BITTERROOT ECOSYSTEM MANAGEMENT RESEARCH PROJECT (BEMRP)

ECO REPORT

SUMMER, 2004

A Progress Report from a Partnership in Landscape Level Ecosystem Management

Great Issues, Great Diversions

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"There are great issues and great diversions. Great issues are matters that cry out for public attention and resolution. Great diversions are relatively unimportant matters that take up a lot of our time and effort." Thus stated Forest Service Chief Dale Bosworth in a speech given in 2003.[1] The 1897 Organic Act established forest reserves "to improve and protect the forest…for the purpose of securing favorable conditions of water flows, and to furnish a continuous supply of timber."[2] This basic Forest Service mission has not changed, but what have changed are the agency's emphases in implementing its mission, driven by political and socio-economic forces.

Forest Service Chief Dale Bosworth. Photo courtesy of the Washington Office.

Prosperity following World War II fueled timber demand, but also increased interest in outdoor recreation, wildlife, and wilderness. Although the agency attempted to mediate these conflicting pressures, it could not offer more timber while also removing more land from timber harvest. Something had to give; ultimately, timber did. By 2003, timber harvest dropped to about 13 percent of its mid-1980s level.[3] Although still legitimate concerns today, timber harvest, road building, threatened and endangered species, and livestock grazing constitute four "great diversions," distracting attention from four "great issues." In his speeches, Chief Bosworth explains that now our greatest issues are fuels and fire, unmanaged recreation, invasive species, and loss of open space (fragmentation)—what he calls "The Four Threats."

The **fire and fuels threat** results from forests that are overgrown, and means our forests are in need of restoration. The reason lies in a complex set of interactions. During most of the 20th century Americans pressured the agency to suppress fires. Fire protection, recreation demand, and decades of wet weather produced dense, fuel-loaded forests. In more recent years, prolonged drought entered the equation, increasing forest flammability. Together, these factors have produced uncharacteristically fire-prone forests.

Researchers are gaining new knowledge about natural processes, treatment effects and effectiveness, and social implications of management options, as well as developing analysis and decision-support tools for use in treating fire and fuels. Bitterroot Ecosystem Management Research Project (BEMRP) researchers have been investigating effects of fire and fuels management treatments on wildlife and aquatic habitat, invasive species, and other resources such as soils and understory plants. Applied research is more critical now than ever before.

Loss of open space is an equally complex threat. Every day, the United States loses 4,000 acres of open space to development activities—about 3 acres per minute.[4] Much of this is ranchland, sold to developers for skyrocketing amenity values to escape debt, drought, and environmental lawsuits. Likewise, working private forests get subdivided, making them less profitable and harder to manage sustainably.

Researchers are learning about impacts of lost open space. For example, breaking large "working" forests into smaller forests makes them more difficult to manage sustainably. Small, wildland/urban interface woodlots often are vulnerable to fire.[5] Forest interior and range habitat shrink. Biodiversity diminishes. Traditionally, buffers offered by ranches and farms protected habitat quality on national forest lands. Today, a growing and shifting population, escalating outdoor recreation, and a global economy are driving urbanization and housing

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Great Issues . . . *(continued from page 1)*

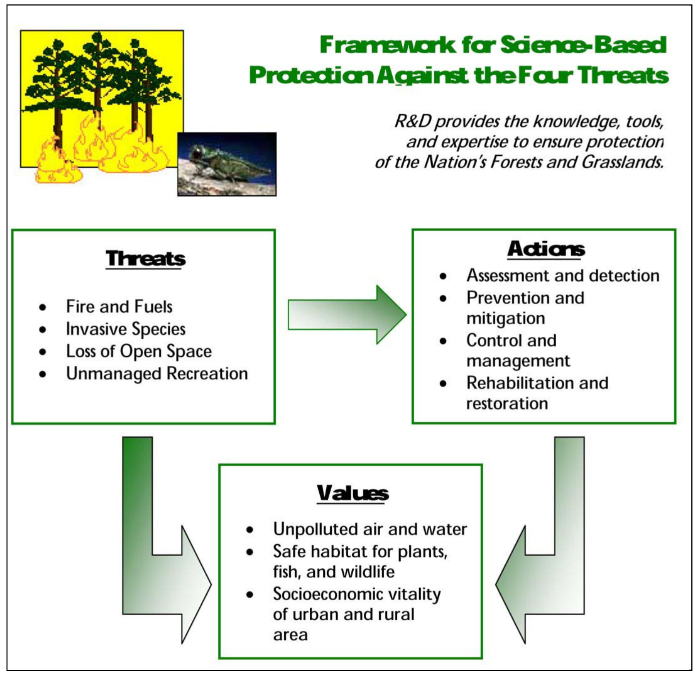
developments nearer to wildland/urban interfaces. Ecological processes and economic enterprises dependent on continuous forest cover suffer accordingly. Research helps us understand, predict, and manage urbanization and land fragmentation.

A third great threat is the increase of **invasive species.** Initially, most invasive species came as food and fiber imports, or ornamental plants. Invasives include non-native plants, fish, insects, diseases, and pathogens. Rapid encroachment of invasive weeds greatly reduces livestock carrying capacity and wildlife habitat value. Several major tree species, including American elm, have suffered severe impacts from invasives. West Nile virus, currently threatening horses, is a high profile invader.

Wide ranging studies to determine the magnitude of the problem, and improve intervention, are ongoing. BEMRP researchers have been examining invasive species biology, environmentally safe control options, and invasives' impact on native species. Researchers have learned that invasive non-native species often reduce native species biodiversity and change natural disturbance regimes. Postfire treatments, other fuels management activities, and grazing can unintentionally encourage non-native plant species to spread. Insects introduced to control spotted knapweed have become food sources for deer mice, increasing the threat of Sin Nombre Hantavirus. To be effective, we need prevention measures that are large scale and, like the invaders, cross traditional jurisdictional boundaries.

Unmanaged recreation is the fourth threat. Recreation demand is growing rapidly, with wildlife viewing and scenery among the top attractions. Millions of people recreating in national forests impact forest ecosystems and recreation quality. Problems include: crowds, noise, degraded trails, eroded river banks, inappropriate campsites, stripped vegetation, damaged meadows, and disrupted wildlife. Particularly important is the seven-fold increase in off-highway vehicle (OHV) use in less than 30 years.[6] Unmanaged OHV use has the potential to do extensive damage. In the Northern Region, Forest Service managers have found that even minimal OHV cross-country travel can cause considerable damage, requiring travel management plans that limit OHV use to designated areas.

Scientific knowledge is prerequisite to successful recreation management. Researchers are learning many things about recreation-induced resource impacts, recreation supply and demand, and quality of recreation experience. For example, OHV noise within about 110 yards negatively affects breeding birds, and noise made by people on the ground disturbs nesting birds more than aircraft noise does.[7] Researchers have also discovered people care about, and return repeatedly to, specific places, meaning alternative recreational areas may not be acceptable to some users. Future research will examine wildlife and recreation interaction, and study behavioral incentives that provide recreation experiences to visitors while preventing undue resource damage. Options for accommodating people's "attachment to place" and managing recreation carrying capacities are under development.



Values, threats, and actions. Forest Service Research and Development graphic.

Finally, one top priority is preserving and maintaining national forest and grassland health. Critical to this effort is amelioration of the Four Threats. The Forest Service intends to protect and enhance social, economic, and ecological benefits offered by healthy forests. This requires continuous up-to-date knowledge to combat the Four Threats. Research on assessment and detection, prevention and mitigation, control and management, and rehabilitation and restoration activities helps preserve values offered by healthy national forests—clean air and water; safe habitat for plants, fish, and wildlife; and socioeconomic vitality of our population.[8] Do not be preoccupied with the issues of yesterday. While some past issues may still be relevant, we must not allow them to divert us from responding to today's emerging problems.

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[1]Bosworth, Dale. 2003. Managing the National Forest System: Great Issues and Great Diversions. Speech to the Commonwealth Club. San Francisco, CA. April 22. 4 p.

[2]Bosworth, Dale. 2003. Changing the Debate on Managing National Forests and Grasslands. Speech to the Society of Environmental Journalists, Annual Conference. New Orleans, LA. September 12. 5 p.

[3]Ibid.

[4]Bosworth, Dale. 2003. We Need a National Debate. Speech to Izaak Walton League, 81st Annual Convention. Pierre, SD. July 17. 7 p.

[5]Bosworth, Dale. 2003. State of the Forest Service, 2003. Speech to National Leadership Team Meeting. Tucson, AZ. February 2003. 17 p.

[6] Ibid.

[7]USDA Forest Service, Research and Development. [n.d.] Briefing Paper: Science-Based Solutions for the Four Threats to the Health of the Nation's Forest and Grasslands. Executive Summary. 16 p.

[8]Ibid.

Making a Difference with Ecosystem Management Projects (Why They're Valuable!)

The greatest value of BEMRP is that it brings agency scientists, land managers, university researchers, and community members together to make a difference on the land and in people's hearts. Photo by Brooke Thompson.

"Never doubt that a small group of thoughtful committed citizens can change the world. Indeed, it is the only thing that ever has." — Margaret Mead. Photo by Janie Canton-Thompson.

Jim Saveland, Assistant Director for Research, RMRS, Fort Collins, CO

Making a difference is an extremely important topic, and I am grateful for the opportunity to write about it. One of the great things about working for the Forest Service is that a lot of people working for the agency chose their profession because of a desire to make a difference. There's often a lot of talk about reward systems, but extensive research on motivation shows that while rewards are effective in gaining compliance in the short-run, they have a negative impact on commitment and are thus counter productive in the long-run.[1] There is no greater motivator than people's own intrinsic motivation to make a difference in something they care about. I am reminded of a quote in what I consider one of the greatest management science books ever written, *The Human Side of Enterprise*.

