THE OSPREY

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CATCH AND RELEASE

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Washington's Forest Practices Habitat Conservation Plan: Adaptive Management or Gridlock?

by Peter Goldman

— Washington Forest Law Center —

Author Peter Goldman is Director and staff attorney for the Washington Forest Law Center in Seattle, Washington. He last wrote about Washington forest and fish issues for The Osprey *in September 2001.*

To learn more about the Washington Forest Law Center, visit their Web site at www.wflc.org.

As a public interest environmental lawyer, I spend a lot of time talking about whether logging practices protect the habitat of threatened and endangered fish, such as salmon, steelhead, and bull trout. Yet some ask, "what does protecting forests have to do with protecting and recovering endangered salmon and steelhead?"

As a fly-fisher you probably know the answer, but in case you don't here it is: some of the most crucial "life stages" of wild salmon, steelhead and trout occur in the forest and, while industrial logging has taken a heavy toll on salmon habitat in the forests, some of the best salmonid habitat remains in forest zones. So how logging takes place in the 10 million acres and 60,000 stream miles of Washington forests is critical to protecting what little salmonid and steelhead habitat remains.

> *Old school forestry in Washington got a wake-up call when runs of salmon and steelhead were listed under the ESA.*

Old school forestry in Washington got a wake-up call in the late 1990s when most Washington runs of salmon and steelhead were listed as threatened or endangered under the Endangered Species Act (ESA) and when watershed-specific protective measures were proposed under the Clean Water Act. In 1999 and 2000, at the urging of the politically powerful timber industry (and other forest State, federal, and tribal "stakeholders" who were anxious to accept any improvements for forestry in salmon country), the State signed on to a negotiated document specifying salmon-friendly logging practices — called the "Forests and Fish Report." The Report was supposed to be a substantial re-write of the pre-1999 forest practice rules to protect and recover salmon.

The political deal implementing the Report went like this. Washington would immediately adopt forest practices (logging) rules based on the Forests and Fish report, develop a federal Habitat Conservation Plan (HCP), and apply to the two federal agencies that have ESA jurisdiction (NOAA Fisheries and the U.S. Fish and Wildlife Service) for a 50 year Incidental Take Permit. The

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FROM THE PERCH — EDITOR'S MESSAGE

Winter Steelhead Doldrums

by Jim Yuskavitch

Many readers of *The Osprey* live in year-round or nearly year-round steelhead country. Unfortunately, here in central Oregon, I'm not one of them. While there are still plenty of steelhead in the Deschutes River, the stretch within striking distance is closed now and it will be another couple of months before the summer run fish make it up into the interior reaches of the John Day. Between stormy winter weather, long distance to travel and work obligations, these early months of the new year are often spent doing more reading and writing about fish and fishing, than actually out on the stream. No matter, as long as we keep at our work advocating for their conservation and preservation, I can look forward to runs of wild steelhead arriving in my home waters when I have more spare time to don my waders.

For those of you who are able to get out steelheading regularly this winter, I will stifle my jealousy and just hope that you won't be too busy casting a fly to take some time to read this issue of *The Osprey*!

Letters to the Editor

Global Warming Sycophant

Dear Editor:

I was somewhat troubled by your editorial comments concerning the causes of global warming. You seem to think that climate change is caused by human activity and specifically the introduction of CO2 through the use of hydrocarbon fuels. Without arguing the actual science of the causes of climate change, your reasoning is neither factual nor can be defended scientifically. The current discussion in the media is neither fact based but rather a political vendetta against those who see the issue differently. I would hope *The Osprey* will not become a sycophant to these pressures and will keep to the subject of Wild Steelhead and Salmon, an area of expertise that you are actually capable disseminating useful and accurate information about.

Love the paper, the work you are doing on the fishery side of things.

Duane C. Dahlgren
via e-mail

Thanks, Rob

Dear Editor:

Thank you, Rob Brown, for your insightful article, "Skeena River in Crisis" in the September 2007 issue of *The Osprey*, Issue Number 58. Your presentation of the history of First Nations management of fisheries was astonishing, informative, and profoundly written. It is indeed thought provoking and I think has relevant parallels in our struggles to preserve and restore wild steelhead and other stocks here in Washington state, with a knowledgeable balance for Tribal and sport harvest for small and larger populations.

Larry Doyle
Port Townsend, Wash.

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then go to Conservation, Conservation Committees, Steelhead

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The Federation of Fly Fishers (FFF) supports conservation of all fish in all waters. FFF has a long standing commitment to solving fisheries problems at the grass roots. By charter and inclination, FFF is organized from the bottom up; each of its 360+ clubs, all over North America and the world, is a unique and self-directed group. The grass roots focus reflects the reality that most fisheries solutions must come at that local level.

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CHAIR'S CORNER

Finding Steelhead Magic

by Bill Redman

— Steelhead Committee —

This reminiscence on the two hours that completely changed this angler's attitude about steelhead fly fishing appears in the chair's space, because there is a conservation message at the end that applies today more than ever.

Before that magical evening of September 20, 1965, I thought of steelheading as a long shot effort to be tried only occasionally, with the rare steelhead hooked largely a matter of luck. I had caught only one steelhead on a fly, in the North Fork of the Stillaguamish River in August of 1961, and although it was exciting, the fish wasn't explosive and didn't measure up to the writings about the sport. A year or two later I hooked another; it promptly broke off in a tangle of loose fly line. Still I wasn't a true steelhead fly fisher.

In mid September of 1965 I drove to Jackson Hole, Wyoming for a week of stream dry fly fishing. In the first few days I had intermittent success, including a 20-inch cutthroat in Flat Creek, a beautiful meadow stream in the National Elk Refuge. But about mid week a major front arrived with a full day of hard rain, followed by unseasonably bitter cold, temperatures in the 20s and ice freezing in the guides.

Ice in the guides was beyond my tolerance level, so I headed west, not knowing exactly where I would stop next. From a bridge over the upper Big Hole River, I saw a few rising fish and caught a couple of grayling. The next day was still bitter cold, so I continued west, down the Bitterroot valley, over Lolo Pass, and down the beautiful Lochsa and Clearwater Rivers to Lewiston, Idaho. Only as I lost altitude in crossing Idaho did the weather soften.

I began thinking about where I could fish on my last vacation day and remembered the lower Grande Ronde River in southeastern Washington, which I had fished briefly for the first time the previous October. Although I had caught nothing on that trip, I liked the looks of the medium sized stream and had actually seen a couple of steelhead taken.

So I drove south along the Snake River to the Grande Ronde and arrived in time for two hours of fishing before darkness would fall in the canyon. I started in the long broad run by the public fishing area, which I learned later was called the Shadow Pool. With all that water, I had a hard time figuring out where the steelhead might lie.

Before that magical evening, I thought of steelheading as a long shot effort and the rare steelhead hooked a matter of luck.

As I waded downstream, I noticed at the lower end a small diagonal riffle with deeper water below it against the far bank. I waded to the riffle and started to fish down through this inviting looking run, water of medium depth with good flow and some boulders to break the current. The swing of the fly felt good. About half way down the fish struck near the end of the swing. Almost immediately it was off on a long run and out of the water. This steelhead was as explosive and exciting as any I have ever hooked, making five jumps and several long runs well into the backing. It finally ran through the tail out and down the rapid into the Turkey Shoot, where I finally landed it. It weighed about eight and a half pounds, large for the Grande Ronde.

I made my way back upstream to the very head of the riffle and began casting again. In no more than five casts another steelhead nailed the fly almost as soon as it hit the water. This was another explosive fish but considerably smaller than the first, a more typical Grande Ronde steelhead of about five pounds, and it came to hand more quickly. By then it was nearly dark and I returned to camp giddy with sudden success.

The next morning I fished for a few hours with no success, but the die was cast; I was an addicted steelheader. I returned to the Ronde for a few days every fall through the early 1970's and always was greeted by steelhead willing to take the fly.

After an 18 year absence while living in the East, I returned to the Grande Ronde in 1991 and have fished it every autumn since then. The contrast between the 1960s and the 1990s was dramatic.

In the mid- and late 1960s only four migration impeding dams stood between the mouth of the Ronde and tidewater. Now there are eight, the last four completed by 1975. The steelhead seemed to be able to cope with four dams and reservoirs. Most of them were wild, and they came consistently every fall. They seemed to work their way up the Ronde at a leisurely pace, and there were always some to be found through October into November. A good percentage of them were hot on the business end of a fly line, with good representation of six to seven pounders. I was sure the fishing was as good as it gets in Washington.

By the 1990s, most of the steelhead were and still are four- to five-pound hatchery clones, stocked by the hundreds of thousands as one year old smolts to "mitigate" for the damage done to the wild stocks by the dams. Many of them simply don't measure up to the wild fish when hooked.

The runs since completion of all eight

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Habitat Conservation Plan Continued from page 1

Incidental Take Permit would immunize the State (and possibly timber companies receiving logging permits from the State) from any ESA liability for "take" of endangered fish. No watershed-specific restoration plans would be required under the Clean Water Act. After years of federal and State review, the deal, known as the Washington Forest Practices HCP, was signed in May of 2006. Any actions to clean-up Washington's waters under the Clean Water Act were deferred until 2009.

