly down through your favorite hole. Not all people who fish, however, are religious fanatics or deep into spirituality. Many people who fish just like to fish. They fish to catch fish and they fish to keep fish and they love it as much as those of us who love to flyfish on our favorite stream. There needs to be fishing opportunities for those individuals who probably form the bulk of the fishing public to enjoy their sport. Those fishing opportunities are often supported by hatchery fish. Odd as it may sound, a good Wild Trout program is dependent in most areas on a good hatchery program. Take, for example, the case where in Montana about half of the fishing is stream trout fishing, nearly all of which is Wild Trout fishing. The other half is lakes and reservoirs. Probably half of those lakes and reservoirs are dependent upon some type of hatchery supplementation to provide an adequate fishery. Without those opportunities available, those people would fish somewhere else. Many of them would wind up on Wild Trout rivers adding to an already crowded situation.

The Wild Trout management program of the future will also need to have a strong native fish management component. This is necessary for a couple of reasons. First, most of our inland western Wild Trout fisheries are not native trout fisheries. They are for brown trout, rainbow or brook trout which were introduced near the turn of the century. Some of those fisheries are at the expense of our native fisheries, our cutthroat and bull trout. To maintain a Wild Trout fishery, it is essential that we have a strong native fish program which rebuilds our native stocks and prevents the complications arising from an ESA listing. We should also be striving for maintaining and developing opportunities to fish for our native species. While our native species cannot stand nearly the fishing pressure or harvest levels that the non-native trout populations can, we should have a program which provides that opportunity as part of our heritage.

In summary then, what does the future of fishing for Wild Trout look like. We know how to manage for Wild Trout populations. I am not sure we have mastered the management of the fisheries themselves. The growing popularity of Wild Trout fishing may be the very thing that most threatens the quality of the fishing experience itself. We collectively need to make a conscious effort to address this issue. The fish management program of the future needs to provide a diversity of opportunities for those anglers who are not Wild Trout enthusiasts. The fisheries program of the future also needs to have a strong native fish management component which assures survival and prosperity for our native fish species and the opportunity for them to be part of our Wild Trout fishery.

Recovery of the Greenback Cutthroat Trout, A Success Story

William P. Dwyer[1], Charlie E. Smith[1], and Bruce D. Rosenlund[2]

Abstract—The greenback cutthroat trout *Oncorhynchus clarki stomias* is indigenous to the South Platte and Arkansas River drainages on the east slope of the Colorado Rockies. Human development, habitat destruction, and the introduction of exotic species caused the subspecies to be eliminated from most of its native range. A recovery plan was initiated and in 1977, 66 fish were removed from Como Creek (Colorado), one of the two remnant populations known to exist at that time, and transferred to the U.S. Fish and Wildlife Service Fish Technology Center in Bozeman, Montana. These fish were used to develop a captive broodstock population. From 1979 through 1992 over 382,000 fry were returned to Colorado for reintroduction into native habitat. Sperm from wild males was used to maintain the wild gene pool at Bozeman. Electrophoretic and asymmetric analysis were used to monitor the genetic integrity of the population. To date, 135 kilometers of stream and 93 hectares of lakes and ponds have been repopulated with fry from the captive broodstock program. This represents 19 reproducing populations. Most restoration projects are open to catch and release fishing.

HISTORICAL BACKGROUND

The greenback cutthroat trout *Oncorhynchus clarki stomias* is indigenous to the headwaters of the South Platte and Arkansas River drainages within Colorado and Wyoming. This subspecies originated several thousand years ago when a headwater tributary in the Colorado River Basin became connected to a headwater stream on the South Platte River drainage. This connection allowed the Colorado River cutthroat trout *Oncorhynchus clarki pleuriticus* to cross to the east slope of the continental divide and establish populations from which the greenback cutthroat trout evolved and later moved into the Arkansas River drainage. Reports indicate that greenback cutthroat trout were once abundant in all mountain and foothill streams along the Front Range of the Colorado Rocky Mountains. However, by the 19th century their abundance had drastically declined. Starting in the 1800's, habitat destruction, and the introduction of exotic species such as brown trout *Salmo trutta* and rainbow trout *Oncorhynchus mykiss* (Behnke 1979) caused the subspecies to be eliminated from most of its native range, with less than 2,000 known to remain by 1973 (Dwyer and Rosenlund 1988).

The greenback, like many inland subspecies of cutthroat trout, does not coexist well with nonnative trout species. The stocking of brook trout *Salvelinus fontinalis* in high elevation streams resulted in the loss of many greenback cutthroat trout populations.

In 1889, David Star Jordan (Jordan 1891) was sent by the U. S. Commissioner of Fish and Fisheries to survey the streams of Colorado and Utah. Jordan noted that deterioration of water quality due to placer mining and stamp mills had rendered water of otherwise clear streams yellow or red with clay and had made the streams uninhabitable for trout. Many parts of the Arkansas and Grand Rivers had been ruined as trout streams by

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mining operations. He also reported that irrigation and habitat loss had taken a substantial toll as noted in the following paragraph:

> In the progress of settlement of the valleys of Colorado the streams have become more and more largely used for irrigation. Below the mouths of the canons (sic) dam after dam and ditch after ditch turn off the water. In summer the beds of even large rivers (as the Rio Grande) are left wholly dry, all the water being turned into these ditches...

He goes on to say,

> Great numbers of trout, in many cases thousands of them, pass onto these irrigating ditches and are left to perish in the fields. The destruction of trout by this agency is far greater than that due to all other combined, and it is going on in almost every irrigating ditch in Colorado.

The greenback cutthroat trout was extirpated from most of its natural range by the early 20th century, and Greene (1937) considered it to be extinct. However, when the U.S. Endangered Species Act was passed in 1973, small native populations of the rare greenback cutthroat trout were known to exist in Como Creek and the South Fork of the Cache La Poudre River tributaries in the South Platte River drainage in Colorado. These populations inhabited 6.4 kilometers of streams and numbered about 2,000 individuals. Meristic characteristics of fish sampled from these populations conformed to characteristics of type specimen collected in 1856. Due to the small size of these populations, the subspecies was listed as "endangered" in 1973. To facilitate recovery efforts, the greenback cutthroat trout was reclassified as "threatened" in 1978.

OBJECTIVE

The goal of the U. S. Fish and Wildlife Service's (USFWS) Greenback Cutthroat Trout Recovery Plan (USFWS 1993) is to improve the status of the subspecies so that it can be removed from the threatened species list. The fish will be considered recovered when 20 stable populations are documented within its historic range. The 20 stable populations must include 50 hectares of lake and pond habitat and 50 kilometers of stream habitat. A minimum stable population is defined as 500 fish over 120 mm separated from other fish populations by barriers. The minimum area is 3 hectares with at least 22 kilograms of fish per hectare with at least two year classes established within 5 years.

RECOVERY EFFORTS

In order to reduce the amount of time required to accomplish the goal and reestablish fishable populations, the Greenback Cutthroat Trout Recovery Team requested that captive broodstocks be established to produce fry for stocking restoration projects. The first captive broodstock population came from the South Platte, Como Creek population in 1977 and was held at the Fish Technology Center (FTC), Bozeman, Montana. Attempts to establish captive greenback cutthroat trout broodstocks had not been successful in 1889 or 1957, so populations were also established with fish from the Arkansas River drainage at a private ranch (McAlpine Pond) in Huerfano County and at Ft Carson military reservation (Lytle Pond) both in Colorado.

In later years the broodstock has been maintained by using eggs from greenbacks at the FTC and sperm from wild populations in Hidden Valley Creek, Como Creek, Hunters Creek, and the Poudre River.

The potential problem of using only genetic material from Como Creek and Como Creek restoration projects was recognized and dealt with. Deformities such as short operculum, short peduncles, and bent jaws were noted in 2-5% of the fish. These occurred most frequently in fish populations founded by direct transfers from Como Creek. To prevent loss of variation by genetic drift and founder events within the Bozeman broodstock, milt from the Hidden Valley and Como Creek populations was used since 1982. Using milt from wild fish and repeated stocking of the restoration area for 3 years minimized the loss of genetic diversity.

To determine the level of genetic variation within and the extent of genetic diversity between populations, electrophoretic and asymmetry analysis of four populations were completed in 1986. Results of the electrophoretic analysis showed statistically significant differences in allele frequency among the four populations sampled which were founded from Como Creek stock. The suspected cause of these differences is reduced genetic variation caused by founder events and genetic drift (Leary et al. 1984, 1985). The asymmetry data supported this contention also (R. F. Leary, University of Montana, personal communication). Gametes were introduced from the Hunters Creek and Poudre River populations into the Como Creek broodstock in 1982. Proebstel (1993) examined fish from the broodstock and determined that the efforts to increase the genetic diversity were

successful. His conclusion was based on variability of basibranchial teeth counts and spotting index, along with reduction in percentage of fish with deformed caudal regions.

CURRENT STATUS

Over 342,800 fry have been returned to Colorado for introduction within the South Platte River drainage as specified in the Recovery Plan. With the captive broodstock held at the Bozeman FTC, sufficient eggs and fry have been supplied to meet the requests of the recovery team. Fry and yearling fish, originating from the captive breeding programs have been used to restock 95 hectares of lakes and ponds and 121 kilometers of stream habitat where non-native fish were chemically removed. Currently, 78 hectares of lakes and ponds and 78.1 kilometers of stream habitat are open to catch-and release fishing. The recovery goal for the greenback cutthroat trout is 20 stable reproducing populations, with 19 stable reproducing populations documented through 1992.

