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Thoughts on the Southern Rocky Mountain Bioregion

Here in the Western Hemisphere, as temperatures and snowflakes begin to drop, many of us head to the mountains. Whether we go seeking solitude, beauty or adventure, our attraction to mountains can feel as strong and natural a force as gravity. Yet it is this very appeal of mountainous regions – combined with mounting global and regional pressures – that puts their ecology at risk.

The Southern Rocky Mountain Bioregion, located along the southern portion of the Rocky Mountains and extending to the plains, is one such mountainous region. As is the case in the rest of the world, the ecological health of the Southern Rocky Mountain Bioregion is being impacted by climate change and sprawl. Yet this area also faces regional challenges, such as water diversion, resort development, exurbia, oil & gas development, energy sprawl and emerging contaminants in the streams & rivers east of the Front Range.

How has this landscape been impacted by the people who have loved and needed it so? What is being done to preserve and regenerate the natural systems, resources and beauty that make this region so special?

Join us as explore the Southern Rocky Mountain Bioregion and find out how people and organizations are responding in positive and hopeful ways to the mountain of pressures it faces.

Photo courtesy of Wildlands Restoration Volunteers

We'll begin by talking with two highly regarded experts who live and work in the Southern Rocky Mountains. First, we chat with geologist, author and professor of fluvial geomorphology at Colorado State University's Warner College of Natural Resources, Dr. Ellen Wohl. Next, we check in with Dr. Jill Baron, an ecosystems ecologist with the U.S.G.S. Natural Resources Ecology Laboratory and editor of Rocky Mountain Futures, a book examining the cumulative effects of human activity in the Rocky Mountain region.

We're delighted to shine our Non-Profit Spotlight on Wildlands Restoration Volunteers, an organization that is simultaneously restoring Colorado ecosystem and people's connection to the land.

Staff members from Biohabitats' Southern Rocky Mountain Bioregion office in Denver draw our attention to a couple of key issues related to region's ecological health. In her article *Red Pines at Morning*, senior ecologist Laura Backus tells us about the mountain pine bark beetle. This creature, the size of a grain of rice, poses a gargantuan threat to Colorado's lodgepole pine trees. Water resources specialist and bioregional leader, Claudia Browne explains why riparian landscapes are arteries of biodiversity in the West.

For more information about the Southern Rocky Mountain Bioregion, be sure to check out our list of resources. Get to know the folks in our Southern Rocky Mountain Bioregion, and find out about the latest Biohappenings.

What do you think about all of this? Share your thoughts on our blog, Rhizome. If you want to reference a specific article, be sure to include it in your post.

Leaf Litter Talks With Dr. Ellen Wohl

Professor of Fluvial Geomorphology,
Colorado State University's Warner College of Natural Resources

A two-time recipient of the Association of American Geographers' G.K. Gilbert award for excellence in geomorphic research, Dr. Ellen Wohl has closely examined hydraulics, sediment transport, controls on channel morphology and human impacts on bedrock and mountain channels. Dr. Wohl is the author of Disconnected Rivers (Yale University Press, 2004), Virtual Rivers (Yale University Press,2001), Rain Forest into Desert (University Press of Colorado, 1994), and her most recent book Of Rocks and Rivers: Seeking a Sense of Place in the American West (University of California Press, 2009). In her new book, Dr. Wohl traces her twenty years of living and conducting research in the natural landscapes of the West. Through this collection of personal essays, she chronicles not only the changing landscape of the West, but also her own evolving perception of what she initially believed to be a region unmodified by humans.

I read that while you were growing up in Ohio, your father, a biology and chemistry teacher and naturalist whose interest in the natural world was a great influence on you. A) How did this childhood interest lead you to a career in geology? B) Based on what you see as a geology professor at Colorado State University, do you think today's college and graduate students have had these kinds of influences growing up?

I always knew I wanted to go into science. In retrospect, I realize I was

unusually lucky in that I had a geology course in high school. When I started college, I actually started in biology, but switched to geology after the first semester. Being exposed to sciences early - both through my dad and through a really good school system - was critical.

I have been teaching here since 1989. I don't teach the undergraduate non-majors, so I already have a big filter. I'm getting the geology and watershed science majors their senior year. Geology and watershed science are not very high profile sciences compared to biology, for example. Most kids don't have those in high school. So there's already a big selection process. I should also say that a lot of our undergrads come from Colorado, so they're more likely to have that connection to the outdoors. They aren't as likely to have grown up in a strictly urban environment with no exposure to the outdoors. I don't think you need to have a scientist as a parent to get into science, but if you're going to be a field scientist, you need some connection with the outdoors. Your parent can be in any line of work as long as they share and encourage that interest and give you the opportunity to be exposed to the outdoors.

Your collection of essays, Of Rocks and Rivers, which covers more than 20 years of your experience living and working in the West, is a well-paced, progressive debunking of the myth of the West as pristine wilderness. What kind of response have you received from those who were still clinging to that myth? Were they particularly surprised by any of the insights provided in your essays?

At this point, not many reviews have come out, so most of the feedback I have received has been from colleagues and friends, many of whom are geomorphologists. Everybody is a little surprised about how much alteration there has been [to the landscape].

I received a similar response to my book Virtual Rivers, which is a history of the alterations in rivers in the Colorado Rocky Mountains. I wrote it because I was shocked when I got here and realized how long the history of alteration had been. Most people are still surprised by that. Even scientists, who are supposed to know that professionally. It's hard to remember how history has changed things. Someone has referred to how our baseline of perception changes through time. If we've never seen a river with lots of wood in it, then we don't expect it or think that it might have been that way once. That's true for scientists as well as other people.

I guess the surprise I've gotten is that people say, "Wow. There has been a long history of change, even in the so-called Wild West." It is hard to keep that in mind. I have trouble with it, too.

Was there a specific audience you had in mind when you assembled this collection?

Yes. People who are interested in natural history, but also anybody who

cares about the outdoors - anybody who likes to backpack, fish, ski, paddle, or just spend time outdoors and think about what they see.

One review I read of your new book said that books like it, which have a personal tone and perspective "are often the only channel through which scientists can make their work accessible to wider audiences." Do you think this is true in your case?

Absolutely. It's interesting. If you go back and read some of the classic papers in my discipline, which were written in the late 1800s, they are much more conversational and relaxed in terms of word length. They are really fun to read. There is a much different standard of writing today. Unless you have training in a particular discipline and you are familiar with the concepts and the very specialized vocabulary of that discipline, the literature in technical journals is fairly inaccessible.

I once had a conversation with my uncle, a carpenter, who was teasing me about scientific jargon. I said, "It's not that we're trying to keep information from people. It's just a more concise way of communicating. As a carpenter, you wouldn't say, 'Please pass me that screwdriver...the one with the long handle and the narrow, flat head.' You'd just call it what it is.' It's just a concise way of communicating with people." But...they have to share that common vocabulary. So yes, [writing in a personal style] is definitely one channel that enables scientists to reach a wider audience.

One of the most powerful essays in your new book is entitled "Poisoning the Well" - the well being the Rocky Mountains, which you refer to as "an enormous water tank." In this essay, you follow the plight of a snowflake from its descent onto a hill slope in the Rocky Mountains to its journey downstream to the eastern plains. In that essay, you have some constructive criticism to offer practitioners of stream restoration. You emphasize the importance of creating sustainable pools when restoring rivers and streams. Many of our readers are involved in stream restoration design. For their benefit, can you elaborate on this?

A lot of times, we focus on very short-term solutions in which we're imposing an engineering design on the river without considering whether that design can be sustained. For example, say there's a channel that used to be meandering with a pool-riffle sequence and now it has become braided and you want to restore it to a meandering condition. That's not going to be self-sustaining if the conditions that promoted braiding are still present. So, for example, if you have a lot of sediment coming into the channel for some reason, the pools are going to fill, the whole channel is probably going to become slightly filled, and you're going to go back to a braided condition.

So one thing is looking at the context and thinking about whether it's even feasible to restore to some idealized or historic condition. Second,

even if it was a meandering river, and could be a meandering river again, to me the greatest irony of stream restoration is when people create this sinuous, meandering river and then they rip-rap the banks. One of the key components of meandering is that the channel moves back and forth laterally through time.

The biggest problem I see in stream restoration today is imposing a form on the river, rather than trying to restore process. Restoring process is harder and usually has a larger context. You have to think about things like the whole riparian zone, the water supply, the sediment supply, and not just a short segment of channel. If it's a municipality, for example, trying to create a little trout stream, their focus is often on a very small spatial scale and short time scale. The way our political and financial systems are set up, it's harder to undertake longer-term actions that will have a long delay before you see any response. The most important thing I can say for stream restoration is to think about restoring process and context rather than just imposing a form.

Is it true that while it is illegal to divert water in national parks, there is no legislation that prevents people from diverting water from national forest lands?

