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Research, part of a Special Feature on Historical and Future Ranges of Variability

The Past and Future of Colorado's Forests: Connecting People and Ecology

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ABSTRACT. The future composition, structure, and dynamics of forests in Colorado will develop in response to both ecological and social factors. Key ecological factors that shaped forests in the past included a great diversity of climatic conditions that results from complex topography and a broad range of elevations, as well as legacies of long-term climate changes and responses of plant and animal species. The influence of direct and indirect human impacts has steadily increased over the past two centuries, changing most forests. A workshop examined how goals of sustaining ecosystems and biodiversity will depend on a confluence of ecological and social changes. Key themes from the workshop included an acknowledgment that the sheer complexity of factors and interactions will limit our ability to shape the future, and that effective combinations of ecology and societies will depend in large part on the use of creative narratives that allow us to communicate productively among people with incredibly different knowledge and perspectives. These insights from Colorado's forest landscapes and communities will likely resonate with other regions.

Key Words: *forest landscape dynamics; historical range of variation; natural range of variation*

INTRODUCTION

Characterizations of the historical conditions of forests in Colorado are fundamental to understanding how the forests develop, function, and change over time in response to climate and disturbances (such as fire and insect outbreaks). These features influence the possible future landscapes of Colorado, but the future that actually develops will be strongly determined by interactions with social communities and policies. The Colorado landscape, with particular emphasis on the Front Range, its ecological history and biodiversity, and its social context, formed one of the regional case studies for the Future Range of Variability (FRV) project funded by the National Commission on Science and Sustainable Forestry. The project developed two closely related areas of investigation. The first was a literature-based ecological assessment of historical variability, current land use, biodiversity status, conservation-management approaches, and possible future biophysical trends affecting management for biodiversity conservation. The second was a social assessment of current attitudes toward the use of historical range of variability (HRV) and FRV as management tools for assessing and planning for biodiversity conservation in light of future social and ecological trends. This was accomplished through analysis of data gathered from focus groups involving a range of participants attending a 2-day workshop in Glenwood Springs, Colorado. The central question we addressed via the two types of assessments was: how do future social and ecological trends affect the usefulness of the HRV concept to manage for biodiversity conservation?

Traditionally, ecological and social assessments have been designed and executed separately, with no acknowledgement that each is crucial to weaving a complete tapestry of a region's biodiversity status, potential, and challenges. However, in many senses, ecological and social contexts are codependent and even co-created: unless we pretend that human beings and their daily pursuits don't exist, how they treat their ecosystems and what they think they know about them are inextricably connected. The FRV project was designed to integrate social and ecological findings—not a trivial task—and thus to investigate the important relationships between the

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state of ecological understanding of a region, the state of a region's biodiversity, and the state of the region's social understanding of how it might be managed for biodiversity conservation into the future.

Ranges of Variability

This project relies on a unified concept of range of variability delineated in separate synthesis papers (Duncan et al. 2007, McComb and Duncan 2007). Those authors rely on established concepts of HRV and have developed the concept of the Social Range of Variability (SRV) to help explain the interaction of social and ecological assessments, in particular their interaction to create FRV. They define them each as follows:

Historical range of variability: the estimated range of some ecological condition or process that occurred in the past. This is often expressed as a probability distribution of likely states. Historically, this range of variability denotes a dynamic set of boundaries between which most native biodiversity variables have persisted—with fluctuations—through time and across space.

Future range of variability: the estimated range of some ecological condition or process that may occur in the future—a dynamic set of boundaries on some condition or process that may occur in the future. In the work of Duncan et al. (2007), this is expressed as a probability distribution of likely states.

Social range of variability: the range of an ecological condition that society finds acceptable at a given time. In the work of Duncan, et al. (2007), this is expressed as a distribution of public acceptability.

Native Biodiversity

Colorado's native ecosystems span the range from high-desert grassland steppes through riparian and wetland ecosystems up into coniferous forests and alpine tundra. The Colorado Natural Heritage Program tracks the status of more than 1100 natural plant communities. This diversity of vegetation types provides habitat for 18 species of amphibians, 48 reptiles, 123 mammals, and 408 birds (70 of which occur regularly) (Schrupp et al. 2000). In general, cold and dry portions of the state support a few dozen species of vertebrates, with vertebrate numbers increasing to 300 or more species with increasing moisture and warmth.