> An equally important reason for management's failure to make effective use of current social science knowledge has to do with a misconception concerning the nature of control in the field of human behavior. In engineering, control consists in adjustment to natural law. It does not mean making nature do our bidding. We do not, for example, dig channels in the expectation that water will flow uphill; we do not use kerosene to put out a fire. In designing an internal combustion engine we recognize and adjust to the fact that gases expand when heated; we do not attempt to make them behave otherwise. With respect to physical phenomena, control involves the selection of means which are appropriate to the nature of the phenomena with which we are concerned. In the human field the situation is the same, but we often dig channels to make water flow uphill.[2]

We often try to make water flow uphill in the management arena by developing clever reward systems, or worse yet, applying sticks as well as offering carrots. The greater challenge is to figure out how to nurture and cultivate an environment where people's own intrinsic motivation to make a difference flourishes. When people are working together to make a difference in what they care about, great things happen.

Which brings me to the title of this short essay. I could recite a laundry list of all the great research that the Ecosystem Management projects have funded and all the new knowledge we've learned, and that would indeed be a substantial and impressive list. (See "BEMRP Turns 10" article for a taste of these accomplishments, p. 4.) But for me, the greatest value the Ecosystem Management projects provide is an opportunity for Forest Service (and other agency) researchers and land managers to work together with university researchers and the people in local communities to make a difference on the land and in people's hearts. When science and management come together in the local community on collaborative projects to make a difference on the land, great things happen. As Margaret Mead said, "Never doubt that a small group of thoughtful, committed citizens can change the world. Indeed, it is the only thing that ever has."

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[1]Kohn, Alfie. 1999. Punished by Rewards: The Trouble with Gold Stars, Incentive Plans, A's, Praise, and Other Bribes. New York: Houghton Mifflin Co.

[2]McGregor, Douglas. 1985. The Human Side of Enterprise—25th Anniversary Printing. New York: McGraw Hill. p. 8-9.

BEMRP Turns 10

Sharon Ritter, Research/ Management Coordinator, Bitterroot National Forest and BEMRP, Hamilton, MT

Ten years ago, the Forest Service decided to establish several Ecosystem Management Units. A group of researchers and forest managers, already working on forest restoration in the Lick Creek area, proposed forming the Bitterroot Ecosystem Management Research Project. It was a partnership from the start, and that partnership kept it going and grounded in real-life management issues. Recently, it also helped BEMRP gain approval to continue for the next 5 years.

BEMRP-sponsored science is applied on-the-ground in the Bitterroot National Forest and other western lands. Here, University of Montana silviculture professor Carl Fiedler describes the results of his research at Lick Creek. Photo by Brooke Thompson.

In a recent review of the five Ecosystem Management Units within Rocky Mountain Research Station, BEMRP scored especially high in relevance. BEMRP-sponsored science is applied on-the-ground in the Bitterroot National Forest and other western lands. Through this unique partnership, researchers and managers share information and ideas, and help plan research projects. This results in timely use of research results and gives managers ownership in those results. One Forest representative was even heard to refer to "our" research. Now that's ownership!

Here are some examples of how BEMRP research results are having an immediate effect on the ground:

- Forests conduct thinning and prescribed burning based on what we learned at Lick Creek Demonstration/Research Forest.
- The Burnt Fork Ranch learned about restoration treatments at Sawmill Research Natural Area, and then completed similar work on more than 8,000 acres.
- Forests use results from noxious weed treatment research occurring on the Lolo National Forest.

BEMRP has been productive, funding 106 studies in the past decade. Some of the questions addressed include:

- What are the historical landscape patterns and fire history within our forests and grasslands, and the recent influences of harvesting and fire suppression?
- What are effective ecosystem restoration treatments to restore our ecosystems to more historical conditions, and what are their effects on various natural resources?
- What factors affect distribution and abundance of wildlife species?
- How can we use models to understand current and future effects of treatments, fire suppression, timber harvest, and natural forest succession?
- How can the Forest Service increase public participation and improve communication among managers, research scientists, and the public?

Long-term research is an important aspect of BEMRP. For example, BEMRP is still studying the effects of treatments done at Lick Creek in the early 1990s. The Tenderfoot Research Project on the Lewis and Clark National Forest is looking at immediate and long-term effects of treatments in lodgepole pine forests. We're compiling a bibliography of research on the effects of thinning and prescribed fire on resources in the Northern Rockies. Except for the shining example of BEMRP, there are very few long-term studies of treatment effects.

BEMRP also has been busy sharing the results of research through field trips, seminars, ECO-Report, our website, displays, demonstration sites, brochures, posters, more than 160 published papers, and participation in conferences and workshops. Through these, researchers, managers, and the public learn how to be better stewards of our environment.

Now that BEMRP has the go-ahead for another 5 years, we're excited about continuing and expanding upon our past research. Soon, we will be setting up new research projects to help us understand and manage western Montana ecosystems.

ECO-Report

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A Vision for RMRS Ecosystem Management Projects

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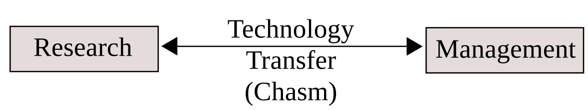
Jim Saveland, Assistant Director for Research, RMRS Management Team. Photo courtesy of Jim Saveland.

In "Fire in the Forest," a paper I wrote for the 1995 National Silviculture Workshop (www.fs.fed.us/rm/pubs/saveland/fire_forest.pdf), I shared my vision for the restoration of short-interval fire-adapted ecosystems and talked about the importance of developing a shared vision. Looking back over that paper 9 years later, my thoughts about the need to restore fire-adapted ecosystems are very much the same. Ecosystem management projects have an important role to play in restoring fire-adapted ecosystems. Rather than repeat myself, I'd like to turn my attention to the larger field we play on and the recent emphasis on improving "science delivery and application."

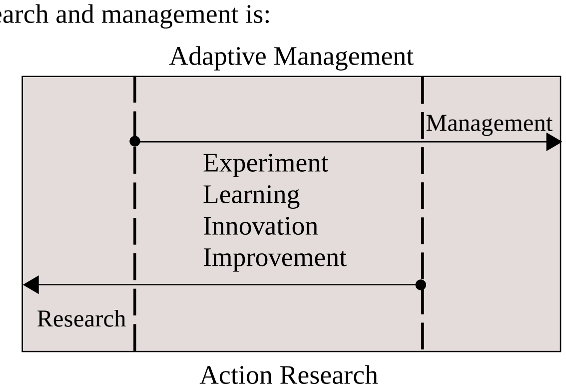
Two reports recently crossed my desk. The first one is the "American Association for the Advancement of Science (AAAS) Report XXIX Research and Development [R&D] FY 2005." It's located on the web at http://www.aaas.org/spp/rd/rd05main.htm. AAAS produces this report each year. It provides a comprehensive overview of the President's proposed budget for research and development. "The request for total federal R&D in FY 2005 is $132.0 billion, $5.5 billion or 4.3 percent more than FY 2004. The entire increase would go to Department of Defense (DOD) development of weapons systems and R&D in the new Department of Homeland Security (DHS), leaving all other federal R&D programs collectively with declining funding." The Department of Defense R&D budget would increase by $4.0 billion to $69.9 billion. That increase is roughly the equivalent of the entire Forest Service budget. The report goes on to talk about the expected federal budget deficit this year ($521 billion) and the tremendous pressure on domestic discretionary spending due to such things as $1.1 trillion in tax cuts over the next decade, and the new Medicare prescription drug benefit costing $539 billion over the next 10 years. The report also looks beyond federal spending for R&D. In 2003, the United States invested an estimated $284 billion in R&D, which represents 2.61 percent of the nation's Gross Domestic Product (GDP). The largest share of this money (63 percent) came from industrial firms. The United States accounts for about 37 percent of all world R&D. Finally, "Science and technology are recognized as key drivers of economic growth, as well as improved health and quality of life in the United States and throughout the world. Economists estimate that up to half of the U.S. economic growth over the past five decades is due to advances in technology."

The second report that crossed my desk is 3M's 2003 Annual Report. It is also available on the web at http://media.corporate-ir.net/media_files/NYS/MMM/reports/2003ar.pdf. 3M is an $18 billion global diversified technology company (creators of scotch guard and post-it notes among many other innovative consumer products). 3M recognizes R&D as a major driver of its growth, investing $1.102 billion (6 percent of net sales) in research and development in 2003. 3M prides itself on a culture of creativity and teamwork. It was interesting to note that 3M has five integrated corporate initiatives. The object of one of them, 3M Acceleration, is "to improve what 3M does best—innovation and new product development. Our goal is to double the number of qualified new 3M product ideas and triple the value of products that win in the marketplace." 3M focuses on increasing speed and efficiency in developing and commercializing new products—bringing innovative products and services to market faster. "Throughout 3M, our employees are getting high-potential products to market faster using a single, company-wide process and a common set of tools for new product introductions." 3M wants "to shorten the distance between research and development and 3M's customers." Like 3M, the federal government is increasingly interested in increasing its speed and efficiency in developing innovative products and services that are useful to land managers and the communities they serve.

To be effective, research needs freedom to question the status quo. We often assume that independence and separation are required to guarantee our freedom to question. This has led to a sacred cow in research: maintain independence. This is not the only viable model. We tend to think and talk about research and management by focusing on the gap and separation:



Another way of thinking and talking about the relationship of research and management is:



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Glossary — "What Do You Mean By That?"

Have you ever spent time pondering the meanings of terms used in ECO-Report, or other ecosystem management (EM) publications? If so, we offer you two opportunities to learn the meanings of EM-related words. You may either visit BEMRP's glossary at www.fs.fed.us/rm/ecopartner or review terms defined annually in "What Do You Mean By That?" Whichever you prefer, remember that some definitions change over time as new information and policies develop. Periodically, we revise our web glossary page to reflect these changes. Feel free to suggest new terms to include in our glossary. This year we've opted to define some potentially unfamiliar terms that appear in articles found in this issue of ECO-Report.

FARSITE – A fire growth simulation model.

DATA-LOGGED THERMOGRAPHS – A temperature data logger is a nonpermanent device secured in a stream channel. It records stream water temperature in specified intervals, and provides data that can be directly downloaded into a computer.

