Foreword by W. Wallace Covington

Edited by Dave Egan and Tayloe Dubay







NORTHERN ARIZONA UNIVERSITY

Ecological Restoration Institute

Breaking Barriers Building Bridges:

Collaborative Forest Landscape Restoration Handbook

Breaking Barriers, Building Bridges:
Collaborative Forest Landscape Restoration Handbook

Edited by Dave Egan and Tayloe Dubay
Ecological Restoration Institute at Northern Arizona University

Foreword by W. Wallace Covington

NORTHERN ARIZONA UNIVERSITY
Ecological Restoration Institute

Contents

Acknowledgments

Guides:
Dan Binkley, Tony Cheng, Jessica Clement,
W. Wallace "Wally" Covington, Joe Crouse, Andrew Eagan,
John Flatberg, Steve Gatewood, Tim Garvey, Yeon-Su Kim,
Carmine Lockwood, Anne Mottek Lucas, Tammy Randall Parker,
Sarah Reif, Ed Smith, Bonnie Stevens, Matt Tuten, Diane Vosick

Reviewers:
M. Kat Anderson, Tony Cheng, Krista Gebert, Ann Moote,
Wayne Robbie, Judy Springer, Keith Stockmann, Matt Tuten,
Diane Vosick, Amy Waltz, Matt Williamson

Support:
Linsey Baker, Anastasia Begley, Krista Coquia, Scott Curran,
Karen Gilbreath, Kathy Mitchell, Shanyn Money

Design/Layout:
Ralph Schmid, Third i Design

Illustrations:
Adriel Begay

Foreword

W. Wallace Covington

The dry forest ecosystems of the American West, especially those once dominated by open ponderosa pine forests, are in wide-spread collapse. We are now witnessing sudden leaps in aberrant ecosystem behavior long predicted by ecologists and conservation professionals. Trends over the past half-century show that the frequency, intensity, and size of wildfires will increase by orders of magnitude. Along with this increase, we will experience the loss of biological diversity, property, and human lives for many generations to come.

In 2012, we saw a near record-breaking nine million acres burned. While the actual number of wildfires was the lowest in a decade, the total acres burned was the second-highest on record. The fires may have been fewer, but they were a lot bigger, burning homes and infrastructure and charring entire landscapes. The accelerating increase in the severity and size of wildfires in the West indicates that average annual losses over the next two decades will be in excess of five to ten million acres. The pace and scale of our current forest health restoration treatments is woefully inadequate given the scope of the problem. Using the reasonable assumption that preventative restoration treatments should at least be within the same scope and size of losses to severe stand replacing fire, one would conclude that we should be treating five to ten million acres per year.

Besides the inextricable link of people to the forest, there are many important environmental and resource benefits provided by forests, such as water, wildlife, recreation, and wood fiber. To protect these values will require landscape-scale treatments in the greater forest. Research across the West has shown that ecologically based restoration treatments substantially reduce fire hazard by thinning trees to decrease tree canopy density, break up interconnected canopy fuels, raise the crown base height, and then reduce accumulated forest floor fuels and debris with prescribed fire. Ecological, evidence-based restoration offers a practical approach for developing scientifically and ethically sound fuel-reduction treatments—which not only treat wildfire symptoms, but also attack the underlying causes of ecosystem health decline. Restoration is mandated for degraded areas set aside as natural areas or wilderness, but it is also a desirable goal in the management of lands where ecosystem health and resource use are shared goals. Scientifically rigorous and adaptively designed restoration plans can offer common ground to resolve preservation/use conflicts.

Knowing what we know now through cumulative evidence, it is critical we move forward with large-scale, restoration-based fuel treatments using an adaptive management framework. We have a solid body of scientific information to support a systematic scientific approach for implementing forest restoration that will protect people, communities, and the forest. Such an ecosystem ecology approach should be based on attempts to objectively discover the truth about how best to improve treatments during the course of ongoing large-scale restoration of the landscape.

The combination of scientifically supported restoration approaches, political will, and popular support—not to mention dedicated advocates—has contributed to the creation of federally appropriated collaborative landscape restoration programs like the Collaborative Forest Landscape Restoration Program (CFLRP). Through the emergence of pioneering CFLRP projects, we have a chance to expand and apply evidence-based restoration principles at unprecedented landscape scales. In these new collaborative settings, stakeholders must be engaged—especially community-based partnerships linked to regional and national agencies and interest groups—with policymakers, natural resource specialists, and resource managers.

In the "2012 Report on the Collaborative Forest Landscape Restoration Program" released by the USDA Forest Service in December 2012, the 23 landscape restoration projects awarded since 2010 (three of which are High Priority Restoration Projects) have collectively:

- Created and maintained an estimated 3,375 part and full-time jobs during 2011 and 4,574 part and full-time jobs during FY2012
- Sold 94.1 million cubic feet of timber and produced 1,158,000 green tons of biomass
- Generated nearly $320 million of labor income
- Removed fuel for destructive mega-fires on 383,000 acres near communities
- Reduced mega-fire on an additional 229,000 acres
- Improved 537,000 acres of wildlife habitat
- Restored 394 miles of fish habitat
- Enhanced clean water supplies by remediating or decommissioning 6,000 miles of eroding roads.

While multiple barriers remain to restoring the millions of acres needed to ensure the resilience of our forests to future fires and changing climates, the groundbreaking CFLRP projects are teaching us how to forge meaningful partnerships and construct bridges to success. Guided by the best available evidence, strong monitoring and adaptive management frameworks, the numbers of acres restored and jobs created through the CFLRP will continue to grow. The purpose of this handbook is to capture the lessons learned from these emergent projects and other landscape-scale restoration efforts and to provide clear, navigable guideposts for collaboration, planning, implementation, monitoring, and adaptive management. The handbook is meant to be a guide for those working collaboratively under one goal: to restore Western dry forests for communities and nature.

As a nation, we have relied on our forests for a wealth of resources — from recreation opportunities to clean water, fish and wildlife habitat, native biodiversity, carbon storage, and more. Reinvesting in them makes sense. However, we cannot be complacent and we cannot pause even for a moment. Research shows that climate change is already influencing the frequency and size of fire. By acting quickly and acting now, we can restore forest health and build resilience that will prepare forests for whatever changes may occur.

We are in an ecological reawakening with respect to restoration and conservation. Restoration is a recent science, but it is the approach of the future, the approach of now. It is about people working together in good faith to learn about ecological functions and conservation principles, including sharing the land with current and future generations. I can say that after 40 years of working in the forests of the West, restoring them is finally within our grasp. If you had asked me if I was hopeful for the future of our forests 20 years ago, I would have said no. But today I have never been more optimistic. We have a cumulative and rigorous body of scientific information to implement preventative restoration treatments that will protect people, communities, and the forest. If we continue to work together to restore these lands, and do our jobs as stewards of the land, there will be plenty of resources for all of us and plenty to share with the rest of nature.

— **W. Wallace "Wally" Covington**, PhD, Executive Director of the Ecological Restoration Institute and Regents' Professor, School of Forestry, Northern Arizona University

Introduction

Dave Egan

Collaborative landscape-scale forest restoration on federally managed lands is an exciting, new public process designed to rescue dry, frequent-fire forest ecosystems through land management actions supported by science and social agreements. Such a complex, multi-perspective undertaking involves individuals, communities, organizations, federal and state agencies, and tribes. It calls upon social scientists, ecologists, foresters, environmental activists, interested citizens, and many others to share their expertise and perspectives for the common good. The stakeholders of a landscape-scale forest restoration project seek to increase the forested ecosystem's resilience and biodiversity while supporting local economies and decreasing the threat of wildfires. By encouraging community-wide agreements, such collaborative efforts strive to create a more socially inclusive, scientifically based course of action for solving land management issues.

The need for scientifically and socially guided restoration of forests on public lands comes at a time when western coniferous forests, the human communities that interface with them and the public agencies that manage them, are in crisis. Each year millions of acres of forested land across the American West are consumed by large-scale wildfires. In some of these ecosystems, such as those dominated by lodgepole pine or high-elevation conifers, these fires are natural stand-replacement events. However, the mid- to low-elevation, dry forests of ponderosa pine/Jeffrey pine, or dry mixed conifer, which historically were shaped by low-severity or mixed-severity fire regimes and small-scale die-offs due to insects, are now experiencing unprecedented levels of insect infestations as well as uncharacteristically large, destructive crown fires. The ecological effects of these large-scale wildfires and insect disturbances often cause these relatively high-diversity ecosystems to collapse into low-diversity states that require long periods of time to recover naturally. Moreover, these wildfires often cause significant losses to human communities and infrastructure, and weigh heavily on the public treasuries for fire suppression and rehabilitation activities. Action to solve these problems is needed and recognized locally, regionally and nationally, but finding the common ground to do so has only just begun.

Fortunately, recent federal and state government actions, particularly the federal Collaborative Forest Landscape Restoration Program (CFLRP) and the recently adopted National Forest System Land Management Planning Rule, are now in place to support collaborative forest restoration activities. These programs provide collaborative groups with the institutional framework and, in the case of the CFLRP, the financial support they need to undertake such large-scale, long-term projects.

This ERI handbook is designed to help those involved in such projects understand and navigate the various aspects of this new enterprise in collaborative land management—including planning, collaboration, developing NEPA documents, implementation, monitoring, economic considerations, and more. While exciting and groundbreaking, this new venture is not without its problems and pitfalls. This handbook aims to serve as a bridge to the many individual and institutional barriers that collaborative groups may encounter in the process.

"

This handbook is designed to help those in collaborative land management understand and navigate various aspects of this new enterprise. While exciting and groundbreaking, this new venture is not without its pitfalls.

Collaborative Forest Landscape Restoration Program

The U.S. Congress established the Collaborative Forest Landscape Restoration Program when it passed Title IV of the Omnibus Public Land Management Act of 2009. The CFLRP is intended to:

- encourage ecological, economic, and social sustainability
- leverage local resources with national and private resources
- facilitate the reduction of wildfire management costs, including through re-establishing natural fire regimes and reducing the risk of uncharacteristic wildfire
- demonstrate the degree to which various ecological restoration techniques achieve ecological and watershed health objectives
- encourage utilization of forest restoration by-products to offset treatment costs, benefit local rural economies, and improve forest health.

Title IV establishes the Collaborative Forest Landscape Restoration Fund to provide funding authority for:

- requests by the Secretary of Agriculture of up to $40 million annually for fiscal years 2009 through 2019 or until the entire $40 million has been expended
- up to 50% of the cost of carrying out and monitoring ecological restoration treatments on National Forest System (NFS) land for each proposal selected
- up to $4 million annually for any one project
- up to two projects per year in any one Forest Service region
- up to 10 projects per year nationally.

The general limitations and uses of the CFLRP funding include:

- funds must primarily be used on NSF lands, although the project may include land under the jurisdiction of the Bureau of Land Management and/or the Bureau of Indian Affairs, or other federal, state, tribal, or private land
- funds may not be used to cover planning costs
- funds may include cancellation and termination costs that may be required under the Federal Acquisition Regulation for contracts used to carry out ecological restoration treatments on NFS land
- funding for any one proposal may be expended for no more than 10 fiscal years.

As of 2012, 20 projects have been awarded CFLRP status; the vast majority on NFS lands in the western United States. According to the CFLRP 2012 Annual Report, some of the first projects are already making good progress. For example, in 2012:

- The Southwestern Crown of the Continent Collaborative treated about 2,500 acres of hazardous fuels on the Flathead, Lolo, and Helena national forests in western Montana, and produced 1,627 CCF (100 cubic feet) of saleable timber. The project also leveraged $6.7 million in funds, created or maintained 156 jobs, restored 52 miles of fish habitat, and improved or maintained 88 miles of roads.
- The Selway-Clearwater Middle Fork Project treated more than 14,000 acres of hazardous fuels on the Nez Perce Clearwater and Bitteroot national forests in Idaho, yielding 9,673 CCF of timber for sale. The project also created or maintained 127 jobs, improved or maintained 256 miles of roads, improved 32 miles of fish habitat, restored 13,166 acres of wildlife habitat, and decommissioned 27 miles of roads.
- The Uncompahgre Plateau Project in southwestern Colorado's Grand Mesa, Uncompahgre, and Gunnison national forests treated 720 acres using prescribed burns and mechanical thinning, and sold just over 5,000 CCF of timber. The project also created or maintained 97 jobs producing an estimated $2.7 million in total

labor income, restored 8,202 acres of wildlife habitat, improved or maintained 329 miles of roads, and decommissioned 30 miles of roads.

- The Front Range Landscape Restoration Initiative on the Pike and Isabel, Arapaho, and Roosevelt national forests in north-central Colorado reduced wildfire threats on 5,500 acres in the wildland-urban interface and restored 6,600 acres of wildlife habit. The project also created or maintained 391 jobs, leveraged $3 million in funds, sold nearly 11,900 CCF of timber, and improved or maintained 85 miles of roads.
- Zuni Mountain Collaborative Landscape Restoration Project in western New Mexico's Cibola National Forest in its first year of operation reduced hazardous fuels on 1,700 acres, sold nearly 9,000 CCF of timber, created or maintained 43 jobs, and maintained or improved 66 miles of eroding roads.
- In Oregon, the Deschutes Collaborative Forest Project sold roughly 15,600 CCF of timber and reduced hazardous fuels on 5,440 acres. The project also restored 2.5 million acres of wildlife habitat, maintained or improved 49 miles of roads, created or maintained 91 jobs, and removed 1,422 acres of invasive plants.
- The Tapash Sustainable Forest Collaborative was able to secure $870,000 in leveraged funds and restore 746 acres of wildlife habitat on the Okanogan-Wenatchee National Forest in central Washington. The project also sold nearly 13,500 CCF of timber, maintained or improved 13 miles of roads, and removed 1,300 acres of invasive plants.
- The Dinkey Landscape Restoration Project, located in California's southern Sierra Nevada Mountains on the Sierra National Forest, treated nearly 4,000 acres of hazardous fuels and sold almost 15,000 CCF of timber. In addition, the project created or maintained 137 jobs worth an estimated $6 million in total labor income.

These projects and others are demonstrating that progress is being made both restoring the nation's forests and learning from the experience (see this 2012 U.S. Forest Service press release for information about 2011 CFLRP accomplishments).

Indian paintbrush (*Castilleja kaibabensis*) grows in a ponderosa pine forest on the Powell Plateau in Grand Canyon National Park-North Rim. *Photo by Daniel Laughlin, courtesy of ERI*

Ecological Restoration

As the criteria for a CFLRP project clearly demonstrate, ecological restoration plays a key role in the process as a land management strategy. However, Title IV of the Omnibus Public Land Management Act of 2009 does not provide a definition of ecological restoration. For that, one might look to the U.S. Forest Service, which defines ecological restoration as: *The process of assisting the recovery of resilience and adaptive capacity of ecosystems that have been degraded, damaged, or destroyed. Restoration focuses on establishing the composition, structure, pattern, and ecological processes necessary to make terrestrial and aquatic ecosystems sustainable, resilient, and healthy under current and future conditions* (U.S. Forest Service, 2011, p. 12).

This rather broad definition is further defined from a scientific perspective in the Society for Ecological Restoration Primer (Society for Ecological Restoration Science and Policy Working Group 2004), which identifies the following attributes of a restored ecosystem:

- The restored ecosystem contains a characteristic assemblage of the species that occur in the reference ecosystem and that provide appropriate community structure.
- The restored ecosystem consists of indigenous species to the greatest practicable extent. In restored cultural ecosystems, allowances can be made for exotic domesticated species and for non-invasive ruderal and segetal species that presumably co-evolved with them.
- All functional groups necessary for the continued development and/or stability of the restored ecosystem are represented or, if they are not, the missing groups have the potential to colonize by natural means.
- The physical environment of the restored ecosystem is capable of sustaining reproducing populations of the species necessary for its continued stability or development along the desired trajectory.
- The restored ecosystem apparently functions normally for its ecological stage of development, and signs of dysfunction are absent.
- The restored ecosystem is suitably integrated into a larger ecological matrix or landscape, with which it interacts through abiotic and biotic flows and exchanges.

- Potential threats to the health and integrity of the restored ecosystem from the surrounding landscape have been eliminated or reduced as much as possible.
- The restored ecosystem is sufficiently resilient to endure the normal periodic stress events in the local environment that serve to maintain the integrity of the ecosystem.
- The restored ecosystem is self-sustaining to the same degree as its reference ecosystem, and has the potential to persist indefinitely under existing environmental conditions. Nevertheless, aspects of its biodiversity, structure and functioning may change as part of normal ecosystem development, and may fluctuate in response to normal periodic stress and occasional disturbance events of greater consequence. As in any intact ecosystem, the species composition and other attributes of a restored ecosystem may evolve as environmental conditions change.

In the past decade, insect infestation reached epidemic levels in many forests across the West. Trees weakened by drought, overcrowding, disease or fire are more susceptible to beetle attack. The potential for high fuel loading from dead and dying trees due to drought stress and beetle infestation greatly increases the risk of high-severity fires. *Photo courtesy of ERI*

Fire fighters hold a defensive fire line as the Rodeo-Chediski fire burns at night. The Rodeo-Chediski Fire burned 468,638 acres in east-central Arizona in 2002. It was the largest wildfire in Arizona's recorded history until the Wallow Fire (538,049 acres burned) in 2011. *Photo courtesy of the Apache-Sitgreaves National Forest*

In describing the attributes of restored ecosystem, the authors of the SER Primer use the term, "reference ecosystems." This term describes a model that is based on scientific and other observations of ecosystem conditions and processes in the historic past and/or in relatively undisturbed contemporary ecosystems similar to the one being restored (Swetnam et al. 1999, Egan and Howell 2001). Such a historical ecology model can be used to make decisions about what processes and/or species need to be restored, and to assess the progress or success of a restoration project. The idea of reference ecosystems is closely linked to the concepts of evolutionary environment and range of historic or natural variability—the evolutionary environment developing over a long time span (typically thousands of years) during which species evolve and co-evolve with other species and various natural processes (e.g., fire, insects, diseases) under variable environmental conditions. This evolutionary pathway produced resilient evolutionary habitats that allow the species and processes to exist at varying, but relatively stable levels (i.e., within the historic/natural range of variability). Many of these evolutionary habitats and interactions have since been disrupted by humans who have degraded or eliminated key components and/or processes (i.e., grazing removed fire-carrying understory grasses, federal fire suppression policy allowed overstocking of forests) (Covington et al. 1999, Moore et al. 1999). Restoration of such evolutionary habitats and processes is vital to halting the loss of biological diversity (Covington 2003).