Although restoration efforts have shown much success, two major actions need to be completed before the species can be delisted. The program has almost achieved the 20 stable populations criteria, but there are only two in the Arkansas River drainage and delisting will not occur until there are five populations there. Therefore, three additional stable populations must be established in the Arkansas River drainage. Second, it will also be necessary to develop a long term management plan and a cooperative management agreement for the greenback cutthroat trout to guide the management after delisting.

Fish culture facilities can serve well as refugia for captive populations of rare or endangered fishes. The use of fish culture to perpetuate endangered species is a valuable management tool and progeny can be used to repopulate reclaimed indigenous areas. However, this is not a solution unless the cause for decline is remedied. The role hatcheries play in the recovery of endangered fishes is only as good as the availability of suitable habitat for reintroduction (Rinne et al. 1986).

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Are "Pure" Native Trout in the Mid-Columbia River Basin?

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Abstract - In light of the growing interest in the status of wild native salmonids, we began to document the remaining populations of "pure" native resident trout in tributaries of the Mid-Columbia River basin. We chose an eclectic approach to identifying these trout by applying both classical and molecular taxonomic methods. Preliminary results for the Methow River drainage, one of the three watersheds surveyed in this study, are presented for all collected species of trout; only results on bull trout are presented for the Wenatchee and Entiat River watersheds. Populations of bull trout (*Salvelinus confluentus*), westslope cutthroat trout (*Oncorhynchus clarki lewisi*), and redband rainbow trout (*O. mykiss gairdneri*) were identified primarily in headwater tributaries and lakes. Knowledge of populations of "pure" native salmonids will assist managers in making informed decisions on such topics as supplementation or stocking efforts, Endangered Species Act and habitat restoration issues, and harvest regulations.

THE CHALLENGE OF LOCATING OUR NATIVE TROUT

Increasingly during the past five years, the public and fishery professionals have voiced concern about the status of "wild" native salmonids throughout the Columbia River basin. In our part of that basin, fishery managers have recognized the paucity of information concerning the distribution and taxonomic descriptions of native salmonids. With the advent of increased federal listings of salmon and trout as threatened or endangered and proposed supplementation of declining fish stocks, we embarked on an effort to reduce this gap in information for native resident trout in the Mid-Columbia River Basin (MCRB). This paper presents preliminary results for all trout species sampled in the Methow River watershed and for bull trout from the Wenatchee and Entiat river drainages.

Project Location and Historic Trout Species

The Mid-Columbia River Basin (MCRB) management area is bounded to the west by the North Cascade Mountains and to the east by the Columbia Plateau. This portion of the Columbia River basin refers to the mainstem and its tributaries between the Grand Coulee Dam, near the Canadian border, and the confluence of the Columbia and Snake rivers. The project included sample sites in the northern part of the basin: the Methow, Entiat and Wenatchee watersheds. Naturally occurring trout in accessible reaches of these three watersheds were depleted by the 1930's. In response to a perceived recreational need, excessive trout stocking programs were initiated. Although stream stocking of resident trout no longer is employed in the state of Washington except in a few select areas, stocking of trout in high mountain lakes continues to occur. The long term stocking history of these watersheds confounds documentation of the distribution of "pure" native trout in the Mid-Columbia River basin.

The upper tributaries of the MCRB historically supported three species of non-anadromous or resident salmonids: bull trout (*Salvelinus confluentus*), westslope cutthroat trout (*Oncorhynchus clarki lewisi*), and interior redband rainbow trout (*O. mykiss gairdneri*). Other

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salmonids native to these systems include mountain whitefish (*Prosopium williamsoni*), pygmy whitefish (*P. coulteri*), and four species of anadromous fishes including steelhead trout (*O. mykiss*). In general, the resident trout species partition the aquatic habitat along an altitudinal gradient, with bull trout and cutthroat trout in the uppermost reaches and resident interior redband rainbow trout in the lower gradient reaches. The MCRB differs from many inland areas of western North America where typically only one species of trout is native.

Cutthroat Trout

It is possible that Yellowstone cutthroat (*O. c. bouvieri*) were the first to inhabit the Columbia basin, and the entire Snake River basin, based on relict populations in Crab Creek and Waha Lake (Behnke 1988, 1992). If this is true, Yellowstone cutthroat were displaced by westslope cutthroat in the Salmon, Clearwater, John Day, and Mid and Upper Columbia River drainages, which were subsequently replaced in many areas by interior redband rainbow trout (Behnke 1992). Exactly how westslope cutthroat were able to gain access to the MCRB is speculative, but most likely this was a result of several massive floods associated with the break-up of ice dams that formed glacial Lake Missoula. The MCRB represents the most westerly distribution of westslope cutthroat, being part of a series of disjunct populations in the Columbia and Frazer river basins. It is not known with certainty whether westslope cutthroat trout were present in the all of the MCRB watersheds prior to stocking events in the last century. It can be assumed that, given the right thermal or physical barriers, native westslope cutthroats would have been found in at least some of the headwaters of the MCRB, such as in the Chelan River drainage where only bull trout and westslope cutthroat trout were indigenous above barrier falls below Lake Chelan. The widespread occurrence of cutthroat in the upper Chelan, Methow, and Chewuch rivers, along with early references to cutthroat trout in other portions of the MCRB (see Behnke 1992), lend evidence to the assumption that the cutthroat subspecies *lewisi* is indeed native to the MCRB.

Rainbow Trout

Interior redband rainbow trout are considered to be a resident form of migratory steelhead distributed throughout the Mid and Upper Columbia basin (east of the crest of the Cascade Mountains, including the Snake River drainage to Shoshone Falls and the upper Frazer basin). Redband rainbow trout are believed to have been widespread in the Columbia basin between 50,000 and 30,000 years ago. At the time of the most recent colonization of the MCRB (10,000 years ago), these were the dominant trout in the MCRB (see Behnke (1992) and Behnke and Proebstel (1992) for a detailed discussion of redband rainbow trout diagnosis and distribution).

Bull Trout

Bull trout, recognized as a "good species" separate from Dolly Varden since 1978, has a broad disjunct distribution throughout interior western North America (Cavender 1978, 1980; Bond 1992). Its distribution in the MCRB is primarily limited to smaller, colder headwater streams, though larger migratory bull trout inhabit large rivers and lakes during most of the year. Several authors have discussed the different life history strategies for bull trout, dividing them into four types (e.g. Leary et al. 1983, Brown 1992, Rieman and McIntyre 1993). Three of these types were present historically in the MCRB. The **adfluvial** form is found throughout the range of *S. confluentus*. It resides in lakes and migrates into tributaries where juveniles remain for one to three years before returning to the lake environment (Fraley and Shepard 1989). **Resident** bull trout remain in a stream for their entire life, while **fluvial** bull trout make extensive spawning migrations, moving between mainstem rivers and smaller tributaries. The fluvial form has a later age at maturity (usually age 5 or age 6) and attains a much larger size (up to 10 kg) than the resident stream form. Although not found in the MCRB, occasional **anadromous** bull trout have been reported in other areas of the species range (Cavender, Ohio State University, personal communication; Haas, University of British Columbia (UBC), personal communication). Very little is known about the genetic basis for these life history differences, or what role these strategies play in the genetic structure of local or "metapopulations". Rieman and McIntyre (1993) provide valuable insight as to the role of the metapopulation with respect to bull trout.

MEETING THE CHALLENGE - METHODS AND PROBLEMS

Study Area

The Methow River (drainage area = 464,140 ha) was sampled in 1992, and the Wenatchee River (drainage area = 343,700 ha) and Entiat River (drainage area = 108,520 ha) in 1993. There were 84 sites sampled in the Methow

River watershed; 20 and 47 sites were included in the project the following year on the Entiat and Wenatchee rivers, respectively. Selection of sample sites were based on three criteria: 1) known locations of a trout species, 2) areas above and below suspected fish barriers, and/or 3) upper and lower sites in minor tributaries. Not all species were present at each sample site. Available information on fish distribution prior to site selection was well documented by Mullan et al. (1992) for the Methow River but sketchy for the other two watersheds.

Collection of Specimens and Preservation of Tissue

The primary focus of this study is the distribution of non-anadromous native trout; therefore, salmon and whitefish were not considered. Steelhead were included in this study in terms of their relationship to resident interior redband rainbow trout and in view a hypothesis that anadromous runs of steelhead may be generated from resident populations of redband trout. Brook trout (*S. fontinalis*), a non-native trout in these watersheds, were also collected to determine possible hybridization with bull trout.

During 1992, the first year of the study, specimens of bull, cutthroat, rainbow, and suspected hybrid trout were collected by hook and line and electrofishing from preselected sites in the Methow watershed. In 1993, specimens of cutthroat, rainbow, and suspected hybrid trout were similarly collected in the Entiat and Wenatchee watersheds. Due to a statewide concern over the decline of bull trout in Washington and a pending ruling on the petition to list this species under the Endangered Species Act, a non-lethal technique was used to sample bull trout in 1993. A clip of the upper caudal fin was taken for genetic analysis. Each bull trout was anesthetized and a series of morphometric and meristic measures were made, in addition to taking color photographs of ventral and dorsal profiles. Once measured, bull trout were returned to the area in which they were captured.