Historical Conditions in Colorado Forests

The temperature, precipitation, and seasonality of climate all change with elevation in Colorado's mountains, leading to patterns of forest composition and dynamics with elevation across 8.6 million ha of forests (Table 1). About one-third of these lands is owned by 200 000 private landowners, and public lands are managed by the U.S. Department of Agriculture (USDA) Forest Service, the U.S. Department of the Interior (USDI) Bureau of Land Management, the USDI National Park Service, and the State of Colorado.

The lowest elevations of Colorado supported grasslands, as a result of drought stress and perhaps fire regimes that limited the success of trees. With increasing elevation along the Front Range, grasslands became mixed with ponderosa pine (*Pinus ponderosa* Dougl. ex C. Laws.) trees in open savannahs. In central and western Colorado, the transition from grassland to forest included areas with substantial shrublands and woodlands with junipers (*Juniperus* spp.) and pinyon pines (*Pinus edulis* Engelm.).

Pinyon and juniper woodlands had a low density of trees that probably limited fire-return periods to somewhere between 50 and more than 100 years (for a review, see Romme et al. 2009). The impacts of fires with such long return intervals would have been severe. Some areas, such as mesa tops in Mesa Verde National Park, have juniper trees more than 500 years old.

Ponderosa pine forests at low elevations probably experienced fire regimes similar to those in northern Arizona, with fires recurring every decade or so, minimizing the long-term establishment of new trees and maintaining open forests. Perhaps only about 20% of the ponderosa pine forests along the Front Range had such frequent, low-intensity fires (Sherriff and Veblen 2007); the spatial distribution for types of fire regimes are not well characterized for the southwestern part of Colorado. More complex topography in the foothills and San Juan Mountains probably promoted a more variable fire regime for many ponderosa pine forests, including longer periods between fires (20 to 40 years, with

Table 1. Extent of major forest types in Colorado (from Schrupp et al. 2000).

Forest Type	Millions of acres
Pinyon–juniper woodlands	6.1
Ponderosa pine	3.4
Mixed conifer–Douglas-fir	1.5
Aspen	3.2
Lodgepole pine	2.2
Engelmann spruce–subalpine fir	4.7

some periods even longer), and higher intensity fires. Overall, the spatial and temporal variations in the middle-elevation ponderosa pine forests led to more intense and severe fires, in some cases killing most or all of the overstory trees and initiating the development of a new stand. A variety of other conifer species were important components of ponderosa-pine-dominated forests in moister sites, and fires in the dry mixed-conifer types depended very strongly on periods of droughts. Heterogeneity of topography and forest structure again created variations in fire intensity and impacts.

In the eastern mountains of Colorado, lodgepole pines (*Pinus contorta* Dougl.) dominated mid-elevation landscapes, characterized by substantial winter snowpacks, and large, intense fires with return intervals of one to a few centuries. Few if any forests of lodgepole pine went more than three centuries without stand-replacing fires.

In western Colorado, aspen (*Populus* spp.) forests dominate landscapes that would tend to have lodgepole pine farther east. Aspen forests do not burn as readily as pine forests, but fires were still important in the long-term development of aspen-dominated landscapes. Aspen trees develop rapidly after fires, sprouting from surviving root systems. In some areas, aspen forests remained essentially monoculture forests with little establishment of understory conifers. Successful conifer establishment in other stands might eventually lead to conifer-dominated stands, until fires again allowed aspen to regain dominance. These general patterns applied to most of the landscapes, but not to high mountain valleys that contained meadows, willow (*Salix* spp.) shrub communities, and wetlands. Although the average age of aspen stands has probably increased in the past 50 years, there is no evidence to support ideas of any widespread decline in the area of aspen forests.

The highest elevation forests of Engelmann spruce (*Picea engelmannii* Parry ex Engelm.) and subalpine fir (*Abies lasiocarpa* (Hook.) Nutt.) also experienced occasional intense, stand-replacing fires, recurring after several centuries. However, some old forests (>500 years) do not record any evidence of any fires, so some spruce–fir forests may have burned only very rarely (and very intensely).