POSTMODERN – A conceptual framework that explains the world in terms of indeterminacy, diversity, difference, and complexity, as opposed to the modern conceptual framework, which considers the world in terms of determinacy, unity, synthesis, and simplification.

PARADIGM – A world view or general perspective that represents what an individual or group thinks about the world. People act according to their paradigms.

SOCIO-ECOSYSTEM – A hybrid term that references both social and ecological systems.

A Vision for RMRS . . . *(continued from page 5)*

Here research and management have several interests in common, including conducting operational experiments, learning from mistakes, spreading innovations quickly, and continuously improving operations. The focus is on the common ground between research and management.

This leads me to some thoughts about a vision for the future of our larger playing field and the Ecosystem Management Projects:

1. I hope that one day we as a society recognize that the major driver of long-term sustainable economic growth is research and development, not the short-term "quick-fix" of tax cuts.
2. I hope that one day the world is a safe enough place that we can take some of the money being spent on weapons systems and invest in environmental research and development such as the Ecosystem Management projects. In the short-term, I hope we don't have to sacrifice non-defense R&D to pay for weapons systems R&D.
3. I hope that one day we take a cue from 3M, limiting the number of "corporate" initiatives and integrating them.
4. I hope that one day our performance accountability systems[1] include an innovation and learning perspective.[2]
5. I hope that one day we take the time to engage in the process of benchmarking.[3] [4]
6. I hope that our current conversations about the need to increase the speed and efficiency of science delivery and application are informed by the science behind the diffusion of innovation.[5] (See Diffusion of Innovations article on p. 15.)
7. I hope we continue to improve our ability to conduct "adaptive management" and "action research."

Our Ecosystem Management projects are pioneers, blazing this path. Our Ecosystem Management projects are one effective way of "shortening the distance between research and development and our stakeholders."

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[1]Performance accountability systems are systems designed to enable organizations to document their performance, including what activities they've completed, how much the activities have cost, and what they've accomplished.

[2]Kaplan, Robert S.; Norton, David P. 1992. The Balanced Scorecard—Measures that Drive Performance. Harvard Business Review. January-February: 71-79.

[3]Benchmarking is the concept of measuring oneself (or organization) against "the best of the best."

[4]Camp, Robert C. 1989. Benchmarking: The Search for Industry Best Practices That Lead to Superior Performance. Milwaukee: ASQC Quality Press.

[5]Rogers, Everett M. 2003. Diffusion of Innovations, Fifth Edition. New York: Free Press.

Symptoms, Productive Systems, and Sustainability

Janie Canton-Thompson, Technology Transfer Specialist and ECO-Report Editor, RMRS, Economic Aspects of Forest Management on Public Lands, Missoula, MT

Outputs or inputs? Which are you most concerned about? Traditionally, most people have advocated sustaining health—whether it was for themselves, society, or the environment—through symptom control (outputs). We train and employ experts to manage symptoms. Examples are plentiful. We've combated encroachment of invasive plants through releasing biocontrols, pulling weeds, or herbicide-spraying infested landscapes. We've treated declining grizzly bear populations by limiting harvest. In human society, we've attacked increasing crime rates by building more jails. Likewise, we've spent billions of dollars treating human disease through prescription drugs and surgical repair aimed at symptom mitigation. In each case, we've focused on outputs—fewer weeds, more grizzly bears, lower murder rate, and fewer heart attacks.

More recently, some have begun worrying less about symptom control and more about inputs—the productive systems (environmental and social contexts) that enable desired or undesired outputs. Ecosystem management and preventive health care are examples of context-focused approaches that assume healthy productive systems naturally and sustainably offer the outputs we desire, with minimal need for symptom treatment.

"Input" or "context" management approaches can be applied in different arenas. For example, wildlife habitat restoration more reliably leads to sustainable grizzly bear populations than does simply prohibiting bear killing. Ensuring continuation of natural processes to the environment, such as returning fire to historically fire-dependent landscapes, often enables native plant communities to sustainably resist invasive weeds better than herbicide-spraying does. Quality education, employment, and family life are more a deterrent to crime than simply building more jails. Likewise, healthy eating, exercise, and stress management are more a deterrent to disease than prescription drugs and surgery. In each case, instead of treating symptoms (undesired output), system managers examine the problems' contexts, and attempt to return contexts to states of health. Healthy systems provide us the outputs we desire, on a sustainable basis at lower cost.

"Socio-ecosystem" (see Glossary, p. 6) managers know that sustaining desired outputs in perpetuity requires attention to inputs. One can apply band-aids to socio-ecosystem health problems, but only up to a point. Each band-aid may stop a symptom; however, band-aids don't always remedy the underlying imbalances causing symptoms to appear. Band-aids may allow sustained outputs in the short-term, but eventually the target system may become so unbalanced we end up with more problems than we originally set out to treat. The side effects become worse—more difficult and expensive to treat than the original problem. Soon we are in a vicious cycle. On the other hand, if we initially promote healthy systems, we more easily and sustainably attain desired outputs, be it larger wildlife populations, fewer weeds, more crime-free societies, or bodies free of disease.

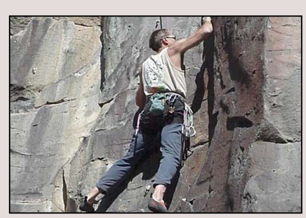
Want a healthy grassland community? Try returning fire to the landscape. Want a healthy wildlife population? Try decreasing habitat fragmentation. Want a healthy body? Try eating more fresh fruits and vegetables. Ecosystem management and preventive health care can take us down the road to sustainability.

INPUT → **OUTPUT**

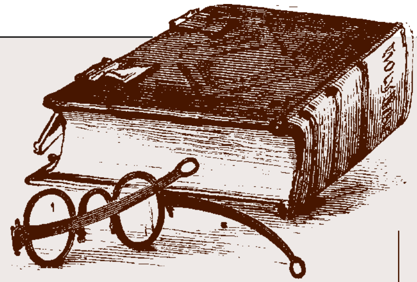
__Natural processes__ can promote healthy plant communities. Fire photo by Steve Arno. Bunchgrass community photo by Yvette Ortega.

__Good elk habitat__ leads to healthy elk populations. Elk habitat photo by Janie Canton-Thompson. Elk photo courtesy of the Bitterroot National Forest.

__Healthy diet__ enables an active lifestyle. Randall Green, rock climber. Vegetables photo from Corel Gallery. Climber photo by Kurt Krueger.



Book Corner



A Review of *Supply-Side Sustainability*

Janie Canton-Thompson, Technology Transfer Specialist and ECO-Report Editor, RMRS, Economic Aspects of Forest Management on Public Lands, Missoula, MT

"…the Earth is our one shot, and that is it."[1] Sound like a doomsayer's statement? Well, it's not. In a "must-read" book for those desiring cost-effective sustainability of our "socio-ecosystem," *Supply-Side Sustainability* authors T.F.H. Allen, Joseph A. Tainter, and Thomas W. Hoekstra[2] critically and comprehensively examine the notion of sustainability through an interdisciplinary lens.

The book begins with a global perspective, dealing a sound blow to the world view that humans are masters of their destiny. Technology will not save us, and building bigger and more powerful widgets is archaic and detrimental to sustainability. The authors range broadly in their treatise on sustainability, holistically examining the interaction of biogeographical and social systems, as well as economic viability.

Sustainability means "maintaining, or fostering the development of, the systemic contexts that produce the goods, services, and amenities that people need or value, at an acceptable cost, for as long as they are needed or valued."[3] Our common sense notion of sustainability assumes people must "do without" to acquire and sustain desired living conditions. The book exposes the fallacy of this view, offering a well-documented argument that sustainability is a matter of understanding how "socio-ecosystems" work, and managing accordingly. Instead of focusing on outputs and complicated management programs to protect natural systems, we need to manage the context[4] that regulates our natural systems. When system contexts are healthy, desired system outputs will flow forth naturally. We must supply ecosystems' needs and no more, and let the systems subsidize our management efforts. Sustainability happens in a social context. It is at bottom a human values question that mediates environment-society relationships, influencing what we manage and what we manage for. Monitoring and prediction are useful to set courses of action and to determine if constraints stay unchanged, and if desired results are becoming realities. Prediction assumes presently identified constraints remain in place. If they do not, prediction will be inaccurate.

According to the authors, sustaining socio-ecosystems requires a five-pronged approach:

1. Manage for productive systems rather than for their outputs.
2. Manage systems by managing their contexts.
3. Identify what dysfunctional systems lack and supply only that.
4. Use ecological processes to subsidize management efforts, rather than conversely.
5. Understand the problem of diminishing returns to problem solving.[5]

These five points are foundational for the lessons we learn throughout the book.

Chapters 2 and 3 develop a framework for understanding what enables societies to be sustainable, and present a fascinating account of previous societies that sustained, restored, or destroyed themselves. Complexity, energy subsidies, and diminishing returns to problem solving have played crucial roles in understanding the rise and fall of civilizations. Because the material world gives us no criteria for what we want to sustain or how to do it, the socio-political system must develop approaches to accomplish these tasks.

In chapters 4 through 6, the authors present a hierarchical approach to understanding and managing socio-ecosystems. This approach contains two major components that are separate analytical considerations: 1) criteria that determine *what* the observer will pay attention to, namely, foreground as opposed to background considerations, and 2) scale of observation, in terms of scope and fineness of distinction. There is an in-depth analysis of criteria for observation and monitoring, including organisms, landscapes, populations, communities, biomes, the biosphere, ecosystems, and energy flows, observable at different scales. The final chapter offers a realistic assessment of postmodern (see Glossary, p. 6) society's ability to attain sustainability. Because both societies and ecosystems are dynamic, achieving sustainability is a moving target. Societies develop to solve human problems—usually by making themselves and their environment more complex. Complexity is costly, and over time becomes subject to the law of diminishing returns. In the final analysis, humans *need to use natural processes* to subsidize their management efforts wherever possible. Our hope of sustainability lies in managing for the systems that produce the resource outputs we consume rather than managing directly for outputs.