Preservation of tissue samples for various forms of DNA analysis is normally accomplished by freezing tissue or whole specimens on dry ice or in liquid nitrogen. For the purposes of the present study, specimens and fin tissue were frozen on dry ice upon collection and stored at -80°C prior to extraction of DNA. As we isolated DNA for the present molecular evaluation, duplicate samples of tissue were taken and stored at -80°C for future genetic evaluation. The specimens were then permanently fixed in 10% formalin, stored in 40-50% isopropyl alcohol, and will be incorporated into the collection of salmonid fishes at the University of Colorado Museum to serve as a permanent reference collection.

Classical Taxonomic Data

All populations were examined using classical morphometric and meristic analyses as an initial screening procedure. Meristic and morphological characters useful in the identification of both westslope cutthroat trout and interior redband rainbow trout are summarized in Behnke (1992) and include: number of scales in the lateral series and above the lateral line, number of pyloric caeca, basibranchial teeth, spotting pattern, coloration, size and shape of parr marks, and number of vertebrae. Meristic characters useful in identifying bull trout include the number of mandibular pores, branchiostegal rays, gill rakers, and vertebrae; morphological characters include the width of head, eye placement, general shape of the mouth, flatness of the head, and position of adipose fin (Cavender 1980).

Several bones of the skull are useful for the identification of bull trout and differentiation of this species from other charr. The skull bones examined include the supraethmoid, vomer, hyomandibulae, gill rakers, frontale, premaxilla, and maxilla.

Molecular Genetic Data

All bull trout and populations with putative "pure" native trout and difficult specimens will be further analyzed by molecular genetic techniques. Methods described in Current Protocols in Molecular Biology (Ausubel et al. 1991), abridged by P. Evans of Brigham Young University, will provide the foundation for DNA isolation procedures. Protocol for isolation of DNA, amplification of mitochondrial DNA regions, and restriction enzyme digestion and resolution of restriction length fragment polymorphisms (RFLPs) are described in Shiozawa and Evans (this volume).

Taxonomic Problems

Cutthroat Trout

The principle problems associated with our study concern the discrimination of native from non-native fish and the identification of rainbow x cutthroat hybrids. It may be assumed that all native cutthroat trout are *lewisi;* although a remote possibility of native *bouvieri*, similar to

relict populations in Crab Creek and Waha Lake, does exist. Westslope cutthroat in the study area are either indigenous relict populations or introduced natives from two Washington lakes (Twin Lakes - an introduced population from Lake Chelan, and King Lake - an introduced population from Priest Lake, Idaho) where eggs have been taken for hatchery propagation (Behnke 1992 and personal communication). Non-native cutthroat trout in the MCRB are most probably Yellowstone Lake cutthroat that were introduced many years ago. The State of Washington received many millions of eggs from Yellowstone Lake (Varley 1979) but very few of the shipments were made directly to locations in the study area. There is substantial overlap in many of the meristic characters between westslope and Yellowstone cutthroat. Differences in coloration, spotting, number of basibranchial teeth, and posterior gill raker development allow clear separation by an experienced observer (e.g. Marnell et al. 1987). Molecular characters (karyotype, electrophoretic data, and unique mitochondrial DNA haplotypes) will also separate the two subspecies (Loudenslager and Thorgaard 1979; Leary et al. 1991; Evans, Shiozawa, and Williams of Brigham Young University, unpublished data and personal communication).

Rainbow Trout

While interior redband rainbow trout are native to the MCRB, widespread stocking of hatchery rainbow trout throughout the region makes identification of indigenous native rainbow trout a formidable task. Where hatchery rainbows are derived from a coastal rainbow *(O. mykiss iridius)*, clear separation may be made on the basis of several meristic characters (scale counts and pyloric caeca numbers, spotting pattern, and shape of parr marks and presence or absence of supplemental dorsal and ventral rows) (Behnke 1992). Coastal and redband rainbows may also be separated by protein electrophoresis (e.g. Allendorf 1975; Currens et al. 1990), and DNA analysis, but corroboration with classical characters is advisable. Many coastal type rainbows are present in the Methow basin due to the proximity of the Winthrop Hatchery (Winthrop strain rainbow trout were cultured extensively and widely stocked in the basin). Other drainages in the MCRB have been stocked extensively with the coastal type of hatchery rainbow (Mullan et al. 1992). In addition to coastal rainbow trout, interior redband rainbow (mostly residual steelhead from the Wells hatchery) have been stocked in the MCRB (Mullan et al. 1992). These fish would be difficult to detect with complete certainty based on available taxonomic markers. It is possible, however, that with sensitive DNA techniques (e.g. microsatellite DNA or DNA fingerprinting), Wells hatchery transplants could be identified.

Hybrids between rainbow and cutthroat trout can be identified on the basis of morphological characters and spotting patterns as well as molecular genetic methods.

Bull trout

There should be little taxonomic uncertainty regarding bull trout in the MCRB. Where present they can be assumed to be native, but there is a possibility of hybridization with non-native brook trout that have been widely planted throughout the MCRB. For many years bull trout were commonly referred to as Dolly Varden. Some confusion concerning the difference between bull trout and Dolly Varden has lingered to the present, particularly in the State of Washington. This is due in part to a dependence on the Haas-McPhail linear discriminate function to distinguish the two species (Haas and McPhail 1991). This index, when rigorously applied by an experienced taxonomist, can give complete separation of the two species. It was, however, developed from specimens collected in British Columbia and did not include any samples from Washington. According to the principle developer of the index, to accurately apply this technique to bull trout south of British Columbia, specimens should be analyzed and a separate set of coefficients to the discriminate function should be regressed for this region. Furthermore, the characters included in the Haas-McPhail index, particularly meristic counts of mandibular pores and branchiostegal rays are not easy to make, especially on anesthetized fish. In an independent test of professional field biologists using the index on preserved specimens, a misidentification of approximately 80% was observed (Haas, UBC, personal communication).

Discrimination of hybrids between bull and brook trout has been discussed by Leary et al. (1983, 1985) and summarized by Markle (1992). The markings on the dorsal fin has been shown to be very diagnostic (Markle 1992) and may be validated using a discriminate function/principle component analysis of standard morphological measurements (Hubbs and Lagler 1947).

FINDINGS FROM THE METHOW WATERSHED

Classical taxonomic evaluation of specimens from the Methow River drainage has been completed. Molecular

genetic analysis of these specimens is in progress. Populations of the three main species of interest found to be "pure" or "essentially pure" were identified primarily on the basis of meristic and morphological characters. These are summarized by species in Figures 1-3. Distribution of non-native brook trout and/or hybrid trout in the Methow are depicted in Figure 4. With the exception of bull trout and cutthroat trout of Cutthroat Lake and Creek and Robinson Creek, these populations generally grade into hybrid zones and are not isolated by clear distinct boundaries. "Pure" cutthroat trout, where present, are found in the higher gradient headwater reaches, but in most streams rainbow x cutthroat hybrids are present below these areas;" pure" interior redband rainbow trout, when present, are often found below hybrid zones.

Findings of the taxonomic research in the Methow River basin revealed several specific locations that are important with respect to native resident trout. These are streams or rivers that contain populations of one or more "essentially pure" taxa of trout.

Twisp River

Despite a long history of stocking in the Twisp River drainage, there are several headwater locations that still contain representatives of the native fauna. At least some of these native trout may be the result of stocking from sources that propagated "essentially pure" native trout. Bull trout are holding on in several headwater tributaries, with upstream distribution generally limited by barrier falls. Populations were observed in the West Fork of Buttermilk Creek (site 18), Reynolds Creek (site 27), South Creek (site 28), and the Twisp River headwaters (site 31). Individual fish from the Twisp headwater site had a rare MtDNA haplotype for the ND2 gene rarely observed in other populations of bull trout throughout their range. No fluvial bull trout were collected in the study, but these larger migratory bull trout have been observed in the Twisp in earlier surveys (Mullan 1992). Populations of "pure" interior redband rainbow trout occur in the West Fork of Buttermilk Creek (site 18) and Little Bridge Creek (site 15). Native westslope cutthroat trout are present in the East Fork of Buttermilk Creek (site 20), Eagle Creek (site 21), War Creek (site 25), South Creek (Site 29), Twisp headwaters (site 32), and North Creek (site 30). There are many collection locations in the Twisp system that contained rainbow X cutthroat hybrids, and most of the locations where "pure" cutthroat trout were found graduated into hybrid zones below the "pure" populations. Some of these collections from hybrid zones contained individual fish that are phenotypically cutthroat, indicating there must be some reaches of little or no gene flow between rainbow and cutthroat. The Twisp system generally follows the pattern where bull trout and cutthroat are located in the headwaters, followed by a hybrid zone, below which rainbow trout tend to dominate.

Goat Creek

This is an important stream in the upper Methow drainage (river mile 64.0) because of its unique hydrology and population of bull trout (sites 38 and 39). The stream is effectively cut off from the Methow River due to irrigation diversion in the summer and fall; although Mullan et al. (1992) speculate that the stream would mostly disappear into glacial till at its mouth before reaching the Methow even without diversion. Individual bull trout were found to have a unique MtDNA haplotype for the ND2 gene that is found in only a few populations throughout the range of the species, including Monument Creek and Twisp River in the Methow basin. Cutthroat trout were planted in the early 1980s at river mile 9. The cutthroat examined from site 38 appear to be of multiple sources or influenced phenotypically by hybridization, but many of the individual specimens were excellent *lewisi* phenotypes. Rainbow trout in the lower reaches of Goat Creek were collected (site 37) and, based on examination of several specimens, appear to be native interior redband rainbows. All the specimens have the primitive elliptical parr marks and supplementary rows of spots that distinguish redband from coastal rainbow trout. Although some stocking has transpired in Goat Creek, it remains a good representative of the native fauna of the MCRB.