These broad patterns in forest structure and dynamics also included substantial effects of insect outbreaks, including mountain pine beetles (*Dendroctonus ponderosae* Hopk.; attacking ponderosa and lodgepole pine), spruce beetles (*Dendroctonus rufipennis* Kirby;attacking spruces), and western spruce budworm (*Choristoneura occidentalis* Free.; attacking primarily Douglas-fir (*Pseudotsuga menziesii* Mirb. Franco)). At the highest elevation, spruce beetle outbreaks may have rivaled forest fires as agents of tree mortality (Veblen et al. 1994), especially in combination with severe winds that topple spruce trees over hundreds or thousands of hectares.

The occurrence of fires across Colorado depended strongly on drought periods. Seasonal droughts were often enough to dry fuels at low elevations, but fuels at high elevations only dried enough to carry fire in severe droughts that occurred at intervals of 50 years or more. Lightning storms are so common across the state that the occurrence of fires was commonly not limited by ignitions. Some fires were probably ignited by Native Americans, as indicated by fire scars in low-elevation forests that document fires occurring outside the typical season for lightning storms. Given the high frequency of lightning ignitions, the ecological impact of Native American ignitions was probably not very large. The large impacts of fires depended on the severity of droughts, and most droughts would have sufficient lightning strikes to account for the major fires that shaped the forest landscapes.

Recent Human Influences on the Landscape

European settlement of Colorado became substantial in the late 1700s, first in the southern part of the state by Spanish colonists, and in the mid 1800s by United States settlers. Colonization and settlement affected forest landscapes in several ways. The introduction of high populations of livestock led to high (and variable) impacts on grasslands, mountain meadows, and forests, probably reducing the fine fuels that carry low-severity fires. Widespread mining (and railroads) led to a high demand for wood products, including mine timbers and railroad ties. The incidence of fires was higher in the late 1800s than in earlier decades, coinciding with the economic development of the state. However, climate conditions were also warmer and perhaps drier during the same period, so it is not possible to apportion the increased fire to the effects of people (and livestock) or climate.

The forests of Colorado were relatively fire free during the 20th century, as a result of the combined effects of land use (especially livestock grazing) and fire suppression. Indeed, historical relationships between climate and fire extent that applied in earlier times appeared to break down in the 20th century, when the North Atlantic Multi-decadal Oscillation (AMO) would have predicted a higher-than-usual incidence of fire. A resurgence of fires at the end of the 20th century and beginning of the 21st century related to periods of drought, but perhaps also to changes in forest and fuel structures that accumulated during a century of infrequent fires.

More recent social changes in Colorado have been compiled into colorful and in some cases worrisome maps. The population of Colorado has been growing at a tremendous rate, with increases of 40% or more between 1990 and 2000 for many of the mountain counties (Forstall 1995, U.S. Census Bureau 2009). This growth has led to a disproportionate rise in “landscape sprawl” as mountain development has emphasized single-family homes (and vacation homes) on parcels of 10 to 100 acres. Daily traffic on Colorado roads has also increased substantially, leading to bumper-to-bumper traffic on the I-70 during peak weekends. Most of the forests of Colorado lie within an hour or two of driving time from the homes of a million people.

Controls on rural (or near-rural) land development in Colorado depend on community and county regulations, with oversight concentrating most heavily on relatively small parcels (35 acres or less). Individual decisions at this small scale add up to the major changes we see at scales of watersheds and counties. Geographic information systems (GIS) provide great opportunities for seeing the larger effects of many small decisions. For example, an analysis of development alternatives near the town of Ridgway in Ouray County evaluated the potential density of housing (case presented by Dave Theobald in the Warner College of Natural Resources at Colorado State University). Current zoning regulations require 35 acres for each new housing unit, and this would allow for a 10-fold increase in houses at full “build-out.” Debates have also focused on allowing one new housing unit for every 17.5-acre parcel, vs. the same density but not allowing any parcels smaller than 105 acres to be subdivided. The GIS analysis showed that the difference in full build-out for the two 17.5-acre scenarios would only be 1% or 2%, and that decision making might need to focus on points with more substantive impacts. A host of social, cultural, and political factors will determine whether these synoptic insights translate into plans and regulations that influence development.