Supply-Side Sustainability will challenge the mindsets of most readers. Complex equations are noticeably absent; narrative accounts prevail. Those with lesser knowledge in the fields of ecology and/or social science may reap giant rewards if they are willing to diligently tackle the book with an ecology dictionary in hand. This well-written,

(continued on page 12)

Moving Through the Night

Sharon Ritter, Research/Management Coordinator, Bitterroot National Forest and BEMRP, Hamilton, MT

Holding the spotlight next to my head, I peered through the darkness at the mossy rocks and logs of the creek. Soon, a tiny pair of amber eyes revealed the creature's location. "There's one," I called.

As the research/management coordinator for the Bitterroot National Forest and BEMRP, I spend a little too much of my time reviewing research proposals. Is this really what I had in mind when I became a wildlife biologist? So last summer, I jumped at the chance to get out to some of the researchers' study sites. With more than 35 research projects going on in the Forest in 2003, there was no shortage of sites to visit. The one that most caught my fancy was helping do frog surveys at night.

On an evening in July, I met up with Nathan Stone and his two field assistants. Nathan is studying tailed frogs, a stream-loving amphibian that does most of its feeding at night. This is part of a much-needed, multi-state study of prescribed and wildland fire effects on aquatic ecosystems. Healthy watersheds and aquatic systems are among the goals researchers and land managers must achieve as they address Forest Service Chief Dale Bosworth's Four Threats.

After getting some quick training, we started our survey at 10:45 p.m. Now, for me to even be awake after 10 p.m. was impressive. But the cool night air had me wide awake. Also, I knew I was in for a special treat; the world at night lit only by a small light has a different feeling than in the daylight.

We walked in waders up a narrow stream within the burned area. As I watched these three college students ahead of me, I sent out a silent plea, "Knees, don't fail me." While we tried to keep our footing on the slippery rocks, we searched for adult frogs. While the others were good at spotting frogs, I did better looking for their amber eyeshine reflected in my light. When we found a frog, we put it into a marked plastic bag, and proceeded on. After about an hour, Nathan and I headed back to the truck to record data on the ones we'd caught, while the others kept searching. Processing consisted of sexing, measuring, and noting breeding status. Nathan marked them using a liquid plastic fish tag inserted into their palms, a different color combination for each frog. He then returned each frog to the location where we captured it.

I visited other research sites last summer, in many cases marveling at the dedication of researchers and their assistants that keeps many of them out day after hot day (or night after night), walking steep hillsides that made my knees creak. Lately, I've been reading a lot of research studies, and I'm even more grateful for these dedicated people who help us answer important questions about the lands under our care.

Tailed frogs provide data on fire's effects on aquatic ecosystems. Photo by Nathan Stone.

A researcher tags tailed frogs in the wee hours of the morning. Photo by Nathan Stone.

Ecosystem Management Means Partnership

Furthering the goals of this project requires public participation in decision making. Would you like to become a partner? For more information, please contact

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Visit the Bitterroot Ecosystem Management Research Project on the Internet!
www.fs.fed.us/rm/ecopartner

Weak versus Strong Invaders of Natural Plant Communities

Yvette K. Ortega and Dean E. Pearson, Wildlife Biologists, RMRS, Wildlife Ecology in Rocky Mountain Landscapes, Missoula, MT

Aggressive plant invaders threaten the diversity and function of natural systems throughout the world. In response to this threat, much research has focused on understanding relationships between invading and resident plant species, with the common approach being to lump species into two broad categories—“exotic” versus “native.” Results of these studies are conflicting. Some indicate exotic species are more prevalent in areas of high native species diversity; others suggest the opposite.

Strong invaders such as spotted knapweed (right) tend to negatively impact native plant species like arrowleaf balsamroot (above). Photos by Dean Pearson.

Our BEMRP-funded work within bunchgrass communities of the Lolo National Forest reconciles conflicting previous results by incorporating a simple notion into our analyses: all exotic species do not behave alike. “Weak” plant invaders become minor components of natural communities and are not known to impact native species. In our region, such weak invaders arrived primarily in the early 1900s and are now intermixed throughout our natural communities. In contrast, “strong” plant invaders are known to overrun natural communities at the expense of native species. One of the most prevalent strong invaders in our region is spotted knapweed (*Centaurea maculosa*), a noxious weed introduced in the 1890s that has now overtaken vast areas.

For comparison to other studies, we first analyzed relationships between exotic and native species without distinguishing between weak and strong invaders. We found exotic and native species were positively correlated in communities with low levels of invasion where both weak and strong invaders occurred at low densities, but negatively correlated in communities with high levels of invasion where the strong invader spotted knapweed dominated. These results suggest that conflicting relationships between exotic and native species reported in previous studies may stem from the prevalence of weak versus strong invaders within study communities.

We next repeated analyses but split exotic species into weak versus strong invaders. Results showed that weak invaders, occurring at low densities, tended to be positively associated with native species, driving overall patterns in low invasion communities. These invaders essentially functioned like natives, responding to similar ecological features, so that areas supporting increased diversity of native species also supported increased levels of weak invaders. Indeed, *some* exotic species appear to coexist with native species. In contrast, we found that strong invaders tended to be negatively associated with native species, driving overall patterns in high invasion communities. Strong invaders often attained high densities, exceeding population levels of native species, and suppressing them in terms of diversity and abundance.

Just as exotic species vary in their ability to impact native species, so do native species vary in their response to exotic species. We found that native perennial forbs, consisting of over 50 species, were abundant in areas without knapweed but showed steep declines as knapweed density increased. In contrast, native bunchgrasses showed declines half as steep, and annual forbs did not appear impacted. The native species most impacted by knapweed was arrowleaf balsamroot (*Balsamorhiza sagittata*), a perennial forb often abundant in bunchgrass communities with low levels of invasion. Balsamroot provides food for insects, birds, small mammals, and big game. Therefore, spotted knapweed invasion shifts native plant communities away from perennial species, with largest effects on dominant forb species like balsamroot. These changes are likely to have profound impacts that ripple throughout the system.

Knowledge of the specific ecological impacts of strong invaders is essential for devising appropriate management strategies. For example, broadleaf herbicides are currently the primary tool for effective knapweed control; yet these chemicals are also known to suppress native perennial forbs such as balsamroot. Therefore, use of broadleaf herbicides to control knapweed may exacerbate some negative effects of knapweed invasion by further shifting bunchgrass communities away from native forbs. Broadleaf herbicides may be effective when management goals are directed at grass restoration, but may undermine success when they include restoration of native forbs and system function. The efficacy of weed control methods must be evaluated in an ecological context that includes understanding specific impacts associated with strong invaders such as knapweed.

Strong invaders are clearly a powerful force in natural systems, whereas weak invaders appear relatively benign. Few systems are likely to escape exotic species and the impact of strong invaders. Research is therefore needed to evaluate the ecological factors underlying the differing behavior of weak versus strong invaders so we can recognize strong invaders quickly and improve weed management efforts. The distinction between weak and strong invaders is important for evaluating weed management alternatives, reconciling conflicting results from previous studies of natural communities, and moving research towards better understanding of strong invaders and their impacts. Effective management strategies require knowledge of ecological consequences associated with exotic plant invasions.

Using Fire to Restore Ecosystems

Mick Harrington, Research Forester, RMRS, Fire Effects, Missoula, MT

Burning excess fuels to help restore a ponderosa pine ecosystem at Sawmill Creek Research Natural Area. Photo by Mick Harrington.

As people view the low elevation forests of western Montana, many see the continuous green of unbroken forest canopy and perceive a natural, healthy ecosystem. Surprisingly, the very nature of this homogeneous condition renders these communities unhealthy and dissimilar from forests in past centuries. In general, our perception of the past is biased by our view of the present. As we understand the dire consequences of this altered condition, we are testing various techniques to restore a more desirable condition.

The Fire Effects Research Work Unit at the Fire Sciences Lab is addressing two of the Chief's four threats—fire and forest health, and invasive weeds—by evaluating alternative restoration treatments in a variety of forest and grassland ecosystems. The three forest stands being studied differ greatly from historical structure and species composition. That, in turn, has led to unhealthy conditions exemplified by slow native plant growth, significant insect and disease activity, and high probability of uncharacteristically severe wildfire. Our grassland study involves monitoring treatment effectiveness for controlling noxious weeds in a native bunchgrass ecosystem. The University of Montana Biological Sciences Department received BEMRP support for three of these projects. Following is a synopsis of our forest stand and grassland studies.

From 1992 to 1994, the Bitterroot National Forest and Fire Lab conducted thinning and prescribed burning treatments in the Lick Creek Demonstration/Research Forest to increase ecosystem vigor and reduce severe wildfire potential in a dense second growth ponderosa pine stand. One study measured 9-year, post-treatment tree health. Results show that trees responded positively to all treatments (thinning alone, and thinning with spring burning or fall burning), showing higher photosynthetic rates, lower moisture stress, greater young foliage biomass, and faster growth than trees in untreated stands. In general, we found no differences among the three active treatments. This implies that managers can use prescribed fire to reduce fuels, stimulate understory species, and create seedbeds without negatively impacting the residual stand.

Old-growth ponderosa pine/western larch stands are rare and valuable, and their protection is vital. We studied old tree health following several thinning and burning treatments on the Lolo National Forest. This stand of 330-year old trees had experienced fire at an average 20-year return interval before 1919, then no fire or cutting for the next 80 years. The dense Douglas-fir understory, established during the fire-free period, was becoming highly competitive with the old trees and created a potential for stand replacement fire. After cutting and burning these understory trees, we discovered that the old trees responded with greater water use, higher foliage production and bud size, and higher needle nitrogen levels than trees with no treatment. This suggests reduced stress, greater resistance to insect attacks, and a greatly reduced crown fire potential.