On national parks, it depends on what situation occurred when the park was established. As an example, when Rocky Mountain National Park was established, which was fairly late, there were pre-existing water rights grandfathered in. The Park gradually acquired those and removed them. I've been involved with Black Canyon of the Gunnison National Park and they just recently settled out of court, reaching a compromise on water issues. As with many other parks, the case there was that water flows into the park from somewhere else. They don't have the headwaters. They were trying to work out a flow regime that would restore some of the processes in the Canyon with water users and the Bureau of Reclamation who held water rights upstream. It's too simple to say that it's illegal to divert water on national parks. It depends on where the water originates and what the water use was at the time the park was established. What I can say is that the parks in general have a stronger base from which to argue against consumptive water use because of the way the national parks were defined [which included ecosystem protection].

The problem the Forest Service has is that the original act that created the forests, the Organic Administration Act of 1897, didn't really say anything about qualities like ecosystems or biological diversity. It focused on flood control and water supply. So if a Forest Service unit can't make the case that a diversion is going to alter flood control, then they don't have a lot of basis for arguing against it.

The situation here in Colorado is not at all unique for the Intermountain West. There are a tremendous number of diversions on Forest Service Land. The typical scenario is that these start as high up in the watershed as is feasible because then you have gravity to help move the water and you have better water quality. The scenario of the "water tank" of the Rocky Mountains is not just the Colorado Front Range. It's the whole Intermountain West. Whatever the nearest mountain range is, that's the

water tank for the urban and agricultural communities living at lower elevations. That scenario of diverting water in national forests is well established, and would be very hard to change. The Forest Service has had a very hard time getting any reserved water rights.

Diversion dam and inlet to irrigation ditch, Cache la Poudre River.

As I learned from your essay "Poisoning the Well," even water high up in the watershed, in seemingly pristine parks and forests, is not so perfect. I was surprised to find out how quickly that little snowflake becomes polluted by excess nitrogen in the air.

Yes. Mercury is the other big one, which scares me and really surprised me when I started looking into it, too because of the atmospheric deposition. Mercury and nitrates are two of the big airborne contaminants that we have become aware of.

Where is the mercury coming from?

Mercury is coming primarily from coal burning power plants. I was very shocked to learn of the situation in one of the wilderness areas farther to the west of the Front Range that's downwind of a coal-fired power plant in Colorado. They have lost a lot of the amphibians in the high elevation lakes. A drop in the number of frogs and salamanders is a pretty important alarm signal that most people are not yet aware of.

One of the points I try to make in the book is that a landscape can look pretty pristine if you just step out of your car and look at it. It may be beautiful, with no houses or roads but it could have experienced major changes that are hard to detect or even invisible.

How has the diversion of water from the western slope to the Front Range impacted the plains rivers?

It's just part of the general changes of flow regulations. I think if the water actually go to the plains rivers it might have more of an impact, but a lot of that water never reaches the plains. It's taken up by the Front Range urban communities at the base of the mountains. If you imagine a graph where you show flow through time over the course of a year, you'd have a big snowmelt peak and pretty low flows this time of the year. All the effects of flow diversion have been to smush the vertical axis on that so that we have a much more uniform flow through the year, and diversion from the Western Slope is part of that.

The Poudre River in Fort Collins, with unnaturally low winter flow due to diversions. Photo courtesy of Dr. Ellen Wohl.

The story of what happened in the fall of 1996 of The Nature Conservancy's Phantom Canyon Preserve along the North Fork of the Cache la Poudre River tells a great deal about the impact of water diversion on the Southern Rocky Mountain river systems and the resilience of those systems. Can you recount that story for our readers?

Phantom Canyon Preserve. Photo by John Fielder, courtesy of The Nature Conservancy.

Phantom Canyon is a deep, narrow canyon - almost a gorge - along the river. The Nature Conservancy bought it in the late 1980s. There is a dam immediately upstream of the Conservancy's boundaries that was built in the early 1900s for agricultural water supply. Now, the city of Ft. Collins is actually a majority stockholder in it. That dam is what's called a "fill and spill" dam. As it's gradually filling during the spring snowmelt, they can let out up to 140 cubic feet per second (cfs). If the reservoir fills up faster than that rate, it just spills out over the top.

Poudre River

The usual scenario is that they draw the water down in the dam late in the growing season (late September) so they have maximum storage capacity the following spring. Because of the way this dam was designed, they cannot bypass sediment. Newer dams have the option to flush sediment through, but this one doesn't. For this dam, most of it accumulates in the upstream end of the reservoir, but some of it - particularly the finer sediment - gradually reaches the base of the dam. When they draw the water level down, if the water level is low, they can release some sediment.

In 1996, the North Poudre Irrigation Company, which operates the dam, released a lot of sediment during this drawdown period and then shut of the water flow completely. The effect of that was dumping a big bunch of sediment into the river and then turning off the water supply, so the sediment just stayed there. It basically filled up some very deep pools close to the dam. As you got farther from the dam, pools were partially filled. There was some evidence that they had done this in the past, but nobody was really aware of it because it's a fairly remote area and before it was purchased by The Nature Conservancy, it was private property with much less public visibility.

When they did this, a lot of fish were killed - at least 3,000 that were counted. The Nature Conservancy brought in the Division of Wildlife. There were newspaper articles about it. People were very upset. They asked me to come in and estimate how long it might take to restore the pools, to scour the sediment and recreate the river that was there before. I really thought it would take a few years, but we were very lucky in that 1996-97 was a big snow year. We had particularly good peak runoff the following spring and early summer. About 80% of that sediment was

removed and flushed downstream. The irony of the original sediment release was that if they kept the water flowing, that sediment would've been gradually deposited over a much longer distance downstream and it wouldn't have been a problem. The main problem was that they released it and then stopped the water flow.

So when we had this great spring-summer snowmelt runoff, it restored a lot of the pool volume, but the system didn't recover immediately because you have to have recolonization by everything from fish to aquatic insects and it takes a while. The system still has some problems today, a decade later, but by and large, the fish populations and aquatic insects recovered within two years, so it was pretty encouraging. From my perspective, chemical contamination can be much worse, because it can persist and you can have very toxic materials linger in sediment for decades or centuries. A physical disruption in water or sediment is much more likely to be reversible as long as organisms can have some way of getting back into the system.

After what happened at Phantom Canyon, have any regulations been put in place to prevent other companies from releasing sediment and then stopping the water flow?

In that particular case, I don't think they will do it again. Initially, the dam operators were rather defensive, but The Nature Conservancy was very diplomatic and talked the operators around to a much more cooperative stance.

A couple of years after that, there was a Denver Water Supply reservoir that had real problems with sedimentation of organic materials and a lot of wood coming in because of a series of very severe forest fires that had occurred. Being aware of what had happened in the Phantom Canyon example, they worked actively with the Division of Wildlife to design releases of the sediment and water so that they wouldn't kill fish downstream. It was all planned out and it worked. They released a lot of sediment and there were no fish kills.

So the bad publicity had a positive effect, but I'm not aware of any legislation that prevents [releasing sediment and then shutting off the water].

Agriculture, gold mining, recreational industries, and water diversion have been influencing Southern Rocky Mountain Bioregion (SRMB) river systems for quite a while. How are more recently acknowledged factors, such as energy sprawl, emerging contaminates, exurbia, and climate change impacting these rivers? Which of these factors has you most concerned?

They all have me concerned. It's very site-specific for some of these. The energy development affects some rivers pretty substantially, mainly by changing the surface water-ground water relations and introducing contaminants to the groundwater, but other basins are really not affected by that.

Urban sprawl is a big one everywhere. Most of the Intermountain states are subject to that.

Climate change is a big wild card. What I see climate change doing is making a tight situation tighter. Most of the predictions in the Intermountain West are for hotter and drier. As population continues to grow, there is more pressure on water resources. If those water resources are shrinking, that's going to be a pretty severe problem. We've had a couple of cushions in the past for water supply. One is groundwater. But that cushion is disappearing. We're pumping the groundwater to the point where it has dropped and it is prohibitively expensive to extract. In agricultural areas, most of the shallow groundwater is contaminated now. In the Eastern Plains of Colorado, there is very little shallow groundwater that is still suitable for urban and municipal consumption. The other cushion has been that we haven't drawn on all of the supplies that are guaranteed to us under the Colorado River Basin Compact of 1922. It governs water use in the Intermountain West, from Colorado to Southern California and Arizona. Southern California and Arizona have, for the last decade or so, drawn their full allocations, and sometimes overdrawn it. They've been able to do that because some of the upper basin states like Colorado have not been withdrawing their full allocation. As our population and water use continue to grow, that stresses the whole system. The rate of population growth in the West is still increasing. If we have climate change creating less water supply, and we have more people, that's going to be a big problem. We can easily see natural systems getting caught in the crosshairs.

In the long term, climate change is the biggest threat. In the short term, patterns of land development and the contamination associated with that are two of the biggest threats. Part of the issue with emerging contaminants is that no water supply system removes those. You can have a superb municipal water supply system, but it won't remove things like pharmaceuticals, personal-care products and endocrine disruptors.