The protection of lands from development has also shown an increasing trend, with towns and counties acquiring open space, and with substantial acreages placed in various types of conservation easements. Protection of land also includes major programs aimed at fostering good land stewardship on private lands. Over 400 000 acres of private lands have professionally prepared forest stewardship plans, and most of these acres are in areas of moderate to high importance for stewardship (Hackett and Frost

2005). A host of partnerships share a goal of protecting Colorado forests and communities, particularly in relation to severe wildfires. The Fire Learning Network of The Nature Conservancy engages agencies and communities in projects that improve forest health and benefit communities. The Front Range Fuel Treatment Partnership brings together people from conservation organizations, university, and federal, state, and local agencies as well as conservation groups. The Public Lands Partnership/Uncompahgre Plateau Project works to enhance diverse, healthy and viable communities, ecologies, and economies.

Rates of forest logging have declined by more than 90% since the 1980s, as a result of lower (and less reliable) supplies of timber being sold from national forests in Colorado. The current rate of harvest is probably less than 5% of the current increment across the national forests, and much of the harvest is focused on reducing forest hazards (fire, beetle kill of trees, and other forest health issues).

Invasive exotic species may become a substantial future issue in Colorado forests. Low-elevation riparian zones are already heavily invaded by tamarisk (*Tamarix* spp.) shrubs, and low-elevation forests are showing increasing amounts of cheatgrass (*Bromus tectorum* L.) and exotic thistles (especially after fires and restoration treatments). Higher-elevation forests show much less invasion currently.

Decisions about Forest Lands

The HRV in Colorado's forests provides insights on the types of ecological interactions that occur within these forests. A good illustration of these interactions is the relationship between fire occurrence before and after 1900; the earlier period showed strong correlation with hemisphere-scale climate patterns (such as the AMO), whereas this correspondence was stripped out of the later period, largely by fire suppression. Similarly, attempts to restore historical fire regimes to low-elevation forests could have the unintended consequence of increasing the proliferation of alien weeds. The FRV will include these interacting processes, as they are driven by changing climate conditions, disturbances (including human use of fire), and social decisions. Our educational programs need to prepare future land stewards for the task of blending an understanding of historical conditions with the new forces that will shape the future.

Some of the changing social factors include major shifts in the role of federal agencies in managing Colorado's public lands, which occupy 42% of the state. The USDA Forest Service enjoyed almost free rein in making unilateral decisions until the last third of the 20th century, when public involvement, the National Environmental Policy Act (NEPA), and massive planning programs undermined that power. Things are different in the early 21st century. Decisions (when they occur) result from collaborative discussions. Many long-term Forest Service employees have retired recently or will in the near future, and many may not be replaced. Many of the remaining positions in the Forest Service are being considered for "outsourcing." Trail maintenance is largely performed (when it occurs) by volunteer groups. Reforestation following the record-setting Hayman fire of 2002 has been financed in part by a utility company seeking credits for carbon accumulation. During roughly the same period, most of the forestry infrastructure in the state has disappeared, hampering opportunities for forest products to help offset costs of forest restoration treatments.

Agencies and institutions have endured almost continual change, running from initial efforts to restrain resource exploitation, to the Progressive Era of Teddy Roosevelt and Gifford Pinchot, and into the mid-20th-century preoccupation with the "efficiency" of resource production. Land-grant universities and agencies focused on wringing the greatest amount of resource from the land, with the lowest possible investment. The condition of the land (and non-resource components of the ecosystem) received little attention.

America became more complicated after the middle of the century, when black-and-white views gave way to more complicated and nuanced ideas about land management. The technical competency of federal agencies no longer enjoyed uniform confidence from the public. Rachel Carson's *Silent Spring* in 1962 launched an environmental movement that progressed through passage of a suite of major acts (including the NEPA and the Endangered Species Act (ESA)), and the declaration of the first Earth Day in 1970. Dissension and discontent within the Forest Service became tangible in the 1980s with publication of

The Inner Voice by the Association of Forest Service Employees for Environmental Ethics. Older employees in the Forest Service owed their greatest allegiance to agencies, whereas younger employees aligned with the land and the natural resources. Dale Robertson (Chief of the Forest Service, 1987–1993) committed to developing new perspectives, new forestry, and ecosystem management, shifting the focus from optimal efficiency to the health of the land. The key role of federal agencies was to be as partners in collaborations that consider all the land within an area as important for land stewardship, rather than as powerful decision makers about the fate of only the portion of the public's lands they administer.