There was, however, a major condition attached to the deal. Because the Report and several of the key stream protection prescriptions were based on little science, numeric defaults, and assumptions that were experimental and unverified, the State agreed to conduct an extensive long-term "Adaptive Management" program. Specifically, the State agreed to prioritize and test (based on the lack of science underlying key protection measures and concomitent risk to fish and amphibians) these multiple numeric assumptions on which the HCP was based, to monitor the HCP's effectiveness, and to determine whether the State was enforcing the HCP's rules on the ground through compliance monitoring.

This Adaptive Management program has been operating since 1999, at a cost of approximately $3 million per year in state and federal funds. The program is staffed by dozens of salaried and donated in-kind professionals. It has a science side (Cooperative Monitoring, Evaluation and Research Committee, or CMER) and a policy side (Forests and Fish Policy Committee). Its cumulative budget through 2010 is expected to be about $30 million.

Half-time report: what's the "score?

So is this Adaptive Management process "working" as promised? Do we even know what was "promised?" Can the HCP and its Adaptive Management program substitute for direct enforcement of the ESA and Clean Water Act? Here is a snapshot of progress made to date; you be the judge.

Study # 1: How wide must the buffers on fish-bearing streams be?

One of the key commitments in the Forests and Fish Report was to grow conifer forest buffers around fish-bearing streams that mimicked the natural conditions of 140-year-old stream-side forests, as measured in "basal area" (area of a stumps surface at breast height), minimum buffer widths, and density of "leave" trees. The Report estimated that the basal area for these buffers should be 190-285 s.f./acre depending on site class (quality of growing ground). In 2005, after a four year study of the riparian conditions in unmanaged forests, however, the science side of the Adaptive Management program found that the basal area for 140 year old stands was 300 to 369 s.f./acre and that, over all site classes of forests, the Report's defaults were off by a margin of 18-44%. The science side forwarded the correct targets to the "policy" side of the Adaptive Management program in 2005 which, in turn, forwarded a rule change proposal to the Washington Forest Practices Board in August of 2005.

Has the Board changed the basal area retention requirement in the rules during the past 2 1/2 years? No, the timber industry caucus convinced the Board to evaluate "alternative" ways to protect riparian areas aside from requiring basal area "leave" trees, and to reconsider whether other riparian protection rules can be adjusted downward to make up for the increase in basal area target number. Moreover, to make its "alternative" analysis, the Board chose to by-pass the Adaptive Management science process and asked the State's Department of Natural Resources to evaluate these alternatives after conducting a prolonged environmental and economic study of each of them. The gridlock result is that the new basal area targets have ping-ponged back and forth in rulemaking since 2005 while logging continues under the old, invalid stream buffer width rule defaults.

Intact conifer forests provide a wide range of benefits to steelhead, salmon and other fish and aquatic species including shade, instream debris for habitat and anchoring the soil to prevent erosion. Photo by Jim Yuskavitch.

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Study # 2: Where does a non-fish-bearing perennial stream begin?

Another key commitment in the 1999 Report was to leave 50-foot buffers on half the length of non-fish-bearing streams, streams which may have intermittent dry portions and whose initiation point can be difficult to detect during the wettest times of the year. To estimate the perennial initiation point of these streams, the Report made a critical assumption which it adopted as a default: a perennial stream's initiation point exists at the upstream end of a defined basin containing an area of 52 acres on the west side of the Cascade mountains, 300 acres on the east side, and 13 acres in the Coastal Zone.

But, just as with the buffer width study described above, the science side of the Adaptive Management program later found in 2003 that these defaults were off by nearly an order a magnitude (10 times) throughout Washington. The Report's underestimation of the length of perennial streams by default had the effect of eliminating a vast acreage of buffers next to perennial streams.

When the issue finally reached the Board in 2006, and only after intense lobbying, the Board agreed to strike the erroneous basin area default numbers but capitulated to timber industry pressure and refused to substitute the accurate defaults for the corrected ones. Rather, the Board decided to allow forest landowners to find their own perennial initiation points in the field, which presents a "fox-watching-the-henhouse" problem. To make matters worse, the Board refused to adopt a field board manual directing landowners how to identify perennial initiation points in the field, even though the State DNR, at the Board's direction, had spent almost a year developing such a manual with the cooperation of all other forest stakeholders except the timber industry.

Study # 3: Are The Fish Getting The Protections They Were Promised?

If the "prescriptions" of the Forests and Fish rules are not being laid out correctly on the ground, threatened and endangered salmon are not getting the habitat protection and restoration measures they need — and were promised — in the HCP. But compliance and enforcement is a huge challenge and unknown risks for fish, since the State has only the resources — and the political commitment— to verify a small percentage of the thousands of forest practice applications submitted each year. The problem is compounded by the fact that the State's "stream typing" maps for determining whether or not a stream or river contains fish — which determines the existence and width of the buffer — have been historically inaccurate by as much as 40-50%.

Powerful timber industry negotiators worked hard to make sure the most costly prescriptions were studied instead of implemented.

Unfortunately, the State's compliance monitoring program has not yet yielded any conclusions regarding landowner protections of salmon and trout streams. First it took the State DNR five years to even design and implement a compliance monitoring study. Once the first round of sampling was conducted, it showed that compliance with the rules was approximately 60% overall but that sampling was considered tentative and non-conclusive. So again the study is underway but a new obstacle has arisen: the State DNR made the tentative decision, over the protest of several stakeholders, not to assess whether forest landowners correctly "typed" their streams when laying out timber harvest units. Not determining whether streams were correctly typed will skew effectiveness monitoring, since one cannot conclude whether the rules are working if the correct buffers were not prescribed in the first place.

How these problems could have been avoided.

It remains to be seen what happens to this HCP in the future. It is no secret that some forest stakeholders are growing increasingly impatient and frustrated with the slowness and political vulnerability of the Adaptive Management process. It offers little comfort that the federal Services are only passively watch-dogging the process.

Space does not permit a treatise on federal HCPs. But based on my experience with Washington's Forests and Fish HCP, several structural provisions might have prevented this Adaptive Management program from hitting a log jam.

HCPs should be based on the precautionary principle.

One of the reasons the Forests and Fish HCP's Adaptive Management program is so important is because many of its forest management prescriptions protecting rivers and streams were experimental, untested, and pose a potentially high risk to aquatic resources. It is no secret that many of these prescriptions were political compromises and were not based on conservatively interpreted best available science. Also, powerful and plentiful timber industry negotiators worked hard to make sure that the most costly prescriptions were placed in an Adaptive Management "parking lot" and studied rather than being implemented immediately in the HCP. Yet logging continues under the original rules while the supposedly "adaptive" process endlessly churns. If, as urged by the environmental community, the HCP had applied the precautionary principle, delay and obstruction would not cut against protecting threatened and endangered fish.

Adaptive management programs for federal HCPs should not be subject to state political vetos.

While the Forests and Fish HCP is supposed to be science-based and science-driven, the HCP's Adaptive Management program is designed so that any changes to the rules proposed

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by the process must be approved by a consensus-guided "policy" committee and the 13-member Washington Forest Practices Board, a governor-appointed board that consists of a variety of forest stakeholders including many from the timber industry. State law — and the HCP — allow this Board and the Policy Committee to disapprove rule changes to preserve the "viability of the timber industry." Nor does the HCP define "viability." To make matters worse, the process is overseen by the elected Commissioner of Public Lands, who may be dependent on the timber industry for campaign contributions. In short, the process contains a fundamentally flawed political bottleneck.

HCP adaptive management programs should be overseen by an independent science review team.

Theoretically, the federal Services are supposed to enforce the HCP and keep its Adaptive Management program following the science. Yet, particularly during the past seven years, the federal government has not made enforcement of the ESA a priority. Moreover, federal agencies do not want to discourage landowners from negotiating federal HCPs, so they tend to "tread lightly" in enforcing HCPs. To make matters worse, some say the HCP is enforceable only by its participants, and its "dispute resolution" procedure is onerous and not independent. The process needs an independent "science stick" to monitor its progress, as recommended by the Governor's science panel in 2000.

Adaptive management programs must have a dedicated, ample, and reliable budget.

Thanks to a salmon-friendly Washington Congressional delegation anxious to catalyze improvements to industrial forestry practices, the federal government financed the development of the Forests and Fish HCP and the initial years of Adaptive Management. However, the federal money has now dried up and the State has been left with the bill. It also does not help that the Washington State Legislature gave the timber industry a tax-cut when it agreed to the HCP, and the industry does not directly fund the Adaptive Management program, except by providing in-kind contributions of timber industry scientists and policy staff. Now funding the HCP's Adaptive Management program stands in line in Olympia with every other environmental cause that desperately needs State money. This is not the best way to guarantee science-driven change.

A key component of Washington's Forests and Fish Report was to ensure that streamside buffers would mimic 140-year-old riparian forests. Photo by Jim Yuskavitch.