Early Winter Creek and Cutthroat Lake and Creek

This is one of the most important systems in the Methow River drainage. Cutthroat Creek (site 42) and Cutthroat Lake are included with Early Winters Creek (site 41) because they are likely contributing westslope cutthroat trout to the latter stream. The bull trout in Early Winters Creek represent one of the more stable populations in the Methow. They are isolated from fluvial individuals by a barrier falls at river mile 7.5 and are probably the result of colonization before the falls was formed. Because of this natural isolation, this population is more vulnerable to decline or extinction. The cutthroat trout in both Cutthroat Creek and Early Winters Creek represent excellent *lewisi* phenotypes. They are among

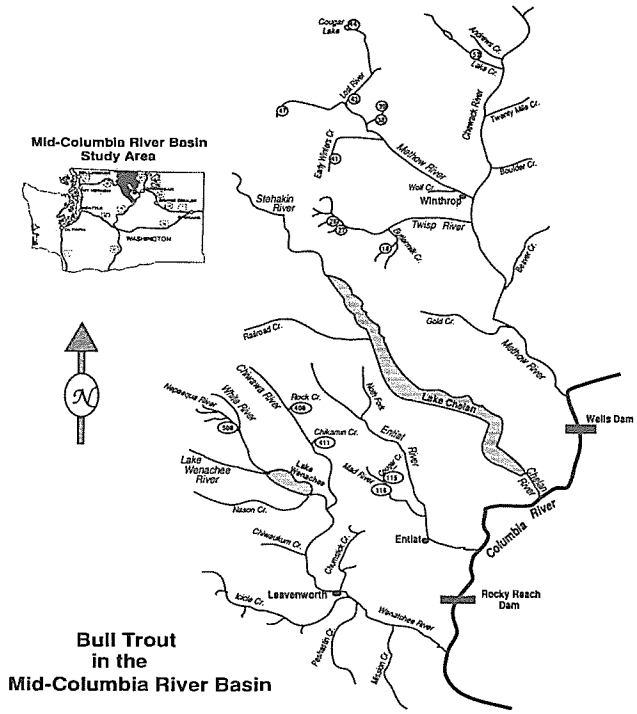

Figure 1. ---Distribution of "pure" bull trout in the Mid-Columbia River watershed, 1992 and 1993. Numbers designate sample sites.

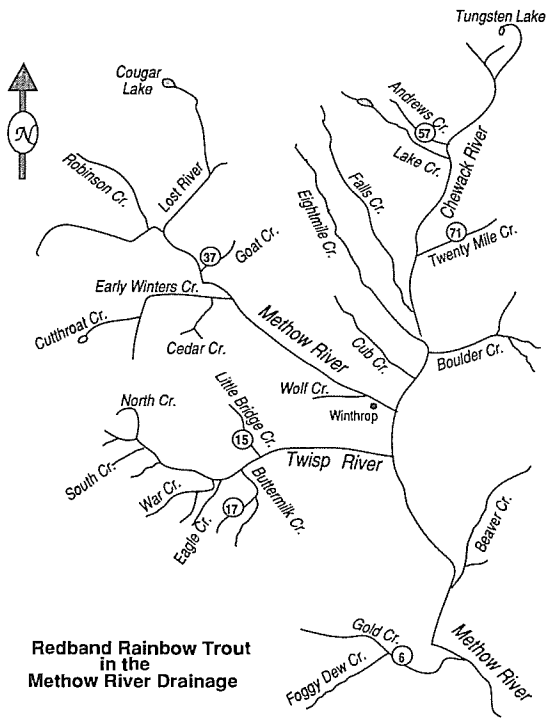

Figure 3. --- Distribution of "pure" redband rainbow trout in the Methow River watershed. Numbers designate sample sites in 1992.

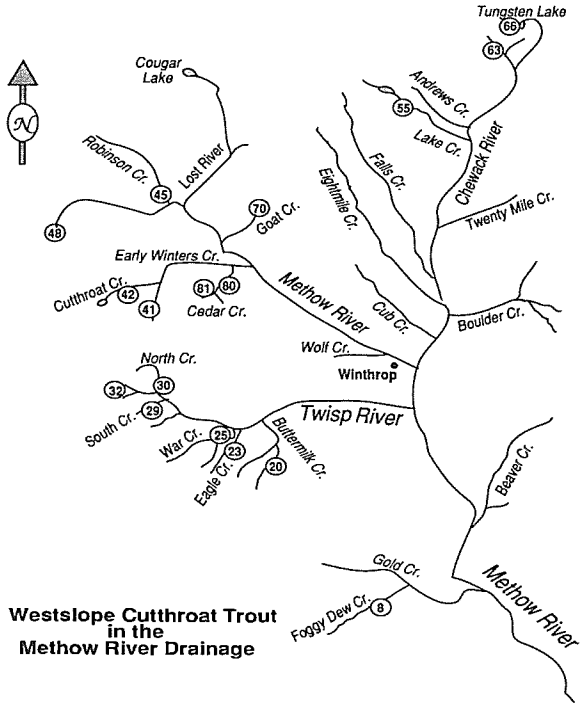

Figure 2. --- Distribution of "pure" westslope cutthroat trout in the Methow River watershed. Numbers designate sample sites in 1992.

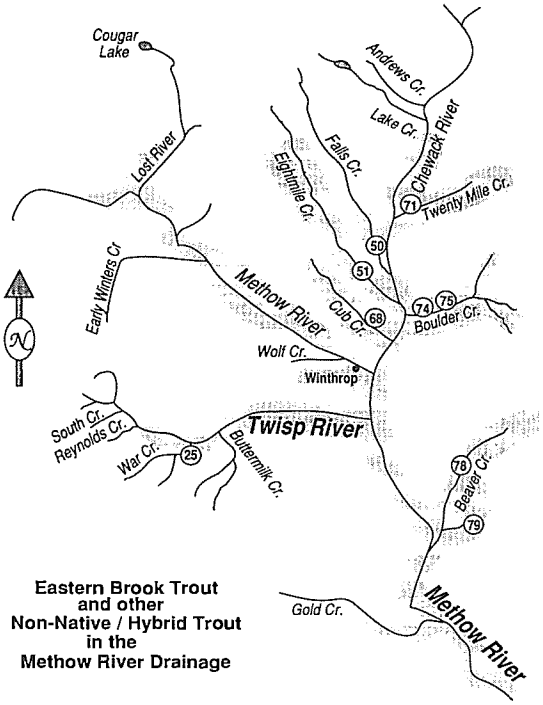

Figure 4. --- Distribution of brook, hybrid, and non-native trout in the Methow River watershed. Numbers designate sample sites in 1992.

the purest westslope cutthroat in the entire Methow drainage. Cutthroat Lake was stocked (source unknown at the time of this report), and it is possible that the cutthroat trout in Early Winters Creek were recruited from Cutthroat Lake (by way of Cutthroat Creek). It is also quite possible that there was an indigenous population of *lewisi* in this system prior to stocking Cutthroat Lake. The presence of more than one MtDNA haplotype in both streams would indicate the latter. In either case, the presence of two native salmonids above a natural barrier makes this a unique situation, and any further stocking would be ill advised. In addition to these streams, Cedar Creek (sites 80 and 81), another tributary to Early Winters Creek, has a population of *lewisi* that show only a slight influence of hybridization.

Upper Chewack River

The Chewack River, below its confluence with Lake Creek, is dominated by non-native brook trout. Lake Creek (site 83-85) is an important stream due to a good population of bull trout (including Black Lake). Cutthroat trout collected at river mile 9.5 of Lake Creek, just above a barrier falls, are phenotypically "pure", but the spotting is atypical for westslope cutthroat and gill raker numbers are high (mean = 21.2). There are several possible explanations for the observed phenotype. They could be merely the product of historic stocking of Yellowstone Lake fish. If they are indigenous above these barrier falls, since they are phenotypically very similar to Yellowstone cutthroat, there may be some type of connection to the relict populations of *bouvieri* in Waha Lake and Crab Creek, or they may be simply a westslope cutthroat population with an aberrant spotting pattern. Effects of hybridization with rainbow trout may also plan a role. Analysis of mitochondrial DNA will provide insight as to the source of this interesting population.

"Pure" populations of cutthroat trout were also collected from Tungston Lake (site 66) in the uppermost reaches of the Chewack. These are likely the result of stocking, but no information as to the source of this population of *lewisi* is presently available. Phenotypically "pure" redband rainbow were collected in Andrews Creek (site 55) which enters the Chewack at river mile 25.6; rainbow x cutthroat hybrids were collected from this stream as well.

Above river mile 33 of the Chewack there are trout that exhibit a full range of phenotypes, from apparently "pure" *lewisi* and *gairdneri* to obvious hybrids. It is difficult to ascertain whether or not there is some degree of reproductive isolation remaining in the system or if there is merely a "hybrid swarm". In either case, this is possibly a representative of a naturally occurring hybrid zone between westslope cutthroat and redband rainbow trout, making it quite unique from an evolutionary and ecological standpoint. Further stocking in this area would possibly upset the balance of this natural process.