At the dawn of the 21st century, we see natural resource and land issues in terms of spectra that span multiple forms, from utilitarian use of resources to benign stewardship for the sake of land health. This world view has only a small amount of room for classic Federalism. State lottery revenues in Colorado are devoted to supporting parks and conservation efforts (GOCO, Great Outdoors Colorado), and Colorado has more than 20 county-level conservation efforts. Conservation by regulation (and zoning) may be a weaker approach than bottom-up economic incentives. The role of non-government groups in land conservation has become huge in Colorado. The past importance of the Colorado Division of Wildlife has been substantially eclipsed by major programs of The Nature Conservancy, The Wilderness Society, Ducks Unlimited, Trout Unlimited, The Rocky Mountain Elk Foundation, The Rocky Mountain Bird Observatory, The Colorado Natural Heritage Program, and 39 land trusts. Colorado's land trusts are buoyed by the state's tax credit program for conservation; the first $260 000 of value in a conservation easement is treated as a credit against state income tax, and this credit can be transferred (sold) to third parties. Tax incentives for conservation easements accomplished more conservation in Colorado in the past 5 years than the combined purchases of open-space land and land-trust acquisitions. Clearly, social change is a key issue across the Colorado landscape and indeed it informs each of the social assessment themes discussed below.

METHODS

Use of HRV in Land Management—Biophysical Assessment

A series of reports on HRV in Colorado forests is being developed by the USDA Forest Service and the Colorado Forest Restoration Institute. This series includes large, detailed syntheses of the state of knowledge, and also briefer papers and brochures aimed at providing useful, applicable information directly to forest managers. A collaborative approach among experts is used to develop "science consensus," with clear statements about areas of sufficient knowledge for general agreement, areas of insufficient knowledge, and remaining areas of disagreement. The reports are provided as printed copies, and are available online (see http://www.cfri.colostate.edu/).

Use of HRV in Land Management—Social Assessment

The social assessment was completed by analyzing data transcribed from a plenary focus group on the second day of the workshop following two focus groups from the first day that had considered social and ecological questions separately. The plenary groups addressed a series of questions concerning HRV, FRV, SRV, and alternative strategies for conserving biodiversity. Specific questions included: How do social factors (e.g., land use, development) affect the ranges of variability we can use when managing for biodiversity? How will biophysical factors (e.g., climate change, invasives) influence the way we use ranges of variability to manage biodiversity? What future strategies incorporating both social and biophysical ranges might be most successful in conserving biodiversity?

The data were analyzed in relation to the research question: how do future trends affect the usefulness of the HRV concept? The 20 workshop attendees included managers from public and private lands, NGO representatives, fire and ecosystem researchers, teachers, a county commissioner, and private landowners.

Analysis identified three key themes: (1) HRV's value to managers is heavily influenced by social dynamics in the region; (2) major changes in land use are altering current and future management opportunities; and (3) FRV will depend on management of differentiated knowledge.

RESULTS

Use of HRV and Social Dynamics

Historical range of variation was broadly conceived as a useful although constrained intellectual concept. It was generally agreed that perhaps its greatest power lies in helping establish which ecological processes and dynamics shaped the landscape historically, how they interacted, which of them is still intact, and which of them it is still possible to restore. It provides a "dynamic, flexible envelope" that suggests "the range of Nature's ways of being," and can help design buffers against future large-scale disturbances.

Beyond recognizing HRV as potentially "an important part of future management," opinions differed widely on its practical value to managers. At the positive end of the spectrum, it was described by the Colorado state forester as a different and preferable way of looking at management strategies:

> *I think it's an essential change from the traditional cutting of the allocation pie, whether it's federal or state forest management; it's a whole new way of grounding your management schemes...for ecological process...I think it resonates better (with the public) than cutting up the pie...*

A public lands manager added:

> *HRV gets at a much better understanding of the processes that have shaped the earth and the structures. So when we have a management proposal of whatever kind we can ask if that is something that ever occurred in these forests previously, or are we trying to do something that hasn't existed in the last number of centuries...so it is a tool in the sense of...informing the kind of questions we should ask about relationships.*

A number of significant difficulties with using HRV to assist management planning were identified by participants. In general, they fell into two broad categories: lack of clarity and disconnection from today's landscape realities. First, definitions and bounds of HRV appear to some to be rather too loose to be of value:

> *I was initially pretty happy with the HRV concept, but find myself less and less satisfied, when I see things and look at the range of HRV and how wide it is, it's almost impossible to do anything that's outside of HRV, so it's just not all that useful a tool...(often) we can't even get agreement between scientists who are close to it.*— Public lands manager.