Conclusion

After 10 years of working in this process, it is my view that whether or not the Forests and Fish HCP works as promised and survives the test of time depends on the timber industry's willingness to allow the process to "follow the science."

The industry should be commended for agreeing to be bound by a process designed to improve forest practice rules that affect salmonids and their habitat. In contrast, Oregon and Idaho forest practice rules lag far behind Washington's, and both of those states have zealously resisted attempts to bring their rules into compliance with the ESA and the Clean Water Act.

That the Washington timber industry agreed to take this step forward, however, does not give it or the State a license to abandon science for politics. The Forests and Fish HCP and its Adaptive Management program is supposed to be a science-driven roadmap to protection and recovery of salmonids in the forest. The Adaptive Management program cannot have a "glass ceiling" over it that prevents rule improvements over time.

It is good forest policy to have a timber industry that is both economically viable and protective of endangered salmonids. But it is neither lawful nor good policy for a federally-approved HCP to be manipulated or delayed to neutralize the ESA and Clean Water Act, increasing risks to the fish.

I encourage all readers to e-mail, Doug Sutherland, Washington's Commissioner of Public Lands, at doug.sutherland@dnr.wa.gov, urging him to keep the process moving along as promised.

Global Warming Law Considered

by Bob Rees

— *Northwest Guides and Anglers Association* —

Bob Rees, president of the Tillamook, Oregon-based Northwest Guides and Anglers Association and himself a full-time fishing guide, writes in favor of current global warming legislation slated for a vote early in 2008.

To learn more about the association, log on to their Web site at www.nwguidesandanglers.org.

I recently returned from Washington, D.C. on a lobbying trip with fellow anglers, speaking to Oregon's senators and representatives about global warming legislation. As a full time fishing guide, the impacts of global warming on Oregon's rivers hit very close to home. As passionate anglers will agree, if you spend enough days, months and years fishing the same spot, you will notice changes in the river, some subtle and some drastic.

Across the state, several of these changes are painting a dim picture. Climate change impacts in Oregon threaten to increase water temperatures to a tipping point, reduce necessary habitat, and intensify the allocation battle between agriculture and threatened species.

Oregon's senators and representatives need to step up to the plate and sponsor comprehensive global warming legislation aimed at reducing carbon pollution. This will help mitigate these negative impacts and work to keep Oregon's fisheries thriving.

The U.S. Congress recently passed an energy bill that includes the first serious updating of fuel economy improvements for automobiles in decades. The average fuel economy of cars sold today is no better than it was during the era of the eight-track tape player. I commend Oregon Senators Gordon Smith (R) and Ron Wyden (D) for supporting this legislation as a down payment on global warming solutions.

While this turnaround is long overdue and welcome, what is still missing is the most important ingredient: specific limits on global warming pollution from large emitters. As it has before with the Clean Air Act and Clean Water Act, Congress needs to again set the precedent and pass a bill that sets scientifically-sound goals for reducing pollution. When you break this problem down, what you find is the need to start now to reduce global warming pollution, and cut carbon emissions by about 80 percent over the next 40 years. That level of reduction can stabilize the climate and avoid the worst effects of global warming.

Juvenile salmon and steelhead already experience lethal levels of water temperatures in our watersheds. During the month of July, temperatures frequently exceed 70 degrees — a threshold that kills these fish within a matter of hours or days. In addition, it is inevitable that Oregon will encounter more situations mirroring the Klamath River fish kill of 2002. As snowmelt-fed summer flows decrease, water temperatures will continue to rise, especially in rivers already taxed by water withdrawals for agriculture. We are approaching a tipping point of runaway climate change.

The math is easy. If we reduce global warming pollution by just two percent each year, by 2050 we can have this under control. Two percent. That's doable.

The U.S. Senate will likely vote on the Lieberman-Warner Climate Security Act early in the new year. This legislation begins reducing pollution by two percent per year and gets us well on the path to what scientists say is necessary to avoid the most dangerous impacts. Senator Ron Wyden just cosponsored this legislation, which is on the scale of the problem. He is affirming his commitment to the people of Oregon. Senator Gordon Smith should step up and publicly support this bill as well. Please call his office and urge him as a concerned sportsman, to cosponsor the Climate Security Act. His Portland office phone number is (503) 326-3386.

Our rivers, fish, and sportfishing community are depending on it.

Chair's Corner, continued from page 3

dams are also marked by inconsistency, both year-to-year and day-to-day. One year may yield a substantial run of steelhead; the next may fall way short. And the hatchery fish seem to travel in large packs and are in a hurry to move upstream to their points of release as smolts. If an angler happens to be on the river when a lot of fish come through, it's possible to catch them in multiples. But it's also possible through bad timing to fish several days without a strike, even though a substantial number of fish may have passed over Lower Granite, the upstream most dam.

All in all the runs of wild steelhead, which provide the best of the fishing, are way down from the 1960s. More important, the science is overwhelming: the future of these once abundant stocks is dependent on these depressed wild fish.

Now, in the face of this before and after comparison, we have, as of October 31, 2007, a draft of the latest Biological Opinion (BiOp) for the recovery of the steelhead and salmon stocks that must negotiate the federal Columbia River power system, with the final BiOp due January 31, 2008. We need go no farther than to point out that this latest BiOp draft continues the fiction put forth by NOAA Fisheries, the Corps of Engineers, and the Bonneville Power Administration, which claims that the hydro system *does not jeopardize* these ESA listed fish, in defiance of the facts, the science, the history, and the law! How the federal managers responsible for the recovery of these magnificent fish can publish with a straight face a plan, the bottom line of which is this no jeopardy claim, is absolutely beyond my comprehension.

Fortunately, the good news is that federal judge James Redden, who has rejected previous BiOps, judging from his statements about this draft, appears to be as annoyed with this latest draft as I am. He has threatened to run the river if the responsible agencies don't do better by the fish. And that would be a decided improvement compared to the status quo.

Space, Time and Sex: Memoir of a Rainbow Trout Watcher

By John R. McMillan
— Oregon State University —

Fisheries biologist John McMillan has spent a considerable amount of time on (and in) streams of the Pacific Northwest studying steelhead and rainbow trout interactions. In the following article, he gives us some of the observations, scientific and otherwise, that he has made over the years.

McMillan is currently a graduate research assistant with the Forest and Rangeland Ecosystem Science Center at Oregon State University.

The Beginning

Rainbow trout have been a pervasive interest as long as I can remember. As a young boy I fished for small rainbow trout in creeks with my father. Nearly every fish was caught on an Adams, my favorite fly. My first big trout was a 17-inch Deschutes "redside" that took a soft hackle dabbled on the surface at dusk. The first steelhead I landed was on a copper Bud's spinner in one of my father's favorite Washougal River riffles. But the culmination was one glorious moment at age 12 when I caught my first steelhead on a fly. The six-pound male rolled slowly over the top of my caddis as it dead drifted along a glassy tail-out on a Vancouver Island summer evening. I remember sitting down on the river bank — smiling and hands trembling. Little did I know that rainbow trout would represent the topic of my first scientific research paper published 24 years later.

After I moved to the Olympic Peninsula in 1997, a year passed before rainbow trout and I shared an experience worthy of memory. In mid-August of 1998 I caught a good-sized resident rainbow trout on an Adams while fishing for cutthroat. The catch was unexpected. The stream was not known for resident rainbow trout. A male, it had a long head and a bottom jaw that jutted out like a pissed-off prizefighter. It was densely spotted from belly to back. I caught two more that day. The find piqued my interest.

I returned the next day with a snorkel and mask, not a fly rod. Early in the morning, dive gear in the truck, I grabbed a coffee from the local stand and was in the water by 9 am. Within an hour I located trout and spent most of the day suspended in a current vortex behind boulders, watching them swim, feed, and interact. That recreational survey provided my initiation into the behavior of rainbow trout and steelhead in the rainforest rivers of the Olympic Peninsula.

I conducted several more snorkel surveys over the next two weeks, finding more rainbow trout. But their overall abundance was relatively sparse. By late fall I decided I had enough information to indulge in a personal research project. The goal of the study was to determine if resident rainbow trout and winter steelhead spawned in the same places at the same time. I also wanted to know if rainbow trout and steelhead attempted to mate, and if so, what behavioral tactics were used.

In 1999 I selected five survey reaches (1.4 to 2 miles in length) representing different locations along the longitudinal profile of the Sol Duc and Calawah rivers, two major tributaries of the Quileute River. To determine the distribution of rainbow trout and winter steelhead during spawning I conducted monthly snorkel surveys and redd counts from January through July over a four-year period. In addition, I spent one to two hours observing one pair or group of spawning steelhead and rainbow trout during each redd survey. The project culminated in a published manuscript in Transactions of the American

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A pair of steelhead spawn in a Pacific Northwest stream. Photo by John McMillan.