Tell me more about endocrine disruptors.

Endocrine disruptors are synthetic chemicals that mimic the effect of endocrines in the human system. They come from things like cosmetics and flexible plastics in margarine and yogurt tubs. Many of them mimic the effects of estrogen. They have the greatest effect on the developmental stages of organisms, including humans. A lot of very pervasive, gradual trends (like early puberty in girls) are being tied to them. There is also convincing evidence that many of these synthetic chemicals are tied to the alarming increases in all forms of cancer. There is almost no testing in terms of the environmental effects on health of humans or other organisms.

Why is that?

That's a very good question. It's expensive and time-consuming, so companies don't want to do it. The standard test is to expose a laboratory organism to high doses of the chemical over a short period of time. They don't look at what background levels would do, because that would take much longer. They don't look at how the breakdown products of these

synthetic chemicals interact with different media like water, soil and air. They don't look at how individual chemicals interact with each other. Herbicides and pesticides are a great example that you can do toxicity studies on a single chemical in the lab, but no one looks at how the breakdown products, which are combining in the environment interact to create biohazards or ecotoxicology.

I'm afraid it comes down to economics. We have not had the regulatory climate that has forced companies to do this testing. This is way beyond what I work on, but I can recommend two authors who are really worth looking into to learn more about this:
Theo Colborn, who wrote the book Our Stolen Future and Sandra Steingraber, who wrote the book Living Downstream.

Are you seeing any positive movement in the Southern Rocky Mountain Bioregion to address the short-term threat of land development and the associated contamination?

There is a proposal right now to build a very large off-channel reservoir on the Poudre, right at the base of the mountains. It is part of a larger project called "NISP," Northern Integrated Supply Project. They also want to build a new reservoir by Greeley, which is farther out in the plains. Basically, it's a big water diversion scheme. This is an Army Corps of Engineers project that is being "sold" as being necessary for promoting growth and development of the smaller agricultural communities by providing a water supply.

The Poudre River just upstream from its junction with the South Platte. Photo courtesy of Dr. Ellen Wohl.

There has been a huge amount of pushback. A citizens group formed to protest the proposal, and they have been very effective. With that effort, and the changing economic situation, where some of the municipalities that were originally part of NISP have pulled out because it's too expensive, I think there is a very good chance that the proposal will not go through.

Equally important, this citizen group is not jus reacting to what they see as a detrimental project, they have been very proactive in saying, "Let's start thinking about the Poudre River as a system, and let's see what we can do to propose alternatives where we can have a viable plains portion of the Poudre. The mountains portion of the Poudre has a lot of impacts, but it's still viable." Once that river hits the plains, it's just a trickle, and it's really very much altered from what was present historically.

Separate from the citizens group, we have very strong and proactive open space and natural areas programs in both the City of Ft. Collins and Larimer County. They have been gradually acquiring land along the Poudre River and they have a vision of having continuous public space and natural areas from the base of the mountains out to Greeley, where Poudre River joins the South Platte River. They are going to need to get some water rights in order to do that, which is going to be harder than

land acquisition, but they're planning for that. I think this is really great. If you have a natural corridor, where people can hike, birdwatch, fish and bike, there will be a lot more public support. Right now, people (including me) tend to look west for recreation. If you have places like this along the Poudre, that are a very short drive from town, I believe there will be more appreciation for plains Rivers.

Many of the cities in Colorado have strong programs encouraging energy conservation and xeriscaping. I just installed photovoltaic panels in my house and I got a big rebate and part of that came from the City. As part of that, they did an energy audit of my house and told me other ways to save energy on natural gas heating for example. They'll do free sprinkler audits. They have a very strong program helping people to xeriscape either portions of their yards or whole yards.

When I first moved to Colorado in 1989, I had no water meter on my house. I moved to another house in 1998, and by that time the City had mandated partial xeriscaping and low water use appliances.

So I see programs at the city and county level that are making people aware of both energy and water use and working to preserve open space and build a constituency for the local rivers like the Poudre.

In the preface to Of Rocks and Rivers, you quote renowned scientist Aldo Leopold, who said "The penalty of an ecological education is to live in a world of wounds." You have witnessed and uncovered many of these wounds in the SRMB. Yet at the conclusion of your book, you seem optimistic. You state that the challenge is now to integrate the insights gained from research like yours into "everyday choices made by individuals and society in order to improve our collective ability to live sustainably in the American West." In addition to open space programs and citizen activism, what are some examples of things you have seen people and organizations doing that are effecting change in a positive way?

Just changing at the very basic level, with lifestyle choices. The City of Ft. Collins really encourages bicycle commuting. That can be something as simple as having bike lanes and trails. But they also have "Bike to Work" days where local businesses donate breakfast for people who commute by bike.

I see positive changes in people becoming more aware of how their everyday actions affect the whole world around us - whether it's the food they eat, how they use water, or how they use energy in their homes or in their transportation.

So a groundswell of changes in people's everyday actions helps buoy you amidst the doom and gloom?

How do I maintain optimism? I have two sources. One comes from a

movie I once saw about social activists. In that movie, someone asks one of the activists that question and the activist just looks in the camera and says, "What's the alternative?"

The other comes every time I go hiking, skiing or paddling. This is worth fighting for. This is worth preserving. The natural world itself is a source of inspiration for me. I suspect anybody who is involved in any kind of activism must find that sense of renewal and purpose in seeing whatever it is they care about.

Photo courtesy of Dr. Ellen Wohl.

You state that your "sense of place" out West constantly changed as you continuously learned about the landscape. How would you describe the "sense of place" of the Southern Rocky Mountain Biordgion today?

I still describe my sense of place as having many of the same components it had when I first moved here. This is a place that has been used, but not as heavily as some parts of the world. In Europe, you have land use changes that go back to the Bronze Age! So there is still a sense of a natural landscape, where it is easy to get away from large numbers of people. There is a sense of openness that is partly a function of climate - the aridity and relatively sparse vegetation. Because of the lack of human alteration of the landscape relative to other parts of the world, there is still that sense of being close to natural processes. You can see evidence of geology - the mountain building or valley cutting of glaciers.

To summarize, it's still a very similar sense of place that I had when I moved here. It's just tempered by that knowledge that it is not as apart from humans as I once thought it was. There is a longer and more intensive history of human interaction with the landscape than I was aware of.

Some of your essays include very strong calls to action. In "Poisoning the Well" you state that "Historical changes along the plains rivers that have so stressed wildlife communities need to be reversed to some extent in order to ease the pressure on threatened and endangered species." Are people heeding this call to action? If so, who is and what is being done?

Because the great majority of our endangered fish species are in the plains rivers, the government agencies that are most tied to that issue, such as the Division of Wildlife and the Forest Service, have taken action. They have undertaken programs both to identify the distribution of these species and protect specific locations where they occur. They have also tried active restocking.

A refuge pool on the Pawnee National Grassland. Photo courtesy of Dr. Ellen Wohl.

I'll give you a specific example. All of the endangered fish species on the plains are very small bodied species - we're talking a couple of inches long. That's one of the ways to survive in that very physically stressful environment. Most of their lives are spent in what fisheries biologists called 'refuge pools,' isolated areas that retain water throughout the year because they intersect the water table. Periodically, when you have a lot of flow, there will be surface water flowing between those refuge pools, so the fish can move out, breathe and disperse. Then, they come back to refuge pools for the rest of the year. One of the actions [the Forest Service has] undertaken on the Pawnee National Grassland is yearly surveys of where these fish are, where the pools are, and how many fish are in them. They have restocked and transplanted some of the fish to create more widely scattered populations. They have fenced off some of the pools to limit cattle grazing. (Primary uses on the Pawnee are cattle grazing and, more recently, energy development.) They have undertaken programs to identify and protect some of these species.

But the Plains in particular are almost off the public radar screen. If you talk about endangered fish in Colorado, people are not going to think of the Plains. They're going to think about trout in the mountains. Part of what we need to do is raise public awareness of the real beauty and unique aspects of these Plains Rivers. That's something I'm going to do with Wide Rivers Crossed, a book I wrote that is currently in review at University of Chicago Press. This book looks at historical changes in rivers of the prairies. I use the Illinois River as an example in the Eastern Prairies and the South Platte River as an example in the Western Prairies.

Any key insights from that book that you'd like to share with people at this point?

People tend to fly over, drive across, or do whatever they can to ignore the prairies, yet they are the most endangered ecosystem in our country. There is almost nothing of the tall grass prairie left and more than half of the short grass prairies have been substantially altered.

I got interested in prairies because I live near a little natural area in town that is a short grass prairie. I take walks out there frequently, and I started seeing a lot of life. It's not just a big, empty field of grass. There's a lot going on out there. I really became fascinated with prairie ecology.

Coyote Ridge Natural Area in

What else are you currently working on?