> *The dialog keeps changing all the time about what happened before. The inherent assumption says that we want to go back to the time before we were there to screw everything up...*—Ranch manager.

The difficulty of quantifying the elements of HRV stands in the way of its use on most ownerships, and it was noted that specific linguistic and metaphorical problems undermine the HRV concept. One is the fact that the effects of the cultural hegemony of using words such as "preservation" and "conservation," loaded as they are with upper-middle-class values, have yet to be fully examined for their economic effects.

Second, most agreed, the realities of today's landscapes may have effectively neutralized the value of using HRV to guide management. Because fire history is extremely varied over the Colorado landscape, for example, generalized fire planning with HRV is believed to have little value, and in fact, one participant noted that some fuels-management actions appear to be taking landscapes outside the HRV in terms of fire frequency. Given that landscapes are now also dominated by humans as a disturbance factor potentially more potent than fires and insects, the effort to revert to some "stable" previous system may be misguided, and could open landscapes to the possibility of explosions of non-native species. One participant noted:

> *If we bring in HRV, people are looking at that as The Answer. I really think that with the community I have, most are newcomers and urban people, and when they hear there's this HRV out there, that's what they want to go back to...the perception is that now we have the new answer.*

Land-Use Change and Management Opportunities

Participants agreed that the dramatic shifts already underway, directly or indirectly, will influence the design and implementation of biodiversity conservation and the ability of managers to identify and manage future ranges of variability. Foremost in all minds is the continuation, even acceleration, of urban sprawl. The wildland urban interface (WUI) contains 50% of the forest types that are from naturally high-risk fire regimes. Roads and population growth increase the fragmentation of landscapes that undermine biodiversity, and somehow, several participants noted, expanding levels of recreational use will also need to become compatible with conservation—a challenge even in relatively uninhabited landscapes. Humans as disturbance agents, through continued urban sprawl, will undoubtedly undermine conservation efforts. In addition, one of the most powerful brakes on it—conservation easements—by their very nature attract development to their boundaries, thus engendering another new and unnatural pattern of use—perhaps concentric circles?—on the landscape. Incipient efforts to work across boundaries are beginning to appear, but a “balkanized political system” can challenge the best laid plans.

A key challenge, of course, in considering the use of HRV, is that most ecosystem processes are large-scale processes, which means working across large landscapes, and thus encountering multiple jurisdictions. Several participants noted that leadership is now needed at the regional level, rather than just the state level.

However, participants were seeing glimmers of hope, even despite some sobering mapped models of the sprawl to come in the “annexation wars.” As noted above, they noted that decision-making power itself is shifting in several key areas. First, federal budgetary constraints are generating downsizing of federal workforces, in particular the law enforcement sections. A wildlife ecologist classified this as public landscapes “going feral” and the outcome amounting to “abandonment” of federal lands and their habitats and resources. He suggested, however, that as a result federal agencies are now more likely to start sharing decision making and serving as catalysts in changed management.

Second, comments and stories from many participants illustrated a variety of ways in which the locus of power over land-use decisions is shifting toward local decision making, collaboration, and interest in ecological realities on private lands.

With the advance of the idea of stewardship, mapping is becoming a vital social process, which “connects counties and landowners at the planning level.” However, concerns about loss of privacy when data are shared, loss of private property rights if outsiders draw the maps and influence policy, loss of trust if agencies foist maps upon an unwilling community, all relate to the crucial need for building trust while planning an acceptable FRV. Practical concerns such as the cost of data sets and decisions about what needs protecting also dog the biodiversity conservation planning process. However, it was agreed that new ways of thinking might evolve, as one participant noted:

> *I think we can actually bring HRV concepts to bear on the land through collaboration, in a way that will get it past that old-school thinking about getting information into the hands of decision makers so they can make the right decisions.*

In concert with other new ways of thinking, mapping and modeling exercises tend to underscore the inadequacy of the planning time frame: several participants commented that 20 years is too short, and 100 years should be standard. Within such time frames, might landowners learn how to make ecological restoration economical? For example, might we ask lessees on public lands to deliver environmental values in return for taking a profit?