Whether reference ecosystems are still valid models has been called into question, especially in the recognition of ongoing or anticipated changes in climate (Millar and Woolfenden 1999, Peterson et al. 2011). These critics of reference ecosystems suggest that realigning ecosystems to present and anticipated future conditions, with the goals of resilience and adaptive capacity, is more realistic than restoring to historic conditions (Millar and Brubaker 2006). This idea is reflected in the U.S. Forest Service definition of ecological restoration. Critics also suggest that, in general, restoration efforts should focus on processes and structure, and significantly less on species composition and populations which they expect will shift in response to climate change (although "assisted migration" may be necessary in some cases). That said, these same scientists and researchers (Millar et al. 2007) think that restorative thinning and prescribed burning, as suggested by the ERI and others, offer immediate solutions to forest environments that will likely become drier and even more susceptible to frequent, larger wildfires and structural losses due to insects and diseases. Thus, studying past ecological conditions as well as past indigenous practices of land management (Anderson 2006, Kimmerer 2011) should not be abandoned, but used to understand how ecological and eco-cultural processes worked over time and in various environmental conditions.

The attributes of what might be described as "strict restoration" become even more nuanced (i.e., more relaxed, expanded) in large-scale, collaborative restoration forest restoration projects where scientific fact encounters individuals, organizations, and communities with multiple perspectives of the environment, economic objectives, common aspirations, and issues of social justice (Egan et al. 2011). As a result, while remaining science-based, the collaborative format of these large-scale, multi-year projects is not a straightforward, fact-based process but is, in reality, also value-laden and context driven, arising from multiple perspectives of the stakeholders.

Four Perspectives

Anyone involved in a collaborative landscape-scale forest restoration project will quickly discover that it is a multi-perspective experience; that is, there are many ways to look at the total project and nearly everyone has their own ideas about collaboration forest restoration and any number of other subjects that become part of the discussions about planning, implementing, and monitoring such a project. This can present problems and cause frustrations for newcomers and veterans alike, especially when/if discussions become stalled due to competing ideas or points of view (Esbjörn-Hargens and Zimmerman 2009). One way to take a larger, holistic view this process and the potential difficulties that may arise is to look at them from the four general perspectives that emerge in a collaborative landscape-scale forest restoration project: 1) scientific, 2) systems, 3) cultural, and 4) personal.

Scientific Perspective

By design, all CFLR projects involve discussions and activities that have a strong scientific perspective. As PL 111-11 states: "A collaborative forest landscape restoration proposal shall be based on a landscape restoration strategy that incorporates the best available science and scientific application tools in ecological restoration strategies." The scientific perspective derives its authority from the objective and empirical study of behaviors. In the case of forest restoration, these studies include the behaviors of individual beings (e.g., trees, animals, people), phenomena (e.g., wildfires, insect outbreaks), and patterns of behavioral relationships (e.g., predator-prey, succession, cooperation, social interactions) across space and time. Such scientific effort produces knowledge (or "fact-based reality") that can be used to support and inform land management decisions (see Chapter 5) as well as proving useful and decisive in legal disputes (i.e., as in the testimonies of expert witnesses and in NEPA documentation; see Chapter 3). The scientific perspective is also useful in monitoring ongoing work (see Chapter 4), addressing economic and social issues (see Chapters 1 and 2), and for providing insights that inform adaptive management decisions (see Chapter 6).

While the power and influence of the scientific perspective is undeniable, there are certain limitations to the scientific process and its application that represent potential barriers for successful landscape-scale forest restoration:

- Knowledge depends on solid, high-quality evidence; scientists and others may disagree about the quality and/or quantity of the scientific evidence, thus creating uncertainty
- Knowledge is never complete; knowledge "gaps" often exist (e.g., wildlife population responses, diameter caps, economic uncertainties, public reactions in terms of ongoing landscape-scale forest restoration projects)
- Scientific pursuit of knowledge may be hampered by logistical and/or fiscal constraints
- In general, the nature of science and experimentation is a relatively slow, methodical process; large breakthroughs (paradigm shifts) occur only occasionally
- The scientific perspective often overlooks or dismisses values and subjective meanings as unimportant in terms of finding solutions
- Scientific work is generally focused on ecological studies with significantly less emphasis on economic and social issues
- The translation and transmission of science-based knowledge may by hampered by the need to "scale-up" from information derived from small-scale experiments to large-scale applications, the specialization inherent in scientific training and inquiry, the use of language particular to scientific research, and the insular tendencies of the scientific community.

With these bridges and barriers in mind, the scientific perspective remains a fundamental approach for advancing the ideas and plans of collaboratives and stakeholders. Indeed, scientists involved in forest restoration-related research have provided the answers to many questions about the various behaviors of trees, plants, fire, animals, and humans—arguably enough reliable knowledge and information to reasonably begin to restore forested ecosystems that have been damaged or neglected. Yet, and despite its influential and vital place within the process, the scientific viewpoint provides only one perspective of the larger issue. As a result, to rely solely or largely on a scientific perspective may result in a poorly developed project because science alone is not equipped methodologically to address many of the personal, cultural, and systems-related issues that arise in a highly social, collaborative undertaking such as landscape-scale forest restoration (Egan et al. 2011).

Systems Perspective

Collaborative landscape-scale forest restoration projects are situated within a milieu of large and small systems (e.g., political, bureaucratic, economic, legal, cultural, ecological) that have their own processes and relationships that drive them through space and time. These recognizable collective structural entities are self-interactive as well as interacting with other systems in both complementary and competitive ways (Gunderson and Holling 2002). Systems are studied and analyzed by objective means in terms of their patterns, trends, dynamics, processes, and structures. Such analyses and meta-analyses reveal the long-term behavior of systems. They may also provide predictions or suggest necessary actions to forestall or avert any negative consequences of the trends or patterns found.

Two basic and inextricably interrelated systems affect any collaborative forest restoration process: 1) the social system and 2) the ecological system. The social system is identifiable by the structural components and procedural mechanisms people create to help organize their various patterns of human relationships as well as the relationship between humans and resources. These typically consist of several sub-systems including a) political/bureaucratic, b) economic, c) legal, and d) cultural (religious, art, music, literature, entertainment, media). The ecological system is a vital counterpart to the human social system and, like it, is identifiable by the structures and processes of a particular ecosystem.

The following are some characteristics of systems encountered in a collaborative landscape-scale forest restoration project:

Political/Bureaucratic Systems

- **Scales:** National, regional, local; connection between scales often incomplete and/or competitive; insular, parochial tendencies
- **Structures:** Generally rigid, slow-to-respond hierarchical organization; heterarchical networks and webs of individuals with common interests and/or specific areas of knowledge or expertise
- **Drivers:** Crisis/fear, elections, budgets, legislations, legal decisions, powerful individuals, political coalitions/collaborations, public opinion, technology
- **Cycles/Patterns:** Fast, slow, random events; include election cycles, economic cycles, budgetary cycles, retirements and relocations of personnel
- **Cultural:** Competitive, dualistic (i.e., winners/losers) environment; may seek short-term compromises/collaboration to solve common problems; influenced by economic, cultural, and legal systems; bureaucrats often have little incentive for innovation and are generally risk adverse due to system's hierarchical structure.

Economic Systems

- **Scales:** Global, national, regional, local; decisions, workforce capacity, and technological advancement at global and national levels can have dramatic influence on local economies
- **Structures:** Hierarchical (corporations and other business organizations); heterarchical networks and webs of individuals with common interests and/or specific areas of knowledge or expertise
- **Drivers:** Market demands, stockholders, key individuals, available capital, workforce capacity, technology, existing infrastructure, government regulations, government support
- **Cycles/Patterns:** Fast, steady, random events; include economic cycles, political cycles; cycles of emerging technologies, patterns of consumer needs/wants; can move quickly in response to market demands when capital, infrastructure, and workforce capacity are available, but slowed when inadequate
- **Cultural:** Competitive, dualistic (i.e., winners/losers) environment, but may seek collaboration to solve common or individual, short-term problems; frequently interact with political and bureaucratic systems, especially in terms of natural resource development, providing employment, and increasing local, regional, and national wealth (see Chapter 2).

Legal Systems

- **Scales:** National, regional, local; Supreme Court, federal appellate courts, federal and state legislators, executives, and land management agencies, general public
- **Structures:** Constitutional law, common law (judicial branch oversight), statutes and ordinances (legislative branch oversight), administrative law (executive branch oversight), federal and state agency rules and regulations, contracts, memorandums-of-understanding, rules of conduct in a collaborative, consensus agreements
- **Drivers:** Desire for order/stability, public opinion, key individuals, politics, economic exchange, ethics/values

- **Cycles/Patterns:** Generally slow; activism often required for change; judicial decisions and administrative rules tend to have long-term consequences; contracts generally faster cycle and typically have shorter-term effects
- **Cultural:** Competitive, dualistic (i.e., winners/losers) environment, although contracts, memorandums-of-agreement, and consensus agreements purport to be win-win situations; provide culturally derived processes to resolve disputes and review new legislation as well as the agency decisions about environmental issues, using legal formats, such as NEPA (see Chapter 3).

Forested Ecosystems

- **Scales:** Spatial scales—regional, landscape, stand; scales of complexity—very complex (i.e., high levels of biodiversity) to more simplified
- **Structures:** Various age classes of trees, understory plants, soil, bare rock, animals, insects, fungi; exist as dynamic assemblage of biotic and abiotic components linked together by energy flows, interactive functions, food webs, genetic information, and structural hierarchies
- **Drivers:** Climatic factors, competition, fire, wind disturbances, insects, diseases, animals, humans
- **Cycles/Patterns:** Fast, steady, slow, random; include various disturbance cycles (e.g., fire return intervals); climatic and seasonal changes; reproductive cycles; chance events; energy flows of nutrients, water, sunlight; evolutionary cycles of stability, change, adaptation, and modification/variation in response to changing environmental conditions
- **Cultural:** Humans make decisions about forested ecosystems to satisfy social and personal needs; society derives "free" ecosystem products (e.g., water, air, food, building materials, medicines) and ecosystem services (e.g., recreation, crop pollination, aesthetics, transportation) (see Chapter 2).

While few people will have a complete understanding of all the systems within which a forest restoration project operates, a collaborative is in a unique position of having experts from many disciplines/practices, either in the collaborative or available to them, for consultation about systems-related issues. As they develop their plans, monitoring protocols and adaptive management strategies, collaborative groups might find it productive to focus on the scales, structures, drivers, cycles/patterns, and cultural aspects of the various systems involved in their particular collaborative landscape-scale forest restoration project.

Cultural Perspective

The cultural perspective looks at reality from a group/collective level and emphasizes the way groups establish meanings, values, rules, agreements, and take action based on their collective sense of reality. While all cultural perspectives are subjective, there are certain aspects of culture, such as language, music, art, religious beliefs and traditions, means of exchange, and others that have long legacies of use and adaptation. These cultural stalwarts provide any group of people with the stability and pragmatic tools needed to meet their personal and collective goals. When such long-lived cultural supports are destroyed, a culture tends to be lost or fade into obscurity.

A collaborative also follows this model. It obtains solidarity and strength as its members determine and understand their shared meanings and values. Once this process is underway, the collaborative is better able to forge written as well as unspoken rules of conduct, find agreement about various issues of common concern, and finalize action plans designed to alleviate commonly perceived problems. Thus, participating in a collaborative working group requires an ability to recognize cultural value sets and worldviews, discover their underlying meanings, and learn how to merge these values and ideas into a working structure that will make the project sustainable for the long term. Chapter 1 provides an excellent overview of this process.

Landscape-scale forest restoration collaboratives often bring together people from various cultures or sub-cultures: academic, environmental, Native American Tribes, business, government, recreation, communities, and media. Each of these sub-cultures has its own goals, attitudes, values, and ways of expressing the reality they see (e.g., media generally transmits reality in terms of crises, sensational stories, and personalities). The cultural norms of these sub-cultures are often deeply embedded and institutionalized; sometimes they are represented by a single individual or a small number of individuals, in other cases they represent significant numbers of people. Integrating these sub-cultural values into a new group can be a challenging effort. Nevertheless, all cultural perspectives need to be heard in order to find the common cultural narratives from which the collaborative can begin to work.

For example, as a sub-culture, restorationists have a worldview that sees the environment as “degraded, damaged, or destroyed” and a corollary view that humans are capable of repairing such environments as well as our connection to nature and our own communities through restorative activities (i.e., they have a “hands-on” approach to resource management). Other cultures or sub-cultures may hold a similar view when confronted with the reality of wildfires and/or declining local economies; other may not (i.e., they may have a “hands-off” management approach). As a result, there can be alliances and antagonists within a collaborative group. Depending on motivations, leadership abilities, access to political and/or economic power and other factors, cultural groups within the collaborative may actively seek to support or derail certain aspects of the collaborative and/or restoration process. Thus, the key work of collaborative leaders is to meld multiple perspectives into a relatively short-lived culture of “mutual resonance” in order to reach the common goals of ecosystem health and human safety and well-being.

Moving to the point of "mutual resonance" may involve negotiation between the sub-cultures involved in the collaborative process. However, before sitting down to negotiate it is important to ask several questions:

- What does your culture/sub-culture have to offer?
- What is your culture's basic philosophy and how might it provide support for the process?
- What are your culture's myths/stories/narratives and how could they be applied to push the process forward and/or to provide insights during difficult situations?
- What are your culture's structural and workforce capacity, and how might these assets be used to advance the goals of the collaborative?
- What facilities or equipment can your culture provide to advance the process?
- What are the philosophies, backgrounds, and experiences of other cultures in the process?
- What positive attributes do the other cultures have to offer?
- Who can help you understand the perspectives of the other cultures in the process; what possible social bridges exist to understanding other cultures?
- What are the cultural barriers that will have to be bridged in order to reach a "mutual resonance" or zone of agreement?

Working with various cultural (or sub-cultural) perspectives requires good information, insight, and purposeful communication. When discussing issues, pay close attention to the cultural perspectives you hear, then frame and reframe your questions and discussion to get through whatever barriers to communication and understanding may exist. Cultural differences may remain, but by attempting to honestly discover cultural perspectives is the first step toward collaboration.

Personal Perspective

As individuals, it is important to remember that we live in a multi-perspective world in which the hiker, when looking at a stand of mature trees, sees their majestic beauty; the logger counts the number of board feet; the environmentalist sees the need for protection; and the ecologist calculates the amount of carbon dioxide transpired. Similarly, every person involved in a collaborative landscape-scale forest restoration effort brings their own set of subjective values and ethics to the process. These values and ethics may or may not reflect cultural standards of society, but are most certainly affected by an individual's own experiences with other people, the environment, their employment situation, and, perhaps, other collaborative experiences. These individual values and ethics will affect how an individual thinks about the process and how they act as a member of the collaborative; creating what some may describe as a person's "agenda." Thus, knowing your "self," as strange as it may seem to some, is an integral part of the collaborative process. Moreover, being part of a collaborative is a potential learning process, providing participants with the opportunity to learn about their personal perspectives within the context of a larger group and situation.

There are a variety of ways to encounter or discover one's personal perspective. Asking yourself hard questions about your feelings or attitudes is a good first step (e.g., Why do I dislike participating in this collaborative process? What am I good at and what role might I play? Why do I think this fact will persuade people to change? Why did I volunteer when I know I'm already overloaded? Why do I get so upset when he talks? What am I going to do about my feeling and thoughts? Where do they come from?). Other means of self-discovery might include talking with others about their values, desires, and fears; exploring your feelings and thoughts through art, meditation, and other cultural practices aimed at self-exploration.

These self-questioning exercises can be supported by other more scientific means, including: 1) taking and carefully examining the results of personality tests, 2) taking part in tests that identify and explain differences within a group of people, and 3) identifying and examining your individual problem-solving and/or thinking approach as well as those of others. These experiences can help each person better see how they typically work in situations like a collaborative landscape-scale forest restoration process.

Personality tests such as the Myers-Briggs Type Indicator, the NEO Personality Inventory-Revised, the 16 PF Instrument, and the Keirsey Temperament Sorter are reliable tools for personal discovery. Such tests can not only provide insights into a person's personality but help them learn how best to effectively communicate and interact with other personality types. The Johari Window is another test that can be especially useful for improving understanding between individuals in a group setting.

Personality types are naturally interrelated with problem-solving and thinking approaches. Below are some archetypical problem-solving/thinking approaches and their general characteristics as developed by Harrison and Bramson (1984) and described in the InQ or Inquiry Mode Questionnaire:

Analyst: Seeks "one best way;" uses formal logic and deduction; interested in scientific solutions; works well with data and details, best in structured, quantifiable situations; may screen out values and subjective meanings; may try too hard for predictable outcomes; may be inflexible

Idealist: Takes a broad view of matters, good at articulating goals but may overlook details, focuses on values and aspirations, best in unstructured, value-laden situations, may screen out "hard" data, may try too hard for "perfect" solutions

Pragmatist: Seeks shortest route to payoff, interested in innovation and any data or theory that solves the problem, focuses on tactics and strategies, best in complex, incremental situations, may screen-out long-term solutions, may try too hard for expediency, can be over compromising

Realist: Uses empiricism and induction (from details to generalizations), relies on "facts" and expert opinion, interested in concrete results, points out realities and resources, good at "cutting through" and getting to the problem/point, best in well-defined, objective situations, may screen out disagreement, may rush to simplify, may overemphasize "facts"

Synthesist: Integrative, process-oriented, sees data as meaningless w/o interpretation, best in controversial/ conflict-laden situations, provides debate and creativity, may theorize excessively, may screen out agreement, may try too hard for change/newness

Identifying and examining your approach to solving problems can help anyone better understand their role in a collaborative, problem-solving process. Doing so can also help people gain insights into others in the process and how they think and react to problems. Be aware, however, that while all these tests and types can raise personal and group self-awareness, they are only guideposts, and not necessarily predictors, of how one might behave in any given setting.