The threat of weed invasion is a concern throughout western Montana. BEMRP funded a vegetation monitoring study following herbicide, tree thinning, and fire treatments at the Sawmill Creek Research Natural Area on the Bitterroot Forest. The Forest treated several hundred acres of grassland with herbicides to suppress noxious weeds, which had greatly reduced productivity of the native bunchgrasses. Also, thinning treatments were applied in the adjacent forested ravines to help protect the old ponderosa pine from competition and severe wildfire. A forestwide fire team burned both grassland and forest sites, using carefully prescribed fires to return this process to the fire-adapted ecosystems. We found an immediate, significant reduction in spotted knapweed and concurrent increase in native grass productivity. Five years following treatment, knapweed is slowly returning. Thinning and burning have greatly reduced the probability of stand replacement fire in the old-growth stands. We plan additional fire and herbicide treatments for this Research Natural Area to return its ecosystem to a semblance of its historal character.

In 2000, Pinesdale was directly affected by an 18,000-acre wildfire. The Bitterroot Forest and community of Pinesdale established a cooperative agreement in 2002 to lessen the probability of severe fire in the Sheafman Creek watershed near this community. That means reducing the fuel hazard on National Forest and adjacent private land. BEMRP is supporting the field sampling and analysis conducted by the Fire Lab to determine efficacy of the Sheafman Creek Fuels Reduction Project thinning and prescribed burning treatments. A local forest contractor has completed most of the thinning and tree removal, and the Forest will soon undertake fuel reduction burns. The Fire Lab will continue to monitor and analyze the fire hazard until all operations are complete.

Trout Stream Fates during Wildfires

(left) Matthew Burbank, RMRS, takes riparian large woody debris measurements to provide important insights into fire effects. Photo by Damian Cremins.

(right) Documented fish kill in Deer Creek, Lolo National Forest. This area burned severely in 2003. Photo by Ethan Mace.

Elaine Kennedy Sutherland, Research Biologist and Project Leader, Ethan Mace, Riparian Biologist, and Michael K. Young, Research Fisheries Biologist, RMRS, Ecology and Management of Northern Rocky Mountain Forests, Missoula, MT

In the Northern Rockies, decisions on how to fight fire and treat burned lands often consider trout populations and habitat. Data taken from fish-bearing streams after fires have provided important insight into fire effects, both short- and long-term. The ideal research design to evaluate fire and firefighting effects would include before-and-after data; however, such data are rare, generally occurring in areas recently assessed for other purposes but coincidentally burned. Because of logistical and safety considerations, few measurements have been taken just ahead of and immediately after active fires. We need this type of information to evaluate the potential impacts of fire, fire management practices, rehabilitation and restoration efforts, and salvage logging on fish populations. With careful planning and coordination between fire management incident commanders and research teams, collection of vital data on active fires is possible.

In 2003, we took on this challenge in a pilot study funded by BEMRP, the Northern Region, and National Fire Plan research funds. There were several objectives:

- Observe and record fire's immediate effects on the riparian vegetation, stream channel morphology, and fish habitat features of trout-bearing streams.
- Collect time-sensitive prefire data such as water chemistry for comparison to data collected immediately postfire, comparing prefire and postfire fish populations and quantifying the magnitude of any fish kills.
- Develop a rapid postfire assessment protocol for land managers, based on what we developed for an existing riparian study project.
- Create the opportunity to assess longer-term system recovery.

To implement the study, we trained and fire-qualified a team of four technicians and a crew leader. Team leaders reached out to the National Interagency Fire Coordination Center (NIFC), local line officers, incident commanders, and others so that the team could be deployed on short notice. In 2003, the Northern Rockies, especially western Montana, experienced many large fires. We collected data just ahead of and immediately after large, uncontrolled wildfires. Efforts included installing data-logged thermographs (see Glossary, p. 6) and stream samplers to evaluate stream temperature and chemistry changes during and after fires, as well as evaluating stream and streamside characteristics (forest structure, coarse woody debris, and fish habitat quality attributes). The team worked on eight large fires burning on the Bitterroot, Beaverhead-Deerlodge, and Lolo National Forests.

Our work will guide firefighting activities, such as burnout operations. For example, the resource team on the Big Creek fire (Bitterroot Forest) asked us whether smoke from burnout operations was adding ammonia to the stream water. Although ammonia is toxic to fish, stream chemistry results for that fire indicated no additional ammonia was added. During the Fish Creek fire (Lolo Forest), Deer Creek burned severely. Deer Creek runs through land owned by Plum Creek Timber Company, the State of Montana, and the Lolo Forest. This stream contained westslope cutthroat trout, and when we performed a postfire fish mortality survey, we found 136 dead fish, 2 live fish, and indications that high temperatures killed fish. We evaluated stream temperatures and chemistry, measured channel characteristics, and estimated pre- and postburn woody debris volume. Results from this effort have already been delivered to Plum Creek, the State of Montana, and the Lolo Forest, with much more information forthcoming. This study demonstrates the ability of Forest Service Research to act rapidly to provide information for our client partners in both the private and public sectors.

Book Corner . . . *(continued from page 8)*

comprehensive treatise on sustainability offers many examples to illustrate the difficult concepts it explains. Readers will experience a revelation that may dramatically change their paradigm of societies and their environments.

***Supply-Side Sustainability* by T.F.H. Allen, Joseph A. Tainter, and Thomas W. Hoekstra. Published in 2003 by Columbia University Press, New York. 459 pages. ISBN: 0-231-10586-X. Available in hardcover ($69.50) and paperback ($34.50).**

[1] Allen, T.F.H.; Tainter, Joseph A.; Hoekstra, Thomas W. 2003. Supply-Side Sustainability. New York: Columbia University Press. p. 2.

[2] T.F.H. Allen is an ecologist, and botany professor at the University of Wisconsin, Madison. Tainter is an anthropologist and project leader for the Forest Service's Rocky Mountain Research Station in Albuquerque, NM. Hoekstra is an ecologist, and Director of the Forest Service Inventory and Monitoring Institute in Fort Collins, CO.

[3] Op cit, p. 26.

[4] As used here, "context" means the environment or setting within which the system or thing of interest functions. For example, the context of declining fish populations might be water quality degradation.

[5] Op cit, p. 14.

Hydrologic Connectivity: Wilderness Watershed Contributions to Ecosystem Health and Community Well-being

Clint Cook, Forestry Technician, RMRS, Aldo Leopold Wilderness Research Institute, Missoula, MT

As humans, we rely on fresh water for many reasons, including domestic, agricultural, and recreational uses. In the United States, our daily consumption of water is estimated to average 100 gallons per person. Humans, however, are not the only species dependent on freshwater resources. The natural environment also requires fresh water to maintain its riverine and terrestrial ecosystems. One current project sponsored by BEMRP aims to understand connections between freshwater resources and the ecosystems they support.

To provide water for orchards, food crops, and hay for livestock, farmers constructed dams in the Bitterroot Mountains in the late 1800s and early 1900s, prior to Selway-Bitterroot Wilderness designation. Forest Service photo.

The connection between freshwater resources and the Bitterroot Valley ecosystem is particularly important because of the Valley's rapid population growth. Flowing north to its confluence with the Clark Fork of the Columbia, the Bitterroot River and its tributaries drain about 2,800 square miles. The River provides nearly 5 million gallons of water per day for human uses within Ravalli County alone. With an annual precipitation of only 12.3 inches, the Bitterroot Valley is classified as a high desert environment. There is a long history of agricultural use of land and water, but with a rapidly growing population, some of this agricultural use is being displaced.

To provide water for orchards, food crops, and hay, farmers constructed dams in the Bitterroot Mountains in the late 1800s and early 1900s. They were built to capture spring runoff from snow melt and store it until late July and August when flows in the river and its tributaries are usually too low to support irrigation. In 1964, 251,443 acres of the Bitterroot Range were classified as Wilderness. Special provisions in the Wilderness Act allowed continued operation and maintenance of these dams for existing uses.

Selway-Bitterroot Wilderness dams have substantial influence, both upstream and downstream, on the biological integrity of this wilderness ecosystem, but these influences may be considered tradeoffs with human needs for the same resource. The area's rainfall could not sustain established agricultural production, and the groundwater supply could not sustain the county's current population levels without the additional water added to groundwater from irrigation. Approximately 90 percent of the water recharging the Valley's aquifers comes from open irrigation ditches and sheet flooding. If irrigation practices within the Valley were modified (because of exclusion of dams or modification of agricultural practices), the biological system would be influenced, and availability of groundwater for human uses would be severely diminished.

Forest Service stewards make many decisions that influence both ecological integrity of watersheds and human values attached to those watersheds. In our case, BEMRP is actively engaged in improving understanding of the wide variety of connections to this hydrologic resource. Understanding human connections to the hydrologic resource, and their effects on ecological integrity of the drainage, will allow the agency to make informed watershed management decisions.

Fire and Forest Health—Landscape Model of Fuel and Treatment Options

Greg Jones, Research Forester and BEMRP Program Leader, RMRS, Economic Aspects of Forest Management on Public Lands, Missoula, MT

How can National Forest lands be managed across the continuum from wilderness to the wildland/urban interface in a way that allows fire to play its natural role while still protecting private values? What fuel treatment prescriptions should be applied to best reduce fire severity and modify fire behavior, and yet require the least future maintenance effort? Where should treatments be located on the landscape to have the most impact? What are the risks and benefits of leaving untreated corridor areas to accommodate various wildlife species? These are some of the many questions managers must consider in planning forest health restoration and hazardous fuel treatments for an area such as the Bitterroot Front landscape.

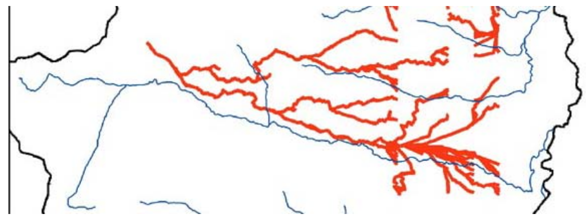
The 471,000-acre Bitterroot Front landscape is characterized by an east to west continuum, beginning with developed private lands in the valley, transitioning to wildland/urban interface, next to roaded National Forest lands, then upslope to roadless areas, and finally reaching the Selway-Bitterroot Wilderness to the west (see map on p. 14). Deep canyons draining east toward the valley and Bitterroot River tend to funnel precipitation, winds, and fires from the west toward the lengthy wildland/urban interface to the east. They also serve as travel routes for people and wildlife.