Larimer Co., CO. Photo courtesy of Dr. Ellen Wohl.

I have a book in press at the University of Chicago that I have been working on for seven years. It's called A World of Rivers, and it looks at environmental change on 10 of the world's major rivers: the Amazon, the Congo, etc. That book will come out in 2010.

Are there any other parts of the world that are similar in some way to the Southern Rocky Mountain Bioregion and can offer some insight regarding potential solutions to today's mounting ecological problems? (Conversely, what can other regions or nations learn from what has happened to the SRMB landscape?)

The details of [a region's] history differ, but the whole idea that multiple land uses occurring through time have a cumulative effect of reducing the diversity and stability of rivers and natural systems...unfortunately, that applies anywhere in the world.

We could learn from lessons from Europe, in terms of sustainability, because there are some places there where they have been able to maintain agricultural societies for many centuries. Jared Diamond makes a good point in Collapse: How Societies Choose to Fail or Succeed. He gives lots of examples of societies that collapsed because they couldn't maintain their rate of resource use. But he also gives examples of those that didn't.

Being more specific, many of the issues that are raised for the Southern Rocky Mountains would apply to the entire Intermountain West. The scarcity of water is the big issue for the Intermountain West, as it is for any arid or semi-arid region.

What could other regions learn from what has happened here? That we need to take a less anthropocentric view of resource use, including water.

Any final words of advice / wisdom to offer Leaf Litter readers? (Any specific messages you hope they take away from the work you have done?)

I'd like people to think carefully about the slogan of "you deserve it." This slogan is often used in advertising to get you to purchase a product because you deserve it. We're so used to indulging ourselves and not thinking of long-term consequences. But everything we do has consequences for the natural world. If you care about that, and if you care about the sustainability of human populations, you need to be aware that we live in a very complexly interwoven environment. Basically, everything you do affects rivers, so think carefully about what you do!

Leaf Litter Talks With Dr. Jill S. Baron

Ecosystems Ecologist, U.S. Geological Survey, and Senior Research Ecologist, Natural Resource Ecology Laboratory at Colorado State University

As the editor of Rocky Mountain Futures: An ecological perspective (Island Press 2002), which documents the cumulative effects of human activity on Rocky Mountain ecosystems and presents a compelling case for re-envisioning the region's future through an ecosystems-based lens, Dr. Baron offers valuable insight into the Southern Rocky Mountain Bioregion. Dr. Baron has garnered awards from the National Park Service, U.S. Geological Survey, and USDA Forest Service, including the Department of Interior Meritorious Service Award. She has been a member of the Governing Board of the Ecological Society of America, is Director of the John Wesley Powell Center for Analysis and Synthesis, and has given testimony to Congress on western acid rain and climate change issues. She also edited Biogeochemistry of a Subalpine Ecosystem (Springer-Verlag 1992), which summarized the first 10 years of long-term research to the Loch Vale Watershed in Rocky Mountain National Park, and she is currently an associate editor for Ecological Applications and Editor in Chief of Issues in Ecology, a publication of the Ecological Society of America that uses commonly-understood language to report the consensus of a panel of scientific experts on issues related to the environment. We were delighted to have the chance to speak with her about the past, present and future of the Southern Rocky Mountain Bioregion.

Of the many types of ecosystems found in the Southern Rocky Mountain bioregion, which do you think are the most unique and why?

There are ecosystems in the Southern Rockies that are not found anywhere else, such as alpine tundra and wetlands associated with mountain environments. Mountain streams are also unique with respect to aquatic ecosystems. Other unique Southern Rocky Mountain ecosystems include high elevation lakes and high elevation grasslands, which are called "parks" in Colorado. (Examples include South Park and Moraine Park.)

How about the most vulnerable?

What we found when we put together Rocky Mountain Futures is that they are all vulnerable in some way to different types of stresses. Land use change has definitely affected our high elevation grasslands, as well as the grasslands at the bottom of the mountain. Pretty much any flat land is vulnerable to development. Nearly all our waters have been manipulated by dams, diversion and extractions, so they, too, are vulnerable. Some of the high elevation areas are very sensitive to disturbance from climate change or atmospheric deposition, Disturbances we're seeing related to climate change, such as pine bark beetle outbreaks, are having a huge influence right now.

How and why did you come to edit Rocky Mountain Futures?

My colleagues and I felt that there was this rapid change, primarily from land use, but also from other human activities, occurring across the Rockies. In the book, there is a wonderful quote (by economist Alfred E. Kahn) about the "tyranny of small decisions." In the Rockies, [land and resource use] decisions have been made one area, one county, one city at a time. The book was an effort to see if we could synthesize across the entire chain and see if there were similarities, and if so, what it meant ecosystem-wide, now and into the future. I got funding through the U.S. Geological Survey to host a workshop [which included 32 leading ecologists, geographers, scientists and researchers]. It was one of the most exciting working groups I've ever been in because [prior to the workshop] people had not talked across disciplines and many of them did not talk across their own specific regions of study. At the workshop, they discovered many similarities and connections.

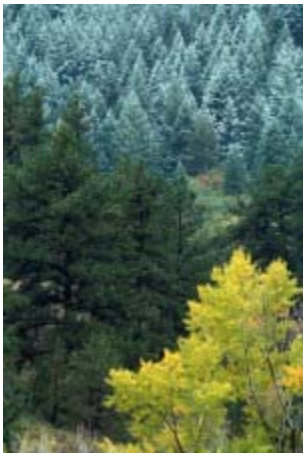
Has that group collaborated since?

No, we haven't, and perhaps it's time to.

Are there any schools using the book?

It was used as a text book at a number of universities when it first came out [2002], but I don't know if that is still true.

In the conclusion of Rocky Mountain Futures, you note what seems to me as perhaps the key challenge to ecosystem protection and restoration in the SRMB. "Because the mountains themselves change little, we can delude ourselves into thinking that the Rocky Mountains are indeed the untouched wilderness we imagine them to be...To the ecologically ignorant...the Rockies look just fine." If you had the chance to sit down to lunch with such a person, what would you say to help him or her be a better steward? Where would you begin?



It's always important to try to make connections to things that people find important. Let's assume this person likes large vistas of healthy looking forest. That would be a touch point to start telling him or her that forests are affected by fire suppression, pine bark beetle, etc.

I do a lot of work with public land managers who, in some cases, are very well-educated and wise, but in other cases have less expertise. So we talk a lot about the resources that they are charged with protecting and how they're changing with respect to different types of disturbances.

There was a great county-by-county GIS study done by researchers here at Colorado State University which looked at areas that were obligate habitat for specific species, such as elk, and overlaid that on top of land use - both current and planned development patterns. Where there was overlap, they went to the county managers and said, "If you value this population of "X" species, you don't want to put a development on this

land because they need it." In many ways, that was an effective tool for getting managers and planners to realize that they needed to rethink the notion that just because land is private and flat, they can develop it.

Of the more historical, human-induced impacts (from mining, agriculture, grazing, logging and even tourism), what do you think has been the most damaging to these ecosystems?

It depends on which systems you're looking at. Back [in 2002] when we wrote [Rocky Mountain Futures] it really looked like land use change was going to be the major disturbing factor that was swallowing Western private lands. That may still be true, but with our economy in a slump, a lot of development has been put on hold, which may give land managers some breathing time to think about what they really want.

Can you give us a few specific examples of historical human impacts that have been particularly damaging to specific ecosystems?

There were waves of development. The first occurred when trappers came in. Before the trappers, mountain streams looked very different than they do today. They had stair-stepped pools stopped up by beaver ponds. You'd have rapids and then a pool; rapids and another pool, etc. Today, they're big kayaking magnets. People come from all over the world to kayak these rivers, which perhaps would not have been free flowing before trappers came in and took out millions of beavers. That was a big change on the landscape.

The next big disturbance in the West was mining. In Colorado. Something like 25% of our mountain streams have been altered by acid mine drainage. An enormous area of the state was disturbed by mining. There were no environmental protection laws from the 1860s through the early 1900s. Placer deposits, which are large piles of waste, are remnants of in-stream dredging. There was also a huge amount of logging that went on at that time to build railroad tracks going into the mines and to shore up the mines themselves. The loggers would denude entire hillslopes and stack up the logs to overwinter. Logs were floated downstream during snowmelt. Check dams were build up the volume of water, then breached to create a wave of water to float the logs. A common practice was to dynamite out large boulders and curves in the streams to straighten them out so the logs could move faster downstream.

Around the turn of the century, someone - I believe it was [Frederick Law] Olmsted - remarked to Teddy Roosevelt that the West was being transformed, right before his very eyes, into bare slopes, mining debris and tremendous waste. This conversation led to the establishment of protected public conservation areas and development of the U.S. Forest Service.

What about the threats of more recent decades (resorts, population growth and sprawl, water diversion, invasive species, fire suppression, etc.)?