While learning about yourself and others is an important part of the collaborative process, such learning is often a slow and sometimes difficult. The collaborative process, in fact, will likely move forward faster than most advances in individual and group awareness. With this in mind, and because the collaborative process can be intensely personal and because there often appears to be so much at stake from any number of perspectives, it is vital to find ways to relax, re-focus, and restore your personal energy. Active, regular practices of many kinds—riding your horse, meeting friends for dinner or a cup of coffee, playing tennis, doing yoga, running alone or with friends, being with children, meditation, dancing with friends, staring at the stars—will help ground the soul and chill the emotions. Find one that suits you, and if you can share it with someone all the better; sharing it across cultures within the collaborative is even better still.

Conclusion

As this Introduction and the other chapters in this handbook demonstrate, there are numerous barriers to successful collaborative, landscape-scale forest restoration. Fortunately, the work has already begun to overcome these scientific, systemic, cultural, and personal barriers. To build the necessary bridges will require investing in and accepting new ways of doing business at every level while honoring and recognizing those relationships, methods, and ways of thinking that have brought us this far. We will have to rise above our cultural and personal tendencies, and learn to become more cooperative rather than competitive, more interested in the common good than the bottom line, and more in tune with a reciprocal relationship to the environment rather a consumptive one.

The Collaborative Forest Landscape Restoration Program is a visionary effort to restore damaged eco-social systems, build partnerships, increase individual and collective well-being, and do right by the resources (e.g., air, water, wildlife, forests, grasslands) we have the personal and collective responsibility to manage. It is an extraordinary example of federal-local cooperation aimed at solving a regional/national problem. While recognizing each collaborative group will address their specific CFLRP project according to local conditions, needs and desires, the authors and editors of this book have worked to provide a general overview of the process from planning through implementation to monitoring and adaptive management. In addition, the chapters of the book include detailed information that may be useful to CFLRP and other landscape-level forest restoration projects. More will need to be written as this process moves forward, and we learn from our successes and mistakes.

To readers from all perspectives—these collaborative landscape-scale forest restoration projects are real work, needed work, the work of a lifetime, the work of consequence to future generations as well as our own. We're all in this together and if we can find the common ground necessary to achieve our collective goals, we will make ecological and cultural history.

References

Anderson, M.K. 2006. *Tending the wild: Native American knowledge and the management of California's natural resources*. Berkeley: University of California Press.

Covington, W.W. 2003. The evolutionary and historical context. Pages 26-47 *in* P. Friederici, ed., Ecological restoration of southwestern ponderosa pine forests. Washington, DC: Island Press.

Covington, W.W., W.A. Niering, E. Starkey, and J. Walker. 1999. Ecosystem restoration and management: Scientific principles and concepts. Pages 599–617 *in* Ecological stewardship: A common reference for ecosystem management. Oxford, UK: Elsevier Scientific, Ltd.

Egan, D. and E.A. Howell, eds. 2001. *The historical ecology handbook: A restorationist's guide to reference ecosystems*. Washington, DC: Island Press.

Egan, D., E.E. Hjerpe, and J. Abrams. 2011. Why people matter in ecological restoration. Pages 2-20 *in* D. Egan, E.E. Hjerpe, and J. Abrams, eds., Human dimensions of ecological restoration: Integrating science, nature, and culture. Washington, DC: Island Press.

Esbjörn-Hargens, S. and M.E. Zimmerman, eds. *Integral ecology: Uniting multiple perspectives on the natural world*. Boston and London: Integral Books.

Gunderson, L.H. and C.S. Holling, eds. 2002. *Panarchy: Understanding transformations in human and natural systems*. Washington, DC: Island Press.

Harrison, A.F. and R.M. Bramson. 1984. *The art of thinking*. New York: Berkley Books.

Kimmerer, R. 2011. Restoration and reciprocity: The contributions of traditional ecological knowledge. Pages 257-276 *in* D. Egan, E.E. Hjerpe, and J. Abrams, eds., Human dimensions of ecological restoration: Integrating science, nature, and culture. Washington, DC: Island Press.

Millar, C.I. and W.B. Woolfenden. 1999b. The role of climate change in interpreting historical variability. *Ecological Applications* 9 (4):1207–1216.

Millar, C.I. and L.B. Brubaker. 2006. Climate change and paleoecology: New contexts for restoration ecology. Pages 315-340 *in* D. Falk, M. Palmer, and J. Zedler, eds., Foundations of restoration ecology. Washington, DC: Island Press.

Millar, C.I., N.L. Stephenson, and S.L. Stephens. 2007. Climate change and forests of the future: Managing in the face of uncertainty. *Ecological Applications* 17(8):2145-2151.

Moore, M.M., W.W. Covington, and P.Z. Fule. 1999. Reference conditions and ecological restoration: A southwestern ponderosa pine perspective. *Ecological Applications* 9(4):1266-1277.

Peterson, D.L., C.L. Millar, L.A. Joyce, M.J. Furniss, J.E. Halofsky, R.P. Neilson, and T.L. Morelli. 2011. Responding to climate change in national forests: A guidebook for developing adaptation options. Gen. Tech. Rep. PNW-GTR-855. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Society for Ecological Restoration Science and Policy Working Group. 2004. *The Society for Ecological Restoration primer*. Washington, DC: Society for Ecological Restoration.

Swetnam, T.W., C.D. Allen, and J. Betancourt. 1999. Applied historical ecology: Using the past to manage for the future. *Ecological Applications* 9(4):1189-1206.

U.S. Forest Service. 2011. U.S. Forest Service Manual, National Forest Resource Management, Chapter 2020 Ecological Restoration and Resilience. Washington, DC: U.S. Forest Service National Headquarters.

___. 2012. US Forest Service restoration projects reduced fire danger, provided jobs in 2011. Washington, DC: U.S. Forest Service National Headquarters.

Chapter 1



Collaboration

Windy Selig

During the last 20 years, many policy makers, stakeholders, and land management agencies have embraced collaborative approaches as a means of guiding forest management on public lands (Lowe and Moote 2005). Working collaboratively on forest management projects began in the 1990s due to public demand for increased participation in federal land management and the application of alternative dispute resolution methods to environmental conflicts. Pressure to increase public involvement gathered speed as the scale of natural disasters, such as wildfires, flooding, insect infestations and tree disease, and the complexity of finding social, ecological, and political solutions began to increase exponentially. Public engagement in forest management planning also evolved as reactionary coalitions. These coalitions often used extreme methods to change the existing situation and became highly functional social networks that pro-actively emphasized science-informed, restoration-oriented management of public lands (Cheng and Mattor 2006).

These efforts found support in a number of federal policies established to aid "cooperative conservation." The Healthy Forests Restoration Act of 2003 and the "Facilitation of Cooperative Conservation" Executive Order of 2004 encouraged federal agencies to work collaboratively with multiple stakeholders on natural resource management issues (Cheng and Mattor 2006). Collaboration was also mandated under the Collaborative Forest Landscape Restoration Act (CFLRA) of 2009 and is an integral part of planning under the proposed Revised National Forest Planning Rule.

Collaboration refers to a process where individuals and groups with different interests come together to address management issues and create agreements. Collaborative forest restoration is a process through which multiple stakeholders jointly explore diverse values and interests and attempt to come to some level of agreement about appropriate land management. Collaboration implies stakeholder involvement that goes beyond the usual processes of public comment on agency proposals,

> ***"Collaborative forest restoration is a process through which multiple stakeholders jointly explore diverse values and interests, and attempt to come to some level of agreement about appropriate land management.***

typical of public meetings and comment periods. The goal of a collaborative is to develop new approaches to restoration that are both scientifically credible and socially acceptable. The ***collaborative process*** provides the framework for creating a constructive dialogue. In a collaborative process, stakeholders participate directly in identifying issues of concern, developing proposed actions, and reviewing alternatives. A key aspiration of collaboration work is building a vision and plan for land management that will address and overcome objections that would otherwise lead to litigation and project delays.

The Council on Environmental Quality (CEQ) *Collaboration in NEPA: A Handbook for NEPA Practitioners* (CEQ 2007) states, "By engaging relevant expertise, including scientific and technical expertise, and knowledge of a local resource, a collaborative body can reach a more informed agreement and advise decision-makers accordingly." The CEQ handbook further states that benefits of collaboration include a fairer process, improved fact-finding, increased social capital, enhanced environmental stewardship, and reduced litigation. To be productive in such a high level of engagement, collaborative efforts often formalize the structure and framework in which they operate.

The Structure and Framework for Collaboration

Collaborative efforts generally move from an under-organized state, where individual stakeholders act independently, toward a more tightly organized relationship, characterized by concerted decision-informing recommendations (Bouwen and Taillieu 2004). Because collaborative groups typically involve diverse and sometimes competing interests, established organizational structures (e.g., charter, decision rules, participation and operating rules, memorandum of understanding) guide the collaborative process more effectively through all forms of engagement, such as meetings, document development and planning. Landscape restoration collaboratives also involve stakeholders from across large geographic areas, which can create logistical barriers. For example, travel to meet face-to-face may not be an option or may only occur intermittently because of the distances, time, and expenses involved. Using appropriate tools between meetings can enhance distance communication, project management, and maintain momentum toward the desired outcome.

Structure and Organization

Collaborative forest restoration efforts can take many forms because groups vary considerably in the number of participants, scope of goals and activities, land ownership represented, interest groups involved, and the decision-making processes used. It is helpful to learn from specific examples of both successful and unsuccessful efforts by looking at how they formed, who was involved, and how they governed themselves. There are a variety of ways to collaborate, including planning committees and advisory councils, networks, co-management groups, and partnerships. While they are all different, what they have in common is the active involvement of multiple stakeholders.

Planning committees and advisory councils provide advice and/or help develop guidelines and plans for other organizations, such as government agencies. Group members are usually invited or appointed based on their expertise. The group typically has no decision-making authority, but its suggestions are used by authorities to guide the details of restoration projects. These groups may last for months or years, or may dissolve once the task at hand has been accomplished. One example is the Arizona Forest Health Oversight and Advisory Councils, which were instrumental in developing the Statewide Strategy for Restoring Arizona's Forests.

Networks are loosely defined groups of individuals with overlapping interests or responsibilities, who engage in informal communication over extended periods of time. The goal is information exchange and resource sharing, not decision making or project implementation. The National Network of Forest Practitioners is an example of a network.

Co-management is a formal process with a focus on shared power among government authorities or between an agency and one or more user groups. Participation is limited to people with legal authority and decision-making capacity. Co-management groups may develop and analyze restoration proposals, develop and ratify legally binding agreements, and share the decision-making process among a handful of key stakeholders. Co-management can operate permanently or may be developed to work for a specified length of time. The Grand Canyon-Parashant National Monument (GCPNM), for example, is co-managed by the Bureau of Land Management and the National Park Service.

Partnerships are generally long-standing and place-based groups that serve to identify issues, gather information, generate management options, and develop recommendations for restoration projects within a specified geographic area. Participants usually represent an agency or special interest group, but non-aligned citizens may also participate. As with planning committees, partnerships usually do not have decision-making authority, but their suggestions are influential and are often adopted by agency personnel and government authorities. The Parashant Partnership is an example. The BLM and NPS, who as mentioned before co-manage the GCPNM, have invited the Parashant Partnership to collaboratively develop management recommendations for areas within the GCPNM.

Each type of collaborative group may decide to formalize a framework for governance to guide planning efforts. Initial steps can include identifying additional participants, establishing ground rules for interaction, clarifying areas in need of agreement, determining resource and funding sources, choosing appropriate meeting times and venues, entering into memoranda of understanding, identifying needs for information and technical expertise, and selecting independent facilitators or mediators as appropriate. There may be subcommittees for each of these steps or the group may act as a whole.

Members of the stakeholder group for the Four Forest Restoration Initiative (4FRI) meet to craft a Memorandum of Understanding. *Photo courtesy of ERI*

Federal Government in Collaboration

Federal agencies are authorized to collaborate with the public under a variety of laws and directives. Under these laws, the boundaries of collaborative influence and the extent of federal agency authority are sometimes areas of confusion or contention. As agencies rely more and more on public involvement, participants continue to push the boundaries to their preferred level of influence. Nevertheless, while collaborating with others, lead agencies retain decision-making authority and responsibility. Understanding the current structures for government involvement and how those structures can be creatively used may offer more innovative insight into the full range of collaborative potential.

The CEQ *Collaboration in NEPA: A Handbook for NEPA Practitioners* discusses four levels of government involvement in collaboration along a spectrum that includes *inform, consult, involve* and *collaborate*.

> *“Because collaborative groups typically involve diverse and sometimes competing interests, established organizational structures guide the collaborative process more effectively through all forms of engagement, such as meetings, document development and planning.*

Each level describes how the government may involve public input in the decision making process, agency goals for that input, case examples, and processes followed to obtain input. The primary focus includes the *collaborate* level, in which the authors of the handbook encourage agency leads by suggesting that the agency will find itself in a more justifiable position when adopting a consensus-based recommendation. Additionally, the lead agency can draw on the increased capacity for cooperation that has developed through the collaboration to expedite implementation. The authors of the handbook are careful, however, to remind participants that the agency remains the sole decision-making authority, regardless of how much collaboration went into making the decisions.

Understanding the agency and becoming familiar with its culture of collaboration, and its internal policy for collaborating with the public are key steps for any collaborative. For instance, the BLM's Appropriate Dispute Resolution program is used in natural resource management to broaden the spectrum of processes for preventing, managing, or resolving conflict outside the conventional arenas of administrative adjudication, litigation, or legislation. These activities range from direct negotiation and mediation through stakeholder working groups, joint fact-finding, ombudsman services, and many other processes and strategies for managing conflict and fostering agreement.

It is important to understand that involved and engaged collaboration between government agencies and the public enhances the collaborative potential for effectiveness and improves the quality of decisions. Participant familiarity and full understanding of the constraints of agency involvement can lead to innovative solutions for involvement.

Barriers to Successful Collaboration

In ideal collaboration, visions are shared and goals are unambiguous and uncontested. However, natural resource planning situations can be typified by competing interests, a lack of scientific agreement, limited time, imbalance in resources, and structural inequities in the access to information and the distribution of political power (Lachapelle et al. 2003). Collaboration requires a high level of interaction and engagement that may tax the ability to communicate competently, debate constructively, and explore thoroughly (Daniels and Walker 2001). Collaboration can be further complicated by stakeholder histories that may involve conflict, cultural barriers, and by working with agencies unaccustomed to collaborating.

Conflict

Anyone who has been involved in a collaborative process knows that a conflict within the group typically involves multiple participants, can be complex, and can intensify dramatically if left unresolved. When multiple parties are involved, the complexity of the problem increases dramatically and may minimize desired outcomes by redirecting group and individual energies from the intended goal. Moreover, as the conflict increases, reasonable people may demonstrate irrational or unwarranted behaviors. Unmanaged conflict can escalate in intensity over time, resulting in counterproductive behaviors (Greer 2012).

Conflict-causing behavior can be managed by dealing successfully with underlying motivations. Fear, distrust, or a lack of awareness of other options for open communication and problem-solving may lie behind rigid positions. When conflict is strategically managed, the results can be beneficial and lead to cohesive decision-making and positive social interactions as well as increased morale and greater innovation toward achieving the overall common goals (Greer 2012).

Stakeholder Histories

It is not uncommon for a "history of conflict" to exist among stakeholders, especially in groups where stakeholders have had previous interactions. Parties engaged in a collaborative process may also be engaged in a litigious battle over property rights or access in land uses. In such situations, perceptions and behaviors may carry over from the litigious battle into the collaborative group. Even when the litigious battle is over for decades, members may maintain a deep emotional memory that influences their interactions. Natural adversaries and natural allies often exist due to past histories of conflict. Being aware of such relationships is important.

Cultural Barriers

Ways of thinking, using language, what we pay attention to, and how we convey our ideas are forms of cultural orientations that influence our interaction with others and the land. Parties who have different cultural orientations may experience barriers that can cause frustration and lead to misunderstandings. Beyond communication, there may be conflicting uses of the land from one culture to another. For instance, snow-making from reclaimed water has caused a dispute among members of the Hopi and Navajo tribes and the owners of the Arizona Snowbowl ski resort in Flagstaff, Arizona. Both tribal councils view the entire San Francisco Peaks mountain region as a spiritual place and, as a result, have expressed their opposition to using reclaimed water in snow-making operations. The owners of the ski resort want to pursue snow-making because they believe that reclaimed water is harmless and will enhance skiing opportunities for mountain recreationists. Such cultural differences may not have a venue for collaborative resolution. However, in many collaborative efforts differences in cultural foundations provide a rich blend of values and perceptions. Combined cultural orientations can, also, offer land management agencies a better understanding of the total value of the landscape restoration process.

Conflicting Science and Interpretations of Science

Collaborative efforts in landscape-scale restoration increasingly rely on science to inform management planning. The nature of science, especially ecology and forestry-based science, is to produce analyses and results to influence outcomes in land management. Conflict may arise over accuracy of results, interpretations of the science, how to transfer results from an analysis to results on the land, and who gets credit for the work. Additionally, research and analyses have historically focused at the project and program level. Attempts are now focused toward simultaneously understanding resources and landscapes at several scales during assessment and analysis to improve understanding of linkages and relationships within and between scales, and provide improved relational context. Such a change in thinking about, observing, and analyzing a situation is new and requires adjustment, but is likely one of the most fundamental hurdles to overcome to effectively implement ecosystem management (Thomas 1996).