(continued on page 14)

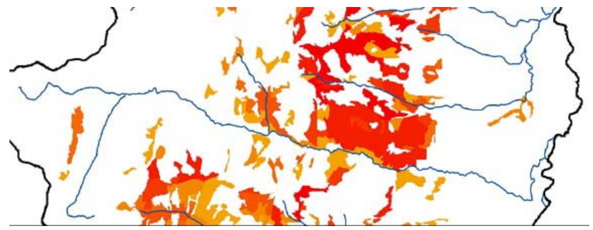
Fire & Forest Health . . . *(continued from page 13)*

Researchers from Rocky Mountain Research Station and The University of Montana are cooperating with Bitterroot National Forest managers in a project on the Bitterroot Front, using three state-of-art landscape models to develop and analyze alternative spatial strategies for applying restoration and fuel treatments. Minimum Travel Time (MTT), a fire spread model derived from FARSITE (see Glossary on p. 6), identifies the most likely and active paths of fire spread, assuming ignition in the vicinity of the Bitterroot divide and strong west winds blowing toward the wildland/urban interface. SIMPPLLE is a spatially explicit model for simulating vegetation change in the presence of fire, insects, and disease. It models fire and other disturbances over time, both in the absence and presence of forest health and fuel treatments. MAGIS spatially schedules vegetation treatments, considering resource objectives (such as wildlife and watershed values), as well as operational constraints (for example, budget and staffing).

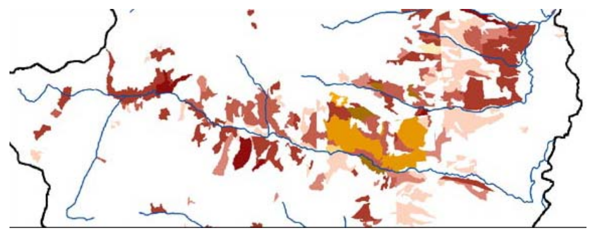
These models address different important aspects of the forest health restoration and fuel treatment problem. Researchers and managers will work together investigating how to best integrate use of these diverse models to effectively address vegetation treatment design questions. Results from this effort will provide guidance for location of a BEMRP-sponsored landscape project to test and demonstrate forest health restoration and fuel treatments. We hope to develop a modeling process that can be applied elsewhere to analyze forest health restoration and hazardous fuel treatment strategies.



MTT: Fire pathways assuming ignition near divide and westerly winds.



SIMPPLLE: Stands with fire probability over 50 percent within 10 years.



MAGIS: Stands selected for fuel reduction treatments – Rx fire or mechanical thin.

Examples of output maps of the same area from three different landscape models used to develop and analyze restoration and fuel treatments. Graphic created by Kevin Hyde.

BEMRP's landscape analysis study will include major portions of the Bitterroot Front Range. Graphic by Kevin Hyde.

New Publication Available

Well-intended human endeavors can go awry, triggering unanticipated consequences. In their new journal article, "Effects of Biological Control Agents and Exotic Weed Invasion on Deer Mouse Populations," Ortega, Pearson, and McKelvey demonstrate how deer mice populations have boomed on account of the release of exotic insects intended to control spotted knapweed. Elevated populations are of concern because mice play important ecological roles, including being carriers of human disease. The authors suggest applying more fully developed criteria to screen potential biocontrol agents, thereby reducing the probability of unintended consequences.

Ortega, Yvette K.; Pearson, Dean E.; McKelvey, Kevin S. 2004. Effects of Biological Control Agents and Exotic Weed Invasion on Deer Mouse Populations. Ecological Applications. 14: 241-253.

Diffusion of Innovations—Rock, Rope, and Collar

Janie Canton-Thompson, Technology Transfer Specialist and ECO-Report Editor, RMRS, Economic Aspects of Forest Management on Public Lands, Missoula, MT

You meet a man wearing a green uniform. He looks frustrated. There's a collar around his neck, and attached to it is a 6-foot rope tied to a heavy rock. Every time the man steps toward his goal of "spreading the word"—what we're calling here "diffusing an innovation"—the rock, rope, and collar constrain his movement.

Diffusing an innovation. Graphic adapted from Corel Gallery.

What do these have to do with diffusing innovations? The collar, rope, and rock represent complexity, barriers, and unanticipated consequences. All hold the man back, slowing his communication effectiveness. Diffusion of innovation is the process by which a new idea, process, or object is communicated over time among groups of people. This is also known as technology transfer, application, extension, or knowledge utilization. The process is anything but straightforward.

"Ecosystems are not only more complex than we think; they are more complex than we can think," noted former Forest Service Chief Jack Ward Thomas at a meeting of Forest Service employees. Substitute the phrase "social systems" for "ecosystems," and one begins to grasp the difficulty of diffusing innovations to people. As with ecosystems, altering a part of social systems can sooner or later change every life on earth. For instance, North American Free Trade Agreement (NAFTA) is altering economies all across the globe.

Consider the innovation featured in BEMRP—the Ecosystem Management (EM) paradigm (see Glossary, p. 6). Diffusing or communicating this paradigm, developed in the early 1980s, is an ongoing effort, and frequently controversial because it represents a new way of managing natural systems. How can we best present the paradigm so everyone can understand its intent and features? What communication channels do we use? Multi-media and interpersonal channels are many, complex, and tailored for different audiences. Individuals, groups, and organizations within social systems interpret messages differently. Communication requires knowing these different audiences, building relationships with opinion leaders and authority figures, resolving conflicts that develop, and demonstrating to potential users why the paradigm is valuable to them. The more complex the innovation, the more work required to diffuse it.

According to Everett Rogers,[1] a leading authority on diffusion of innovations, chances improve that innovations will be adopted, and adopted relatively quickly, when all stakeholders perceive them as advantageous, compatible with their respective values/experiences/needs, and easy to understand and use. It also helps if innovations include a "try before you buy" option, and produce visible positive results. Innovations that don't meet these criteria are less likely to be adopted, or are adopted at slower rates.

Diffusion specialists work under the constraints imposed by several stages of adopting new ideas. Rogers identifies five stages: awareness (How do targeted audiences learn of an innovation?), interest (What communication mechanisms motivate what types of people to seek more information about it?), evaluation (What processes do different kinds of people use in deciding whether to try an innovation?), trial (What kinds of options do people have in trying out an innovation?), and adoption (What kinds of people accept and commit to what kinds of innovations?). The difficulty of diffusing innovations becomes especially challenging when deciding whether adopting an innovation will be an individual choice, a collective decision (where most of those affected must be convinced an innovation is worthwhile), or superimposed by higher authorities.

These are a snapshot of some complex variables that retard or facilitate technology transfer—the rock, rope, and collar that make spreading the word so difficult to accomplish. The more that people charged with diffusing innovations (called change agents) understand 1) innovations, 2) idiosyncrasies of communication channels and patterns, 3) time constraints surrounding adoption, 4) social and cultural characteristics of potential adopters (for example, individuals or groups), and 5) nature of human group conflict and its drivers (relative to natural resource issues, in our case),[2] the more effectively they can facilitate adoption.

Change agents dare not ignore unanticipated consequences of innovations, which typically alter societies in unexpected and unintended ways. Rogers tells how introduction of snowmobiles in Lapland "led to disastrous consequences for…reindeer, and for the Lapps who depended on the animals for their livelihood."[3] For example, frightened reindeer had fewer calves, and Lapps slaughtered many animals for meat to pay for snowmobile purchase, gas, and maintenance. The snowmobile revolution pushed the Skolt Lapps into a tailspin of unemployment and reliance on government subsistence payments. The rock attached to the collar grows heavier as the word about unanticipated negative consequences spreads.

Regardless of innovation source and type, there are tradeoffs when the diffusion process is set in motion. In nature, disturbances like fire, wind, and floods change ecosystems in unpredictable ways. Some species lose, others win, but nature doesn't care. Nevertheless, people care because they assign

(continued on page 16)

Science, Experience, and Education: A Hike in the Forest

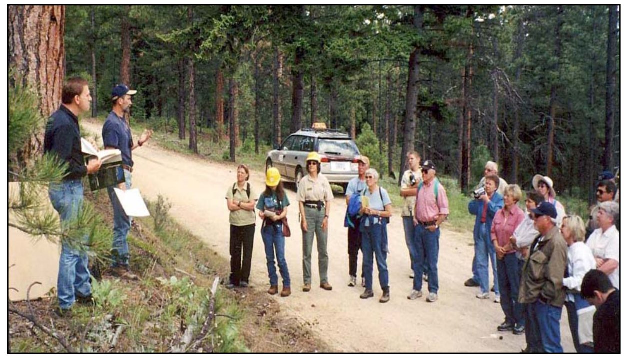
Janie Canton-Thompson, Technology Transfer Specialist and ECO-Report Editor, RMRS, Economic Aspects of Forest Management on Public Lands, Missoula, MT

White coats, rubber gloves, and microscopes? Sound like scientists engaged in an intricate laboratory experiment? Well, experiments don't just happen in sterile labs; they even take place on National Forest lands. 2003 marked the 10th anniversary of an experiment on Montana's Bitterroot National Forest. RMRS research scientists Mick Harrington, Clint Carlson (retired), Steve Arno (retired), and The University of Montana's School of Forestry professor Carl Fiedler began their research at Lick Creek Demonstration/Research Forest in 1991. They designed different treatments—thinning, understory burning, or thinning and understory burning—that Bitterroot Forest managers applied to portions of three experimental sites. Researchers subsequently began monitoring vegetation on these sites, and on a similar control (no treatment) site, observing changes over time.