With the affluence, mobility and road systems that have come in the past 50 years, people have penetrated further into wildlands than they have before. The migration of people out of cities into more rural areas - exurbanization - has become very prevalent in the Southern Rockies. Everyone wants their own little piece of wilderness, and that creates all kinds of problems.

Even if people are living in wilderness, they like to recreate their own environment, so they plant ornamental shrubs and grass, and they bring their household pets. Pets are very destructive to native species. You can think of cats, for example, as an invasive species. They do away with native birds, squirrels and small ground dwelling animals. Studies have shown that even if human density is not very high, local animal populations can be decimated when people bring in their pets and let them roam.

When people move into forested areas, they don't necessarily protect themselves against fires. Western forests are fire prone ecosystems. Fire is obligate to their maintenance at elevations below 9,000 feet or so. Montane forests include ponderosa pine and lodgepole pine. Ponderosa has a very frequent fire return interval which creates an open savanna landscape by burning groundcover but not the trees. Lodgepole has a much longer fire return interval. When it burns, the entire forest is consumed. People move into these areas and build their houses and then are surprised when these fires come through.

Fire suppression has been an important human disturbance in parts of the Rockies. The whole Smokey Bear phenomenon of the past century was promulgated on the idea that fire was a bad thing. Only in the past 30-40 years have people begun to realize that fire is integral to most of our Western systems. Suppression only postpones the inevitable. People moving into fire-prone areas have become much more vulnerable to large fires. Climate change interferes here because the propensity for fires is almost directly related to temperature. If you have warm years, you get fires.

So people are becoming more vulnerable, but at the same time, they are becoming more aware that fires are beneficial. Is there still a lot of fire suppression occurring?

Yes. The conundrum that public land managers have is that they feel they need to protect human life and property and they have people living in these increasingly fire prone areas.

Speaking of climate change, tell me

about what has been observed and the effects on high-elevation ecosystems.

Throughout much of the West, there are trends of earlier snow melt. As temperatures warm, you get above freezing earlier in the spring than before. Parts of Colorado are definitely seeing this phenomenon. The longer growing season is very tightly correlated with fire frequency, intensity, and duration across the western U.S.

Earlier snowmelt has a big effect on downstream water supply. Our reservoirs were designed to capture snowmelt, but they were designed to rely on snow being its own reservoir, holding water for a period of the year. If winter snowpack melts sooner, reservoirs fill up earlier and water managers have to let some water run downstream. That may be a good thing for downstream ecosystems because they get water they hadn't gotten before, but it's a bad thing for water supply and the human need for water.

Climate change is altering phenology, or the timing of biological events. Some animals are emerging or arriving earlier than they had been before, which may be a problem because their food sources may not be synchronous. Glaciers and rock glaciers are melting throughout the Southern Rockies. In the long run there will be less late summer water and an icon of the West will disappear.

Unfortunately climate change is superimposed on the other disturbances and stresses we have already caused to the Rockies from mining, damming, climate change, habitate fragmentation, and invasive species.

I was surprised to learn about the amount of excess nitrogen in the air at high elevations in remote, protected areas such as Rocky Mountain National Park. Tell me about your work monitoring nitrate deposition in the Loch Vale watershed of Rocky Mountain National Park and what it has revealed.

Back in the early 1980s, Congress funded the National Acid Precipitation Assessment Program. The program funded government agencies to find answers to the questions. "Is there acid rain? How bad is the problem? Where is it occurring and what are the effects?"

I was very fortunate to get in on this and came to Colorado to answer these questions for Rocky Mountain National Park. We established a long-term watershed study to measure what goes in, in terms of chemistry, precipitation and weather; what comes out, in terms of chemistry and water; and what goes on in between. Loch Vale watershed ranges from about 13,500 feet at the top about 10,000 feet at the bottom. It has alpine tundra, alpine lakes, glaciers, subalpine forests and subalpine lakes.

Using monitoring, research, modeling and paleo-techniques to go back in time, my colleagues, students, and I been trying to find out what is going

on. We don't have year-round acid rain. There is summertime acid rain, however, and it is due to nitrogen deposition not sulfuric acid, the product of coal-fired power plants in much of the eastern U.S. In Rocky Mountain National Park, these nitrogen species seemed to be coming from the east. There are many sources: conventional and irrigated agriculture, confined animal feeding operations, cars, construction vehicles and energy producing power plants. All of those sources emit nitrogen that can be transported to Rocky Mountain National Park. We found that atmospheric nitrogen deposition has been affecting all aspects of high elevation mountains.

Nitrogen is a fertilizer. High mountain ecosystems have historically had a very harsh, nutrient poor environment. When nitrogen is added you increase their productivity. In protected areas, this is not necessarily a good thing because these areas are supposed to be representative of species that are native to those systems. We saw changes due to nitrogen in alpine tundra, in soils, in forest vegetation, in lakes and lake sediment...basically everywhere we looked.

What's an example of how that fertilization affects an ecosystem?

Alpine tundra is made up of very low growing plants. Our collective vision of tundra includes carpets of colorful miniature wildflowers. Fertilizer gives some plants, such as grasses and sedges, an advantage over others. Grasses and sedges outcompete smaller wildflowers that are so special to alpine tundra. Nitrogen deposition will decrease biodiversity in the long run.

Did anything change (policies, action) as a result of this research

The National Park Service is mandated not to allow ecosystems to be damaged from air pollution. About four or five years ago, they agreed that the body of evidence we had produced was sufficient that they needed to do something. They are not a regulatory agency, so they went to the State of Colorado and the EPA and convinced them that there had been change due to atmospheric deposition and that this change was not in the best interest of protecting Rocky Mountain National Park. The state very wisely set up a long-term nitrogen deposition reduction plan. They hope to reduce nitrogen emissions, mostly from the area to the east of us, over the next 30-some years, to a point that would be low enough to protect our most sensitive indicators: algae.

What are some of the strategies they are employing to try to achieve that?

The initial strategy was to hope that changes in the automobile fleet would reduce the amount of nitrogen oxides coming out of tailpipes. The catalytic converters in newer cars reduce the amount of nitrogen oxide produced. We have seen a slight decline in the amount of nitrogen oxide emitted and deposited over time. The other voluntary actions from ranchers and managers of confined animal feeding operations could

reduce ammonia loss. There's no regulatory hook to go after them, so they are relying on ranchers' good will. Some are actively searching for solutions.

Let's talk about projections. One chapter of your book includes a prediction that land development at exurban densities (one dwelling unit per 10-40 acres) will increase from 8.9 million acres in 2000 to 19.7 million acres by 2050. 5280 Magazine predicts 1.5 million new residents to the Denver area by 2035. Do you think these projections are accurate?

I think they are accurate. American population is increasing, the Southern Rockies are a highly attractive place to live, and it's no longer a secret (if it ever was). I do think we are expecting a great number of people to move in. What we do with them is the question.

What would you say is one of the most important things that need to happen to protect ecosystem functions in the prairies, foothills, and mountains around the City of Denver as the population increases?

I would love to see greater density inside the urban areas as a way of absorbing newcomers.

The conclusion of Rocky Mountain Futures forecasts a simplification of food webs and processes and increased catastrophic disturbances to natural and human habitats if things continue the way they have. This set the stage for your very compelling call to action to "define a goal for Rocky Mountain ecosystems and chart a path that will get us there." The book was published in 2002. Has anyone heeded this call?

Both the National Park Service and the National Forest service have - not necessarily in response to the book but in response to climate change and the need to figure out how to adapt to climate change. Rocky Mountain National Park has held several meetings to discuss how to manage their natural resources into the future. Soon after the book was published, Rocky Mountain National Park held a regional workshop. They brought in the Forest Service, cities, counties and NGOs and said, "Let's collectively come up with a vision of where we want to be and where we don't want to be, and let's start working toward those goals."

There has been a very active discussion about how to protect natural resources. The incentive is that because climate change will occur on top of all of the other disturbances we highlight in the book - land use changes, habitat fragmentation, increased fire, etc. - we have to address them all in a regional manner.

Has that workshop or those discussions resulted in any products or documents that can be reviewed by the public?

There was a document that was put out by Rocky Mountain National Park a few years ago that was specifically related to climate change. They prioritized. They said, for example, climate change is going to affect

pikas, these cute mammals that live at tree line and are very temperature sensitive. As the temperature warms, they're likely to disappear. The document is a beginning blueprint to go forward into a regional planning program that hopes for a shared vision for managing some natural resources across national park, national forest, and other lands. We're trying to get people to think across boundaries.

The Great Lakes have many non-profit organizations and governmental bodies such as the EPA's Great Lakes National Program Office, the International Joint Commission and others, all working towards their protection and restoration. Do the Rocky Mountains - as a collective region - have this kind of support?