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Fisheries Society [McMillan, J., Katz, S., and Pess, G. 2007. "Observational evidence of spatial and temporal structure in a sympatric anadromous (winter steelhead) and resident *Oncorhynchus mykiss* mating system on the Olympic Peninsula, Washington State." Transactions of the American Fisheries Society, 136: 736 – 748.]. Although a published manuscript provides important sharing of information, the technical jargon and dry nature of scientific story telling seldom stirs the imagination. I will briefly describe some aspects of salmonid mating systems involving resident and anadromous life histories in the context of two specific experiences that served as benchmarks in my understanding of steelhead and rainbow trout in the Sol Duc and Calawah Rivers. I would like to provide a window into the behavior of a salmonid species that holds a special place in the hearts of anglers in the Pacific Northwest.

Space and time

Space and time are fundamental constraints in evolution. They are the clockwork and template against which organisms tune their behavior to achieve an optimum balance between survival and reproductive fitness. Space and time have been given great consideration in the scientific study of salmon and trout. It should come as no surprise that many investigations into the reproductive relationships of sympatric anadromous and resident life histories first centered on documentation of spawn time, spawn location, and spawning behavior. Research on brown trout, charr, and Atlantic salmon indicates that resident and anadromous forms often share the same spawn times and locations. Presumably, organisms which share similar breeding times and places are more likely to breed together than those who do not.

The first published study on the mating system of steelhead and resident rainbow trout examined spawn time and spawn location. The research project, authored by Christian Zimmerman and Gordie Reeves, was conducted in the Deschutes River, Oregon. They documented that steelhead and trout shared similar spawning grounds, but they generally spawned at different times. Additionally, the authors used otoliths (ear bone) to determine if the mothers of fish from each form were anadromous or resident. They found that all the resident fish they sampled had resident mothers, and all the anadromous fish sampled had anadromous mothers. The results provided convincing evidence that trout and steelhead display some level of reproductive isolation in the Deschutes.

My results tend to contrast with the Deschutes River work. I did not examine parentage, so I can not comment on reproductive isolation. But, I did find that trout and steelhead coexisted on the spawning grounds each month of the spawning season. That said, there were some differences between steelhead sexes and rainbow trout in their time of entry to our survey reaches. Specifically, April was the median entry time for male steelhead and April/May for females. This compared to May for resident rainbow trout. Space was also important. Steelhead entered the upper survey reaches earlier than the lower reaches, and trout were most abundant in the middle and upper survey reaches.

Space and time are basic constraints on evolution that optimize the balance between survival and reproduction.

The tendency of trout to be more common higher in the watershed is similar to observations of sympatric summer run steelhead and rainbow trout found in the Yakima River basin by Washington Department of Fish and Wildlife scientist Todd Pearsons. Although he documented extensive overlap between steelhead and rainbow trout, trout were more common at higher elevations than steelhead. It is theorized the resident form may predominate at higher elevations because over summering conditions (e.g., cooler water temperatures) are more favorable in those locations. Whatever the reasons, space and time exerted a strong influence on the spawning distribution of trout and steelhead. To some degree, those results were expected.

The first hunch I had that the distribution of steelhead and trout varied across space and time occurred in mid-May of 2000. It was an overcast day of 64 degrees. Stream flows and visibility were perfect for snorkeling. I was a little more than a mile from completing my last June survey in a reach on the upper Sol Duc River.

As I swam down through a long riffle I noticed a female and male steelhead on a redd. I stopped and observed them for a minute or two. As I turned around to continue downstream I noticed several smaller, trout-sized fish sitting in a boulder field about 30 feet below the steelhead pair. I slowly swam by the fish and pulled over into the shallows behind them. They were 10 to 14 inches in length, chubby, densely spotted, and each had a dark red stripe running the length of its side. They had the same masculine heads as the fish I caught in 1998 and were clearly resident rainbow trout. After watching the fish for ten to fifteen minutes I started off downstream to finish my survey.

That day I counted seven rainbow trout in the 1.4-mile-long reach. I also counted two female steelhead and one male steelhead. I had only observed a single rainbow trout in my February and March surveys, and I did not observe any trout in April. The increase in rainbow trout documented in May was similar to the previous year's findings. A month later, in June, I counted ten rainbow trout and five steelhead, which were all female. Again, this was similar to the previous year. In July, I counted one female steelhead and eight rainbow trout. Again, I did not observe a male steelhead. Rainbow trout were apparently the only mate source for late arriving female steelhead. The May survey represented my first glimpse of spatial and temporal structure in the distribution of spawning steelhead and trout.

The result of the observations in the

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manuscript was a statistical analysis followed by a brief description of the findings. However, there was much more to my epiphany in May than could be described in a scientific journal. I had stumbled onto a space-time continuum: a continuum of movements and migrations, a dance between rainbow trout and steelhead and their environment. This revelation provided a personal understanding into the world of steelhead and rainbow trout that was more rewarding than any catch of my youth.

Sex and size

Previous research on salmonid species indicates most matings between sympatric anadromous and resident forms occurs between resident males and anadromous females. In many cases, the resident population is either solely male or at least male dominant, while the anadromous form is typically female dominant. This is well documented in Atlantic salmon, where small resident males commonly sire offspring with anadromous females. The thought of a five-inch-long precocious male friskily courting a 20-pound female salmon should make both anglers and scientists reconsider the common dogma that 'big' males are the key to reproductive success. After reading through volumes of literature on Atlantic salmon, brown trout, and charr, I realized that I needed to rethink my understanding of steelhead.

Male rainbow trout and/or male precocious parr (residualized steelhead offspring) have been observed attempting to mate, probably successfully, with female steelhead. Some of the first observations came from Waddell Creek in 1954 (Shapovalov and Taft), a small creek draining redwood forests in California. Similar observations were noted in a recent literature review of resident rainbow trout in the Columbia River basin conducted by Kathryn Kostow (ODFW). She cited numerous biologists who had observed male trout trying to sneak matings with female steelhead. On the other hand, male steelhead were rarely, if ever, observed trying to mate with female trout. Like other salmonids, the male trout appear to be the reproductive vector between the two life histories.

This rainbow trout the author caught on Washington's Olympic Peninsula inspired his interest in researching rainbow-steelhead interactions and relationships. Photo by John McMillan.

Recent studies on entire populations of steelhead provide indirect support for interbreeding between male trout and female steelhead. For example, parentage studies of steelhead in Snow Creek, Washington (lead author: Todd Seamons, graduate student at University of Washington) and of steelhead in the Hood River, Oregon (lead author: Hitoshi Araki, post-doc at Oregon State University) revealed a high number of missing parents that ranged up to 50% in some years. The authors hypothesized that the missing parents were resident males (either rainbow trout or precocious parr). Understanding the behavioral component responsible for the genetic relationships is critical to improving conservation and management.

In our study, we documented 169 attempted matings between female and male steelhead and 29 attempted matings between male trout and female steelhead over 118 hours of direct observation. I never observed a male steelhead and female trout attempting to mate, nor did I observe any trout excavating redds. That I only observed male trout attempting to mate with female steelhead, and not vice versa, was consistent with my expectations based on the literature.

Rainbow trout were not observed attempting to mate with female steelhead until April, but by June they accounted for most of the attempts and were the lone mate source for the females that returned in July. Spatially, the greatest number of interactions between the two forms was documented in the upper survey reaches. These same reaches contained the greatest proportion of wild resident fish during snorkel surveys. No attempted matings between forms were observed in the lower Sol Duc, where rainbow trout were least abundant. Thus, the onset and increase of attempted matings between forms was consistent with the distribution structure observed during snorkel surveys.

Prior to the snorkel survey in May of 2000 when I counted several trout, I had documented three mating attempts between male rainbow trout and female steelhead. In each case, a single trout held just below a pair of steelhead. I guessed the trout ranged in length from 10 inches up to perhaps 15 inches in length. The steelhead ranged from 8 pounds to 15 pounds. At some point during the courtship between the female and male steelhead, the female would settle into the

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redd and arch her back, open her mouth, and shudder slightly as she released her eggs. The male steelhead, already along her side, would also drop into the redd, open his mouth very widely, and discharge a white cloud of milt. At the moment this event was initiated the male trout shot upstream alongside the unoccupied side of the female steelhead and discharged his milt. Although I had counted multiple male trout in previous snorkel surveys, I had never observed more than a single trout trying to mate with a female steelhead.

Two days after I finished a snorkel survey in mid-May of 2000 I finally observed the type of behavioral diversity I hoped to encounter. I was a couple hundred meters downstream from where I had previously counted several trout holding below a steelhead pair. Upstream I saw wakes in the channel margin which I assumed to be male steelhead fighting for access to a female. I approached slowly and saw two smaller dark male steelhead and two other larger males swimming towards me. Strangely, the fish were circling each other, biting at one another's tails in a violent slashing ruckus. They whirled around and around — nipping, biting, and ripping at each other. Fascinated by the aggressive activity, I continued to watch from behind a boulder.

The two males, soon exhausted, moved downstream to hold behind a couple of large boulders. Minutes later a large female, perhaps 15 pounds, swam towards me and moved onto the redd. The two smaller males that had been waiting anxiously moved up alongside her. Then another large male, which I had not noticed, moved in and pushed the other males away. There was no fight between these fish. The smaller fish sensed his dominance. The large male and female courted for several minutes, him shuddering and her occasionally sliding under his belly from one side to the other.