Challenges within a Changing Agency

Natural resource policy, planning, and decision-making has historically addressed the ecological and recreational characteristics of resource management, while social processes have not been adequately understood or addressed in management frameworks (Van Riper 2003). In "Exploring Barriers to Collaborative Forestry," authors Ann Moote and Dennis Becker examine national policies and other factors that may be hampering project implementation and offer suggestions to aid collaborative forestry groups in moving forward:

> Acceptance of collaboration in land management planning varies among different land and resource management agencies as well as among departments and individuals within the same agency. Many agency employees see collaboration as an inappropriate or inefficient use of their time, and in some cases agency staffers are suspected of using existing

procedures as an excuse to justify non-participation in collaborative partnerships. On the other hand, many agency employees effectively collaborate despite agency cultures and policies. Collaborative groups perceive barriers when agencies limit the discretion of local field staffers or discourage innovation. Under these circumstances, collaboration is a "hard sell" to agency personnel who foresee a considerable increase in work load for limited benefits or suspect they may lose control of the planning and implementation process (Moote and Becker 2003).

Legal Requirements as a Barrier to Collaboration

Some environmental legislation may create barriers to the collaborative process due to misunderstandings or a lack of clarity about how such legislation and regulations affect decision-making and operations. The NEPA and the Forest Advisory Committee Act (FACA) are two such pieces of legislations.

Under NEPA regulations, agencies are required to engage in forms of public participation, such as notice and comment procedures, and public outreach. Agencies are also required to involve the public to the extent practicable in developing Environmental Assessments and Environmental Impact Statements. Challenges in the NEPA process can occur when agencies follow minimum requirements for engaging the public. They also occur when members of the public have higher expectations of how their input will be used in the agency process than is realistic.

The FACA governs advisory committees within the Executive Branch of the federal government. Advisory committees are formally chartered committees developed to provide collective advice to the managing agency. The FACA provides many of the best practice recommendations for collaborative problem-solving and can be effective for carrying out a collaborative process. However, the FACA can present challenges to agencies wishing to collaborate with groups that include non-federal organizations or private citizens because incorporating advice and recommendations from groups involving non-federal organizations or members of the public can lead to a FACA violation. Bridging such legal barriers is important to garnering public support and, ultimately, implementing the project (see below as well as Chapter 5 for more information about ways to achieve this goal).

There are more barriers to collaboration than those described here. However, whatever the barriers may be for a given collaborative group, they likely can be overcome through constructive measures that may simply involve open and transparent communication or more structured facilitated negotiations. While barriers are likely to exist in any collaborative process, the benefits of collaborating far exceed the costs. Barriers, also, often serve as catalysts to strengthen a collaborative process and collective resolve to achieve the greater goal of landscape scale restoration.

ERI's Doc Smith guides a field trip to the Fort Valley Experimental Forest, north of Flagstaff, Arizona. *Photo courtesy of ERI*

Trips into the field are good team building exercises. *Photo courtesy of ERI*

Federal Government Support for Collaboration

Environmental policies have evolved during recent decades and now offer legal guidelines that support collaborative efforts by identifying how to secure funding and work with government agencies. Programs developed around these policies also offer support in various forms.

The CFLR Program, in particular, provides selected projects with benefits that, in addition to funding, can enhance the collaborative process. The CFLR Program offers a suite of resources that draw from experiences of past and ongoing projects to assist newly forming projects in terms of education and training. For instance, the U.S. Forest Service (USFS) and National Forest Foundation co-host a series of Peer Learning Sessions that includes members from projects nationwide in webinar, or online presentation, format. These sessions serve as an opportunity for cross-learning, informal discussion, and sharing of information among collaborators and USFS personnel.

As noted above, bridging the barriers created by NEPA and FACA is a key step in the collaborative forest restoration process. Fortunately, there are a variety of processes and tools available to agency and public members about how to collaborate more fully within and across the different phases of the NEPA process. One key tool is the CEQ *Collaboration in NEPA: A Handbook for NEPA Practitioners* (2007). This handbook introduces the NEPA practitioner and other interested parties to the issue of collaboration, outlines general principles, presents useful steps, and provides information about methods of collaboration. The insight offered in this handbook can provide innovative methods for collaborating in the NEPA. This handbook also addresses challenges from FACA regulations.

> “*When conflict is strategically managed, the results can be beneficial and lead to cohesive decision-making and positive social interactions as well as increased morale and greater innovation toward achieving the overall common goals.*”

To avoid a FACA violation, the managing agency must show that collective advice was chartered from public input and collaborative groups, meetings were noticed in advance and open to the public, the membership was balanced in the points of view represented, and the public had an opportunity to submit comments. In the collaborative process, if a group is not a federally appointed advisory committee, the managing agency can be innovative in designing a collaborative process that meets the interests of all members of a group and satisfies FACA. In addition to the CEQ *Collaboration in NEPA: A Handbook for NEPA Practitioners* (2007), the USFS Partnership Resource Center is another useful resource to learn ways to navigate FACA requirements.

Resources for Successful Collaboration

Effective collaborative resources, typically provided by credible, experienced sources (e.g., government agencies, foundations, non-profits), offer a range of tools to guide each aspect of the collaborative process. For instance, the USFS Partnership Resource Center offers a full range of tools designed to assist in developing an understanding of each phase of the collaborative process, including understanding the art of collaboration, developing strong partnerships, finding funding, and developing monitoring strategies and joint learning. This is an informative resource that can serve as a template for gauging quality among the plethora of collaborative resources available.

Credibility is an important consideration when seeking quality resources. The collaborative process can be complex and should be informed by resources that demonstrate experience and expertise. The U.S. Institute for Environmental Conflict Resolution of the Udall Foundation, for example, serves as a good example of a credible resource for informed, experienced, and expert use of collaboration in natural resource management. They offer services in facilitation and training in conflict resolution to anyone involved in an environmental conflict involving the United States government. They have trained various staff and the leadership of professional organizations, universities and federal agencies including the Department of Interior, the U.S. Army Corps of Engineers, and the USFS.

Resources to help determine which type of collaborative structure may be appropriate for a project and how best to organize the social framework of that project come in a variety of forms. In an ongoing effort to explore the human dimension side of ecological restoration, the Ecological Restoration Institute has published a series of papers that identify collaboration as a tool as well as barriers and policy challenges to different types of collaborative efforts.

Another useful resource is The Collaboration Handbook published by the Red Lodge Clearinghouse, which provides common sense and practical advice about putting a collaborative effort together and making it work. Among many good books available on the topic of collaboration in ecological restoration are two that are truly insightful and in depth. *Working through Environmental Conflict: The Collaborative Learning Approach* (2001) by Steven Daniels and Gregg Walker discusses both the theory and technique of collaborative learning and presents cases where it has been applied. This is a professional and teaching tool for scholars, students, and researchers involved with environmental issues as well as dispute resolution. *Human Dimensions of Ecological Restoration: Integrating Science, Nature, and Culture* (Egan et al. 2011) discusses the social, political, economic, and cultural dimensions of successfully implementing ecological restoration projects. This book takes an interdisciplinary look at human aspects of ecological restoration and provides practical and theoretical information, analysis, models, and guidelines for optimizing human involvement in restoration projects.

Quick Links

The following agencies and organizations provide tools and resources for conflict resolution and bridges to successful collaboration:

BLM Collaborative Stakeholder Engagement and Appropriate Dispute Resolution (ADR) Program

CEQ Collaboration in NEPA: A Handbook for NEPA Practitioners

USFS Partnership Resource Center

U.S. Institute for Environmental Conflict Resolution

Red Lodge Clearinghouse Collaboration Resources

Connectivity

There are many tools available for distance communication and project management that help create the level of connectivity that spatially distant collaborative members often need. While one should never discount the effectiveness of phone or video-conferencing communication, some government leaders, scientists and academics, non-governmental organization (NGO) advocates, and practitioners are discovering how new computer-assisted, decision-informing tools and emerging forms of electronic communication can be useful in resolving controversial decision-making processes. Examples include web-based project and information management tools, computer-assisted decision support systems, visualization, modeling, and simulation tools, and a range of survey tools and electronic methods for content analysis. These tools represent opportunities in finding appropriate applications to foster collaboration and dispute resolution.

For example, any Ware Polling was designed as an ecosystem based stakeholder engagement and outreach tool for use in public meetings to obtain anonymous feedback from participants at key decision points. This tool allows the group to confirm whether consensus is reached or it may inform the process facilitator that additional information or discussion is required. Another useful tool is Google Docs, which is a web-based real-time collaboration tool for editing documents, spreadsheets, presentations, and more. Basecamp and Team box are web-based project collaboration and management tools that include messaging, file sharing, timeline management, and goal setting.

Some collaborative efforts will need only a tool to enable distance communication. Some will require a more project management oriented tool. Whichever the need may be, a variety of tools are available both at cost and for free. These tools can enhance the collaborative momentum and keep stakeholders actively engaged across distances.

Case Studies as Resources

Among the various resources available, case studies may offer the most useful representation of how the phases and nuances of collaboration can be managed and may lead to successes or failures. There are a multitude of resources available to share the stories of other collaborative efforts. We offer a brief list here as a starting point.

- *Forest Communities, Community Forests* (Kusel 2003) is a collection of case studies that document twelve communities in the United States and their efforts to protect and restore their community forests. It explores the struggles and opportunities faced by people as they work to invest in natural capital, reverse decades of poor forest practices, tackle policy gridlock, and address community as well as ecological health.
- RedLodge Clearing House offers a list of links to collaborative project summaries. Each summary includes the project's objectives, participants, lessons learned, accomplishments, and more.

Each resource that offers information on collaboration is likely to have case studies as supporting documentation. Case studies are powerful examples of the complexity of the collaborative process and how the management of nuances can lead to a success or failure regardless of the volume or amount of effort put into the support and development of a project.

For any newly forming collaborative effort, the challenge of taking an idea and turning it into a functioning system with a set of managed outputs and benefits can be overwhelming. Becoming familiar with the available resources to assist in each step of the collaborative effort can be the most effective step along the evolution from idea to established collaborative project and finally to success.

Alternatives to Collaboration

Although the goal of collaborative groups is to build and promote a collective vision for how to manage the land, collaboration may not be the first step in all cases. Some situations, for example, may require facilitated negotiation or other methods to help groups work through controversial or divisive problems before collaboration can occur. There may be other instances when collaboration is not

> *"Case studies are powerful examples of the complexity of the collaborative process and how the management of nuances can lead to the success or failure of a project.*

appropriate because key stakeholders are not interested in resolving an issue, one or more key parties have other avenues to better achieve their interests, or not everyone involved agrees that there is conflict or an issue that needs resolution. Whether a forest restoration project is ready for the collaborative process or requires a negotiation approach or resolution through other means, every collaborative effort needs to become familiar with the expert resources available that can help them translate theoretical ideas into action on the ground.

Conclusion

Collaboration in landscape restoration is a complex, challenging and imminently rewarding undertaking. Interweaving the complexity of social and ecological issues at the size and scale necessary for landscape scale restoration challenges dimensions of our human ability, and forces an evolution in our approach and understanding of the land we inhabit and the communities in which we live. The challenge to find innovative processes and methods to honor local, regional, and national interests in landscape restoration is continual. Still, as this evolution occurs, many strong collaborative efforts are forging through associated challenges to return the health of the natural landscape.

References

Bouwen, R. and T. Taillieu. 2004. Multi-party collaboration as social learning for interdependence: Developing relational knowing for sustainable natural resource management. *Journal of Community & Applied Social Psychology* 14:137–153.

Cheng, A.S. and K. Mattor. 2006. Why won't they come? Stakeholder perspectives on collaborative national forest planning by participation level. *Environmental Management* 38:545–56.

Council on Environmental Quality (CEQ). 2007. Collaboration in NEPA: A handbook for NEPA practitioners. Washington, DC: Council on Environmental Quality.

Daniels, S.E. and G.B. Walker. 2001. *Working through environmental conflict: The Collaborative Learning Approach*. Westport, CT: Praeger Publishers.

Egan, D., E.E. Hjerpe, and J. Abrams, eds. 2011. *Human dimensions of ecological restoration: Integrating science, nature, and culture*. Washington, DC: Island Press.

Greer, W.J. 2012. *Managing sources of conflict in collaborative settings*. ERI Fact Sheet. Flagstaff, AZ: Northern Arizona University, Ecological Restoration Institute.

Kusel, J. and E. Adler. 2003. *Forest communities, community forests*. Lanham, MD: Rowman and Littlefield Publishers.

Lachapelle, P.R., S.F. McCool, and M.E. Patterson. 2003. Barriers to effective natural resource planning in a "messy" world. *Society and Natural Resources* 16(6)473-490.

Lowe, K. and M.A. Moote. 2005. *Collaboration as a tool in forest restoration*. ERI Working Paper 11. Flagstaff, AZ: Northern Arizona University, Ecological Restoration Institute.

Moote, M.A. and D. Becker. 2003. *Exploring barriers to collaborative forestry*. Report from a workshop held at Hart Prairie, Flagstaff, Arizona, September 17–19, 2003. Flagstaff, AZ: Northern Arizona University, Ecological Restoration Institute.

Thomas, J.C. 1995. *Public participation in public decisions: New skills and strategies for public managers*. San Francisco: Jossey-Bass Publishers.

Van Riper, L. 2003. *Can agency-led initiatives conform to collaborative principles? Evaluating and reshaping an interagency program through participatory research*. Ph.D. Dissertation for Doctor of Philosophy, University of Montana.

Chapter 2

Ecological Economics

Evan E. Hjerpe

Frequent-fire forests in the western United States burn more intensely and at a greater spatial scale than during any other recent time. The increase in fire intensity is symptomatic of unnatural forest structure spurred by more than a century of grazing, fire exclusion, logging, and road building in these forests (Covington and Moore 1994, Brown et al. 2004) combined with warming climates (Westerling et al. 2006). This loss of ecological integrity in western, frequent-fire forests has numerous political and economic ramifications for communities, management agencies, and taxpayers. Moreover, it has caused a reduction in the flow of ecosystem services—the suite of benefits provided by nature to mankind, such as water purification, recreational opportunities, wildlife habitat, and biodiversity (Benayas et al. 2009).

To address increasing fire management challenges and decreasing ecosystem service benefits, politicians, researchers, land managers, and the public have called for large-scale, forest restoration treatments. The intent of restoration is to return greater naturalness and resilience to forest structure, function, and processes primarily by thinning, prescribed burning, and wildland fire use. Forest restoration is often coupled with watershed restoration to improve degraded streams, decommission old roads, and remove invasive plants. Forest restoration prescriptions are often informed by historical reference conditions, while anticipating future, altered successional trajectories (Allen et al. 2002).

Ample evidence-based research illustrates that forest restoration can effectively change wildfire behavior and help return natural fire regimes to degraded western forests (Cram et al. 2006, Murphy et al. 2010, Fulé et al. 2012). Likewise, research shows that restoration is also effective at increasing the quality and quantity of critical ecosystem services (Benayas et al. 2009). The combination of restored natural fire regimes and increased ecosystem services make forest restoration a powerful economic vehicle for rural communities and the nation. Translating these ecological changes into economic values is paramount for understanding the total value and potential of large-scale forest restoration. Moreover, the ecologically oriented primary intent of landscape-scale forest restoration requires novel social and economic valuation methods to illustrate its associated costs and benefits.

This chapter explores the economics of landscape-level restoration treatments in degraded western forests by focusing on the first large-scale forest restoration program of the U.S. Forest Service (USFS), the Collaborative Forest Landscape Restoration Program (CFLRP). It is important that collaborative stakeholders understand the economics of the CFLRP because the value placed on fiscal returns and responsibilities represent significant aspects of the legislation. In addition, there is significant, vested interest on behalf of the tax-paying public.

The San Francisco Peaks jut out behind a line of yellow aspen trees in the Inner Basin north of Flagstaff, Arizona. In the foreground is a City of Flagstaff well. Every fall, thousands of tourists visit Flagstaff to see the changing aspen leaves. In June 2010, the Inner Basin was threatened by the 15,075-acre Schultz Fire. Subsequent flooding from the fire destroyed a major waterline for the city and shut down the road to the Inner Basin for a year. *Photo by Brienne Magee, USFS Coconino National Forest*

CFLRP Economics

Title IV of the Omnibus Public Land Management Act of 2009, known as the Forest Landscape Restoration Act (FLRA), established the Collaborative Forest Landscape Restoration Program in large part to deal with wildfire-related issues. The purpose of the Act is to "encourage the collaborative, science-based ecosystem restoration of priority forest landscapes." The legislation emphasizes that forest restoration should be done efficiently so as to maximize regional economic impacts and benefits while achieving significant social and policy objectives.

CFLRP: The Economic Rationale

While the primary intent of the CFLRP is to restore degraded forests, the most important drivers of this legislation were the escalating costs and frequency of fire (Schultz et al. 2012). Section 4001(1–4) of the Act promotes restoration through a process that: "encourages ecological, economic, and social sustainability; leverages local resources with national and private resources; facilitates the reduction of wildfire management costs, including through reestablishing natural fire regimes and reducing the risk of uncharacteristic wildfire; and demonstrates the degree to which—

> (A) various ecological restoration techniques—
> > (i) achieve ecological and watershed health ob jectives; and
> > (ii) affect wildfire activity and management costs; and
>
> (B) the use of forest restoration byproducts can offset treatment costs while benefitting local rural economies and improving forest health."

The legislation received widespread support because a restored forest was viewed as additionally enhancing numerous economic values, such as better fish and wildlife habitat, improved water quality, more jobs in-the-woods, and useful woody byproducts.

CFLRP: Leveraging Funds and Economic Monitoring

The CFLRP is a competitive program within the USFS designed to incentivize broad stakeholder agreement about project goals while leveraging local and private resources with federal funding. The competitive nature of the CFLRP theoretically directs funding to the projects and collaborative groups that best illustrate a structure and strategy most capable of successfully implementing landscape-scale restoration. Project selection and continued funding depends significantly on the ability of the designated CFLRP project to create and maintain regional economic impacts, particularly those associated with job creation.