We are fortunate that much of western mountain lands and waters are managed by either the Department of the Interior and Department of Agriculture. By talking with them, you can accumulate a lot of momentum for a large amount of land. There is also a non-governmental organization, the Southern Rocky Mountains Wildlands Network. It's a coalition of private land owners, non-profits like The Nature Conservancy and the Colorado Department of Transportation The organization is trying to protect corridors for wildlife. They are working to get land owners to agree to support wildlife migration.

In the conclusion of Rocky Mountain Futures, you point out that failure to optimize natural processes and "consider the broad ecosystem consequences of narrow management" results in that "tyranny of small decisions" you discussed earlier. Have you had the chance to discuss this issue with any state policy makers?

I have not. That would be really interesting to do.

If you had a chance to sit down with Governor Ritter, what would you pick as the 3 top issues you'd like to see him address to help protect the Southern Rockies and adjoining ecosystems?

You'd have to capture his attention, which these days is on energy and climate change. I would veer away from the book itself and talk about ways energy development and actions to mitigate and adapt to climate change could be harmoniously blended with the values the state is so famous for.

Can you elaborate?

I read an interesting article in yesterday's Denver Post. It's about the San Luis Valley, in the southern part of the state. Large areas - hundreds of acres - of the valley are having solar panel arrays built on them. The solar panels themselves take up a lot of land. But the electrical grid that will be necessary to connect the energy source to places that need it is creating anxiety among people who live in the valley. Sources of energy, and renewables like solar are definitely preferable to fossil fuels. But even solar energy does not solve all problems. It's not like there are simple ways of solving the problem of land use change and protecting ecosystems at the same time. There will be trade-offs. A broad-scale systems approach is the only way to go at it. What do you lose and what

do you gain by doing one or the other?

What is the most satisfying feedback (or outcomes) you have received from Rocky Mountain Futures?

The book has been very favorably received among public land managers. A lot of public land managers read the book and said, "OK, I have to act on this."

Rocky Mountain Futures was published in 2002. If you were to do it again today, or if you had the chance to do a second edition, how would you change it?

It would be very interesting to try to bring this group back together and use their expertise to say, "Did your projections pan out? Are these priorities still the main priorities? What has changed?

I speculated [earlier in this interview] that we might have been able to put the brakes on rampant exurban development, but I don't know if that's true, or if it will ramp back up again as soon as our economy improves.

Climate change has become much more prominent in the public discourse out here. Several cities and counties in the Southern Rockies are taking a much more serious view about how they are contributing to climate change and how they may reduce the impact. That will change the way development occurs through transportation networks and energy usage.

I think what we'd see if we brought this group back together would be an increased emphasis on the interactions of climate change with all the other drivers that we spoke about.

Are there some examples of successful ecological restoration projects that you have seen in the Southern Rocky Mountains that you'd like to highlight?

I'm a big fan of restoration because ecosystems are very resilient. If you give them the opportunity to come back to something you value, and if you do it thoughtfully, you can be successful. There was a plutonium processing plant on the base of the foothills right outside of Denver that is now a national Wildlife Refuge called Rocky Flats. There is also a former chemical weapon manufacturing site called the Rocky Mountain Arsenal that is also being transformed into a wildlife refuge. They have cleaned up quite a bit of the radioactive material and the wildlife has come back in droves. Rocky Flats and the Rocky Mountain Arsenal.

I think a lot of areas can be reclaimed, but the trick is to do it with respect to services and processes and not just something that looks like a natural landscape.

Rocky Flats, formerly a nuclear weapons productions facility, is being transformed into a wildlife preserve. Photo courtesy of the U.S. Department of Energy.

As part of the Rocky Mountain Arsenal's comprehensive cleanup program, all of the manufacturing structures were demolished, including the complex shown here. These areas and others were reseeded with native plants and grasses. Photo Property of the U.S. Army, circa 1960s.
By the time the cleanup program is complete, more than 10,000 acres (62 percent of the site) will have been returned to the native short-grass prairie ecosystem. Photo Property of the U.S. Army - Rich Keen/DPRA Inc.

What are you working on now?

I am working in two directions and they converge One is related to atmospheric nitrogen deposition and how it is affecting pristine systems - high elevation alpine lakes - worldwide. We looked at three regions in Colorado: an area along the Front Range, an area in the San Juan mountains in the southern part of the state, and an area around the center of the state. We then added in large data sets from the entire countries of Norway and Sweden. We produced a paper that just came out, which has a very simple message: very small increases in nitrogen have a profound effect on pristine high elevation lakes. It causes eutrophication.

There is a lot of work going on with respect to how climate change is affecting ecosystems, specifically high elevation headwaters. We are also looking at what will happen ecologically as the highest elevations as our glaciers melt.

I also spend a great deal of time talking with public land managers (from the National Park Service, U.S. Forest Service and Bureau of Land Management) about how to think about adapting to climate change. We had a paper that just came out in the *Journal of Environmental Management* that which gives guideline on how to think about climate change so you can act on it in the most thoughtful way. Research is wonderful and rewarding, but implementing action based on findings is the important thing.

Non-Profit Spotlight

Wildlands Restoration Volunteers
www.wlrv.org

Photo courtesy WRV

Ten years ago, when former software developer Ed Self recruited a group of 20 friends to help him plant willows to improve habitat around a local wetland, he had no idea that this group would swell to become a 2000+member organization known as Wildlands Restoration Volunteers (WRV).

Photo courtesy WRV

"I had no intention of starting a non-profit," said Ed, who now holds a Master's Degree in Volunteer Program Management with an emphasis on ecological restoration and environmental education "I was just trying to bring together all of the things I personally care about - outdoor education, botany, volunteering and service learning. I wanted to do something that was healing - for the earth, people and community."

Photo courtesy WRV

With a mission to "foster a community spirit of shared responsibility for the stewardship and restoration of public lands among residents of the Northern Colorado Front Range and beyond," WRV volunteers now take on 35-40 restoration projects throughout Northern Colorado each year. Project examples include removing invasive species; obliterating old roads that fragment wildlife habitat; planting trees to re-establish a critical subalpine wildlife corridor for Canada Lynx; stabilizing and restoring eroded hiking trails; restoring a mile long stream and riparian corridor destroyed by motorized recreation; planting tens of thousands of plants to restore wetland habitat, adopting and restoring an urban stream, and collecting native seeds for future revegetation efforts.

Photo courtesy WRV

Funded through grants, individual donors, and government fee for service arrangements, WRV is headquartered in Boulder, CO. Since its humble beginnings, WRV has completed 217 projects through which their volunteers have contributed over 153,000 hours (valued over $2.7 Million). They have restored 13 miles of streams and shorelines; obliterated over 15 miles of roads to protect and restore habitat, planted

more than 120,000 trees and native plants, removed more than 1,800 acres of noxious weeds, and much more.

WRV trains volunteers to be crew leaders. Photo courtesy WRV.

According to Ed, "The greatest impact of our work reaches beyond the thousands of hours of volunteer labor on the ground. WRV provides skills, education, tools, and a vision of hope that catalyzes people to fall in love with places and realize that they can work together to restore those places and make a tangible difference in the world.

WRV's motivated volunteers have provided much needed labor for partners such as the U.S. Forest Service, Colorado State Parks, the City of Boulder, Boulder County, Rocky Mountain National Park, U.S. Fish & Wildlife Service and many others. WRV's primary focus is on ecological restoration on public lands, although they may perform work on private land if there is a public benefit.

"In some cases, the land agencies we help have very limited staff and funding," said Ed, "and they either couldn't do these projects without us, or it might take them ten years to get done."

There's a reason WRV's mission includes the words "the Northern Colorado Front Range and beyond." Not only does Ed see WRV's future involvement in ecological restoration extending beyond the Front Range, he sees the human engagement element of WRV's work as a movement that can ripple throughout the world.

"Just endlessly doing more and more restoration is not going to solve the underlying issue," said Ed. "In order to really accomplish our mission, we need to do things that lead to a transformation in human relationships to the natural world. When people get their hands dirty doing restoration work, it fundamentally changes their relationship to the land. In order to achieve that transformation, we have to reach a critical mass of having enough people engaged in public land stewardship that that perspective can seep into the larger culture.

Assuming WRV continues to grow at a phenomenal pace, inspire such enthusiasm that volunteers outnumber opportunities, and foster the development of new stewardship volunteer groups in other communities (a high WRV priority), Ed's concept is likely to catch on.

WRV projects include lots of food an fun. Photo courtesy of WRV.

We sure hope it does. To learn more about Wildlands Restoration Volunteers, to support the organization, or to contact them about how you can start a similar program in your area, check out their web site.

Red Pines at Morning

Laura Backus, Senior Ecologist

Photo courtesy of the Colorado State Forest Service.

My first Colorado summits in 1971 offered views of dark green pine, spruce, and fir forests stretched across the mountains as far as the eye could see, broken only by snow fields, red and gray rock outcrops, and the grayish green tundra of the highest peaks. I thought the forests always had and always would look dense and green. Now the mountain traveler in the Rocky Mountains of the United States, Canada and Mexico sees the green forests broken by vast swaths of red pines or ghost grey pines bereft of all needles. The immediate cause: bark beetles. The primary cause: warming and drying of forest lands. The drivers of this change are green house gas emissions coupled with changes in land uses.