Lost River and Robinson Creek

The Lost River enters the Methow at river mile 73.0. Rock slides across the river, high gradient reaches, and reaches of dewatering provide barriers to fish movement. These appear to be recent phenomena, as there are bull trout, cutthroat trout, and rainbow trout in the upper Lost River. Bull trout present in Cougar Lake (site 44) and Monument Creek (site 84) represent fragmented, isolated populations, making them susceptible to extinction (Rieman and McIntyre 1993). Monument Creek bull trout have a rare mitochondrial DNA haplotype for the ND 2 gene. Rainbow and cutthroat trout were not collected in this study but are known to occur in several locations (Mullan et al. 1992) and may be native populations based on the presence of barriers discussed above.

Robinson Creek (site 45) has a population of "pure" or "essentially pure" native westslope cutthroat. High scale counts, low pyloric caeca counts, presence of basibranchial teeth in all specimens, and typical *lewisi* spotting pattern make this one of the best cutthroat populations in the Methow River watershed. They are protected by a natural barrier falls near the confluence with the Methow River.

SUMMARY

The preliminary results reported above will be shared with fishery managers in our area to assist them in decisions regarding the use and conservation of aquatic resources in the MCRB. These data also will provide a baseline from which to monitor potential changes in the distribution and taxonomic character of trout populations in our area. Once molecular analysis is completed on Methow River samples, we will process data collected from the Wenatachee and Entiat watersheds. Final results from this project will provide us with information on the composition and location of unique trout populations in our area, suggest areas to concentrate habitat and population restoration efforts, and provide further insight into the relationship of "pure" trout populations in the Mid-Columbia River basin to those in other areas.

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Mobile Trout: Consequences of a New Paradigm

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Abstract—Trout living in streams have been thought to move very little, often occupying single pools their entire lives. Recent research has demonstrated that adult brown trout may move seasonally as far as 96 km, and that much smaller Colorado River cutthroat trout moved up to several kilometers. The mobility of trout has probably affected estimates of fish abundance, perceptions of habitat quality, and the delineation of populations, and could nullify the desired outcome of restrictive angling regulations. Also, fragmenting streams may be reducing the changes of persistence of native trout populations by restricting movement and thus restricting population size.

IMMOBILITY: THE REIGNING PARADIGM

Unlike their anadromous relatives, stream-resident trout are often considered to be relatively immobile. Northcote (1992) stated that the "home ranges for yearling and older salmonids are...usually a few tens of meters." This notion of restricted movement of stream-dwelling trout has persisted for over 50 years (Hoover and Johnson 1937) and was canonized by Gerking (1959). Adult brown trout (*Salmo trutta*) have been considered to follow this paradigm (Stefanich 1952; Bachman 1984). Cutthroat trout (*Oncorhynchus clarki*) also have been suggested to be very sedentary, supposedly living their entire lives within a single pool (Miller 1957; Heggenes *et al.* 1991).

But the methodology for studying movement may have been biased toward this conclusion (Gowan *et al.*, in press). The protocol for most studies was to mark fish in relatively short reaches of streams, then return to these same reaches weeks to a year later and resample them, then discuss only the recapture of marked fish. Because the majority of marked fish that were recaptured came from the reaches where they were originally marked, most authors considered this evidence for a lack of movement. But they typically failed to address the fate of the 15 to 90% of marked fish that were never recaptured, or attributed their absence to mortality or lost marks. Studies employing other techniques, such as direct observation, were handicapped because fish were not followed during all seasons or at night (e.g., Bachman 1984). Thus potential movement was inadequately evaluated.

NEW VIEWS OF MOBILITY

Recent research in the Midwest and the Rocky Mountains has disputed the paradigm of immobility of stream-dwelling trout. Clapp *et al.* (1990) and Meyers *et al.* (1992) used radiotelemetry to monitor the positions of large brown trout in Michigan and Wisconsin, and observed seasonal movements of over 30 km. Similarly, Young (in press) implanted transmitters in over 50 adult brown trout in tributaries of the North Platte River in Wyoming. He observed fish moving as far as 96 km, and he hypothesized that fish began spawning migrations from the river to the tributaries in late summer, wintered in the tributaries, then returned to the river during spring high flows. Young (unpublished data) used the same technique to monitor much smaller Colorado River cutthroat trout (*O. c. pleuriticus*) and detected movements

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over 2 km in mid-summer. Twenty-four-hour observations of both species frequently revealed movements over 100 m and up to 1.1 km (Young, unpublished data). In contrast, Riley *et al.* (1992) used a two-way fish trap to monitor movement in small Colorado streams and reported extensive, continuous movements of brook trout (*Salvelinus fontinalis*) in mid- to late summer. Investigations of these species, as well as rainbow trout (*O. mykiss*) (Young, unpublished data), continue to demonstrate that movement is commonplace among adult trout.

CONSEQUENCES OF MOBILITY

Much of our interpretation of trout biology implicitly rests on the assumption of immobility. If this assumption is invalidated, it challenges several aspects of current trout management and research.

Special regulations.—Restrictive regulations are usually designed to prevent harvest of some or all of a trout population. These regulations presume that the desired size classes will remain within protected stream reaches. But this presumption is not always correct; Clapp *et al.* (1990) noted that some large brown trout, originally tagged in a no-kill section, spent most of their time in a standard-regulation reach. In Wyoming, a slot limit has protected spawning-age trout in the North Platte River since 1982 (Mike Snigg, Wyoming Game and Fish Department, personal communication), and this may have led to increases in the abundance of these age classes in the tributaries during the spawning run. The tributaries, however, are under standard regulations, and these fish are frequently harvested once they enter the tributaries. Thus future gains to the overall population may be limited.

Up- and downstream effects.—Another belief is the overriding importance of local habitat on fish populations. For example, structural rehabilitation has been thought to increase the abundance of trout in a treated reach by increasing survival. Following thorough monitoring, Riley and Fausch (in press) instead attributed the increased abundance of trout in structurally enhanced reaches of six Colorado streams to greater retention of mobile fish arriving from outside the treated reaches.

Structures not intended to enhance trout populations, such as water diversions or dams, are often constructed without considering the possibility of fish movement. One consequence is that fish may be blocked from seasonally critical habitats up- or downstream (e.g., spawning or over-wintering sites). Alternatively, such barriers may cause the extinction of mobile life history forms, and if these forms are genetically distinct, genomic impoverization will result. Furthermore, these structures isolate populations into smaller fragments that run a greater risk of extinction and lose access to other individuals that might bolster or re-found populations.

Up- and downstream effects are not limited to physical disruptions. The stocking of non-native trout above or below native trout populations has been supposed to have little effect, but the subsequent redistribution of stocked fish led to the loss of many indigenous trout populations, except where barriers prevented further migrations. For example, a single stocking of brook trout in a headwater lake apparently led to the eventual displacement of Colorado River cutthroat trout from most of the Battle Creek, Wyoming watershed (Eiserman 1958). Furthermore, whether a stream drains into another small stream or into a large lake has a noticeable effect on fish community composition (Osborne and Wiley 1992).

Sampling fish abundance and population characteristics.—It is probable that most estimates of fish abundance in streams are derived from one or a few short reaches of stream, often only once each year or several years. Movement of fish through these reaches would render these counts suspect, in part by violating one of the assumptions of mark-recapture estimates. Decker and Erman (1992), after repeatedly electrofishing reaches of one stream throughout a summer, noted that trout abundance was variable. They attributed this variability to fish movement, and questioned the value of one-time sampling for estimating fish abundance. Over 55 years ago, Shetter and Hazzard (1938) reached the same conclusion, stating that "populations of stream fish are relatively unstable in specific areas of a stream during the summer months, and...calculations of stream populations from counts made on one or two short sections of stream at only one period of the year are not reliable."

This unreliability can extend to other kinds of sampling. For example, meristic and morphometric analyses were used to determine the genetic purity of Colorado River cutthroat trout from two tributaries and the mainstem of the North Fork Little Snake River in southern Wyoming (Binns 1977). The analyses indicated that fish in the mainstem were genetically pure, fish from Harrison Creek were obviously contaminated by hybridization, and fish from Green Timber Creek were assumed to be intermediate. However, in movement studies con-

ducted in 1992 (Young, unpublished data), a single radio-tagged adult occupied all three locations within three weeks. Moreover, all the fish originally captured in Harrison Creek and Green Timber Creek eventually migrated to the North Fork Little Snake River and could have been thought to represent the presumptively isolated populations in any of the three streams. Because of the potential seasonal and annual variability in population composition, we should consider the consequences of one-time sampling for describing population genetic structure (e.g., Loudenslager and Gall 1980).

Habitat and population modelling.—Modelling may also be confounded by trout movement. Many habitat-based models, constructed from physical or biological data often collected at a single point in time, attempt to predict the abundance or biomass of salmonids (see Fausch *et al.* 1988 for examples). The inability to incorporate temporal variation in stream characteristics has been recognized as a shortcoming of such models i.e., habitat characteristics change seasonally without apparent concurrent changes in fish abundance (Conder and Annear 1987). Yet rarely considered was the potential temporal variation in fish abundance produced by mobility, which could add substantially to the unexplained variation in such models. Additionally, that many species e.g., brown trout, may not be in feeding positions when sampled by electrofishing (Young, personal observation) may further degrade the performance of these models. Long-term modelling of population fluctuations (Platts and Nelson 1988) or community composition (Ross *et al.* 1985) are especially sensitive to annual or species-specific variation in mobility.