On June 11, 2003, interested area residents, including a KPAX TV reporter, examined first-hand how the experimental sites look today. Two RMRS work units—BEMRP and Fire Effects—partnered with The University of Montana and Bitterroot Forest to host the tour.

Twenty-seven tour participants gathered at Wood's Cabin on the shore of beautiful Lake Como to hear Rick Floch, forester on the Bitterroot Forest, narrate a fascinating tale of Lick Creek's social, biological, and geological history. Bud and Irene Wood, donors of the now Forest Service-owned cabin, accompanied the group.

Next, participants were bussed to the Lick Creek experimental forest. Here, they learned that researchers first began studying this forest in 1945. Harrington, Fiedler, and Carlson described their current experiment, designed to evaluate how thinning, understory burning, and combined thinning and burning treatments could help restore ponderosa pine forests. Like many other American forests, nearly a century of fire exclusion has caused serious health challenges for this forest.



University of Montana Professor Carl Fiedler (left) and Research Forester Mick Harrington, RMRS, describe BEMRP monitoring results at Lick Creek Demonstration/Research Forest. Photo by Brooke Thompson.

Researchers explained that ponderosa pines are wonderfully adapted to frequent low-intensity fires. Without fire, shade-tolerant Douglas-fir outcompete the pines for valuable nutrients and water. Bitterroot Forest wildlife biologist John Ormiston also talked about treatment effects on wildlife, particularly elk and birds. With interests whetted, participants hiked downhill through a mosaic of treated and untreated forest. Periodically, they stopped to discuss treatment effectiveness.

Back at Wood's Cabin, discussion and fellowship continued for participants who opted to share a Job Corps-catered dinner. Reflecting on what they enjoyed most about the tour, participants focused on interacting and learning in a forested environment. For some, walking amidst the experimental plots provided an eye-opening experience. Others valued hiking through the forest and hearing researchers' and managers' interpretive commentaries. Some simply enjoyed being in the forest. The interaction of science, experience, education, and on-site presentations by speakers captivated yet others. All agreed the treated sites looked much healthier than the control sites, 10 years following treatments. Exclaimed one couple, "We'll be back!" They are eager to see what the treated sites will look like down the road, say in another 10 years.

Diffusion of Innovations . . . *(continued from page 15)*

value to things, interpreting changes as good or bad in accord with their values, beliefs, and experiences. By human standards, innovations are also "natural disturbances" that differentially affect members of society. Once they are adopted by a critical mass of people, the social world is never again the same. Change agents need to anticipate the tradeoffs provoked by their innovations. Above all, they need to understand that most natural resource-based conflicts are rooted in deep-seated value differences that can never be fully resolved.

To wrap up, spreading the word about innovations is a multi-faceted, difficult process. Rogers and others offer tools to lighten our load. They can help you crack your rock, discard some weight, and hasten your progress. Collars, ropes, rocks, and laws of nature and society—building the bridge from research to development to application (diffusion) is both exciting and a lot of work. It will take you places you've never been, or expect to go. Adventure is guaranteed.

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[1]Rogers, Everett M. 1995. Diffusion of Innovations, Fourth Edition. New York: The Free Press.

[2]Nie, Martin. 2003. Drivers of Natural Resource-based Political Conflict. Policy Sciences. 36: 307-341.

[3]Rogers, p. 408.

The "Spotlight"...highlighting researchers at work:

Ethan Mace

"No Place I'd Rather Be"

Janie Canton-Thompson, Technology Transfer Specialist and ECO-Report Editor, RMRS, Economic Aspects of Forest Management on Public Lands, Missoula, MT

"I can't think of any place I'd rather be than in a stream or on a fire. To have them both is just outstanding!" Ethan Mace, riparian biologist in RMRS's Ecology and Management of Northern Rocky Mountain Forests Work Unit, started life in Shawnee and Eufaula, Oklahoma. Early, he relished "playing in creeks and looking at turtles, frogs, and snakes," and watching nature shows on T.V. His science teacher grandparents gave him a yen for nature; his parents unconditionally supported his biological pursuits. Hunting, fishing, and hiking also immersed him in nature.

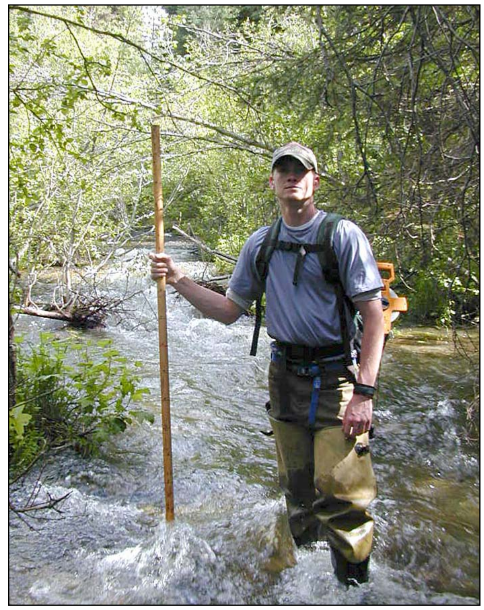
"Fire was always a part of my childhood. I've been fascinated with it since day one." His grandparents annually burned thinning piles on their land, with Ethan's help. "I look back, and it was forestry we were doing."

Ethan commends his high school teachers, Mrs. Capps and Mrs. Shirley, who taught him to think analytically. "They accommodated my desire to learn and offered me a 'ticket of knowledge' to chase whatever adventure I wanted." At the end of his senior year, a car accident changed plans to attend Massachusetts Institute of Technology (MIT), and Ethan enrolled in Colorado College. Here, students complete one course every three and a half weeks, under the "block plan." After 2 years, Ethan concluded: "I need to absorb knowledge—sort of sit back and soak it in. I couldn't do that with the intensive nature of the block program." Transferring to The University of Montana, he enrolled in Forestry School, hoping for a Forest Service career in fire management. His friend and partner, Susan Scalia, strongly supported his decision, and he credits her with helping him achieve success.

Working his way through Forestry School, Ethan did various jobs. Discovering fire management jobs were scarce, he opted to study fisheries, and worked for the Lolo National Forest as a fisheries technician. Later, he worked on the Missoula District fire crew. "That was heaven because they let me set stuff on fire. I just love fire. I was getting my fisheries understanding, and my fire understanding." Completing a challenging academic program, Ethan received a bachelor's degree in aquatic wildlife biology.

Next, he pursued a masters degree in resource conservation, emphasizing riparian restoration. Professors Jim Burchfield and Jack Ward Thomas were a significant influence. Thomas made him realize that "pontification is easier than responsibility," and ecosystems are more complex than humans can think. Burchfield taught him the importance of collaboration. In 2000, he finished his masters course work, along with his professional paper addressing fire's effects on riparian ecosystems.

Then came the fires of 2000. Ethan fought fire on Powell District, Clearwater National Forest, transferring afterward to Nine Mile Ranger District, Lolo National Forest, to do postfire rehabilitation.



Ethan Mace in the field studying riparian dynamics and disturbance processes. Photo by Eric Ziegler.

Searching for his dream job, in spring 2001 Ethan learned about a vacant position in the Ecology Unit. "I told [Project Leader Elaine Sutherland] there are people who know more about fire and people who know more about fish, but nobody knows more about fire's effects on fish than I do. Of course, that was being overzealous trying to get the job. I never wanted a job so bad." He got the job!

Ethan embraces research on riparian area dynamics and disturbance processes because it delves into ecosystem complexity. Initially, his study team identified drainages on the Lolo and Bitterroot that were similar but had different fire histories. The team developed fire histories for riparian zones and upland areas to compare and contrast them. Ethan studies the linkages among fire characteristics, tree demographics, and fish habitat, as well as active wildland fires and their influence on fish.

Another component of his research is "rapid response," meaning he goes on active fires and conducts research while they burn. "First, we find the right active fire—big, extreme, accessible, with a low probability of being suppressed." Arriving within 24 hours of detection, Ethan's "Rapid Response Team" coordinates with the Incident Command Team. "We wake up at 04:30 a.m., hike into the belly of the beast, get our equipment in the stream, and get out by 13:00. That gives us a 2-hour buffer before the most intense burning period. We use time of day as our major safety feature."

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Forest Service, Ranch Owners, and Habitat Restoration—A Common Vision

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"And what is so rare as a day in June? Then if ever come perfect days."[1] Forty-five field trip participants who toured Sawmill Research Natural Area (RNA) and the Burnt Fork Ranch on an idyllic June 3, 2003 afternoon/evening outing couldn't agree more with 19th century bard, James Russell Lowell. Sponsored by BEMRP, Bitterroot National Forest, Rocky Mountain Research Station, The University of Montana, and Burnt Fork Ranch, the trip helped interested people learn about the work underway at Sawmill RNA and the Burnt Fork Ranch. Here, Forest and ranch managers aim to restore grasslands and forests under their stewardship. This means they must control exotic weeds that started invading the area decades ago, and return fire, a natural process, to this ponderosa pine and bunchgrass ecosystem.

"Research Natural Areas are lands within the National Forest System that are permanently protected as places to conduct research and monitoring, maintain biological diversity, and foster education. Here, scientists can 'read' the lives of trees, wildflowers, soils, animals and landforms to learn how nature works."[2] In 1992, the Forest Service established Sawmill RNA ". . . as the best remaining example of Idaho fescue/bluebunch wheatgrass and rough fescue/Idaho fescue habitat types on the Bitterroot National Forest."[3] Elk heavily use this mountain foothill site for winter range.

Researchers Mick Harrington, Fire Sciences Laboratory, and Peter Rice, The University of Montana, are guiding Sawmill restoration management by the Bitterroot Forest. Managers have been treating invasive weeds, thinning stands of trees too dense for optimum forest health, and reintroducing fire as a natural process. During the trip, Harrington and Rice explained their extensive monitoring of vegetative response to treatments, thinning, and fire. Restoration efforts found an appreciative audience, and several inquired how they might pattern their private land stewardship after the RNA model.