FRV and Differentiated Knowledge

Evaluating and designing FRV to assist in the planning of biodiversity conservation will depend on management of differentiated knowledge; as one workshop participant noted: “You cannot sustain a community on granola and ecology; you need civic engagement.” And with civic engagement comes challenge and change.

Changes and challenges in knowledge management are already underway in many forms. Management of many kinds of knowledge, it was agreed, must be planned if the conservation community is to design acceptable future landscapes. The use of the term “differentiated knowledge” at the workshop referred to different levels, types, and sources of knowledge, including the ecological basis of HRV.

A number of participants recognized that community-based ideas for FRV are attracting and engaging a whole new type and range of audience. One listed some of the components as “retirees, the wealthy, the super-wealthy, the cyber desk-jockey, the mushroom crowd.” Strange bedfellows, it was agreed, can be expected when you blend traditional and new knowledge, move from the command-and-control mentality of national decision making to the participatory nature of local collaboration, where it pays to “invest in the eager learner.” Such change contributes to the continually dynamic nature of social acceptability, which forms the social range of variability (SRV) defined above as the range of an ecological condition that society finds acceptable at a given time.

Broader views of the landscape, drawing upon HRV, a possible FRV, new maps and models, and different kinds of knowledge, will help communities better recognize the tyranny of small decisions, and perhaps establish a clearer framework for thinking about the interactions of many social forces and their effects on those broader landscapes.

In the challenge to change established ways of thinking, the oft-cited need to “translate for the public” suggested that collaborative decision making will need an attentive educational component. Such education will come in many forms and will be crucial to decisions about fire, of course, but also about what to protect—should it be the economic value of large species, for example, or something else?—and how to go about protecting it. Mapping, again, is a central part of knowledge management and can operate in many dimensions.

Collaboration at many levels is seen as the preferred path to establishing FRV in a meaningful way:

> *It’s all about the relationships, the trust, the building, the networking, and putting those tools in place. We tend to focus as a society on quick fixes, but collaboration is about healthy relationships between people, which take time.*

Building trust and designing a future are mind-bending exercises, participants agreed, with challenging “layers of complexity,” especially when they face such questions as: How can we make restoration economical, how do we make it pay? How do we make a whole economy that pays for itself? The implied answers had much to do with the economy, but also related to new ways of interacting at both a community and regional level, and to the fact that “political systems are broken in a lot of places.”

The layers of complexity link to the need for a story framework to support the ideas of HRV, biodiversity conservation, and future options. With population growth continuing apace, options may become limited:

> *One thing we haven’t really talked about is that change is being driven by a large population growth. Do we accept that as a given, as what has to happen? You can get away with a lot of environmental sins if you don’t have so many people. You have more flexibility.*

Flexibility in the ways HRV might successfully inform FRV seems to be key: across the participants at the workshop, it was recognized that many forms and many sources of knowledge must be added to ecology to establish manageable sideboards for future landscapes.

DISCUSSION

The actual implementation of effective policies is the only measure of success that really matters. Policy implementation may be limited by social and ecological knowledge, but social and ecological knowledge alone will not implement policy. Clear attention needs to be paid to the complete system. Thus, fixing one crisis after another without affecting the social forces that create the crises in the first place is, to paraphrase Aldo Leopold, like “fixing the pump without fixing the well.” As a workshop participant noted, “We’re great with the pump, terrible with the well.” The well is analogous to society’s mindset (including avid consumerism), and working on that mindset may be the most critical step toward accomplishing a desired blend of ecological and social stewardship. Suburban sprawl is the expression of a society’s desires, and focusing on sprawl is like fixing a pump without considering the state of the well.

It is notable that climate change and invasive species were not much discussed in the plenary focus group session at the workshop. The major focus, and the reason for the overarching social themes that have been articulated above, is the encroachment of human effects across the landscape. Regardless of whether it is yet technically or ecologically true, humans are perceived to be among the pre-eminent disturbance forces in Colorado by the people who think about HRV and its implications for future landscapes and biodiversity. Humans, in other words, strongly influence the current SRV, and will dominate the future ranges.

Neither was very much attention devoted to the demographics of the incoming population, large as it is. The fact that it is bringing considerable disposable income, which frequently translates into development on the landscape, was noted, and the urban–rural divide was recognized as part of the overall education and collaboration challenge. Specific demographics were not discussed.