Arbitrary definition of populations.—Perhaps because of a perceived lack of mobility in fishes, biologists often attempt to geographically, but not spatially, define populations. That is, we often designate the trout in a small stream as a single population (in a sense, isolated by immobility). Yet rarely is this designation merited, because trout may immigrate to the small stream (for example, to reproduce) or emigrate from it (perhaps to overwinter). That the range of a single population may include far more waters than the "type location" is consistent with the emerging concept of metapopulations. Metapopulations consist of a collection of subpopulations that are linked by immigration and emigration (Hanski and Gilpin 1991). The individual subpopulations may thrive, suffer losses of genetic variation, or go extinct, but individuals from other subpopulations within the metapopulation can contribute to the growing subpopulations, restore genetic variation to small subpopulations, or found new subpopulations after extinction. To persist, metapopulations must consist of periodically mobile individuals in habitats without continuous barriers to movement (Gilpin 1987). Whether metapopulation theory explains trout population structure remains to be investigated.

CONCLUSIONS

A new paradigm for stream-dwelling trout considers (but does not mandate) mobility as one of the possible responses to food, growth, competition, predation, environmental disturbance, and daily and seasonal cycles. Movement may be minimized under some circumstances i.e., abundant macroinvertebrates, complex habitats, and environmental stability. But because environments are typically spatially and temporally heterogeneous, trout may elect to move frequently and extensively. The challenge for managers and researchers is to recognize when and where movement will be advantageous or necessary for maintaining wild trout populations.

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Will The Clean Air Act Protect Wild Trout Streams In The Southern Appalachian Mountains?

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POSTER ABSTRACT

Acid-sensitive stream waters in the southern Appalachian mountains are not in equilibrium with atmospheric sulfur deposition. This is due to sulfur retention by watershed soils in this region. Stream-water sulfate concentrations are increasing as soils become sulfur-saturated, with the result that stream-water acidity levels are increasing. Although implementation of the Clean Air Act Amendments (CAA) of 1990 should reduce the equilibrium sulfate concentrations for stream waters in this region, the resulting equilibrium values will still exceed current stream-water sulfate concentrations. Thus, stream-water sulfate concentrations will continue to increase and stream-water acidification trends will continue.

We have examined the implications of this assessment by calibration of a steady-state acidification model to estimate the future acid-base status of wild trout streams in the mountains of western Virginia. Based on data obtained through six years of quarterly ion-concentration analysis for 70-80 streams included in the Virginia Trout Stream Sensitivity Study, we estimate that the loss of stream-water acid-neutralization capacity (ANC) will equal up to 60% of the increase in stream-water sulfate concentrations depending upon watershed geology. The most sensitive streams (about 50% of the total) are those associated with siliciclastic and minor carbonate (or primarily sandstone) bedrock. Despite reductions in sulfur deposition anticipated for implementation of the CAA, our model indicates that among the siliciclastic streams of Virginia's Blue Ridge province, the median baseflow ANC will change from the present value of 5 ueq/L to -20 ueq/L. For the siliciclastic streams of Virginia's Ridge and Valley province, the median baseflow ANC will change from the present value of 2 ueq/L to -43 ueq/L. For the minor-carbonate streams in the Ridge and Valley province, the median baseflow ANC will change from 20 ueq/L to 13 ueq/L. Based on observed rates of change in the 1980s, we estimate that these changes will occur over a period of 40-50 years.

We have further examined the implications of continuing trout stream acidification under the CAA implementation by reference to biologically relevant pH values. Based on our model prediction of change in stream-water ANC, the number of streams with baseflow pH values < 5.0 (the approximate minimum for the most acid-tolerant fish species present in Virginia mountain streams) will increase from 5 to 68% for the Blue Ridge siliciclastic streams, from 8 to 100% for the Ridge and

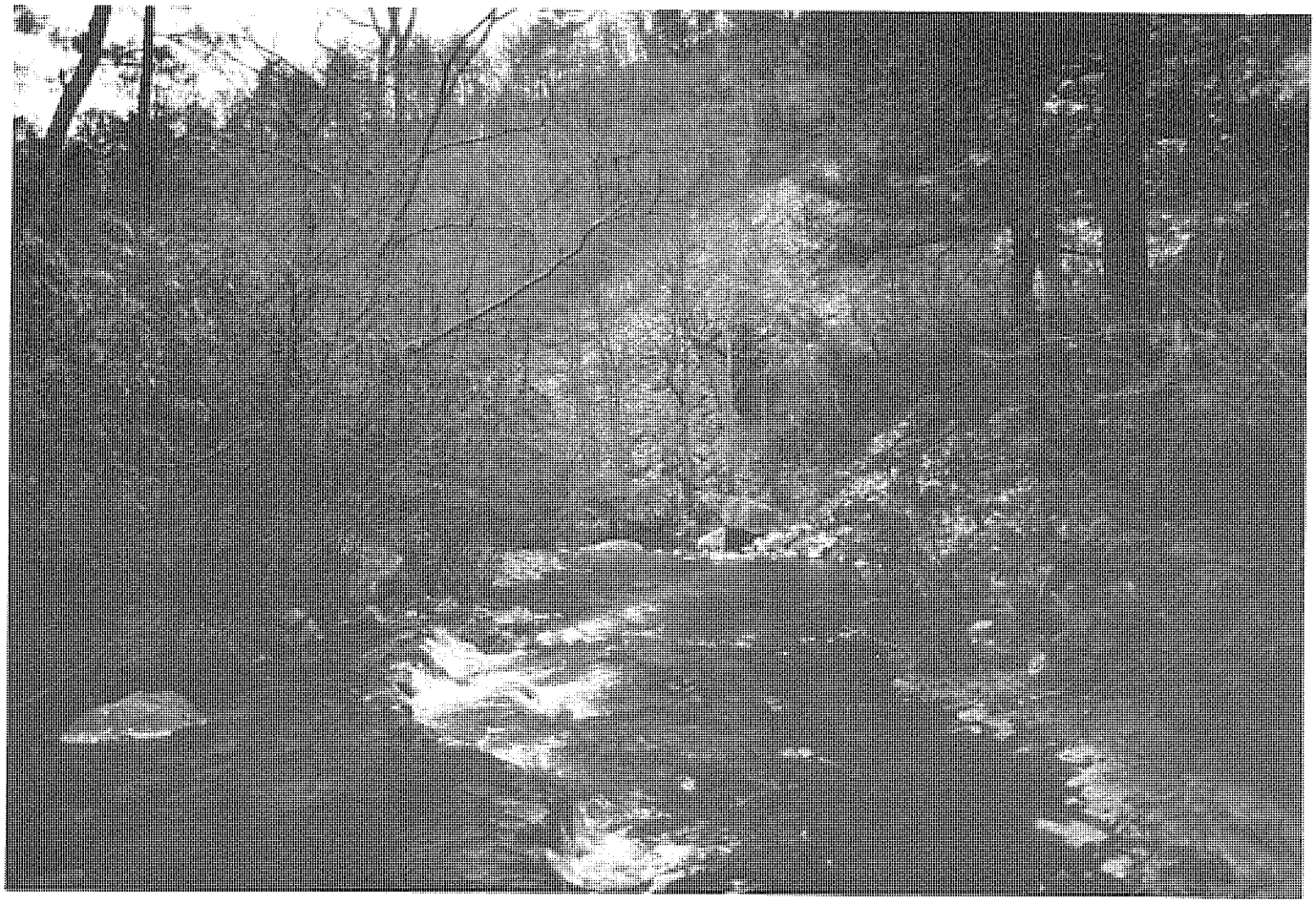

Figure 1. – St. Mary's River. A siliciclastic stream on the George Washington National Forest.

Valley siliciclastic streams, and from 0 to 13% for the Ridge and Valley minor-carbonate streams.

Finally, we have applied the model to estimate the level of sulfate deposition reduction that is required to protect Virginia's wild trout streams from further acidification. Whereas the CAA will provide a reduction of about 35% in sulfate deposition in the Virginia mountains, our model indicates that a reduction of about 70-80% is needed. Thus, assuming an approximate linearity between national sulfur emissions and sulfate deposition to Virginia's mountain watersheds, it appears that the CAA will achieve only about one-half of the needed reductions.

ACKNOWLEDGEMENTS

Support for the Virginia Trout Stream Sensitivity Study has been provided by the Virginia Department of Game and Inland Fisheries, the U.S. Fish and Wildlife Service, the U.S.D.A. Forest Service, the U.S. National Park Service, and Trout Unlimited.

The analysis summarized in this poster is presented in a report, THE ACID-BASE STATUS OF NATIVE BROOK TROUT STREAMS IN THE MOUNTAINS of VIRGINIA. This report can be obtained by contacting the authors or the national office of Trout Unlimited.

Habitat use by Apache Trout (*Oncorhynchus apache*) on the Fort Apache Indian Reservation, Arizona.