After half an hour the two steelhead initiated a couple of mating attempts. On the third attempt two small fish bolted alongside the female and discharged milt. They then held in about 8 inches of water directly in front of me, no more than 15 feet away. The fish were 10 to15 inches, about the same size as the ones counted during the snorkel surveys. I watched them for fifteen minutes and confirmed that their morphology fit my definition of a resident rainbow trout. They had dark red stripes along the length of their body, relatively blunt but masculine heads, and their sides were an inverted Milky Way of black spots running from the dorsal fin down through to the belly. Over the next couple hours I was privy to as great a display of behavioral diversity as any naturalist or scientist could hope for.

I watched ten different attempted matings that day. Five included two rainbow trout sneaking in alongside the female steelhead, who was flanked on both sides by two male steelhead. The other attempts included various numbers of trout and steelhead. Six steelhead and one trout simultaneously attempted to fertilize the female in the most extraordinary act observed.

The large male and female courted for several minutes, him shuddering and her occasionally sliding under his belly.

When the activity ceased, I sat back against the boulder. For the first time I had found something more interesting than the standard ménage à trios. Over the next three years I would make similar observations. But at the project's end, all I could remember was watching a few horny trout triangulate behind the plump female steelhead as I peeked from that boulder on the bank in May of 2000.

A fresh perspective

I conducted the last snorkel survey, redd count, and behavioral observation in June of 2003 in the same reach where I first observed multiple male rainbow trout soliciting a female steelhead in 2000. That week I counted a couple female steelhead and some rainbow trout during snorkel surveys, and found two fresh steelhead redds. My last behavioral observation involved a female steelhead and two male trout. In absence of a male steelhead the female was courted by the two trout. Each male took turns shuddering alongside the female, which is part of the courting process. The large female, about 12 pounds, was responsive. I watched the group of fish interact for about an hour before I walked down to the river bank. As I approached, the male trout darted for cover. The female slowly slid downstream and disappeared under a bubble curtain formed by several boulders. In the vein of The Doors famous lyrics, I thought 'this is the end, my friend, the end."

Four years of swimming, walking, and watching then shifted to data entry, analysis, and writing, a process that took another two years to complete. I must admit, most of those long days spent behind a computer were made bearable by reliving the vivid memories of the field work. I suppose this is the case with most scientists — at least the ones I know. The field work charges the batteries. It primes the pump for the 'real' work of drafting manuscripts and reports that each scientist hopes will positively impact the conservation and management of the fish we study.

I cannot say that my research on steelhead and rainbow trout will have any great influence on conservation, science, or management. The results are relatively simple and are but a single step in a long line of future questions. What I can say is that the project was fun, intriguing, revealing, and spiritually cathartic. I had given it all I had, and nature had responded. The lesson I took home was that observation stimulates a more visceral understanding of rainbow trout than angling. That has been a personal step of progress for me in the transition from fervent angler to budding biologist. Thank you rainbow trout! Thank you for the smiles, the trembles, and for imparting upon me some bit of your mysterious ways.

Fish Creek, Wild Idaho Steelhead Haven

By Gary Macfarlane
— Alliance for the Wild Rockies —

Although not well known, Idaho's Fish Creek is a wild steelhead stronghold. In this article, author Gary Macfarlane introduces us to this important stream and the potential threats facing it.

Gary Macfarlane is President of the Alliance for the Wild Rockies (www.wildrockiesalliance.org) and Ecosystem Defense Director for the Friends of the Clearwater (www.friendsoftheclearwater.org), a local group working to protect areas such as Fish Creek in the Clearwater basin.

The locally famous Fish Creek is arguably the most important wild steelhead stream in Idaho. This tributary to the famed Lochsa River — itself a major subbasin in the Clearwater River drainage— encompasses a watershed of about 50,000 acres. The main twin streams of nearly equal size, Fish and Hungary creeks, form the watershed into a twisted Y shape. Interestingly, it is Hungary Creek, which appears to be a bit larger than its twin even though beyond their confluence the stream carries the name Fish Creek. The steelhead habitat in Hungary Creek may even be slightly better overall, although the best spawning habitat is likely in Fish Creek not far above its confluence with Hungary Creek. Most of this watershed is roadless and has been little affected by human activity. It is the centerpiece of the North Lochsa Slope inventoried roadless area — a large swath of wild country which would be designated as wilderness by HR 1975, the Northern Rockies Ecosystem Protection Act (Note: For more information about this visionary legislation, visit the Alliance for the Wild Rockies website at www.wildrockiesalliance.org).

The steelhead in Fish Creek (and most of the Clearwater) are the larger B-run fish which spend two years in the ocean. In spite of outplanting efforts in the 1970s and 80s in the Lochsa, is it thought that there is little genetic difference today from steelhead in the past in Fish Creek. The habitat in Fish Creek is generally very good. Elevations range from less than 2,000 feet at the confluence with the Lochsa to more than 7,000 in the higher reaches. Precipitation is high for Idaho, ranging from 40 to 60 inches.

The history of this region is rich. The Nez Perce had many trails throughout the entire Clearwater Basin. The major east/west route into Montana went along the northern ridge of the Fish Creek watershed. This route, known as the Nez Perce trail, separates the Lochsa from the North Fork Clearwater. It was in the Fish Creek drainage that Lewis and Clark became lost and deviated from the main ridge trail used by the Nez Perce to travel from Idaho to Montana to trade. Hungary Creek got its name and spelling from the journals of Lewis and Clark. Today this deviation from the Nez Perce trail is the largest undeveloped segment of the Lewis and Clark route as major highways now parallel most of it. One could conclude from reading the history of the expedition that the Corps of Discovery didn't fully appreciate wild fish as a food source. They also may not have been very adept at catching enough fish to supply the whole group. For whatever reason, Hungary Creek was not a pleasant place for them as it was for the Nez Perce.

> ***Despite past outplantings in the Lochsa, there has been little historical change in Fish Creek wild steelhead genes.***

In spite of the fact the Fish Creek watershed is undeveloped, it does have a slightly different character today than what Lewis and Clark found in the early 1800s. In the early 1800s, the end of the Little Ice Age was approaching. Some of the terrain in the Fish Creek watershed, especially at lower elevations on south-facing slopes, which was forested by conifers in the time of Lewis and Clark, today consists of large deciduous shrub fields. Fires in the early 1900s, especially the Pete King Fire of 1934, have affected the vegetation up to today.

Nonetheless, fire has shaped the Clearwater for eons. Research has shown that in the time of Lewis and Clark, shrub fields caused by fires were found in the Clearwater Basin. While fires have short-term impacts on watersheds and fish, they usually provide long-term watershed benefits. For example, burned trees and snags fall into streams and create fish habitat. Important watersheds like Fish Creek evolved with these "pulse" events, and they are necessary for proper hydrological function. This is different than human-caused" events" such as roads and road construction, which harm rather than help long-term watershed health. Indeed, Fish Creek is an example of a healthy watershed. Comparing it with the nearby Pete King drainage, which has been roaded and developed, is very revealing.

Fish Creek is also the site of a steelhead research project by the Idaho Department of Fish and Game (IDFG). The IDFG has a fish weir near the mouth of the stream. Alan Byrne, an expert fishery biologist with IDFG, was kind enough a few years ago to conduct a tour of the area for the Friends of the Clearwater and Palouse Group Sierra Club, two local conservation organizations (for more information about Friends of Fish Creek visit www.friendsoftheclearwater.org). The IDFG has been very accommodating to groups interested in visiting the area. Access to this area is an easy drive up US Highway 12 along the

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Lochsa River, then a few hundred yards up the short spur road that leads to the trailhead for the path that goes up this beautiful creek.

According to IDFG data, more than 100 wild steelhead spawned in Fish Creek in 2001. The runs of 2001 were considered some of the better since the construction of the lower four Snake River dams. The following couple of years were even better, and 2003 appears to have been a record year since completion of the lower four Snake River dams, though recent runs have again dropped.

Because of the research, fishing is restricted in Fish Creek. The entire Lochsa River basin is closed to harvest, as all steelhead are considered wild. Those fishing in the Lochsa must use barbless hooks and practice catch-and-release fishing

There are some interesting findings from the IDFG studies. Byrne told the group visiting the site that steelhead and west slope cutthroat may interbreed on rare occasions. It appears the genetic makeup of the steelhead and the west slope cutthroat in Fish Creek shows a small degree of overlap. Since Fish Creek is an undisturbed watershed, it is hypothesized that some infrequent interbreeding between the two species is natural and has been going on for eons. Future research may shed more light on this fascinating topic.

Chinook salmon and bull trout are also found in Fish Creek. This area is also home to rare harlequin ducks, wolves and other species that inhabit undisturbed habitat. Near Fish Creek, but in the same roadless area, are Bimerick Meadows on Bimerick Creek. This natural area contains rare ecological features and has been studied by Dr. Fred Rabe, a retired aquatic biologist from the University of Idaho. Also nearby, the Lochsa Research Natural Area has rare species like Pacific dogwood that are only found here or on the coast. Tim Egan did a recent story of this region in the New York Times travel section. Indeed, the large north-central Idaho wildland complex, which includes Fish Creek, is known locally as the Big Wild, the largest wildland ecosystem in the lower 48 states.