Several elements in analyzing the value of HRV in biodiversity conservation are unique to the Colorado setting. First, the combination of substantial federal lands, rapidly changing land-use patterns on private lands, and the lost forest management infrastructure, creates a current situation with highly variable opportunities for application of HRV. Relatively undisturbed national forests, for example, may be able to set in motion management plans that allow certain percentages of beetle kill, or choose not to suppress wildfire in certain areas. These potentialities, of course, are constrained by the SRV.

Public ownerships may also have sufficient land to provide a base of operations for lessees to custom design environmental restoration projects with enough flexibility to deliver ecosystem services while making a profit—the beginnings of stewardship as an industry. Private lands, on the other hand, unless they are very large, or have collaborated within communities to create larger conservation easements, have considerably less opportunity to manage actively for ecosystem processes and structure. This likely becomes increasingly true the closer they are to centers of population (see Wear et al. 1999).

Second, Colorado's proactive support of conservation efforts through the tax structure has generated a simultaneous backward- and forward-looking approach to conservation: backward to consider the fullest available spectrum of ecological history upon which to balance management plans, and forward to imagine the best ways to restore, retain, or mimic those ecosystem processes and structures still recognizable from the historical data. The implication is that use of HRV concepts may be encouraged by structural social changes within SRV such as tax benefits.

Whether we can extrapolate that the spread of conservation across a landscape implies greater use of HRV, in an intriguing reverse operation, remains to be seen: HRV in the Colorado region has gained some traction as a conservation benchmark process, but it could become just one among many.

What are the implications, then, for FRV? With the findings suggested above, we can hypothesize that HRV could "variably" inform FRV, not just based on degree of human impacts on a site or landscape, but also on the socially acceptable range of options for conservation management. As a socially negotiated set of variables, FRV will continue to be informed by the legacy nature of today's range of variability, and by the social dynamics and levels of knowledge at play upon the landscape.

CONCLUSIONS

At the end of the day, all the issues workshop and project participants discussed are people issues, and the important ecological question is whether ecology can inform the changes brought about in response to social issues. Are we wise enough, and effective enough, to use ecological insights to improve overall outcomes and avoid unpleasant surprises?

We have a social mandate to protect forest lands but great uncertainty about many of the details. Experts may have trouble providing really useful information on the location, population, and sensitivities for wildlife species of concern; nevertheless, county commissioners and other decision makers will have to go ahead with decisions about land use. We need to be more enlightened about the needs and opportunities in Colorado for engaging with local-level administrations, providing the best information we can in forms that can be used by non-natural-resource professionals.

Two related ideas emerged from workshop discussions. First, the confluence of multiple social and ecological changes in Colorado will inevitably require new approaches to biodiversity conservation management. Some new approaches are already being tested, others are being discussed, and the effects of their presence on both the ecological and social landscapes is yet to be understood.

Second, maps illustrating dramatic changes over time can be effective tools that empower the public to understand the longer term outcomes of decisions, helping to shift the balance between intended and unintended consequences. To be useful planning tools, though, growth scenarios need to go beyond the simple aspects of numbers of people or houses to include the impacts these changes will have on forest lands. For example, how will a zoning decision (and subsequent development) influence the size and configuration of the wildland–urban interface and fire management? In other words, mapmakers need to consider how to represent spatially the transition between HRV and FRV.
We conclude with the recognition of core features of any discussion about the real future of Colorado's forests, and we expect these features apply broadly to other forest landscapes as well:

- Complexity is real and fundamental, in both time and space. We can wish it wasn't so, but wishing won't make complexity go away.

- All of our communication and collaborations are based on words, language, imagery, and metaphor (have any images had more influence on views of nature more than Bambi running in a forest set on fire by Man?).

- We have emotional lives that resonate with powerful, simple ideas (such as "natural," "Nature knows best," "What God intended). What powerful and simple new stories will be able to pull honorably on people's heartstrings?

- All this "high-falutin'" talk about ideas won't matter much if we don't have a well-trained workforce and infrastructure of working on the land.

- Social and ecological assessments very often produce findings that are removed from each other in conception, time, and space. The effort to integrate these findings represents a step toward understanding how HRV and SRV can both contribute to a more robust idea of FRV options.

Responses to this article can be read online at:
http://www.ecologyandsociety.org/vol14/iss2/art9/responses/

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