Lorena L.L. Wada[1], O. Eugene Maughan[2], and Stuart C. Leon[3]

Habitat use by Apache trout (***Oncorhynchus apache***) was evaluated on Firebox Creek on the Fort Apache Indian Reservation. All fish were captured in pools, therefore, all measurements were taken in pools. Kruskal-Wallis analysis using a Mann-Whitney-U showed significant values for depth, instream cover, and bankcut. Pools containing Apache trout had greater depths (8.48 cm) and larger volumes of instream cover (14.44 *l*) and bankcut (21.68 *l*) compared to those pools without Apache trout (4.5 cm, 0.06 *l*, and 0.17 *l*). Apache trout selected the deeper areas of the pools. All pools occupied by Apache trout had large logs, debris piles, or bankcuts for cover but also had some portion of the pool exposed to sunlight. Apache trout of all sizes fed or basked during the day in this area of bright sunlight but periodically moved in and out of cover. A multiple regression relating biomass and habitat in Firebox Creek yielded the following equation: Biomass of Apache trout = -2.107 + 3.980(depth) + 0.155(icover) - 0.471(ocover) - 0.247(bankcut) - 0.412(shade) + 5.084(area), which accounted for 83% of the biomass of Apache trout. According to the discriminant function [Canonical variable = 0.46 (current) + 1.33 (depth) + 0.11 (substrate) - 0.23 (icover) - 0.80 (ocover) + 0.06(ht) + 0.08 (bankcut) - 0.65 (shade) +0.34(area)], any pool that has a canonical variable value of ≥ -0.138 will have Apache trout.

APACHE TROUT

Apache trout are believed to have been originally distributed within the upper Salt River, the San Francisco River and the headwaters of the Little Colorado river, Arizona (U.S. Fish and Wildlife Service 1989). However, by the time they were scientifically described (Miller 1972), populations had been greatly reduced through habitat loss, overfishing and interspecific interactions with introduced species (U.S. Fish and Wildlife Service 1989).

By 1950, Apache trout were restricted to waters on the Fort Apache Indian Reservation. In 1955, the White Mountain Apache Tribe closed the Reservation to all fishing for native trout (U.S. Fish and Wildlife Service 1989). Although Apache trout have been cultured successfully and have been reintroduced into streams on

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the Fort Apache Indian Reservation and on U.S. Forest Service lands, they are currently listed as a threatened species.

The White Mountain Apache Tribe, the U.S. Fish and Wildlife Service, the U.S. Forest Service, and the State of Arizona are working towards establishing self-sustaining populations of Apache trout so they can be removed from the list of threatened species and established as the dominant sport fish within their historic range.

FIREBOX CREEK

The study was conducted on Firebox Creek on the Fort Apache Indian Reservation. Firebox Creek (a tributary of the East Fork of the White River) is about 14 km long and runs through mixed conifer forest. The area sampled was at an elevation of 2550 m and contained only Apache trout. Through the summer, parts of this stream went dry. There was no barrier on this stream and it was closed to fishing.

Fish populations within defined habitat areas were sampled by electroshocking. Block nets were simultaneously set above and below the sample area. The stream reach between the nets was sampled until two successive passes with a D.C. backpack electro-fisher failed to yield fish.

Environmental conditions in the section of the stream sampled for fish were measured along transects that lay perpendicular to the direction of flow. Transect lines were separated from one another by the following distances: 1) when the sample site was less than 2 m long, transect lines were 0.25 m apart, 2) when the site was 2 to 4 m long, transect lines were 0.5 m apart, 3) when the site was greater than 4 m long, transect lines were 1 m apart. Points of measurements on transect lines were: every 0.25 m when the sample site was less than 2 m wide; every 0.5 m when the site was between 2 and 4 m wide; and every 1 m when the site was greater than 4 m wide.

At each measurement point, water depth was determined with a metric wading rod, water velocity was measured with a Pygmy-Gurly meter, and streambed substrate was ranked according to a modified Wentworth particle scale (Bovee and Cochnauer 1977). Measurements of the volume of water under bankcuts and cover (reported in liters), percentage of shade the pool received, and the area and height of out-of-stream cover were also taken.

Observations showed Apache trout would seek cover when the stream was entered. Therefore, only undisturbed habitat use was measured. Locations of individual fish within the stream section were noted by observations made from the bank and marked before the stream was sampled. Markers were placed at the point judged to represent the anterior portion of the fish. Around this point an XY coordinate (each axis 40 cm in length) was superimposed and habitat factors were measured every 5 cm along each axis. Water depth, water velocity and streambed substrate were measured using the same methods described above. This procedure worked well with Apache trout because the stream was shallow and very clear, and Apache trout were easy to observe.

Statistical tests performed at the 0.05 confidence level included:1) analysis of variance (ANOVA) tests for differences in current, depth, and substrates within streams and between streams 2) Mann-Whitney-U tests for differences in other habitat measurements 3) multiple regressions, discriminate function analysis, and principle components analysis to determine habitat quality for Apache trout. All statistical analyses were done using the Systat program.

RESULTS

All fish were captured in pools; therefore all habitat measurements were taken in pools. Fish movement between pools via runs was observed on several occasions. In each instance, time spent in the run was less than 3 seconds. Apache trout were relatively easy to observe, both underwater and from the surface. They did not react to an observer on the bank. However, noise or shadows cast over the stream caused them to seek cover.

A 200 meter stretch of Firebox Creek was sampled and 35 fish ranging from 1.0 g at 4.8 cm to 40.0 g at 16.5 cm were captured. Kruskal-Wallis analysis using a Mann-Whitney-U test showed pools containing Apache trout had greater depths (8.48 cm), larger volumes of instream cover (14.44 *l*), and bankcut (21.68 *l*) compared to those pools without Apache trout (4.5 cm, 0.06 *l*, and 0.17 *l*) (Figs 1 & 2). The same type of test also showed that the depth of sites occupied by Apache trout was greater (27.87 cm) than the depth of available sites (8.48 cm)(Fig.3).

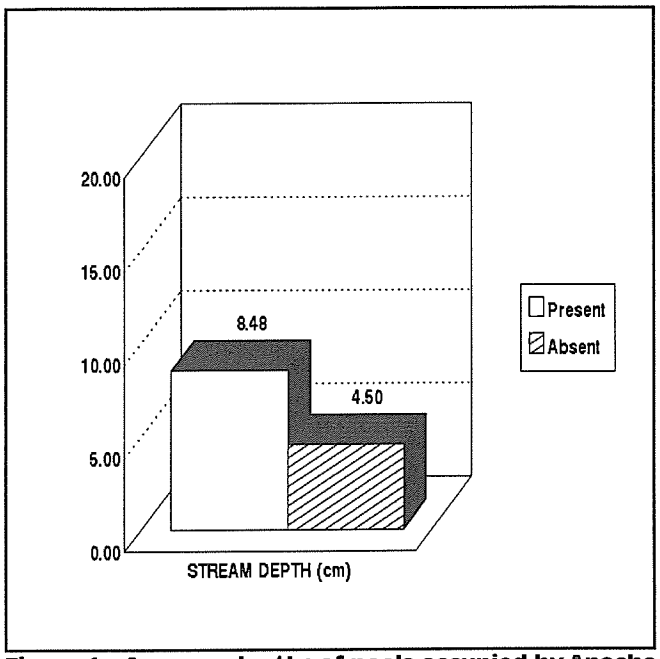

Figure 1. - Average depths of pools occupied by Apache trout and pools unoccupied in Firebox Creek.

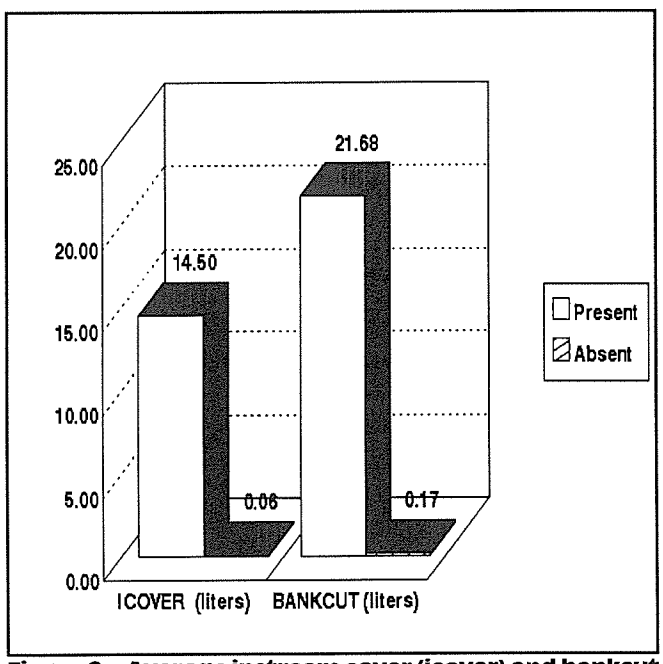

Figure 2. - Average instream cover (icover) and bankcut in Firebox Creek for pools occupied by Apache trout and unoccupied pools.

A multiple regression relating biomass and habitat yielded the following equation: Biomass of Apache trout = -2.107 + 3.980(depth) + 0.155(icover) - 0.471(ocover) - 0.247(bankcut) - 0.412(shade) + 5.084(area) (Table 1). This model, accounted for 83% of the variation in the biomass of Apache trout between pools.