The most notable infestations involve the native mountain pine bark beetle (*Dendroctonus ponderosae*). This tiny critter, the size of a single rice grain, moves through lodgepole, ponderosa, or limber pine forests in three predictable stages:

1. Green needle - During mid- to late-summer dispersal, beetles bore into the inner bark of a living tree and lay their eggs, usually selecting trees over five inches in diameter and avoiding those where beetle pheromone secretions establish that a tree is already infested. Yellowish-white pitch tubes show that an infested tree is attempting to flush out the beetles.

2. Red needle - The red needle stage, highly visible during the second to fifth year of infestation, is evidence of the beetle's double whammy. Eggs have matured into larvae, which eat the inner bark, while a fungus brought in by the burrowing adults has spread in a blue-gray stain, cutting off the flow of water and nutrients. In late summer, the new adult beetles emerge from the bark and fly off to infest near-by trees.


Photos courtesy of the Colorado State Forest Service.

3. Gray tree - Following red needles drop, the stem and branches of the once-infested tree stand out as gray in the landscape for up to 20 years before dropping to the forest floor.

Photo courtesy of the U.S. Forest Service.

Mountain pine beetle infestations, both negligible and wide-spread, have moved through lodgepole forests over thousands of years of tree and beetle co-existence, and indeed play a role in forest health by creating a patchwork of old and young trees. Joining the mountain pine beetles in the forest dynamics are a host of other native beetles, each generally specific to one tree species: Douglas-fir beetle, spruce beetle, pinyon ips, and fir engraver. Native western spruce budworm, wood borers, white pine blister, and Douglas-fir tussock moth cause additional tree damage and mortality. Splashes of red highlight Colorado areas of dead and dying trees in recent mapping of infestations. The loss of coniferous forest is compounded by Sudden Aspen Death, a syndrome of factors such as cankers, stem borers, and grazing pressure, which diminish the green and golden aspen groves that spring up following forest fire.

Photo courtesy of the U.S. Forest Service

Climate change makes this infestation particularly rapid and unpredictable. Severe drought and warmer temperatures are stressing already crowded even-age tree stands. In response to a lengthening growing season, mountain pine beetles can produce two generations a year instead of one generation every one or two years. Episodes of fall and spring temperatures low enough to kill larvae (around minus 40 F) have become less frequent. Mountain pine beetles have been attacking smaller diameter trees as well as trees at higher elevations. Normally limited by their short flight capacity, beetles have lately been observed on radar, high above the canopy, boosted by high winds many miles into uninfested forests. Some researches report that mountain pine beetles have been observed crossing into previously untouched conifer species. To make matters worse, in killing the trees, these little critters turn what was a carbon sink into a carbon source likely to last more than a decade.

The large tracts of dying and dead trees raise concerns of mountain residents - conversion of majestic, deep green forest into unattractive red and gray trees, wind throw damage to power lines and buildings, and the threat of uncontrollable wildfires, to name a few. Some ski towns, such as Breckenridge, require landowners to cut and remove all beetle infested trees. The Breckenridge Ski Resort is working in partnership with the U.S. Forest Service to revegetate old lift lines and trails with a diverse selection of conifer species. Some property owners are investing in treating healthy trees with a preventative spray, trying out pheromone pouches to discourage beetle attack, or thinning forests to allow more water and nutrients for the remaining trees. To encourage use of tree thinnings and beetle-killed trees, the Colorado State Forest Service is promoting use of local wood for landscape timbers, animal bedding and landscape timbers. Boulder County, on the other hand, is letting the mountain pine beetle infestation run its course.

One might fear that the increased dead and dying trees might increase the risk of wild fires, but in a recent wild fire literature review, western forest researchers concluded that bark beetle infestations do not set the stage for catastrophic crown fires. High-intensity fires are result of very dry conditions which allow the spread of flames through both living and dead trees.

How will the pine bark beetle impact Colorado's future? Plant communities of classical ecology over time reset to a stable climax system of foreseeable species and interactions with the environment. In our time, change has become far less predictable. Eventually, the epidemics of mountain pine beetle and other insects will collapse from overuse of tree food sources. Depending on future climate, the now emerging woody species will develop into new tracts of dark green pines or possibly a new combination of mountain vegetation. We may see more aspen coloring the mountain sides and a higher proportion of hardy shrubs and grasses. Trees such as pinyon and ponderosa pines, adapted for the warmer, low elevation forests are likely to become more common at higher elevations. Mountain plant communities will adapt, and we will adapt along with them, changing our expectations of forestry functions and mountain beauty.

Riparian Buffers - Arteries of Biodiversity in the West

In the semi-arid west, streams and their adjacent riparian areas wind their way down from the mountains and across the plains as "thin green lines" through the otherwise tan and brown prairie. Although riparian areas make up a fraction of the vast western U.S.

landscape (less than 1% or 2% depending on the source), they play a disproportionately large role in supporting biodiversity. For example, some reports suggest up to 80% of vertebrate species rely on these areas for part of their life span. Riparian areas are also instrumental in supporting an area's hydrology, water quality protection, and aquatic ecosystem food chain. The protection and management of these areas, however, lags behind, belying their ecological significance.

Riparian areas are magnets for human activity of all types, in particular recreational use along greenway trails that parallel the streams. Meanwhile, communities across Colorado, as elsewhere in the country, are wrestling with how to protect river corridors and the quality of life they bring, in the absence of adequate regulatory programs, plans, funding, or enforcement. As a result, a patchwork of local efforts has emerged to try to protect and enhance the riparian landscape. Mechanisms to achieve protection include land acquisition, education, stormwater management best management practices, restoration, planning, and regulation and zoning. Among the many ideas, the establishment of protected buffers is a central approach that is gaining ground.

Recommended buffer widths and specific mechanisms for protection vary widely, but in general, the wider the buffer the more ecological functions are maintained. The City of Fort Collins has fixed width buffer zones based on the stream or size of wetland (50-300 ft) in which no development is allowed to occur. Much of the Cache la Poudre river corridor has been acquired by the city and is managed as natural areas providing additional opportunities for cohesive long-term management.

In the City of Boulder, where about a dozen drainages bisect the city from west to east, infill developments near the creeks and a burgeoning community of outdoor enthusiasts are literally bumping up to the edge of the waterways. As a result, the City has implemented overlay regulations that include a multi-zone buffer approach in their ordinance for *Streams, Wetlands, and Water Body Protection*. Rather than prohibit all activities in a single zone, the ordinance "encourages avoidance and minimization of regulated activities" within the different regulated areas. Various levels of permit review are required depending on the proposed activity, with minor activities and pre-existing activity exemptions. In preparing for the recent update to the ordinance, City of Boulder staff compiled a summary (with assistance from Biohabitats) entitled "*Wetland and Stream Buffers : A Review of the Science and Regulatory Approaches to Protection*." which is a compendium describing the functions of buffers as well as regulatory examples of the approaches used by dozens of other communities to protect these valuable resources.

Buffers are only the beginning, however, of protecting biodiversity along stream corridors in the Southern Mountain Bioregion. Ongoing stewardship of riparian areas requires management of invasive species, restoration of impaired areas, stormwater quality improvements throughout the watershed, and management of human activities and pets. Revegetation projects, in particular, provide an opportunity to reestablish sufficient structure and species composition. However, bird studies in Front Range communities suggest that the "if you build it they will come" habitat approach will not necessarily work if heavy trail use then occurs nearby. Establishing a range of intensities for human uses with at least some areas designated for conservation (and excluding human activity) has been suggested as one technique to ensure a variety of protected habitat types.

Resources

In addition to the many links that appear throughout this issue we have gathered the following recommended resources on the Southern Rocky Mountain Bioregion.

Central Rockies Chapter of the Society for Ecological Restoration

Colorado Association of Stormwater and Floodplain Managers

Colorado Department of Natural Resources

Colorado Division of Water Resources

Colorado Division of Wildlife Natural Diversity Information Source

Colorado Front Range Infrastructure Resource Project

Colorado Geological Survey

Colorado Native Plant Society

Colorado Natural Heritage Program

Colorado Riparian Association

Colorado State Forest Service

Colorado State Parks

Colorado Tree Coalition

Colorado Watershed Association

High Altitude Revegetation

High Country News

National Park Service in Colorado

Natural Resources Conservation Services in Colorado

Rocky Flats National Wildlife Refuge

Rocky Mountain Arsenal National Wildlife Refuge

Rocky Mountain Arsenal: Turning Vision Into Action

Rocky Mountain Field Institute

Rocky Mountain National Park

State Wetlands Program - Colorado

Southern Rockies Ecosystem Project

U.S. Department of the Interior, Bureau of Land Management, Colorado Field Office

U.S. Fish & Wildlife Service, Mountain-Prairie Region

U.S. Forest Service, Rocky Mountain Region

Warner College of Natural Resources at Colorado State University

Wildlands Restoration Volunteers

Books by Dr. Ellen Wohl

Disconnected Rivers, (Yale University Press, 2004)

Virtual Rivers, (Yale University Press,2001)

Rain Forest into Desert (University Press of Colorado, 1994)

Of Rocks and Rivers: Seeking a Sense of Place in the American West. (University of California Press, 2009)

Books Edited by Dr. Jill S. Baron

Rocky Mountain Futures: an ecological perspective (Island Press 2002)

Biogeochemistry of a Subalpine Ecosystem (Springer-Verlag 1992)

Bark Beetle Links

Biology, Ecology and Management of Western Bark Beetles

Hot Topic: Bark Beetle

Colorado State University: Common Forest Insects & Diseases

What's Happening in Colorado's Aspen Forests?