In the upper reaches of the stream, clear cold water flows through meadows. A few years ago, Clearwater National Forest officials formally closed the trail to motor vehicles that led to the meadows. There had been serious resource and watershed damage in this area. Unfortunately, the Forest Service has failed to close other foot trails in the area to vehicle use, trails traditionally used by those on foot or horseback, and even opened up a trail to the four-wheel all-terrain vehicles. This was done in violation of the forest plan that requires 100% habitat effectiveness for elk in that part of the Fish Creek drainage. The stream grows considerably larger as it descends. Its average width is about 30 feet, though it is much wider in lower reaches.

Fish Creek offers high quality spawning habitat for a historical population of wild Idaho steelhead. Photo by Gary Macfarlane

The vegetation reflects the fire history and is quite diverse. Habitat types include deciduous riparian vegetation, wet cedar forests in lower elevations to mixed conifer and even subalpine fir in the upper reaches. According to Forest Service habitat surveys, the stream headwaters is relatively unconfined with a sandy gravel channel in and around the meadows. Spruce flats surround this meadow complex. Lower down, the stream becomes steeper, more confined, and the substrate coarser. Just before the confluence with Hungary Creek, there is a fairly extensive bottomland of scattered old cedars, brushy riparian vegetation and old cedar snags. It is here the best habitat for steelhead spawning is found. Interestingly, most habitat surveys have been conducted in Fish Creek proper, even though it is thought Hungary Creek may be better habitat overall, at least according to the population viability assessment by government agencies.

One can see the changes in Fish Creek by hiking the trail from the trailhead near the Lochsa. The trail follows the fast tumbling stream as it races over large boulders. Here, one can observe the influence of fire as many south and western exposures have few conifers, though small hardwoods, important food for elk in the winter, dominate the landscape. Old cedar snags and renewed forests cover the north and east facing slopes. In a few places, some large cedars are found. The trail, after about 4 miles, eventually reaches Obia Cabin, an old Forest Service structure. Here is the confluence of Fish and Hungary Creeks. Further up, the meanders can be observed in the bottomlands. One can also deviate and take a rough side trail that parallels Hungary Creek or one of a few side trails that lead from Fish Creek itself.

Some intrepid kayakers run the lower reaches of the stream during the spring. It requires hauling a kayak up the Fish Creek trail and taking out around the trailhead, just before reaching the fish weir. Anyone who has seen Fish Creek in the spring will realize only the most experienced and expert kayakers should make such a run.

Even though the area has some protection, all is not well. The population viability assessment notes that even though steelhead have a large popula-

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tion in the Lochsa (and Fish Creek), they are at risk. The Snake River steelhead population is listed as threatened under the Endangered Species Act because of consistently low returns of wild fish, especially since the completion of the lower four Snake River dams. Historically, a small percentage of the kelts would return to spawn again in Idaho's rivers. The Snake River dams have completely eliminated that possibility.

More permanent protection of the Fish Creek watershed would help ensure steelhead viability into the future. While the area received some support in the early 1990s from former Idaho 2nd District Democratic Representative Larry LaRocco for wilderness designation, the most consistent support for protection has come from citizens. The Nez Perce Tribe challenged the ill-advised North Lochsa Slope Timber Sale in court a few years ago and won in U.S. District Court on some of their claims. The government appealed the decision to the Ninth Circuit Court, as did the Nez Perce Tribe on the claims rejected by the District Court. A settlement was recently reached between the Nez Perce Tribe and the Forest Service, but most details are lacking. We do know there will be no logging in the Fish Creek watershed or any roadless area and that many roads will be removed. Citizen conservationists have consistently pushed for the Northern Rockies Ecosystem Protection Act., which would protect all of the roadless Fish Creek watershed as wilderness. With changes in Congress, it is possible a hearing will be held on HR 1975 in the near future.

Streams like Fish Creek epitomize the statement of John Muir that everything in the universe is hooked to everything else. It will take dedication to protect the Fish Creek watershed, including action against global warming, which could have disastrous circumstances for steelhead in the Clearwater basin, and making the rivers function as rivers by putting topics like breaching the lower Snake River dams on the table again to ensure that generations to come will have wild steelhead and salmon in the Fish Creek watershed.

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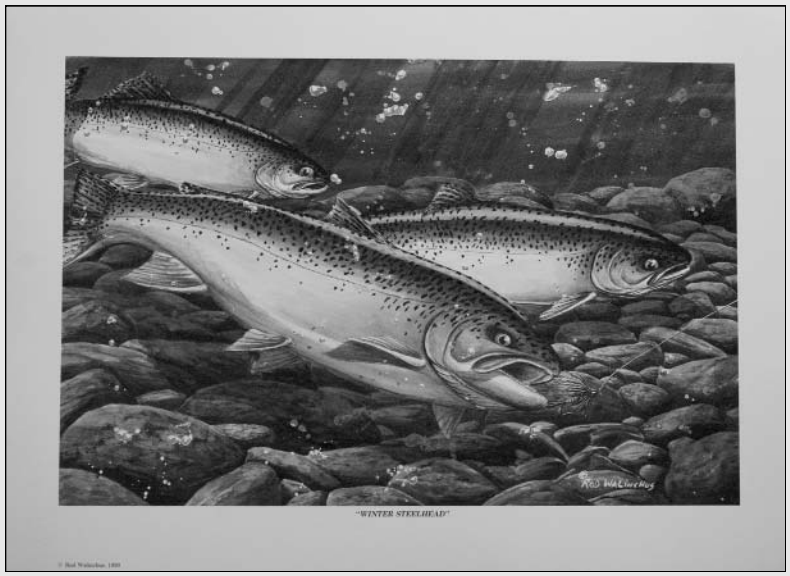


Fizzy Science: Big Hydro's Hidden Role in Global Warming

Dr. Patrick McCully
— International Rivers —

Hydropower is typically characterized as "green" with little or no carbon footprint to contribute to Global Warming. While that is mostly true in temperate climates, the situation may not be so rosy in tropical areas where large reservoirs have been shown to produce significant amounts of greenhouse gasses, and methane in particular.

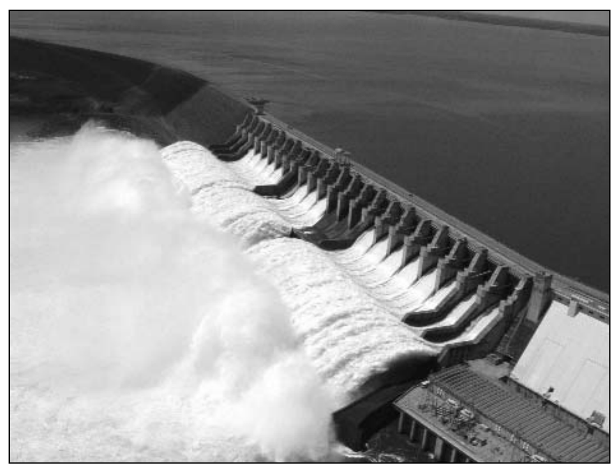
The tropics seem a distant place for coldwater anglers to be concerned about. But Global Warming is global and things that cause temperatures to rise down there will eventually affect us up here, along with our already at-peril populations of wild, coldwater fish — steelhead and salmon included.

Author Dr. Patrick McCully is Executive Director of International Rivers, based in Berkeley, California. For more information about International Rivers go to http://www.internationalrivers.org/. The full "Fizzy Science" report can be found and downloaded at http://www.internationalrivers.org/pdf/greenhouse/FizzyScience2006.pdf.

Large dams and their reservoirs are likely a significant contributor to global warming. In the case of big reservoirs in the tropics — where most new dams are proposed — hydropower can actually emit more greenhouse gases per kilowatt-hour than fossil fuels, including infamously dirty coal plants. This discovery is, of course, not good news for the construction companies and utilities that are aggressively touting hydropower as a clean, green and environmentally friendly alternative to coal and other fossil fuels.

Just how much greenhouse gas can a hydropower dam emit? According to estimates by noted Brazil-based climate change scientist Philip Fearnside, hydro projects in the Brazilian Amazon on average have twice the global warming impact of coal powered plants. Brazil's Balbina Dam, the worst example cited by Fearnside, had a climate impact in 1990 higher than that of 54 natural gas plants generating the same amount of power as the dam. In French Guiana, the average climate impact of the Petit Saut Dam was nearly five times that of a gas plant over the dam's first 20 years of operation.

A recent study by Ivan T. Lima and his colleagues at Brazil's National Institute for Space Research (INPE) estimates that large dams _ those over 15 meters (50 feet) high — contribute some 104 million metric tones (115 U.S. tons) of methane to the world's atmosphere each year. Brazil and India contribute nearly a third of that total. The INPE researchers also calculated that dams could be responsible for up to a fifth of Brazil and India's total global warming impact.



The cost of building Tucuruí Dam in Brazil included forest loss, greenhouse gas emissions and blocked aquatic species migration. Photo by Eneida Castro.