Incentives for leveraging additional funds for CFLRP projects are an important component of the Act because CFLRP funds are not used for National Environmental Policy Act (NEPA) planning, and they only pay for up to 50% of project monitoring. Additionally, an "all lands" approach was employed, leading to project proposals being partially judged by the amount of non-federal investment that would be leveraged. These stipulations force collaborative groups and the USFS to build a foundation of matching funds for many parts of the CFLRP process, and to use additional appropriations for NEPA planning. They also incentivize the regional stakeholders and collaboratives to expose projects to potential outside investors, such as commercial interests, non-profits, tribes, and states.

The economic monitoring of CFLRP projects is extensive. Collaboratives, in conjunction with the USFS, must track various economic metrics—costs of treatments, matching and in-kind resources, leveraged restoration resources adjacent to CFLRP projects, timber and woody biomass sold, and economic impacts. Economic monitoring is critical to determine whether projected economic impacts are realized, if treatment costs decrease over time, and if fire management costs are reduced in the long run.

To streamline and standardize project proposals and economic monitoring, the USFS developed the Treatments for Restoration Economic Analysis Tool (TREAT) to estimate the economic impacts of each proposed CFLRP project. The TREAT provides teams with a standard interface to estimate employment and labor income impacts from proposed restoration activities (Box 1).

CFLRP: Tracking the Flow of Money

Annual congressional appropriations fund CFLRP projects and, while funding is currently only authorized through 2019, there is widespread congressional support for the CFLRP at this time. Initially $10 million were appropriated for the CFLRP in Fiscal Year 2010, $25 million in 2011, and $40 million in 2012. Nevertheless, future appropriations remain uncertain given the concerns about the federal debt and the desire for "smaller" government.

Box 1. The Treatments for Restoration Economic Analysis Tool

The Treatments for Restoration Economic Analysis Tool (TREAT) model is used to help estimate the economic impacts for proposed and ongoing CLFRP projects, specifically employment and labor income. The standardized inputs in TREAT allow for simple aggregations and comparisons among CFLRP projects. The uniform templates also allow USFS economists to calculate final economic impacts based on data entered by CFLRP-associated stakeholders and project managers. USFS economists also work with project managers to ensure accurate data entry.

The first version of the TREAT model was developed specifically for the CFLRP and the 2010 project proposals. That version provided a comprehensive, easy-to-use economic platform for estimating the economic impacts of implementing ten-year strategies. A new version of the TREAT model is now available for the CFLRP projects. Three recent updates to the TREAT model represent advances in terms of capturing more accurate CFLRP economic data:

- County-level economic data is used, which means economic impacts are isolated from out-of-region or national impacts. The original TREAT model used state-level economic linkages that matched USFS regions. That model overestimated the multiplier effects, or the indirect and induced effects, of CFLRP project expenditures. The current TREAT model uses localized economic data for the specific counties where projects occur, producing more reliable estimates of economic impacts.
- Economic impacts are now monitored by specific year. The initial TREAT versions had users enter ten-year total estimates to produce annual averages.
- Local estimates for direct effects of timber harvest and processing are now incorporated. The latest version incorporates local commercial forest product response coefficients as determined through site-specific economic surveying from the University of Montana's Bureau of Business and Economic Research. This allows for more precise estimates of the economic impacts associated with commercial forest products from CFLRP projects.

Appropriations for CFLRP projects are made available at the discretion of the Secretary of Agriculture, acting through the Chief of the USFS. Funds are dispersed to regional USFS offices and individual national forests that are sites of proposed or ongoing CFLRP projects. The funds are then expended on contracts and agreements developed in collaboration with regional forest stakeholders (for more about contracts, see Chapter 5). Contracts and agreements for implementation and monitoring activities are signed with businesses, non-profit organizations, and academic institutions. Expenditures are tracked in annual reports by budget line items for the USFS and by matching funds (Box 2).

Costs and Benefits of Landscape-level Forest Restoration

Landscape-scale forest restoration is designed to protect human lives, communities, and infrastructure as well as return resilience to forest ecosystems. To achieve these goals, CFLRP projects, like all forest management activities, produce costs and benefits. While costs may be more-or-less immediately known, many benefits may not be recognized for quite some time. This can make landscape-scale restoration more difficult to achieve given our culture's desire for immediate gratification. However, if the goals of social and ecological sustainability are to be truly embraced, the current generation must begin to pay off the high-interest, natural capital loans that are the result of logging, development, and fire suppression practices. The following section examines the costs and benefits of forest restoration and summarizes some emerging concepts, such as payments for ecosystem services, which may help offset the costs of landscape-scale forest restoration.

Box 2: Regional Economic Impact of the CFLRP

The ten original CFLRP projects designated in 2010 have already generated tremendous ecological, economic, and social impacts. Initial CFLRP project selections were made near the end of the FY2010, making FY2011 the first full year of project activities. Annual reports for FY2011 were submitted in 2012 by all ten initial CFLRP selections. The cumulative annual impacts for all ten initial projects are impressive. As a result of direct CFLRP funding and matching funds in FY2011, these ten projects accomplished the following restoration objectives:

- Approximately 159,000 forested acres received restoration treatments, and moved those acres from high risk to lower risk for catastrophic wildfire
- Of these restoration treatments, about 31,000 acres were treated by mechanical thinning; 53,000 acres were treated with prescribed fire; and 75,000 acres experienced wildfire managed for resource benefits
- Roughly 43 miles of degraded streams were restored
- Numerous other watershed and forest restoration activities were conducted including: miles of road decommissioning, removal of invasive plants and noxious weeds, culvert replacements, and reforestation.

The ecological accomplishments of CFLRP projects and the associated project monitoring spurred substantial regional economic impacts in FY2011:

- Approximately 2,240 direct full and part-time jobs were created or maintained
- Including indirect and induced effects, about 3,375 total full and part-time jobs were created or maintained
- Nearly $82 million of direct labor income was generated (Labor income is the sum of wages, benefits, and sole proprietor income.)
- Including indirect and induced effects, approximately $125 million of total labor income was generated in the regions

- Much of the labor income and employment came from woody byproduct utilization and commercial forest product activities
- Some 320,000 green tons of small-diameter and low-value trees were made available for bioenergy
- Roughly 240,000 hundred cubic feet of timber was sold within CFLRP project boundaries
- Numerous other values were enhanced by ecosystem service improvements. Many of these increases in value take decades to accrue and/or are non-market in nature.

These results represent significant success for the CFLRP in its first full year of restoration activities, and were achieved even though direct funding was well below the authorized level. The regional economic impacts created by the CFLRP are critical as most of the designated projects occur in rural areas that typically have some of the highest unemployment rates and lowest per capita incomes in the nation. Given that CFLRP appropriations reached the authorized annual funding level of $40 million in FY2012, and that ten additional projects have been chosen, even greater impacts should occur as the CFLRP matures.

The ten projects include the Selway-Middle Fork Clearwater, Southwestern Crown Collaborative, Colorado Front Range, Uncompahgre Plateau, Four Forest Restoration Initiative, Southwest Jemez Mountains, Dinkey Landscape Restoration Project, Deschutes Collaborative Forest, Tapash Collaborative, and Accelerated Longleaf Pine Restoration.

Costs of Forest Restoration

Fighting wildfires is a means to protect lives, property, and structures. The costs of fire management are immense and rapidly increasing as both fire risk and human settlement continue to increase throughout forests in the western United States. Fire management costs for the Forest Service now regularly exceed two billion dollars annually. Some of the most costly wildfires are in frequent-fire forests that have seen per-acre tree densities dramatically increase from historical reference conditions. To wit, the costs of the Rodeo-Chediski and Hayman fires in Arizona and Colorado in 2002 exceeded one-half billion dollars when including suppression, rehabilitation, structural, and tax losses (WFLC 2010).

Many of the costs of uncharacteristic wildfires can be lessened, or avoided, with preventive forest restoration treatments. The direct costs of forest restoration are the result of implementing thinning and burning prescriptions. The cost of these treatments has been the focus of much research. In general, prescribed fire is considered to have the lowest costs per acre for treatment type, although wildland fire use (allowing natural wildfires to burn for resource benefit) can often be the cheapest per acre method of restoring natural fire regimes for larger fires. The cost of thinning-based treatments, including hand-thinning and mechanical treatments, varies significantly. For example, Hartsough et al. (2008) found a range of thinning costs from $500 to $2,000 per acre. In almost all cases, economies of scale exist in both prescribed burning and mechanical treatments, rendering larger treatments less expensive per acre.

Planning costs for forest restoration are substantial, but are likely similar to planning costs for any type of forest management. Additionally, all management actions come with opportunity costs. That is, for whatever action was chosen, other actions could have been implemented but were not undertaken. For example, instead of implementing landscape-level forest restoration, the USFS could pursue a bigger program of traditional timber production. While this could also reduce uncharacteristic wildfire in places, it would come at the cost of virtually all other ecosystem services (see Hjerpe 2011) and could continue the cycle of leaving future generations with greater forest management problems.

Finally, there are other potential costs, or risks, associated with forest restoration. For prescribed fires, these risks include the potential for escaped fires as well as safety and health concerns due to smoke. For thinning, associated risks include erosion from ground disturbance, introduction of invasive weeds, and wildlife disturbance. Additionally, many business costs are necessary to incur if byproduct utilization is able to play a substantial role in offsetting overall restoration costs. Transporting woody material from the forest as well as investing in wood processing equipment and facilities are major initial costs that are incurred prior to the final sale of wood products. Ultimately, potential environmental, social, and commercial costs are risks that will only receive attention when the risk of inaction becomes too great.

Economic Benefits of Forest Restoration

As landscape-scale forest restoration moves forward, there are several ways of examining the benefits that restoration provides. The first valuation method is to examine costs that would have likely accrued without restoration intervention (i.e., avoided costs) and measure the difference of these costs with and without treatment. The second metric involves examining improvements in market values resulting from restored forests. Finally, many benefits spurred by forest restoration can be considered as improvements in the quantity and quality of non-market ecosystem services.

Avoided costs are realized, for example, when restoration treatments help reduce or eliminate the management and societal costs created by catastrophic wildfires or other destructive forces. Such a list of avoided costs might include:

- Avoided fire suppression costs
- Avoided post-fire rehabilitation costs
- Avoided property and structural damages
- Avoided fatalities and injuries
- Avoided flooding and erosion damages
- Avoided tourism and recreation expenditure losses
- Avoided timber losses.

Researchers have investigated and substantiated these avoided costs (Loomis et al. 2003, Mason et al. 2006, Snider et al. 2006, and Mercer et al. 2007). For example, Mason and his colleagues (2006) found that the present value of many of these avoided costs (benefits) was much greater than the present value of treatment costs. Recently, USFS economists and researchers developed the Risk and Cost Analysis Tool (R-CAT) to determine avoided fire suppression costs for CFLRP projects for comparison to the treatment costs (Box 3). This powerful tool should help CLFRP collaboratives estimate potential savings for the federal government and taxpayers from their project.

It is important to note that costs and damages from wildfire or other destructive forces will not be eliminated by applying restoration treatments. However, landscape-scale forest restoration can substantially reduce these costs and damages, and validating long-term savings and avoided costs is critical to understanding the benefits of restoration.

Similarly, numerous research studies have documented market improvements resulting from forest restoration (Loomis et al. 2002, Kim and Wells 2005, Hjerpe and Kim 2008). A partial list of market improvements derived from these studies includes:

- Increased use values for fishing and hunting by improving habitat
- Increased property values
- Increased woody byproducts available for utilization
- Increased production of non-timber forest products.

Recently, disciplines, such as ecological economics, have focused attention on increases in non-market ecosystem services due to restoration treatments or similar conservation efforts (Loomis and Gonzalez-Caban 1998, Winter and Fried 2001, Loomis et al. 2003, Garber-Yonts et al. 2004, Benayas et al. 2009, Hurteau and North 2009, Meyerhoff et al. 2009, North and Hurteau 2011). These include:

- Increased native biodiversity
- Increased water quality and quantity
- Increased long-term carbon storage
- Increased consumer surplus for reduced fire risk
- Increased existence, option, and bequest values.

The reader will note that there are areas of overlap in all the benefits provided by forest restoration. In accounting for the benefits of forest restoration, a clear distinction between benefits will be necessary to reduce the potential for double-counting and exaggerating benefits.

Paying for Restoration

Given the substantial costs and benefits of landscape restoration, who should pay to repair environmental damages and how? While appropriations funded by taxes are the primary payment mechanism for restoration, alternate payment concepts are bridging the gap, including:

- Payments from state, county, or municipality taxes and/or bonds (e.g., the recently approved Flagstaff, AZ bond measure)
- Payments from wood products businesses for access to wood byproducts
- Payments from fishing and hunting organizations for improved habitat (e.g., Rocky Mountain Elk Foundation)
- Payments from private individuals and foundations, typically through non-profit, conservation organizations (e.g., The Nature Conservancy)
- Volunteer labor and management
- In-kind payments for labor from tribal organizations, academic institutions, and others.

As forest restoration yields numerous benefits, new economic strategies are also being developed to capture some of the lesser known, non-market ecosystem services generated by restoration efforts. These include efforts to "marketize" and internalize restoration benefits and are known as Payments for Ecosystem Services (PES; see Forest Trends and others 2008, Greiber 2009). To incorporate PES into a restoration project involves four primary steps:

- Identify ecosystem service prospects and potential buyers
- Assess institutional and technical capacity as well as access
- Structure agreements
- Implement agreements.

While taking such steps can be complicated and difficult, especially on public lands, examples from New York City and Denver illustrate how PES can be captured and used to offset treatment costs. The forested areas

Box 3: The Risk and Cost Analysis Tool [R-CAT] and Avoided Fire Suppression Costs

National Forest System economists and other researchers recently developed the Risk and Cost Analysis Tool (R-CAT). This modeling tool provides a framework for CFLRP projects to estimate avoided suppression costs due to forest restoration and compare avoided costs to fuel treatment costs. The R-CAT model combines spatially explicit fire occurrence and spread models with a statistical fire cost model to predict future suppression cost savings. The R-CAT is currently being operationalized for CFLRP project use, and is now a mandated part of the economic monitoring for the projects.

To use the R-CAT, project teams are asked to help create spatially explicit baseline fuel model and fire behavior maps for their project areas. Next, teams construct a spatially explicit fuel treatment schedule and covert their modeled landscape using this schedule. To determine avoided suppression costs, teams enter information about: 1) fuel treatment acreages over time; 2) fuel treatment effectiveness; 3) fuel treatment costs and revenues; and 4) pre- and post-treatment suppression costs.

Total post-treatment suppression costs, for an assumed duration, can be subtracted from the expected suppression costs associated with no treatment to estimate potential wildfire management cost savings—avoided costs. These savings are then compared to fuel treatment costs to determine impacts of treatments on expected fire program management costs.

However, not all forest restoration will necessarily result in avoided suppression costs. Wildland fire use and less aggressive suppression strategies may reduce per acre costs for fire management, although they can also increase overall costs due to larger, longer-lasting fires (Gebert and Black 2012). Similarly, the economic theory of avoided suppression costs, in general, has been called into question (e.g., Rideout and Ziesler 2008) because fire suppression and restoration treatments are both inputs of fire management, having a range of impacts on fuel levels, fire risk and fire behavior, along with interaction effects. Given the complex nature of new management directions, forest restoration should be examined by considering a broad suite of values as opposed to a simple financial return on investment. Avoided suppression costs are one important economic variable among many when considering the economic benefits and impacts of forest restoration.

for both cities were degraded resulting in diminished water quality and supply (Chichilnisky and Heal 2002, Kaufmann et al. 2005). Municipal utilities often construct expensive man-made purification and treatment facilities in such cases, but New York City and Denver decided to invest in upstream forest restoration and preservation for their water supply and purification needs, saving billions of dollars that would have otherwise had to be expended on water treatment plants. Water and utility companies and their customers now pay for restoration and preservation to produce ecosystem services such as water collection, purification, and delivery.

Clean, plentiful water is just one example of the ecosystem services that can be enhanced by forest restoration. Others include carbon storage, nutrient cycling, water temperatures, fish and wildlife habitat, native biodiversity, recreation opportunities, cultural services, and many more. By bundling multiple ecosystem services, payments for restoration can be increased and management is less likely to focus on singular objectives.

Economic Barriers and Bridges

Economically speaking, landscape-level restoration projects, such as those supported by the CFLRP, represent a new way of doing business in the nation's forests. However, innovation and inventiveness are not always rewarded in a timely manner, and this presents barriers for most CFLRP projects. These barriers are reflections of long-held values, systemic traditions, and out-dated means of accounting for resource goods and services. The major barriers (see Table 1) include:

- Misalignment in term of incentives, information, and practices between ecological restoration and the market economy
- Nascent development of ecological restoration, especially at the landscape scale
- Massive number of acres that need restoration treatment and the relatively short time frame before uncharacteristic wildfires occur throughout degraded forests

"Clean, plentiful water is just one example of the ecosystem services that can be enhanced by forest restoration. Others include carbon storage, nutrient cycling, water temperatures, fish and wildlife habitat, native biodiversity, recreation opportunities, cultural services, and many more.

- Lack of complete social acceptance of treatment alternatives
- Continued belief in logging-only treatments as the solution to economic troubles
- A belief that forest management should pay for itself; no new taxes
- Inability to account for non-market flows between the nation's forests and the greater economy.