Recent Forest Insect Outbreaks and Fire Risk in Colorado Forests: A Brief Synthesis of Relevant Research

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Biohabitats' Projects, Places and People

Biohabitats' Projects

Wetland and Riparian Restoration In The City of Fort Collins
The City of Fort Collins Natural Areas Program manages over 1,000 acres of open space properties along the Cache La Poudre River, including numerous former gravel ponds with significant water resources and habitat values. We were pleased to have been selected to help the city by providing on-call consulting and engineering services related to the assessment of alternatives, design, planning and construction of wetland and riparian restoration projects. As an initial step, we have been participating in the update of the Poudre River Master Plan, conducting a riparian assessment along over 10 miles of river, evaluating groundwater and surface water hydrology, and assisting with vegetation mapping. Restoration planning is currently underway to identify projects that can then be selected based on viable water sources, unique habitat features, opportunities to improve impaired areas, and opportunities for community education and partnerships.

Countin' Burrows, Dog Gone It!
We recently helped the City of Louisville, CO in their efforts to develop an updated management plan for the prairie dog, a keystone species of western grasslands. We conducted a mapping effort to identify active, vacant and treated burrows in the city's open space areas. The project covers 10 management areas and over 6000 burrows!

Boulder County Is Getting To Know It's Riparian Corridors
Biohabitats completed the inventory and assessment of four plains streams and adjacent habitat, totaling 21.7 river miles to

assist Boulder County Parks and Open Space in understanding their riparian corridor properties as a whole and to prioritize restoration and maintenance projects. The properties ranged from difficult to access and seldom visited to areas highly impacted by agriculture and urbanization. As part of the project, we complied existing information (including GIS mapping) which we used to develop an assessment methodology based on the Bureau of Land Management Proper Function Condition standard.

Restoring Streams on Tribal Land

Stabilized Meander Bends on Rock Creek.

The Ute Indians are Colorado's oldest continuous residents. Over the past several years, we have had the honor of partnering with the Southern Ute Indian Tribe to reduce erosion and flooding, and create riparian habitat on tribal land. To date, we have collaborated on the restoration of four degraded stream sites near Ignacio, CO. These efforts have included initial site investigations and planning; permitting, stream restoration design, and restoration construction including planting activities with tribal workers and local volunteers. The Tribe's deep connection to and respect for the land is evident in the way the Tribal Council and Tribal members have embraced and participated in these important projects.

New Bank Stabilization Technique Receives Preliminary Approval From Colorado Trout

A recent stream restoration project in Park County, CO provided an opportunity to utilize a new bank stabilization technique. Tarryall Creek, a rural, meandering, riffle/pool stream, is located in a hayfield on the Puma Hills Ranch. Because the floodplain is maintained for hay there is little woody vegetation to stabilize the meanders (curves), which were actively eroding. Most of the outside meander banks in the project reach were losing five to ten feet per year and the excessive sediment production was degrading prime trout habitat. While attending the Southeast Stream Restoration Conference in North Carolina in November 2008, Biohabitats Senior Fluvial Geomorphologist Vince Sortman heard Dave Rosgen describe a new technique for bank stabilization which uses logs and tree limbs placed at the toe (bottom) of the new meander bank to provide toe protection and create trout habitat. This seemed like a good fit for Tarryall Creek, because trees on the property would be used for log vanes and rootwads and there would be plenty of tree limbs and other woody debris available for toe stabilization.

This past August, the restoration was constructed using this new technique. First, rootwads were installed in the meander, with root balls placed at the thalweg (deepest part of the stream). Tree limbs and other large woody debris were placed behind the rootwads to form the toe of the new bank.

Large cobble material, harvested from the point bar (sediment deposition on the inside of a meander), was dumped on top of the large woody debris to anchor the wood material. Soil was placed on top of the cobble material. Finally, sod and willows, also harvested from the point bar, were transplanted in the soil to form a bankfull bench and complete the new meander bank. Larger willows were pruned back to allow them to expend energy growing roots.

While this is a new restoration technique it appears to be very successful at least at creating trout habitat. No trout had been observed in any of the eroding meanders of the Tarryall Creek project site. But just a day after completion of the stream restoration using this technique, trout were observed in several of the new meanders. The resiliency of the technique will be tested next spring during peak snow-melt discharge. We look forward to keeping you posted on its progress!

Baltimore Mayor Sheila Dixon listens to Beechfield Elementary School students talk about the importance of Maidens Choice Run.

Dedication Ceremony Draws Dedicated Stewards

Dignitaries, school children, community members and engineers alike were on hand to celebrate the dedication of Maidens Choice Run, an urban stream restoration project we designed in partnership with the U.S. Army Corps of Engineers and the City of Baltimore. In addition to stream stability and enhanced habitat, the project presented a nice opportunity for outreach and education, as the stream runs through elementary, middle and high school property. In her glowing remarks about the project, Baltimore Mayor Sheila Dixon spontaneously called a few elementary school students on stage to tell, in their own unrehearsed, words why the stream was important. The audience gushed (especially us) as they talked about the need for habitat, cleaner water, and a healthy Chesapeake Bay. While we're delighted to see the design come to life, bringing with it stability and function, we're particularly thrilled to witness the stewardship the restoration has inspired within the community.

Places

Environmental Scientist, Suzanne Hoehne will be in Lacrosse, WI this February to present "Integrating Stream and Wetland Restoration through an Innovative Approach" at the inaugural Upper Midwest Stream Restoration Symposium.

February 19th is the date for this year's SER Mid-Atlantic Conference,which will be held in New Brunswick, NJ. The theme of this year's conference, "Ecological Restoration: Why Bother?" is sure to stir the pot - and we can't wait to jump in!

People

Get to know the folks in our Southern Rocky Mountain Bioregion office:
Bioregion Leader & Water Resources Specialist, Claudia Brown
Senior Fluvial Geomorphologist, Vince Sortman
Water Resources Engineer, Mike Lighthiser
Senior Ecologist, Laura Backus

Though we're generally the kind of folks who follow trends (unless they involve cutting edge innovations in ecological planning and design!) we just couldn't help ourselves when it came to Facebook, Linkedin and Twitter. You've got to admit...social networking is pretty fun. Check us out and be a fan!

Bryon Salladin, Biohabitats environmental scientist and ISA certified arborist, has been appointed to the Baltimore City Forestry Board. Forestry Boards, functioning in all 23 Maryland countries and Baltimore City, were established in 1943 by the Maryland Department of Natural Resources (DNR). The Baltimore City Forestry Board is composed of individuals who serve voluntarily as advocates for trees and forest. Board members provide leadership for urban and suburban environmental improvement and help educate people about the benefits trees and forests. Yay, Bryon!

Glossary

Exurbia: A spatial pattern of settlement that differs from suburbia in that it is located farther from urban centers and features a different mix of land uses and population (Exurban Exchange Program, n.d.). Exurbia is characterized by low population density, high population growth, and commuting to urbanized areas for work. It is often associated with rural gentrification, as people willing to commute long distances move to rural places, raising the cost of living there while also transforming those places socially (Berube, Singer Wilson, & Frey, 2006; Salamon 2003a; Salamon 2003b). (Source: Sloan Work and Family Research Network)

Fire-Return Interval: The number of years between two successive fire events at a specific site or an area of a specified size. (Source: National Park Service)

Photovoltis: arrays of cells containing a material that converts solar radiation into direct current electricity. (Source: Wikipedia)

Water diversion: Changing the natural flow of water to another location by using dams, canals, or pipelines. (Source: Colorado State University Extension: Glossary of Water Terminology by R. Waskom and M. Neibauer (3/08))

Xeriscape: The use of plant materials and practices that minimizes landscaping water use; usually native plants; environmentally friendly form of landscaping. The term "xeriscape" was copyrighted by Denver Water in 1981. (Source: Colorado State University Extension: Glossary of Water Terminology by R. Waskom and M. Neibauer (3/08))

View the online version of this edition of Leaf Litter at http://www.biohabitats.com/ndg_newsite/newsletter/2009winter/.