Burnt Fork Ranch managers are treating weeds, thinning their forest, and using fire to clean up fuels on their property adjacent to Sawmill RNA. Their restoration efforts resemble those under way on the RNA. Here is a wonderful example of how private land owners can learn from research and management occurring on our National Forests and apply that knowledge to restore their own lands. If you are interested you can read about the Burnt Fork Ranch's restoration efforts in the May-June 2003 issue of *Bugle*, published by the Rocky Mountain Elk Foundation.

Come join us for future tours and learn more about how public and private lands are being restored to historical conditions. You can contribute to the sustainability of your own lands.

[1]Lowell, James Russell. 1848. The Vision of Sir Launfal. In: Cross, Tom Peete; Smith, Reed; Stauffer, Elmer C. eds. 1931. Good Reading for High Schools: American Writers. Boston: Ginn and Company. p. 213.

Lessons in restoration—On a memorable June afternoon, BEMRP field trip participants observe the effects of herbicides in improving health of native grasslands. Photo by Janie Canton-Thompson.

[2]Research Natural Areas—A Living Library. [n.d.] [Place of publication unknown]: U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Intermountain Region, and Northern Region. 6 p.

[3]Rice, Peter; Harrington, Mick. 2003. Native Bunchgrass Community Restoration Using Knapweed Herbicides and Fire. Unpublished handout supplied to Sawmill RNA tour participants on June 3, 2003. p. 1.

Spotlight . . . *(continued from page 17)*

For Ethan, ecosystem management means incorporating the linkages between different landscapes and organisms. "We're exploring those interactions so they can be incorporated in management plans." His research emphasizes landscape level analysis, consistent with BEMRP objectives and new RMRS forest research guidelines.

Running a successful field campaign also involves crews, logistics, and safety. "I've gotten to work with some awesome people, and I like that part a lot! These field crews end up being pretty close to me by the end of the year, so I take it personal about their safety."

"In my Forest Service career, I've gone from doing snorkel surveys in 6 degrees Celsius water—that's pretty chilly—to being out in front of ripping fires in the heat of summer. Everything I've done has been a team effort. All the people who promoted the success of the study so far—they're the ones it's all about. I can't stress enough that it's not a one-man show. We work together." According to Ethan, understanding ecological linkages is paramount because it's a key to improving management techniques. "I think we're just scratching the surface on what we can do with this, and I'd like to add a huge technology transfer component down the road."

Ethan anticipates more service to the Bitterroot Forest, as a resource advisor. "I'd rather do science than think about doing science. I'm all about 'just do it!'" Outside work, he expects to continue hunting, fishing, hiking, remodeling his house, and doing family time.

"That's the Power of Education!"

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How can the Forest Service get messages out to the public to promote good land stewardship? What better way than to gain an understanding of how organizations specializing in conservation/ environmental education (CE/EE) successfully accomplish their work?

In 2000, the Forest Service's Northern Region (Region 1) and Bitterroot National Forest possessed no directory of CE/EE providers when they needed to "get the word out" about the fires that burned much of the Forest. Although lots of CE/EE efforts were underway, coordination appeared minimal. By better understanding the local CE/EE network, Forest Service specialists thought they and CE/EE groups might work together to achieve common goals. BEMRP then issued a call for proposals to address six knowledge gaps:

1. Who provides CE/EE programming?
2. What topics do they cover?
3. What makes CE/EE more or less efficient or effective?
4. Are there program duplications?
5. Do members of these educational networks communicate with each other, and if so, how?
6. Are there opportunities to partner with CE/EE organizations?

The University of Montana and Aldo Leopold Wilderness Research Institute scientists developed a two-phase study. First, they assessed education programs offered by Bitterroot and Missoula area CE/EE groups. Researchers surveyed and interviewed 15 group representatives, assessing covered topics, audience type (for example, group served), and activity type (for example, field trips) used to promote learning. They also identified the general communication pattern among CE/EE programs. Researchers did a follow-up assessment, surveying representatives from 13 of the original 15 CE/EE programs. Survey data were intended to increase researchers' understanding of the direction of information flow among groups, by specific topic (for example, wildland fire). It also identified information sources, and how coordination between groups and the Bitterroot Forest might deliver more effective CE/EE messages.

The study answered many questions. For example, the most common form of program delivery is the field trip. Fifth and sixth grade classes and teachers have the most CE/EE programs available to them; children under age 5 have the fewest. Analysis revealed Bitterroot Valley CE/EE organizations are extremely well-connected and coordinated. Groups respond to new information quickly, and it eventually reaches everyone. All CE/EE groups have multiple pathways to channel information to all other CE/EE groups.

Bitterroot Valley and Missoula area CE/EE educators use 60 different organizations or individuals as information sources for their educational programming. They also consult the Internet, books, and journals. For example, CE/EE educators consulted 24 unique sources on the topic of fire ecology and 31 on watershed restoration. Richest sources of unique information are for watershed restoration and land stewardship. Bitterroot Valley groups communicate with the Bitterroot Forest through face-to-face communication, telephone contacts, and e-mail. Missoula area groups communicate more with the Lolo Forest than the Bitterroot. Although Bitterroot Valley educators seek information primarily from Bitterroot-based sources, they also use several Missoula-based groups. Information sources consulted by CE/EE groups include Region 1, Rocky Mountain Research Station, and Fire Sciences Lab. Analysis shows communication networks for individual topics are not fully saturated—not all groups communicate with all other groups on a given topic.

Conservation education groups encourage responsible stewardship through communication and coordination. Photo courtesy of the Bitterroot National Forest.

If people gain knowledge about the environment, how its pieces work together, and factors that limit its function, they will likely act more responsibly and help sustain all its parts in harmony. CE/EE's goal is an informed citizenry engaged with natural resource management issues and direction. Improved communication and coordination, among and through CE/EE programs, help create an informed citizenry. "That's the power of education," remarked Kari Gunderson, one of the study's researchers. This research project has helped local Forest Service managers better understand what kind of coordination and communication takes place in local CE/EE organizations. They know better how to enhance their messages about people's connection to the land and good stewardship across all landscapes.

Bitterroot Environmental Education Partners (BEEP)—a group formed at the same time the research began—is delighted because research findings will help legitimize grant applications to expand/improve its CE/EE programs. Gunderson exclaimed, "Talk about application. They're saying, 'This is great. We can say that there's actually been research done on effectiveness and efficiency of educational programming, and where the high and low representation is if we want to offer new programming.'" BEEP used the research results to help develop a 5-year Strategic Plan. Results show where BEEP is now, which topics and audiences are underserved, and indicate arenas for future programming. Concluded Gunderson, "Change is happening, and it's informed change"—largely because of this CE/EE research project's findings.

Websites or publications that provide additional information:

-Montana Environmental Education Association, www.montanaeeassociation.com/
-Montana Ecosystem Management Learning Center Program, www.forestry.umt.edu/learning/
-North American Association for Environmental Education, www.naaee.org
-The Journal of Environmental Education, www.heldref.org/html/body-jee.html
-Environmental Education Research, www.tandf.co.uk/journals/carfax/13504622.html
-ERIC Clearinghouse for Science, Mathematics, and Environmental Education, www.ericse.org/journals.html

BEMRP Journeys on: Vision for the Next 5 Years

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Last fall the Rocky Mountain Research Station conducted a 10-year review of BEMRP and the other four ecosystem management research units in the Station. As a result of that review, BEMRP was re-chartered for another 5 years. A central focus in BEMRP's new charter is undertaking an integrated landscape-scale research/management project, with replication of treatments to address critical information gaps associated with fuel and restoration treatments. This research will build on past BEMRP and other relevant research. Our landscape research/management project would be located somewhere within the 471,000-acre Bitterroot Front landscape. First, we will conduct an integrated analysis of the landscape to identify effective locations for this project, and other future vegetation-treatment projects. (See "Landscape Model of Fuel and Treatment Options" article on p. 13.)

In numerous ways, the Bitterroot National Forest and surrounding lands typify forest conditions and management challenges present in many areas of the Western United States, making this an excellent location for the project. The area contains a variety of fire regimes where naturally occurring wildland fire once played an important role in shaping vegetation and wildlife components over many centuries. Successful fire protection and suppression programs have produced vegetative structures and fuel accumulations increasingly susceptible to higher intensity fires. Fires are also becoming ever more resistant to control. Firefighter exposure to complex wildland fire environments, public safety and health issues, and settlement in the wildland/urban interface all contribute to complex decisionmaking, difficult fire suppression, and expensive attempts to exclude wildland fire from the assessment area. Exacerbating this situation is an extensive and continually expanding wildland/urban interface along the National Forest/private land boundary.

Fuels treatment and forest health have become major priorities in managing National Forests, as evidenced by Federal Wildland Fire Management Policy (1995, revised 2001), the Cohesive Strategy, the National Fire Plan, the 10-Year Comprehensive Strategy, the first of Chief Bosworth's Four Great Threats, and the President's Healthy Forests Initiative. Extensive areas of forestland with unnaturally high fuel buildups and associated forest health issues, along with a continually expanding wildland/urban interface, lead to the conclusion that treatments for hazardous fuels and forest health will be high priority well into the foreseeable future. It is essential that land managers be able to characterize and evaluate how vegetation treatments are likely to affect the amount and severity of wildfires, as well as various insects and diseases over both the short- and long-term.

ECO-Report

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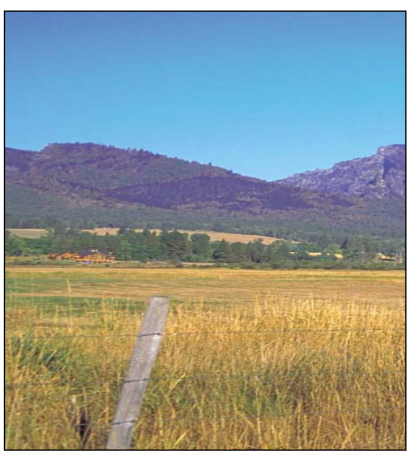

Bitterroot Front Range, north of Hamilton, MT. Photo by Dave Bunnell.