The barriers to achieving landscape-level forest restoration are significant, requiring innovative bridges to overcome these hurdles. The development of bridges can be viewed as ongoing experiments in the fertile learning grounds of CFLRP projects. Specifically, bridges to greater restoration can be found in the practices of collaboration, sustainability, diversity, education, research, ecosystem services, and community forestry (see Table 1). Continuing to emphasize and expand these practices within a CFLRP project is as important as thinning trees or making wood products. This is why from an economic perspective:

- Collaboration provides the necessary degree of certainty for business interests by providing confidence that the federal agencies, county, municipalities, conservation groups, academic institutions, and tribal organizations all have a level of commitment to completing these projects.
- Collaborative restoration is pro-active in treating forest health symptoms and has a greater and more consistent regional economic impact on rural communities than fire control and suppression practices while providing more ecosystem services than traditional logging practices.
- Comprehensive restoration requires a number of different activities on the landscape (e.g., thinning, burning, removal of invasive plants, road de-commissioning, monitoring, and wildlife habitat improvement) requiring varied workforces (Combrink et al. 2012). It is also labor intensive. In places, landscape restoration has been shown to produce more jobs per million dollars of expenditures

The Horse Pine Stewardship Contract is an ongoing project that will eventually commercially thin 2,334 acres and, using the value of the timber removed, treat at least 1,400 acres non-commercially in order to enhance wildlife habitat. *Photo courtesy of U.S. Forest Service, Southwestern Region, Kaibab National Forest*

Wildlife viewing is an ecosystem service enhanced by healthy forests. Birders and hunters alike bring money into local economies. *Photo by George Andreijko, Arizona Game and Fish Department* in affected rural communities than traditional timber management, despite creating fewer "marketed" goods for immediate sale (Hjerpe 2011).

- Collaborative restoration emphasizes woody byproduct utilization that involves local workforces as much as possible, which tends to result in fewer exports of final products than traditional timber management. This, in effect, supports USDA and USFS policy goals aimed at supporting and developing rural economies.
- Collaborative restoration embraces the concept of ecosystem services and payments for these services. Deriving payments for bundles of non-market ecosystem services may be the greatest hope for replacing taxation as the primary funding mechanism for landscape-scale forest restoration.

Table 1. Economic Barriers and Bridges to Restoration

Economic Barrier to Restoration	Contributing Factors	Manifestations	Economic Bridges
Misalignment between restoration and market economy	Lack of holistic accounting Discounting the future Lack of understanding restoration benefits Cumbersome and expensive valuation methods Rigid economic system Incentives for resource development and extraction Lower-valued byproducts	Restoration is undervalued and underfunded Resource legislation, policy, and management that hinders restoration Difficulty in obtaining business grants and loans	Capture positive and negative externalities Promote research, education, and awareness of restoration Seek payments for ecosystem services Embrace sustainability and inter-generational equity concepts

Economic Barrier to Restoration	Contributing Factors	Manifestations	Economic Bridges
Novelty of restoration	Blueprints are lacking Incentives and metrics are lacking or not appropriate The public has limited awareness of restoration	Projects take years to develop and achieve social license New skill sets and workforce needed	Experiment and manage adaptively Engage communities and local champions Maximize local economic impact
Scale of lands needing restoration	Millions of national forest acres in need of restoration Billions of dollars needed for treatments Reactive fire protection funds takes priority over pro-active restoration funds	Incomplete funding Problems outpace agency resources Continued suppress-and-control fire mgmt.	Maximize restoration impact in treatment location and type Employ cost effectiveness Engage adjacent land owners and diverse constituents Leverage resources from non-traditional sources
Social acceptability	Fire is perceived as bad Treatments involve disturbing the land, creating smoke, and cutting trees Compliance with other laws and codes Confusion between traditional logging and restoration thinning	Lack of understanding the natural role of fire Projects stopped via legal challenges Distrust of industry Distrust of agency Compliance expenses	Promote education and outreach Conduct thorough, collaborative planning Conduct authentic restoration Engage communities and stakeholders Promote transparency

Conclusion

Collaborative landscape-scale forest restoration is a new, hopeful investment in both landscapes and communities. It values a reciprocal attitude to land as opposed to one that only takes from the land. Collaborative landscape-scale forest restoration also seeks to economically reward the community for its ongoing participation in the process. The CFLRP is an excellent example, and model, of a federal agency and regional stakeholders leading in a direction that will yield vast landscape improvements, while providing economic assistance to the rural communities most affected by wildfire and adverse economic conditions.

Despite this progress, stakeholders and policymakers should not expect forest restoration to be an economic silver bullet without some significant evolution in the marketplace for ecosystem services. This is a challenge for all involved and will take considerable time, will, and effort. Collaboratives should also consider monitoring economic activities not only to provide information to refine restoration activities but to also ensure that unintended economic consequences do not happen, such as timber production masquerading as "restoration" in areas that need little, if any, logging. Ultimately, the challenge in achieving collaborative forest restoration may be maintaining the authenticity of restoration projects and adhering to both the ecological and economic principles that have set ecological restoration apart from other forest management practices.

References

Allen, C.D., M. Savage, D. Falk, K. Suckling, T. Swetnam, T. Schulke, P. Stacey, P. Morgan, M. Hoffman, and J. Klingel. 2002. Ecological restoration of southwestern ponderosa pine ecosystems: A broad perspective. *Ecological Applications* 12(5):1418-1433.

Benayas, J.M., A.C. Newton, A. Diaz, and J.M. Bullock. 2009. Enhancement of biodiversity and ecosystem services by ecological restoration: A meta-analysis. *Science* 325(28):1121-1124.

Brown, R. T., J.K. Agee, and J.F. Franklin. 2004. Forest restoration and fire: Principles in the context of place. *Conservation Biology* 18(4):903-912.

Chichilnisky, G. and G. Heal. 1998. Economic returns from the bio sphere. *Nature—London:*629-630.

Combrink, T., W. Fox, J. Petersen. 2012. Workforce needs of the Four Forest Restoration Initiative Project: An analysis. Ecological Restoration Institute White Paper. Flagstaff, AZ: Northern Arizona University, Ecological Restoration Institute.

Covington, W.W. and M.M. Moore. 1994a. Southwestern ponderosa forest structure: Changes since Euro-American settlement. *Journal of Forestry* 92(1):39-47.

Cram, D. S., T. T. Baker, and J. C. Boren. 2006. Wildland fire effects in silviculturally treated vs. untreated stands in New Mexico and Arizona. RMRS-RP-55, U.S. Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Forest Trends, The Katoomba Group, and United Nations Environmental Program. 2008. Payments for ecosystem services, getting started: A primer. Nairobi, Kenya: UNON/ Publishing Services Section.

Fulé, P. Z., J. E. Crouse, J. P. Roccaforte, and E. L. Kalies. 2012. Do thinning and/or burning treatments in western USA ponderosa or jeffrey pine-dominated forests help restore natural fire behavior? *Forest Ecology and Management* 269:68-81.

Garber-Yonts, B., J. Kerkvliet, and R. Johnson. 2004. Public values for biodiversity conservation policies in the Oregon coast range. *Forest Science* 50(5):589-602.

Gebert, K.A. and A. Block. 2012. Effect of suppression strategies on federal wildland fire. *Journal of Forestry* 110(2):65-73.

Greiber, T., ed. 2009. Payments for ecosystem services: Legal and institutional frameworks. Gland, Switzerland and Bonn, Germany: IUCN Environmental Policy and Law Paper No. 78.

Hartsough, B.R., S. Abrams, R. J. Barbour, E.S. Drews, J.D. McIver, J.J. Moghaddas, D.W. Schwilk, and S.L. Stephens. 2008. The economics of alternative fuel reduction treatments in western United States dry forests: Financial and policy implications from the National Fire and Fire Surrogate Study. *Forest Policy and Economics* 10(6):344-354.

Hjerpe, E.E. 2011. Seeing the Tongass for the trees: The economics of transitioning to sustainable forest management. Wilderness Society Science Report. Washington, DC:The Wilderness Society.

Hjerpe, E.E. and Y. Kim. 2008. Economic impacts of national forest fuels reduction programs in the Southwest. *Journal of Forestry* 106(6):311-316.

Hurteau, M.D. and M.P. North. 2009. Fuel treatment effects on tree-based forest carbon storage and emissions under modeled wildfire scenarios. *Frontiers in Ecology and the Environment* 7:409-414.

Kaufmann, M.R., P.Z. Fulé, W.H. Romme, and K.C. Ryan. 2005. Restoration of ponderosa pine forests in the interior western US after logging, grazing, and fire suppression. Pages 481-500 *in* J.A. Stanturf and P. Madsen, eds., Restoration of boreal and temperate forests. Boca Raton, FL: CRC Press.

Kim, Y. and A. Wells. 2005. The impact of forest density on property values. *Journal of Forestry* 103(3):146-151.

Loomis, J.B. and A. González-Cabán. 1998. A willingness-to-pay function for protecting acres of spotted owl habitat from fire. *Ecological Economics* 25:315-322.

Loomis, J.B., D. Griffin, E. Wu, and A. González-Cabán. 2002. Estimating the economic value of big game habitat production from prescribed fire using a time series approach. *Journal of Forest Economics* 8(2):119-129.

Loomis, J.B., P. Wohlgemuth, A. Gonzalez-Caban, and D. English. 2003. Economic benefits of reducing fire-related sediment in southwestern fire-prone ecosystems. *Water Resources Research* 39(9):1260-1267.

Mason, C.L., B.R. Lippke, K.W. Zobrist, T.D. Bloxton Jr., K.R. Ceder, J.M. Comnick, J.B. McCarter, and H.K. Rogers. 2006. Investments in fuel removals to avoid forest fires result in substantial benefits. *Journal of Forestry* 104(1):27-31.

Mercer, D.E., J.P. Prestemon, D.T. Butry, D.T., and J.M Pye. 2007. Evaluating alternative prescribed burning policies to reduce net economic damages from wildfire. *American Journal of Agricultural Economics* 89(1):63-77.

Meyerhoff, J., T. Liebe, and V. Hartje. 2009. Benefits of biodiversity enhancement of nature-oriented silviculture: Evidence from two choice experiments. *Journal of Forest Economics* 15:37-58.

Murphy, K., P. Duncan, and C. Dilingham. 2010. A summary of fuel treatment effectiveness in the Herger-Feinstein Quincy Library Group Pilot Project Area. Quincy, CA: USDA Forest Service R5-TP-031.

North, M.P. and M.D. Hurteau. 2011. High-severity wildfire effects on carbon stocks and emissions in fuels treated and untreated forest. *Forest Ecology and Management* 261:1115-1120.

Rideout, D.B. and P.S. Ziesler. 2008. Three great myths of wildland fire management. Pages 319-325 in A. González-Cabán, tech. coordinator, Proceedings of the second international symposium on fire economics, planning, and policy: a global view. PSW-GTR-208. Albany, CA: USDA Forest Service, Pacific Southwest Research Station.

Snider, G., P.J. Daugherty, and D. Wood. 2006. The irrationality of continued fire suppression: An avoided cost analysis of fire hazard reduction treatments versus no treatment. *Journal of Forestry* 104(8):431-437.

Westerling, A.L., H.G. Hidalgo, D.R. Cayan, and T.W. Swetnam. 2006. Warming and earlier spring increases western U.S. forest wildfire activity. *Science* 313(5789): 940-943.

WFLC (Western Forest Leadership Coalition). 2010. The true cost of wildfire in the western U.S. Lakewood, CO: Western Forest Leadership Coalition.

Winter, G.J. and J.S. Fried. 2001. Estimating contingent values for protection from wildland fire using a two-stage decision framework. *Forest Science* 47(3):349-360.

Resources

Schultz, C.A., T. Jedd, and R.D. Beam. 2012. The Collaborative Forest Landscape Restoration Program: A history and overview of the first projects. *Journal of Forestry* 110(7):381-391.

U.S. Wildfire Cost-Plus-Loss Economics Project Reference Library

Chapter 3

Planning and NEPA

Dave Brewer

Passage of the Omnibus Public Lands Management Act of 2009 (P.L. 111–11) signaled a significant shift in how the federal government wanted federal public land management agencies to interact with interested publics and environmental organizations. This legislation directs federal land management agencies to develop proposals that restore "the structure of old-growth stands according to pre-fire suppression old growth conditions characteristic of the forest type" using "a collaborative process that includes multiple interested persons representing diverse interests and is transparent and nonexclusive." It does not, however, absolve the agencies from meeting the planning requirements of the National Environmental Policy Act (NEPA) and other federal laws (e.g., Clean Air Act, Clean Water Act, Threatened and Endangered Species Act, National Forest Management Act, and Antiquities Act).

These requirements create a formidable task for collaborative groups and agency planners in terms of meeting the requirements of site-specificity and other legal components of NEPA within project areas at least 50,000 acres in size or larger within a ten-year time horizon. This scale of documentation and planning is especially perilous given the successful appeals and litigation of smaller-scale forest projects. Typically, such successful appeals are due to lack of site-specificity, insufficient environmental effects analysis, and poorly developed proposed action and issues statements that have led to an inadequate range of alternatives.

Probably the greatest challenge facing planners at all levels of environmental analysis, especially as it relates to projects at the larger landscape scale, is to demonstrate that a "hard-look" at the environmental consequences was undertaken as decided in Natural Resources Defense Council v. Morton, 458 F.2d 827, 838 (D.C. Cir., 1972). In this landmark environmental case, the court ruled a federal agency is required to make a substantial, good faith effort in terms of studying, analyzing, and expressing the environmental effects in the document and decision making process. As a result, the courts carefully check environmental documents, like environmental impact statements (EIS), for completeness of information and detail, soundness of analysis, thorough discussion of alternatives, and disclosure of sources. However, courts have also recognized that the rule of reason must prevail, meaning that if the analysis provides sufficient information to allow a firm basis for weighing the risks and benefits of a proposed action and alternatives, the courts will find the analysis to be sufficient (County of Suffolk v. Secretary of Interior, 562 F.2d 1368 (2nd Cir. 1977)).

In order for planners to achieve this "hard-look" at the environmental consequences of a project, they must build the analysis from the smaller scale and then aggregate those site-specific treatments and effects upwards to a landscape level (i.e., tiering). This will ensure that the planners are able to discuss specific treatments and effects at the larger scale and remain on firm ground with respect to site-specificity since the analysis was built-up from the smaller level.

The Omnibus Public Lands Management Act of 2009 also calls for the use of the "best available science" in planning and implementing landscape-scale forest restoration projects. Freeman (2007) concluded there are five steps for integrating the best science in a NEPA analysis:

- Survey published reports and studies, and record findings about which ones are the most current and relevant to the resource questions being asked
- Explain how cited studies apply to the site-specific resource conditions in the project area
- Cite internal agency reports and studies, including prior NEPA documents, that are relevant to the site-specific conditions in the project area
- Address questions and concerns from the public or from other governmental agencies and explain what the cited information does and does not show
- Make impact projections even when cited information and other relevant sources are sketchy or missing.

Planners invariably will need to make some assumptions concerning resource conditions, however, as long as this is documented and they can establish the "best available science" has been included in their analysis, then the legal responsibility as it relates to NEPA, will be met (CFR 1500 to 1508, Section 1502.24).

This chapter will investigate a potential methodology for planning and developing large-scale proposals to restore the former structure, composition, and function of frequent-fire ecosystems while at the same time meeting the intent of the regulations for implementing the procedural provisions of NEPA and other environmental laws (Box 1). Its purpose is to demonstrate to stakeholders and planning professionals a reliable way to formulate a Collaborative Forest Landscape Restoration Program (CFLRP) implementation proposal to attain the site-specificity needed so a "hard-look" at environmental effects at the landscape level can be achieved.

One Possible Solution

Professionals and stakeholders involved in planning a CFLRP project have a significant barrier to overcome when gathering information and developing a NEPA document. The procedure outlined in this chapter is one suggested way to bridge that barrier and ensure legally defensible compliance with the country's environmental laws. Moreover, this procedure will result in better management decisions and NEPA documentation. These steps involved are sequential and include:

- Develop a logical stratification system that will allow discussion of resource conditions at both the small and landscape scale
- Collect site-specific information, conduct analysis, and interpolate from the small scale to the landscape level
- Identify desired conditions and compare to existing conditions; Develop resource objectives and management practices that, if implemented, will move resource attributes to desired conditions
- Develop a site-specific proposed action/ purpose and need
- Develop significant issues and alternatives to the proposed action
- Disclosure of environmental effects
- Other considerations.

Develop a Logical Stratification System

Developing a logical stratification system requires a dependable, accurate base layer of data. Published data sets that work well as a base layer can often be found in soil survey reports develop by the U.S. Forest Service (USFS), Bureau of Land Management (BLM), or the National Resource Conservation Service (NRCS). Landscape-scale restoration planners should consider the use of this type of survey because 1) there is generally enough similarity between mapping units that substantial combinations can be made, thus simplifying discussions about

Box 1. NEPA Documents

Environmental Assessment (EA): A smaller, shorter document than an Environmental Impact Statement (EIS); prepared by a federal agency when there is uncertainty about whether or not there will be a significant environmental impact due to a proposed action. If the agency finds no significant impact, it may move forward with the proposed action. If significant impacts are likely, then a full EIS is required. EAs do not need to be circulated but they must be made available to the public through notices of availability in local, state, or regional clearinghouses, newspapers and other means.

Environmental Impact Statement (EIS): NEPA requires Federal agencies to prepare to prepare an EIS for major Federal actions that significantly affect the quality of the environment. An EIS is a full disclosure document that details the process through which a project was developed, includes consideration of a range of reasonable alternatives, analyzes the potential impacts resulting from the alternatives, and demonstrates compliance with other applicable environmental laws and executive orders. The EIS process in completed in the following ordered steps: Notice of Intent (NOI), draft EIS, final EIS, and record of decision (ROD).

Categorical Exclusion (CE): "Actions which meet the definition contained in 40 CFR 1508.4, and, based on past experience with similar actions, do not involve significant environmental impacts. They are actions which: do not induce significant impacts to planned growth or land use for the area, do not require the relocation of significant numbers of people; do not have a significant impact on any natural, cultural, recreational, historic or other resource; do not involve significant air, noise, or water quality impacts; do not have significant impacts on travel patterns; and do not otherwise, either individually or cumulatively, have any significant environmental impacts." 23 CFR 771.117(a)

Programmatic Environmental Impact Statement (PEIS): An environmental impact statement that addresses a proposal to implement a specific policy, to adopt a plan for a group of related actions, or to implement a specific statutory program.

resource conditions; 2) the information associated with soil survey reports can help prioritize treatment areas (e.g., treatments on shallow versus deep soils); and 3) it will assist in building the effects analysis. The NRCS Soil Survey website can be a valuable resource to check the status of soil survey work for individual project areas and the availability of publications.