Lima and his team suggest that the world's 52,000 large dams are responsible for more than four percent of the total global warming impact of all human activities, including power plants, transport, farming and deforestation. Fully a quarter of all human-caused methane emissions may emanate from dams, making them the largest single source of human-caused methane.

Methane is a particularly potent global warming contributor. The UN compares the warming impact of different greenhouse gases by comparing the impact of a given weight of each gas to that of carbon dioxide, over a 100-year period. Using this "100-year global warming potential" (100-year GWP) method, methane is considered 25 times more efficient at trapping heat than carbon dioxide.

Methane has a much shorter life-span in the atmosphere than the very long-lived carbon dioxide, so considering its impact over 100 years understates its impact over shorter periods.

Over 20 years the GWP of methane is 72 times higher than carbon dioxide. Using this 20-year GWP, methane from the world's large dams, as estimated by Lima, has a global warming impact equivalent to that of 7.5 billion tones (8 billion U.S. tons) of carbon dioxide. In other words, each year's emissions of methane has an impact over the following two decades equal to an emission in the same year of eight billion tons of carbon dioxide.

The amount of greenhouse gases produced by dams and their reservoirs varies widely. Emission levels are dependent on climate zone, reservoir depth, reservoir surface area and a number of other factors. In general, the climate impact of hydropower generated in temperate and boreal regions is far lower than that of fossil fuel alternatives, but tropical hydropower can have an impact much worse than even the dirtiest fossil fuel plants.

For example, while the Balbina Dam is a significant source of greenhouse gas compared to its output of electrici-

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ty, Itaipú Dam, also in Brazil, is not. Itaipú Dam created a deep reservoir with a relatively small surface area compared to its massive generating capacity — second only to that of China's huge Three Gorges Dam.

Lima and his colleagues are currently developing a system for capturing reservoir methane and burning it to generate electricity. The researchers believe that such a technology is economically and technically feasible and could provide significant amounts of electricity.

Counter Intuitive Emissions

When a dam blocks a river, its reservoir floods large amounts of carbon in vegetation and soils. This is usually in the form of drowned forests and other submerged plant life. As organic matter rots underwater, it creates carbon dioxide, methane and, in at least some cases, an even more potent warming gas, nitrous oxide. Reservoir emissions are particularly high in the first few years after a reservoir is created because of the carbon in flooded plants and soils. The releases, however, can remain significant for many decades. This is because the river that feeds the reservoir — and the plants and plankton that grow in it — will continue to provide more organic matter to fuel greenhouse gas production.

Methane is generated when bacteria decompose organic matter in oxygen-poor water. Water at the bottom of reservoirs is commonly depleted of oxygen, particularly in warm climates. As bubbles of methane rise toward the surface of the reservoir, some will be oxidized to carbon dioxide. Because methane takes longer to reach the surface in deeper reservoirs, these will normally have lower methane emissions per unit of area flooded than shallow reservoirs.

Some methane emissions occur at the reservoir surface. But for tropical hydropower dams most methane emissions appear to occur at the dam itself. While some of the methane rising to the reservoir surface will be oxidized on the way, when methane-rich water jets out from turbines and spillways, it abruptly degasses, just like fizz from a newly opened bottle of Coke.

Kill the Messenger

In the coming green economy, energy technologies with the lowest greenhouse gas emissions will dominate. There is a lot of money to be made in this energy transformation, and the big hydro lobby is pushing hard to be seen as climate-friendly. The last thing the dam industry wants is to be considered as yet another global warming culprit, and unsurprisingly the industry is taking steps to protect its future.

Hydropower interests dispute findings that their dams can contribute significantly to global warming. In 1995 when International Rivers first suggested hydropower reservoirs were a source of greenhouse gas emissions, the reaction was one of sputtering disbelief. "It's baloney and much overblown," exploded one spokeswoman for the U.S. National Hydropower Association. "Methane is produced quite substantially in the rainforest and no one suggests cutting down the rainforest."

Hydro projects in the Brazilian Amazon have twice the global warming impact of coal-powered plants.

The language of hydropower proponents has tempered since then, yet Canadian and Brazilian hydro interests (which dominate funding for reservoir emission science) still try hard to control the terms of debate and the interpretation of research. The manager of Hydro-Québec's Greenhouse Gas Program recently insisted that hydropower plants "generate 35-75 times less" greenhouse gases than fossil fuel plants, a contention that completely ignores current science on tropical reservoirs.

Canada's Hydro-Québec has also taken more direct action on the issue. The company cut funding to scientists whose work was leading to conclusions the utility considered inconvenient. Hydro-Québec also tried, unsuccessfully, to pressure a scientific journal to not publish a peer-reviewed paper on reservoir emissions by those same scientists.

Meanwhile, in hydropower-dependent Brazil, hydropower companies and the government have backed a group of scientists whom Fearnside charges have "made a career out of trying to prove me wrong." The industry-backed scientists accuse Fearnside, a rigorously independent researcher, of being seduced by the "lures" of the fossil fuel and nuclear lobbies. When Fearnside compared the degassing of methane from a dam to that of the "fizz" from newly opened can of Coke, they even asserted that the use of an American drink as an analogy was "highly symbolic of [Fearnside's] way of thinking." They suggested he use a Brazilian soft drink, instead.

Despite such accusations, Fearnside's findings were supported in a 2006 editorial in the respected scientific journal *Climatic Change* written by Danny Cullenward and David Victor of Stanford University. Cullenward and Victor criticized the hydro industry's control of the reservoir emissions research agenda and called for an independent analysis of the data and their interpretation by the UN's Intergovernmental Panel on Climate Change (IPCC).

Where To Now?

Given the high stakes — the billions of dollars that will be directed to reducing climate change and the importance that these investments be made as effective as possible — it is vital that decisions on climate policy are made on objective evidence, not information produced by self-interested industry lobby groups.

As the debate now stands, a small number of independently-funded scientists is facing off against hydroelectric power-supported researchers. What is needed is an independent review of reservoir emission science. The United Nation's IPCC should produce a special report on reservoir emissions that all competing parties can accept as scientifically rigorous, independent and accurate as a baseline for discussions about the issue.

Conflicting Wild Steelhead Management Goals on Oregon's Molalla River

Bill Bakke
— Native Fish Society —

Bill Bakke, Executive Director of the Native Fish Society, prepared this evaluation of wild winter steelhead management on Oregon's Molalla River. To learn more about The Native Fish Society visit their Web site at: www.nativefishsociety.org

Watersheds have a finite capacity to produce salmonids. When that capacity is reached, density intrudes and competition for rearing space and food limits smolt production. Each year and each season presents a new habitat capacity because each year presents new environmental conditions. This fluctuating environment can come in many long-term and short-term forms, including floods, prolonged drought and increases in water temperature.

Salmonids home to their birth streams and are therefore locally adapted to the environmental conditions and changes in their home rivers. Their numbers may fluctuate in response to habitat changes, so a river may produce more juvenile salmonids one year than the next, depending on whether the ecological conditions of the watershed favor or challenge survival. Therefore it is difficult to calculate the capacity of a watershed to nurture salmonids.

Ecological conditions are constantly changing and the fish are constantly adjusting. Change is the only constant.

With this ecological variation in mind, fish managers would be more successful in their craft if they focused on maintaining the reproductive capacity of the fish, as well as the habitats that support it.

An informed estimate of a watershed's capacity to produce salmonids — its carrying capacity — is important, but this information is lacking for most steelhead and salmon streams even though this information is needed to develop criteria for long-term productivity of native, wild salmonid populations.

By having an estimate of a watershed's carrying capacity for steelhead, it is possible then to estimate the egg deposition needed to fully seed the available habitat. This can be translated into the number of spawners required and the number of females needed. This information can be used to determine the number of redds. Since we do not usually have the ability to count how many spawners a river receives annually, redd counts are used as a surrogate for spawners. For example, in the 1992 Molalla River basin plan, the Oregon Department of Fish and Wildlife (ODFW) estimated that at least 3,500 native winter steelhead were needed to fully seed the available habitat. They determined that the female to male ratio was 1:0.8 and each female has 4,000 eggs and each redd has one female. They estimated that there were 110 miles of spawning habitat . Based on this estimate the biologists determined that 18 redds per mile of stream would produce 3,500 adult steelhead in the next generation.

The Molalla River was one of two major wild steelhead spawning areas in the upper Willamette basin.

In the 1992 Molalla River Steelhead Plan, the ODFW biologists were concerned about wild steelhead. Their primary objectives in this plan were to maintain the "genetic integrity and productivity of the native late steelhead stock" and to "maintain an average annual escapement of at least 3,500 late run steelhead." A conservation requirement was established for the river.

A production goal was based on an ecological estimate of the river's capacity to produce wild steelhead and an institutional commitment to securing the needed spawners. A production goal depends on maintaining the reproductive success of the steelhead. This means the health (abundance, distribution and diversity) of the wild fish population has to be maintained and the habitat that supports that population must be protected.

It is a two part management strategy that includes both the naturally produced fish that rear in the river for two to three years and the habitat that makes it possible.