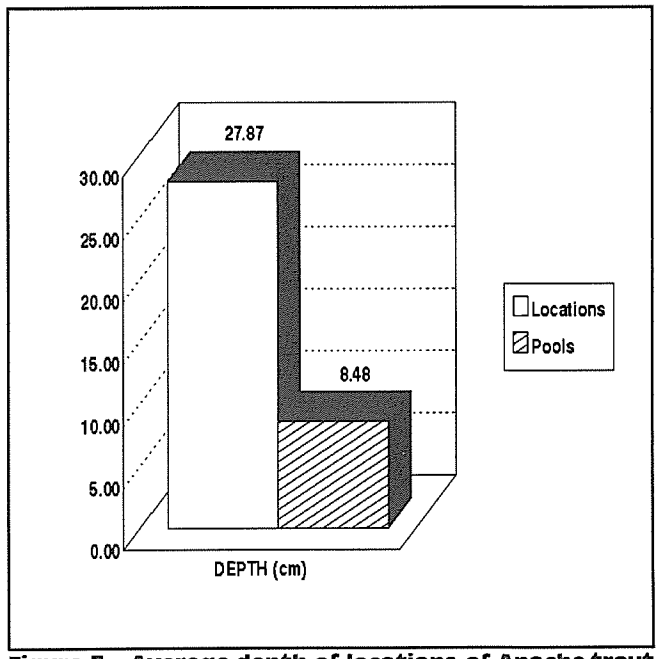

Figure 3. - Average depth of locations of Apache trout and available depth of pools in Firebox Creek.

Table 1. - Effects of area, depth, shade, instream cover, overstream cover, and bankcut on biomass of Apache trout in Firebox Creek.

Source	Sum-of-Squares	DF	Mean-Square	F-ratio	p	R^2 +
Regression	14965.35	6	2494.22	16.01	< 0.01**	0.83
Residual	3115.32	20	155.77			

**Significant at the 0.05 level.
+ R^2 is the amount of variance explained by the predictors.

A discriminant function analysis was run relating the independent variables to the presence of Apache trout. According to the resulting function [Canonical variable = 0.46 (current) + 1.33 (depth) + 0.11 (substrate) - 0.23 (icover) - 0.80 (ocover) + 0.06(ht) + 0.08 (bankcut) - 0.65 (shade) +0.34(area)], any pool that has a canonical variable value of ≥ -0.138 will have Apache trout. The analysis correctly classified 15 out of 17 pools (88%)(Table 2).

DISCUSSION

Apache trout in Firebox Creek seemed to use habitat in a way that is unlike the general pattern of habitat use for

Table 2. - Discriminant function predictions of Apache trout presence/absence in 27 pools in Firebox Creek.

Pool number	Apache trout occurrence	Canonical value	Prediction
1	Present	2.709	Correct
2	Present	0.904	Correct
3	Present	0.527	Correct
4	Present	0.058	Correct
5	Present	0.355	Correct
6	Present	1.182	Correct
7	Present	2.330	Correct
8	Present	1.546	Correct
9	Present	1.970	Correct
10	Present	-1.151	Incorrect
11	Present	1.596	Correct
12	Present	-0.138	Correct
13	Present	0.861	Correct
14	Present	1.919	Correct
15	Present	1.733	Correct
16	Present	1.775	Correct
17	Present	-0.665	Incorrect
18	Absent	-3.071	Correct
19	Absent	-1.009	Correct
20	Absent	-0.380	Correct
21	Absent	-2.428	Correct
22	Absent	-1.238	Correct
23	Absent	-1.996	Correct
24	Absent	-2.665	Correct
25	Absent	-2.120	Correct
26	Absent	-1.032	Correct
27	Absent	-1.575	Correct

other trout species. Apache trout of all sizes spent a considerable part of each day feeding and basking in the portions of the pool exposed to direct sunlight and only occasionally entered cover. They seldom occurred in pools that lacked these open exposed areas. Robinson and Tash (1979) concluded that Apache trout required light levels ≥ moonlight (10^{-3} fL) to feed successfully. Their preference for pools partially open to the sun may be related to this light requirement for successful feeding. In addition, the preference for pools that are partially open to direct sunlight suggest that Apache trout evolved in forest systems with partially open canopies.

We do not yet know what proportion of a pool needs to be exposed to direct sunlight to provide optimum habitat for Apache trout. However, we believe that the optimal amount of exposed area is defined by a complex relationship between water temperature, degree of canopy closure, and the physical characteristics of the stream. The unique way that Apache trout bask in open areas and seldom use cover may suggest why Apache trout appear to be displaced by brown trout in areas of coexistence. In streams similar to Firebox Creek, brown trout occupy cover throughout the daylight periods. Casual observations on other streams where the two species coexist, suggested that Apache trout could not displace brown trout from this cover unless the former was larger than the latter. If access to daytime cover affects survival, the inability of Apache trout to obtain such cover could explain their gradual disappearance from areas where they coexist with brown trout.

The multiple regression model showed a positive relationship only between instream cover and biomass; relationships between other cover categories (overstream cover, bankcut volume) and biomass were negative. We have no explanation for the failure of this analysis to show a positive relationship between Apache trout biomass and volume of bankcut. A positive relationship between biomass of trout and overall amount of cover, including instream and bankcut cover, is common for other trout species (Coulston and Maughan 1983). The negative relationship between biomass and overstream cover can be explained by the preference of Apache trout for pools that contain areas that are partially exposed to sunlight; the greater the amount of overstream cover, the smaller the area of the pool exposed to sunlight.

The Kruskal-Wallis analysis, and the discriminant function model seemed to give different pictures of the importance of cover to Apache trout. The Kruskal-Wallis analysis showed that pools that contained Apache trout had more instream and bankcut cover than those that did not. Conversely, discriminant function analysis showed a positive relationship only between the presence of apache trout and volume of bankcut; relationships with other cover categories (instream cover, overstream cover) were negative. The data from the Kruskal-Wallis would seem to suggest that cover was very important to Apache trout but the discriminant function analysis would seem to indicate that cover was of limited importance.

We think that our habitat use data may underestimate the importance of cover and that the differences in the conclusions indicated by these analyses comes in part from the way we took our habitat use data. Undisturbed Apache trout spend very little time in cover; we took our data from unfished streams in remote areas closed to the public. Therefore, because our analysis related habitat

importance to the number of fish in each habitat type, and because few Apache trout were observed in cover, our data show a low importance for cover. However, our data do not in any way reflect the importance of cover to survival. In contrast, the Kruskal-wallis analysis would seem to incorporate availability of cover a s a function of survival (as measured by occurrence) and therefore may more closely approximate the overall importance of cover to the survival of Apache trout.

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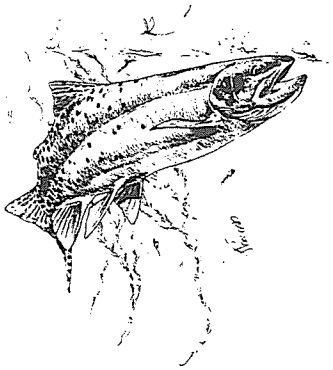

Movements of Rainbow Trout among Clear Water Tributaries of a Glacial River in Southwest Alaska

F. Jeffrey Adams[1]

Abstract - During summers 1990-92, rainbow trout were captured by hook and line from five clear water tributaries of the King Salmon River. Objectives were to determine: (1) the distribution of rainbow trout in the King Salmon River system; (2) timing and location of overwintering areas; and (3) timing and location of spawning areas. Eight hundred sixty-nine fish were marked with Floy anchor tags, and 27 of these were implanted with radio transmitters. A quarter of 239 individuals recaptured and half of the radio-tagged individuals exhibited movement among the tributaries. Relocations of radio-tagged fish identified two major overwintering areas in the main stem river. Recaptures of tagged fish and relocations of radio-tagged fish identified Whale Mountain Creek as the principal spawning stream. Rainbow trout in the King Salmon River system appear to be one population that travel freely through turbid water. While harvest of rainbow trout is low due to limited access and a strong catch and release ethic, the small population of rainbow trout in this system (estimated at 1,508 fish) could easily be affected by overfishing or habitat degradation. Therefore, conservative management of habitat and fishing pressure is recommended.

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Wild Trout and Megawatts: A Case for Compatibility

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Among wild trout enthusiasts, hydropower projects are often viewed with disapproval. In many cases dams block fish migration, diversions dewater natural channels, or impoundments are managed with exotic species or hatchery products. But where habitat quality is sufficient and fish introductions are controlled, wild trout and megawatts can coexist. This poster describes some of the findings from comprehensive fisheries studies associated with a medium-sized (185 Megawatt) but complex hydropower project built in the 1940's and 1950's in the western Cascade Mountains, Oregon. The North Umpqua Hydroelectric Project directly affects about 40 miles of headwater streams, but wild trout (brook, brown, and rainbow) are abundant in most stream reaches (mean density is 280 trout >6 inches long per mile). Impoundments and forebays (ponds) constructed for water storage created lentic habitats where none previously existed, and these support larger wild trout than found in the stream reaches. A variety of angling opportunities are present among stream and still-water habitats, but the still waters support the greatest effort with over 40,000 angler-hours per year. Since trout have not been stocked into project waters since the mid-1970's, the existing populations result from several generations of natural production during hydropower operations. The diverse and popular fishery occurs with little cost to management agencies. The project generates angling opportunities -- and electricity -- year-round.

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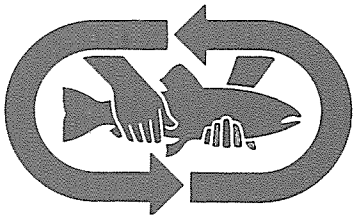
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