A recent assessment conducted for the Four Forest Restoration Initiative (4FRI) CFLRP project on the Coconino and South Kaibab national forests is an example of using a soil survey to create a base layer. After a thorough analysis, my colleagues and I determined that out of the 160 Terrestrial Ecosystem Mapping Units (TESU) on more than 900,000 acres, 50 individual strata accounted for most of the variability found within the individual TESU (Brewer et al. 2012). Within the 50 individual strata, we found that 22 strata, encompassing 579,635 acres or 60% of the project area, represented soils that have high production potentials, low restrictions for management activities, and moderate to high reforestation/revegetation suitability. Conversely, the remaining 40%, or 346,065 acres, have generally severe limitations with respects to timber harvest and reforestation/revegetation suitability. Analyses such as this enables the planners to not only discuss existing resource at the landscape scale but allows them to begin framing the pre-NEPA analysis since the combination of TESU found within each specific stratum will respond in a relatively similar fashion to management actions. The stratification system also reduces the time spent describing existing conditions and other components of the analysis because planners only need to work with 50 strata and not 160 individual TESU.

Table 1 and Table 2 are examples of how the data can be structured. In Table 1, each strata and sub-strata are identified in terms of:

- percent slope
- TESU unit number(s) in overall area
- total number of acres
- final strata combination number(s)

- total acres of TESU in project area
- climatic class (High Sun Mild [HSM], High Sun Cold [HSC], Low Sun Mild [LSM], and Low Sun Cold [LSC])
- potential plant community (PPC)
- habitat types
- erosion hazard
- natural tree regeneration potential
- level of plant competition, especially the likelihood of invasive plant establishment
- site index
- timber harvest limitations
- potential and maximum herbage/forage production.

Table 1 indicates which individual TESU were combined in the stratification process with interpretations relative to such items as erosion hazard, site index, and forage responses.

Table 2 builds on the information found in Table 1. The indicators for each strata and sub-strata include:

- percent slope
- total number of acres
- final strata combination number(s)
- number of acres in strata or sub-strata
- soil taxonomic classification
- climatic class
- existing plant cover (dominant species types, e.g., Popr/Fear, Fear/Mumo)
- sheet-and-rill erosion levels (potential, tolerable, current, and natural)
- percent current surface cover (rock, vegetation, litter, bare soil)
- percent vegetation cover levels (potential, tolerable, current, and natural)
- soil condition (saturated, unsaturated)
- acres of unsaturated soil condition.

Former ERI Outreach Coordinator Charlie Denton leads an ERI field event explaining stand structure, historic range of variability, and proposed thinning strategies. Members of the field trip, including USFS staff, examine a tree stump to determine how old the tree was at the time it was cut. *Photo courtesy of ERI*

Two important aspect of this analysis are: 1) site-specificity is being built into the analysis, although at this stage it will not meet the standards required for NEPA documentation because it is still too general; 2) important watershed, range, and silviculture attributes that might be used in describing existing conditions are identified; and 3) units of measure to disclose environmental effects are being recognized and documented.

Collect Site-specific Information, Conduct Analysis, and Extrapolate to the Landscape Level

In addition to soil surveys, stakeholders and planners should consider other available sources of information about resource conditions within the project area. These sources include publications completed by the USFS or other land management agencies as well as research publications and graduate thesis work. As with in-house resource surveys, publications completed within the project area will be the most valuable. The planning team needs to spend ample time to research the documents and bring the science forward from them into the descriptions of the strata identified within the proposed project area. This review is extremely important because it will be used in just about every phase of the project from the pre-NEPA assessment to developing the proposed action, describing the affected environment section in the environmental document, and building the effects analysis (Freeman 2007). Various methodologies for conducting systematic reviews of scientific literature are available for this part of the process (e.g., Evidence-based Conservation Protocol, the Cochrane Handbook for Systematic Reviews).

Examples of useful information for planning include range allotment analysis surveys, which if consistently repeated over a period of time, will yield information regarding changes in plant diversity, ground cover, and rangeland health based on changes in stock density,

“

In order for planners to achieve a “hard-look” at the environmental consequences of a project, they must build the analysis from the smaller scale and then aggregate those site-specific treatments and effects upwards to a landscape level. This ensures that the planners are able to discuss specific treatments and effects at the larger scale and remain on firm ground with respect to site-specificity.

silvicultural treatments applied, grazing systems employed, and rangeland improvement projects that were completed on the allotment. Likewise, surveys of sensitive, threatened and endangered plant and animal species, population surveys of big game within the project area, and habitat assessments will assist the biologist in determining current conditions. Forest Inventory Plots and standard compartment exams enable the silviculturalist to describe dominant VSS classes, trees per acre, basal areas, and other important characteristics of stands within the identified strata. This information along with range surveys can assist the biologist and other specialists in defining forested conditions and understory plant diversity, which can be used to describe habitat conditions for the species that will be tracked through the analysis. Since most CFLRP projects are working in degraded former frequent-fire ecosystems, the resource attributes highlighted need to include those that influence fire behavior.

In some cases the data used to establish existing conditions and build the effects analysis might be five to ten years old or older. Regardless, this information and other sources are the best information the planners may have to properly build their effects analysis and as such will normally meet the test for NEPA sufficiency.

The data obtained in the literature can be analyzed in a variety of ways, although it is best used if it is linked to the stratification system. For example, in order to analyze data from many decades of Parker 3-Step plots (Ruyle and Dyess 2010), my colleagues and I developed a database that contained the recorded information by survey year for each data point located in 121 Parker 3-Step plots within the proposed project area. We also scanned all the photos taken for a particular plot and placed them in the database as well. Next, we used the pivot table function in Microsoft Excel to summarize changes by to plant frequency and effective ground cover during the survey period. We summarized data by strata developed from combinations of similar TESU units found in the project area. By using TES as a basis for stratification, the data could have been mapped using GIS technology for individual TESU. However, since we desired landscape level trends for the project area, all data points for a specific stratum were pooled.

Site-specificity is developed by adding additional layers to the base stratification map. Depending on the complexity of the analysis, size of the area, resource objectives and how specialists want to disclose environmental impacts, adding the watershed boundaries may be enough to complete the task. In most cases, watershed boundaries work well for most resource areas including timber, fire and roads, since proposed fuels reduction (live and dead), timber sale activities, road construction/reconstruction, and prescribed fire will influence soil and water variables (e.g., soil erosion, water yield, water quality). These attributes need to be tracked and their effects disclosed at a watershed level. However, it may be the case that additional site-specificity needs have to be built into the process by adding the borders of herd unit boundaries, grazing allotments, threatened or endangered species territories, northern goshawk home ranges, and, possibly, forest plan management areas (see Box 2). Again, how the landscape is broken into discrete areas to gain site-specificity depends on what questions the individual specialist wants to answer and the important direct, indirect, and cumulative impacts that will be addressed.

The key is to build the analysis (i.e., existing and desired conditions, existing and desired values, potential management practices) from the smaller to larger scale and have a process in-place that is reasonable and based on resource information specific to the project area. What this means under this recommended methodology is the planners look at specific stratums within a 5th code watershed (40,000–250,000 acres) or 6th code sub-watershed (10,000–40,000 acres) and build the proposed action and other components of the analysis based on the stratification system. With the large size of most CFLRP projects, discussions of the affected environment and other components of the analysis will more than likely be, for brevity sake, at the larger landscape scale. As long as the record demonstrates the team started at the smaller scale and progressively built up to the larger one, then site-specificity will have been demonstrated and a "hard-look" of environmental effects can be completed.

Box 2. Working with Cross-boundary Resources

Some resource areas, including wildlife and domestic livestock grazing, do not conform well to watershed boundaries for the disclosure of effects. In the case of wildlife species that are harvested, such as deer, elk and antelope, herd unit boundaries are probably more appropriate since game and fish agencies and others are interested in projected population trends at this level. By taking this approach, the wildlife specialist is actually beginning to define their cumulative effects area for these species, which is an important aspect of the effects analysis.

Federally managed grazing allotments are another case where management units rarely, if ever, conform to watershed boundaries. As a result, allotments are one of the layers that the range conservationist may use in describing current resource conditions. Past and present activities including stocking changes, water developments, alterations in management (rest-rotation to deferred rotation), and forage improvement projects will ultimately influence understory diversity, and these changes are tied to specific allotments. Although CFLRP projects normally will not include any decisions about changes in livestock grazing per se, it is a cumulative impact that needs to be disclosed in the environmental documentation. Another important consideration is the effect of restoration activities on changes in carrying capacity and overall rangeland health.

For small mammals, birds, and reptiles where homes ranges can vary considerably, the wildlife biologist might need to assess the silvicultural information, their own surveys, and, possibly, the range understory information. To the best degree possible, a determination needs to be made of the current habitat conditions (e.g., low, moderate, high) for each species that will be tracked in the analysis and the number of acres of the appropriate condition class. This effort needs to have the layers of site-specificity attached (e.g., watershed boundaries, stratum, and northern goshawk territory). By determining the area of high, moderate, and low habitat quality for the species that are going to be part of the analysis, planners begin to develop the baseline they will use to compare to desired conditions and eventually the disclosure of environmental effects.

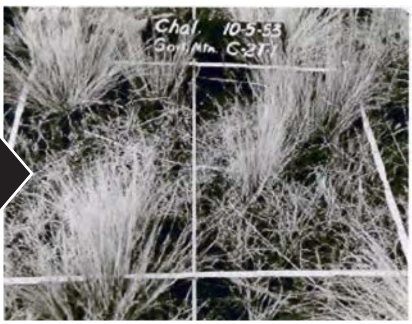
When documenting resources attributes that cross watershed boundaries, planners might consider first using smaller sub-watersheds, building up to the larger watershed level, and then combining the various watersheds that comprise a specific herd unit boundary, grazing allotment, or wildlife home range.

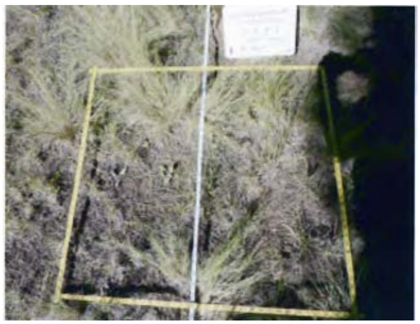
Identify Desired Conditions, Compare to Existing Conditions, Develop Desired Management Practices

In the next phase of the process, planners undertake a plan-to-project or pre-NEPA analysis that identifies desired conditions and compares this information to the existing conditions. If there is a significant difference between existing and desired conditions then there is likely a need for change. Management practices are then designed that, once implemented, move the area of interest toward these desired values. Other components of this process include identifying specific mitigation practices, possible monitoring requirements, maintaining consistency in programmatic planning documents, and, if amendments are necessary, implementing specific management practices. This step allows members of the team and the collaborative group to communicate with other interested publics about resource conditions (both existing and desired) at both the site-specific and landscape scale. In addition, any departure these resources have from reference conditions can be highlighted and disclosed.

The desired conditions assessment needs to focus on those resource attributes that will eventually be part of the environment effects analysis. For the timber and fire specialist, those attributes will be qualities that influence fire behavior (e.g., trees per acre, basal area, and mean crown base height) whereas for the range specialist it will be current stocking levels, animal units months produced, and understory diversity. This is not an all-inclusive list and care needs to be exercised to determine what aspects the specialist is going to use to disclose both direct/indirect and cumulative impacts. If the analysis is well referenced, especially with research and resource inventories that were completed within the project area, the proposed action will have the site-specificity as required and the side boards of the effects analysis will be established.

Photos 1-2. The Government Mountain allotment in 1953 shows a very open stand with young presettlement trees. This same view from 2010 has dramatically changed with the growth and expansion of trees.





Photos 3-4. Government Mountain C2T1 3X3 Plot 1953. An examination of the plot data shows the frequency of mountain muhly decline from nearly 60% of the composition in 1953 to less than 30% by 2010.

Information from previous and ongoing research as well as research publications and repeat photographs can help establish the existing conditions in the project area. For example, photos 1–4 were taken within the Government Mountain Allotment, west of Flagstaff, Arizona. Photo 1, taken in 1953, shows an open stand with young post-European settlement trees. By 2010, this same view dramatically changed with the growth and expansion of ponderosa pine trees (photo 2). Declines in understory plant density can also be seen in framed plot photos from 1953 and 2010 (photos 3 and 4). Confirming the evidence in this photo-pair, the data from these plots indicates that the frequency of mountain muhly declined from nearly 60% in 1953 to less than 30% by 2010.

Once the resource surveys and other data are summarized, planners can begin to build the pre-NEPA analysis. For USFS proposals, land management plans and their corresponding Environmental Impact Statement (EIS) and Record of Decision will help establish desired conditions. With most federal agencies (e.g., BLM, U.S. Fish and Wildlife Service, National Park Service) there will be either policy direction or a programmatic land management decision (PEIS) that will guide the establishment of desired conditions.

All planners need to do at this point is compare these existing conditions for the individual stratums to desired conditions from the forest plans and other documents and the team will be able to develop the need for change as well as those practices that will accomplish this task. This effort needs to have the layers of site-specificity applied and the team needs to identify those individual polygons for specific stratums that will be treated. This will assure that site-specificity is achieved and the appropriate level of environmental effects analysis is designed.

Develop Site-specific Proposed Action and Purpose and Need Documents

Next, the planners compile a site-specific proposed action and purpose and need documentation. If the previous steps are completed in a comprehensive manner, this will be a relatively easy process since the proposed action as well as the purpose and need fall out of this pre-NEPA analysis and are simply a list of management practices (proposed action) and analysis between existing and desired conditions (purpose and need).

Proposed Action

The proposed action answer four key questions: 1) who takes the action?; 2) what action is taken?; 3) when is the action taken?; and 4) where is the action taken? For example, to answer the "what" question requires taking an interdisciplinary approach working through the project area. Each specialist has previously established the mean and desired values for their resource areas for the stratums identified within the project area. For instance, the wildlife specialist might look at understory diversity and mean production, VSS classifications, and snags per acre whereas the watershed specialist would be concerned in unsatisfactory watershed condition acres, water and sediment yield, and location of springs and seeps. Prescriptions to achieve desired conditions are developed for individual polygons of specific stratums for the watershed. In the case of CFLRP proposals, by far the most pressing underlying need is reduction of fire hazard and wildfire suppression costs. Therefore, prescriptions should, to the best degree possible, meet this need while considering other multiple use goals and objectives. Mitigation measures and monitoring requirements must also be recognized. Other implementation actions, such as road construction/reconstruction, acres of prescribed fire, and frequency and/or acres of reforestation are also identified and documented during this step. As the team continues to merge the various layers that have been developed with the stratification map, the analysis they develop, as it progresses from one watershed to the next, will be able to demonstrate site-specificity.

As the team works through the individual watersheds and the various polygons therein, they will identify specifically where the impacts will likely occur, and, thus be able to prove that they took a "hard look" at the environmental effects. Otherwise, what the planners are likely to develop is more of a programmatic environmental document, much like a forest plan, which lacks enough site-specificity to implement projects.

Planners might provide a concise overview by simply listing the 5th code watershed, total acres of each stratum, and acres of each prescription to be applied within the stratum. However, if the CFLRP team wants to ensure that they produce a well-documented, legally defensible document, they set their goal higher and create a record that demonstrates a logical progression down to the site-specific level.

Purpose and Need Statement

The purpose and need statement is simply a comparison between existing conditions and desired conditions. Planners need to develop an adequate list of unit of measures that can be used to describe 1) differences between existing and desired conditions, and 2) assist in identifying those attributes that eventually will be used to disclose environmental effects as well as how the alternative(s) are able to meet the purpose and need of the project. Normally, units of measure will vary between resource areas, although in some cases they may not. For example, growing stock level, trees per acre, canopy bulk density, and basal area are all important attributes that will assist in describing current forest conditions and fire hazard. They also can be used by the range and wildlife specialists to denote changes in conditions related to understory forage production and diversity. With respect to such aspects as growing stock levels and trees per acre within frequent-fire ecosystems there are threshold values established for these parameters that once exceeded indicate a decline in forest resiliency and health (and may serve as a trigger for adaptive management action; see below). Knowing these values will assist in defining desired conditions and enable discussing this in the purpose and need statement. With CFLRP proposals, the purpose and need statement, like the proposed action, may be summarized at a more landscape level.

The purpose and need assessment will drive development of management practices that ultimately are listed in the proposed action. The purpose and need statement, as with all the attributes of the analysis, will be built up from the smaller scale since there might be different desired conditions developed depending on the watershed being examined. For instance, watersheds that contain important springs or perennial stream courses may have practices developed and designed specifically to improve water yield and quality. Likewise, areas of important threatened and endangered or sensitive plant or animal species might have different prescriptions developed to improve or protect resource conditions for these species.

Determine Significant Issues and Develop Alternatives to Proposed Action

Determining Significant Issues

This step brings the general public into the process by giving them the opportunity to provide comments and raise issues that concern them about the proposed action and purpose and need statement. The planning team's identification and documentation of preliminary and significant issues are a key process point since these comments will drive the development of alternatives. The key in developing good issue statements is to release a proposed action that is not general or vague and has site-specificity so that the public and others can readily understand what the agency is trying to accomplish and where. It is also important to write issue statements in a cause-and-effect manner and establish units of measure in order to show trade-offs between the alternatives.

Once the proposed action is released, people who are interested in the project can submit their concerns to the responsible official. Planners need to catalog all letters and conduct content analysis to identify preliminary issues. Comments regarding the decision itself or appropriateness of the proposal are not considered issues. Issue statements from the public, other governmental agencies, or internally need to contain the same level of site-specificity as the proposed action as well to be of value within the process. For example, issue statements to identify the wildlife species and/or what aspect of the species' habitat is of concern and where it is located in the project area. To elevate a preliminary issue to a significant issue, the comment needs to have some basis in science and research, although the responsible official always has the discretion to elevate an apparent non-significant issue to a significant one and develop an alternative for it, and even abandon it at a later date.