By 1992, the native, wild steelhead in the Molalla River had already declined. It is reasonable to expect the Molalla River can produce 4,000 to 5,000 wild steelhead per year, given the historic record. In 1965-1966 the wild winter steelhead run size was 4,454 (Clady 1971).

Hatchery winter steelhead were not released into the Molalla River until 1971, so the winter steelhead population in the mid-1960s was entirely naturally produced wild fish, representing 32 percent of the steelhead run above Willamette Falls. The Molalla River was one of two major spawning areas for wild steelhead in the upper Willamette River.

In 1971 there were 44 wild steelhead spawners per mile, but by 1993 wild steelhead spawners declined to a low of seven fish per mile. (Lichatowich 1999). In 1999 the Molalla wild winter steelhead were given federal protection as a threatened species under the Endangered Species Act.

What happened? The Oregon Department of Fish and Wildlife had

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developed a conservation requirement for wild steelhead, but it was not enough to prevent the downward slide of this wild population. The department adopted a policy that gives "native winter steelhead priority over all other non-native stocks and species...." The agency also said, "Winter steelhead in the Molalla subbasin shall be managed for natural and hatchery production." (ODFW 1992)

In 1971, the Oregon Department of Fish and Wildlife began releasing non-native Big Creek Hatchery winter steelhead and in 1984 Skamania Hatchery summer steelhead into the Molalla River. The agency said that the hatchery winter steelhead were introduced to "extend the winter steelhead fishery by providing an early-run fish." (ODFW 1992)

The agency rationalized the introduction of hatchery summer steelhead because it would "increase angling opportunities in the Molalla River, which formerly consisted only of the four-month winter steelhead fishery and the two-month hatchery trout fishery. Through the introduction of summer steelhead, angling opportunities now exist year-round."

The ODFW achieved its goal to provide angling opportunities year-around with the addition of non-native hatchery steelhead. But what was the impact of these hatchery fish on their priority concern, the native, wild winter steelhead?

In its plan for the Molalla River the agency admits that the amount of "interbreeding and competition between introduced stocks such as the Skamania summer steelhead and Big Creek winter steelhead and the native winter steelhead stock is unknown." What is known is that the wild, native winter steelhead declined from over 4,000 adults and 44 redds per mile before stocking hatchery fish to less than a thousand fish at seven redds per mile after stocking.

Other factors were also operating in the Molalla watershed during this period of time. Logging in the basin was intense and destructive to watershed health in the 1960s. The native winter steelhead productivity was affected by the conversion from old growth conifer to second growth and the effects of heavy sediment loads, major rain-on-snow flood events, lack of large wood stream structure, culvert passage barriers, and high summer water temperatures. All contributed to the decline of wild steelhead.

The Oregon Department of Fish and Wildlife introduced non-native hatchery fish to the Molalla basin when the native steelhead were struggling with habitat degradation.

The ODFW biologists were concerned about the impact of hatchery fish on the wild steelhead and designed their releases of hatchery fish in areas of the watershed they believed would maximize their harvest and minimize impacts to the native winter run. Because there is no barrier to prevent hatchery fish from spreading throughout the basin, they spawned in areas used by wild steelhead. In addition, the winter and summer hatchery steelhead adult runs overlapped with the native run, so the increased fishery for hatchery fish also harvested more wild fish.

The combination of factors ranging from ecological impacts on wild steelhead from hatchery fish, such as competition for food and rearing space in the river, to the increased kill of wild adults in hatchery-based fisheries contributed to their decline. These management impacts came at the same time the wild steelhead were trying to cope with a degraded habitat.

ODFW emphasized conservation of wild steelhead in the written plan, yet it focused management on expanding harvest opportunity.

Annual releases of 75,000 Big Creek Hatchery non-native winter steelhead were made to create a fishery on early winter run steelhead. On average 500 hatchery winter steelhead and 600 wild steelhead were harvested annually. Fish managers did not evaluate the effect of hatchery fish and fishery on wild steelhead.

In 1984, the ODFW began releasing 70,000 non-native hatchery summer steelhead in the Molalla to create a year-around fishery. The goal was to create a run of 4,900 steelhead. The hatchery fish spread throughout the basin, but ODFW said they did not know the extent of natural production of these non-native fish in the basin or the extent of competition with wild winter steelhead.

Introduction of hatchery winter and summer steelhead increased the risk to wild steelhead from interbreeding, competition, harvest, and reduced productivity.

Following the release of 145,000 non-native hatchery fish into the basin to increase fishing opportunity, the wild run declined from 44 wild spawners per mile to seven fish per mile. The hatchery program was a success, but the agency's number one objective, to protect the wild steelhead, was not. When the wild steelhead were listed as a threatened species under the federal Endangered Species Act in 1999, ODFW stopped releasing hatchery steelhead in the Molalla River.

Recent spawning ground surveys by the Native Fish Society show an average of 12 redds per mile, indicating that the wild steelhead are beginning to rebuild after nine years or about two generations.

The Molalla is the only watershed in the upper Willamette River with a strong wild late-run of winter steelhead. Even though stray hatchery steelhead, non-native coho salmon and releases of hatchery spring chinook compete with steelhead for habitat, the resident trout and steelhead fisheries are managed for catch and release. So the impact on ESA-listed steelhead has been reduced.

The Native Fish Society is working to determine the abundance of wild steelhead in the basin and their distribution.

As the wild winter fish begin to increase in number, ODFW is suggesting this run is strong enough to withstand some impact and has floated the idea that hatchery summer steelhead could be added to the river again.

Their own research indicates that hatchery summer steelhead suppress the productivity of wild winter steelhead by competition for rearing space and food (Kostow et al.). Once again the agency is pressing to increase fishing opportunity, and, if they do, this action would be inconsistent with their own rules and the ESA that set the protection and recovery of the late-run wild winter steelhead as the first priority.

John Sager Retires from Steelhead Committee

John Sager, founding Steelhead Committee member and editorial board advisor for The Osprey *recently announced that other time commitments and priorities necessitate his retirement from active participation in Committee affairs.*

Pete Soverel, another Steelhead Committee veteran and also an editorial board member of The Osprey, *has penned a few words in John's honor.*

The Steelhead Committee and *The Osprey* depend heavily upon volunteer participation. Founding member John Sager epitomizes the necessary qualifications — knowledgeable, enthusiastic, dedicated, and politically savvy. John has displayed all these qualities in spades in the twenty plus years that he has devoted to steelhead conservation. I met John at the first Steelhead Committee meeting I attended (1987) — it was friendship at first sight. A couple of years later, when I took over chairmanship of the Steelhead Committee, John encouraged the Committee to take the lead in several key areas:

1. Establish the Committee as *the* source for advice to the Washington Fish & Wildlife Commission on matters relating to steelhead management practices. To this end John served on a steelhead advisory board to the Washington Department of Fish and Wildlife. Equally important, John organized periodic face to face meetings between individual Commissioners and John and me. These meetings provided a very effective forum to discuss wild steelhead management issues;

2. Secured a commitment from the Commission to host the first wild steelhead summit. John played a key role in determining the agenda and presenters for the summit;

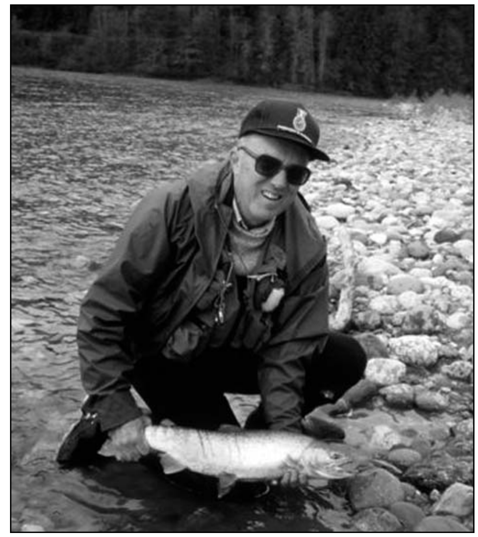
3. Pressed the Committee to participate actively in various dam re-licensing processes.

John has worked tirelessly to make The Osprey our signature calling card as editor for many years, careful proof reader to insure error free issues and key member of *The Osprey's* editorial committee.

Throughout, he has been a trusted advisor/confidant, close friend, and fishing buddy. In addition to his many contributions briefly touched on above, John also was a camp director for me in Kamchatka over-seeing the implementation of the joint Russian-American Kamchatka Steelhead project.

You can imagine my dismay when at our last Steelhead Committee meeting, John announced that it would be his last. Of course, John has earned the respite, but those of us left behind will be hard pressed to fill the void. Best wishes and tight lines, John. We will miss you!

— Pete Soverel



John Sager on the Skagit River, 1989. Photo by Stan Young.

2007 Honors List

The Osprey wishes to thank the dedicated people and organizations who gave their financial support in 2005. Our readers are our primary source of funding. It's pretty remarkable that our home-grown journal, which only comes out three times a year, has developed such a generous following. Don't think we're not grateful, and a bit humbled.

We have always skated on thin financial ice, and will continue to do so. But without your support we fold up. The usual donation envelope is provided. Whatever you can afford will be much appreciated (and used wisely).

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