Designating an issue as significant typically occurs when it is evident that the public and/or federal or state agencies are aware of a resource condition or effects that likely will be of interest for a considerable length of time, the effects of the proposed action will last for a long time, or the effects are potentially severe.

Developing Alternatives

Once the list of significant issues is developed and approved by the responsible official, the team is ready to develop alternatives to the proposed action. A reasonable alternative needs to meet both the purpose and need statement, and address a significant issue, although there might be cases where an alternative is fully disclosed that is not, by definition, reasonable. For instance, if the purpose and need statement has some discussion about doing the project for the least cost, there could be an instance where the team might come forward with an alternative with costs far and above what the proposed action stated. What the planners are trying to demonstrate in such a case are the trade-offs of increasing the cost and what the differences are in terms of the effects.

To develop sound alternatives, the planning team needs to:

- Discuss all possible combinations of issues to limit the total number of alternatives the team needs to develop
- Identify a no-action alternative first as a baseline for comparison to other alternatives
- Combine parts of alternatives in a logical manner, if possible
- Provide an alternative for each significant issue, although there may be enough common themes in the issue statements to allow planners to reduce the number of alternatives by combining potential scenarios.

A range of reasonable alternatives should demonstrate a variety of outputs, effects, and an ability to meet the purpose and need statement. Having a range of reasonable alternatives reflects well on the overall process (i.e., original proposed action was clearly articulated, the public comments led to meaningful issue statements) and gives the responsible NEPA official the full range of choices from which to make an informed decision. Another important aspect of an alternative is the need for substantial treatment of each action. In addition, the description of each alternative should be as equal and site-specific as possible so reviewers may evaluate the comparative merits of each scenario. This means that the units of measure developed to show attainment or nonattainment of the purpose and need statement or of any significant issues are essentially the same for all actions considered in the document. The discussion of no-action should be given about the same amount of space as any other alternative. Alternatives and virtually all components of the analysis should be described objectively with no bias. It is also important to determine whether or not the alternative is consistent with the Forest Plan.

As with issues, knowing the reasons to eliminate an alternative from consideration or selection can help the team manage the NEPA process. Some of the reasons for dismissal of alternatives include:

- Illegal action required
- Fails to meet the purpose and need statement
- Unreasonable, remote, and/or speculative
- Cannot be implemented.

Disclose Environmental Effects

Direct, indirect, and cumulative effects will be a comparatively easy process to complete if the previous steps have been thoroughly completed and documented. Other than developing quantitative measures that are understandable to the public, the most important work is building cause-and-effect relationships. Direct and indirect effects are the result of the proposed action alternatives. For example, the cause may be the total acres of treatments with a specific prescription applied, miles of roads constructed/reconstructed, and, possibly, the acres of activity fuels burned or prescribed fire used to maintain certain timber stand conditions. The effect will be specific to a resource area and could include acres of declining insect and disease problems (silviculture), anticipated water yield increase in acre-feet (watershed), changes in erosion rate in tons/acre/year (watershed), and acres of improved understory habitat for ground nesting birds (wildlife). These are all direct and indirect impacts of the proposed action and alternatives.

Cumulative impacts, which are invariably one of the most complicated sections for planners to write as well as the most likely sections to be appealed and litigated, are the incremental impacts of other actions occurring within or adjacent to the project area that influence the same resources the planners are dealing with in their analysis. For example, once the fire specialist has determined how much of the project area has a reduced the fire hazard and to what degree, along with the anticipated costs savings for the alternatives, the planning team needs to determine what other actions are occurring within or adjacent to this project area that essentially do the same thing. A review of past NEPA documents that have been implemented, current proposals that have or have not been implemented, and reasonably foreseeable activities all need to be part of the assessment. Generally, the Schedule of Proposed Actions is an excellent place to start in determining reasonably foreseeable actions. Planners need to make some assumptions and make their best estimate of the cumulative impacts for their resource area.

Planners also should recognize that other federal, state, and private lands could all be bounded into one cumulative effects area. For instance, if antelope move off of the project area and spend two months on state and private lands and then move onto other federal lands, the activities in the project area that add to or detract from antelope habitat need to be assessed and documented.

Other Considerations

The Omnibus Public Lands Management Act of 2009 as well as current and predicted environmental conditions creates other concerns for CLFRP planners and collaborators. Three significant and interrelated considerations include collaboration, climate change, and adaptive management.

Collaboration

The Omnibus Public Lands Management Act of 2009 calls for intensive dialogue with interested publics, state and local governments, environmental organizations, and others. Planners and stakeholders can refer to the Council on Environmental Quality *Collaboration in NEPA: A Handbook for NEPA Practitioners* for guidance on this issue (see Chapter 1 for more discussion).

Climate Change

Climate change signals another important consideration for CFLRP collaboratives and NEPA planners as they decide about implementation strategies and other related issues. The USFS has published two important documents about climate change and NEPA analysis that provide guidance in such matters. The first, Climate Change Considerations in Project Level NEPA Analysis, is designed to help NEPA planners include climate change-related issues in the documentation. It is based on the following four principles:

- Climate change effects include the effects of agency action on global climate change and the effects of climate change on a proposed project.
- The Agency may propose projects to increase the adaptive capacity of ecosystems it manages, mitigate climate change effects on those ecosystems, or to sequester carbon.
- It is not currently feasible to quantify the indirect effects of individual or multiple projects on global climate change and therefore determining significant effects of those projects or project alternatives on global climate change cannot be made at any scale.
- Some project proposals may present choices based on quantifiable differences in carbon storage and greenhouse gas (GHG) emissions between alternatives (see Squillace and Hood 2012 for further discussion).

Another USFS directive, Climate Change Considerations in Land Management Plan Revisions, while aimed at land management plan revisions, nevertheless provides helpful information about climate change-related questions to ask when planning (e.g., How is climate change likely to modify conditions on the planning unit? How will management of the planning unit influence levels of global greenhouse gases and thus climate change?). It also contains discussions about the role of Historic Range of Variability, how to identify potential risks to desired conditions, and examples of hypothetical planning decisions.

Adaptive Management

Adaptive management (AM) was developed in the 1990s to help land managers work through the inevitable uncertainties produced by unforeseen treatment outcomes and/or unanticipated natural and social events (Stankey et al. 2005, Fleischman 2008). However, including AM in a process that also requires NEPA planning and documentation can be tricky. Generally, this is best accomplished in an EIS rather than an EA, or Finding of No Significant Impact (FONSI), because an EA is insufficient when there is significant uncertainty about how treatments will affect a resource while an EIS provides greater latitude to acknowledge uncertainty in the effects analysis. To do so effectively and with less risk of legal entanglement may require including identified (and often quantitative) thresholds and triggers that are defensible, enforceable, capable of being implemented when required, and, in the case of triggers, explicitly and transparently developed. Policy researchers Nie and Schultz (2011) report: "We find that courts have allowed agencies to proceed with adaptive management plans as long as they demonstrate compliance with substantive standards and comply with key NEPA requirements. If triggers are employed, agencies should explain what they indicate, demonstrate that they are enforceable if legal requirements are implicated, and show that the plan as a whole will ensure that substantive legal requirements will be met."

If monitoring indicates that substantive changes are deemed necessary during the course of a project, the courts may require new analysis, generally in the form of plan amendments and a supplemental EIS. Planners in such situations will be required to re-analyze the situation taking into account the new information and/or circumstances even if the original NEPA document discussed possible future actions. Courts are less likely to require additional NEPA analysis when changes in actions and predicted effects are within the range of what was analyzed in the original NEPA document (see Chapter 6 for more discussion about adaptive management).

Project Record

Finally, given the complexity and longevity of CFLRP projects, planners will need to keep a well-documented project record to demonstrate how they built the analysis from the smaller scale and summarized it at the larger landscape level. Without a project record, there is a greater likelihood of successful appeals and litigation.

References

Fleischman, F. 2008. Bureaucracy, collaboration and coproduction: A case study of the implementation of adaptive management in the U.S.D.A. Forest Service.

Freeman, L. 2007. NEPA analysis and the "best science." Farmington, UT: The Shipley Group.

Nie, M. and C. Schultz. 2011. Decision-making triggers in adaptive management: A report to USDA Pacific Northwest Research Station, NEPA for the 21st Century.

Ruyle, G. and J. Dyess. 2010. Rangeland monitoring and the Parker 3-Step Method: Overview, perspectives, and current applications. Tucson: University of Arizona, Arizona Cooperative Extension Publication AZ1525.

Squillace, M. and A. Hood. 2012. NEPA, Climate change, and public lands decision making. *Environmental Law* 42:469-526.

Stankey, G.H., R.N. Clark, and B.T. Bormann. 2005. Adapive management of natural resources: theory, concepts, and management institutions. Gen. Tech. Rep. PNW-GTR-654. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

U.S. Forest Service. 2009. Climate change considerations in project level NEPA analysis.

___. 2010. Climate change considerations in land management plan revisions.

Chapter 4

Multi-party Monitoring

Dave Egan

As of 2012, nineteen Collaborative Forest Landscape Restoration (CFLR) projects were funded across the western United States under Title IV—Forest Landscape Restoration (FLR) of the Omnibus Public Land Management Act of 2009 (P.L. 111-11). Congress not only funded these projects, they mandated that the collaborative stakeholder groups that received the monies comply with the legal requirements of the legislation, which includes establishing a multi-party monitoring program to measure and record the project's effectiveness in terms of meeting the intent of the act, and improving forest health and socio-economic conditions.

Monitoring of any sort involves taking repeated measurements (usually quantitative, but also qualitative) in project locations over time to determine whether stated project goals and objectives are being met. Multi-party monitoring is part of the entire collaborative process in that the design and actual monitoring of a CFLR project

Members of the Uncompahgre Plateau Project Group meet for a trip into the field. *Photo courtesy of ERI*

is overseen, if not actually undertaken, by members of the collaborative. In other words, there is an important social dimension to multi-party monitoring—one that brings people with different perspectives together to help oversee and implement the project. The results of such efforts not only supply information that can be used to adaptively manage the project, they build support for the project through active involvement. This chapter will examine what it takes to develop an operational multi-party monitoring program for a CFLR project.

“

Monitoring of any sort involves taking repeated measurements (usually quantitative, but also qualitative) in project locations over time to determine whether stated project goals and objectives are being met.

Why is Multi-party Monitoring Necessary?

The legal guidelines for multi-party monitoring a CFLR project can be found in Section 4003 (g) (4) of the FLR, which states “The Secretary [of Agriculture, acting through the Chief of the Forest Service] shall, in collaboration with the Secretary of the Interior and interested persons, use a multi-party monitoring, evaluation, and accountability process to assess the positive and negative ecological, social, and economic effects of projects implementing a selected proposal for not less than 15 years after the project implementation commences." This section is part of the FLR that includes language describing requirements for a work plan, project implementation, annual reports, and multi-party monitoring. In doing so, Congress sought assurances that it would maintain oversight over the CFLR projects and the funding that supports them. There are other reasons, however, for assessing these projects with a multi-party monitoring process. These include:

- It examines the results and effectiveness of restoration efforts
- It looks at not only ecological results, but economic and social outcomes as well
- It supports an adaptive management approach
- It serves as an "early warning" system against dramatic/unexpected changes
- It helps determine whether actions/thinking/assumptions were correct or need to be modified
- It provides support from a number of agencies and groups, thereby potentially spreading the cost of monitoring among multiple stakeholders
- It helps maintain and develop trust within the collaborative and the community by involving a variety of stakeholders and by providing a transparent process
- Its findings support outreach and education
- It serves as a reference for other CFLR projects.

Types of Monitoring

There are three basic types of monitoring—*compliance*, *effectiveness*, and *validation*. Of these, compliance monitoring and effectiveness monitoring are the most important for CFLR projects.

Compliance monitoring (also known as implementation monitoring) documents whether or not practices were applied in such a way as to meet the requirements of the supporting legislation, funding agency, or some identifiable best management practice. This type of monitoring answers the basic question: *Did we do what we proposed we would do in order to meet the general goals and objectives of the legislation and the collaborative?* The answers to this question will be important in complying with Section 4003 (h), which requires CFLR reports to Congress every five years, and for other reports by project and contract administrators. Compliance monitoring reports tend to be an accounting of project progress. For example, compliance monitoring performance measures would include such items as: number of acres of "improved" forest, number of miles of stream habitat restored or enhanced, volume of timber or biomass sold, and the number of jobs created or maintained. Information from effectiveness monitoring may also be used in developing the report.

Effectiveness monitoring answers the basic question: *Did the actions taken have the desired result on the condition(s) of concern?* In other words, this type of monitoring evaluates whether collaborative management activities have been effective in moving a set of existing conditions toward a set of desired future conditions; that is, it involves measuring condition change over time relative to management actions. Effectiveness monitoring is essential because it supplies the quantitative and qualitative information needed by land managers, scientists, policymakers, and other collaborators to assess progress and make adjustments to management practices under an adaptive management protocol. The results of effectiveness monitoring can also supply much of the information and data needed for the other two types of monitoring, as noted above. Establishing an effectiveness monitoring protocol will likely be one of the major early efforts for any collaborative forest restoration group.

Validation monitoring is a longer-term process that seeks to answer the questions: *Did our assumptions prove true? What caused the changes we identified during effectiveness monitoring to occur?* This type of monitoring is more research oriented and requires rigorous sampling designs, and extensive data collection and analysis—in many cases much more so than any effectiveness monitoring protocol. As such, most validation monitoring is often done by researchers from universities affiliated with a collaborative or by U.S. Forest Service (USFS) research station personnel. While it may take some time before information from validation monitoring is completed, the results from this type of monitoring will help the agencies and Congress determine whether the basic thinking for supporting the programs was sound and whether future changes need to be considered.

National Multi-party Monitoring Indicators

There is an effort under way to develop a national set of monitoring indicators that will relate directly to the purpose and goals of the Act. The USFS expects to approve these indicators sometime in FY 2012. Broadly defined, these national indicators include: 1) fire costs, 2) jobs/economics, 3) ecological, 4) leveraged funds, and 5) collaboration. This set of national indicators should provide consistent data from all CFLR project sites. This database can then be used to communicate the results of the entire CFLR effort to Congress and national audiences. (The current version of the national multiparty monitoring indicators is available at http://nationalforests.org/conserve/learning/cflrp.)

This document will focus on what it will take to organize a landscape-scale, multi-party effectiveness monitoring protocol for a CFLR project. Such a process will assess many of the same issues as the national indicator monitoring protocol, but with a greater specificity and more project-specific detail. And, as mentioned previously, the data obtained through a successful effectiveness monitoring program will complement and inform the reports and monitoring indicators that are required under the FLR legislation.

As part of any long-term monitoring effort, measurements, such as understory cover, tree diameter and tree height, must be taken at various stages of restoration. In this illustration, the measurement of a tree within a plot is taken at breast height, before thinning operations.

The same measurement is taken soon after thinning and prescribed burning operations, or post-cut.

Data is taken again on the same plot six years after thinning. At this time, it is hoped that indigenous forbs and grasses dominate the understory and the remaining trees have grown without competition for resources.

Issues to Address When Organizing a Landscape-scale, Multi-party Monitoring Protocol

Establishing and implementing a landscape-scale, multi-party effectiveness monitoring program will require addressing numerous issues that will be basic to all CFLR projects (Figure 1). These basic issues include:

- Organizing and coordinating the multi-party monitoring group
- Identifying key concerns and establishing desirable conditions
- Identifying measurable indicators and their metrics
- Identifying monitoring and administrative costs, and addressing budget issues
- Identifying and gathering existing data and background information
- Selecting the appropriate level of monitoring
- Identifying means of data recording, storage, and administration
- Prioritizing key questions based on ecological and socio-economic issues, existing data, and budget constraints
- Testing and implementation of monitoring indicators
- Adaptive management
- Use of monitoring information for outreach.

The following sections will address each of these issues.

Organizing and Coordinating the Multi-party Monitoring Group

By its very nature, a CFLR project will involve many individuals and organizations, each having their own motivations, values, knowledge, and technical and financial resources to bring to the multi-party monitoring effort. In general, this is an asset because having knowledgeable, hard-working people in the proper positions is vital to a successful and effective monitoring program. Because of the multi-party nature of the CFLR projects, collaborative groups may have access to people with expertise in the various areas of ecology, economics, sociology, and other areas of interest. These stakeholders are often involved in the decision-making activities of the collaborative and will be familiar with the goals, objectives, and indicators that have been proposed and approved for the monitoring program. Typically, their assignments will sort out according to their areas of expertise. In addition to this group, federal and state agencies as well as educational institutions may have experts who may either be currently employed doing monitoring work (e.g., range conservationists, endangered plant specialists, invasive species specialists) or who may be available to do so. In some cases, however, there may be positions within the monitoring team that require expertise (e.g., resource specialist, financial, administrative, legal) outside of the collaborative group.

“ ***Managing and coordinating a multi-dimensional group and its resources is no easy task, so leadership is of critical importance.***

Managing and coordinating a multi-dimensional group and its resources is no easy task, so leadership is of critical importance. The designated lead must possess the credibility to function as a convener, facilitator, and coordinator of multi-party monitoring group. This means having the necessary human, technical, and knowledge capacity to identify the right people, organize meetings, coordinate communication, elicit knowledge, and facilitate the entire process. The designated lead must also possess current scientific and technical knowledge about monitoring measures and protocols. The leader will also be familiar with the policies and procedures of the federal land management agencies and be able to effectively cross-walk between the collaborative and the agency. Because multi-party monitoring is a novel approach in resource management, the designated lead must be at once strategic and nimble – strategic in the sense of advancing a clear vision for the multi-party monitoring process and nimble in terms of being flexible to changing social dynamics within the multi-party monitoring group.

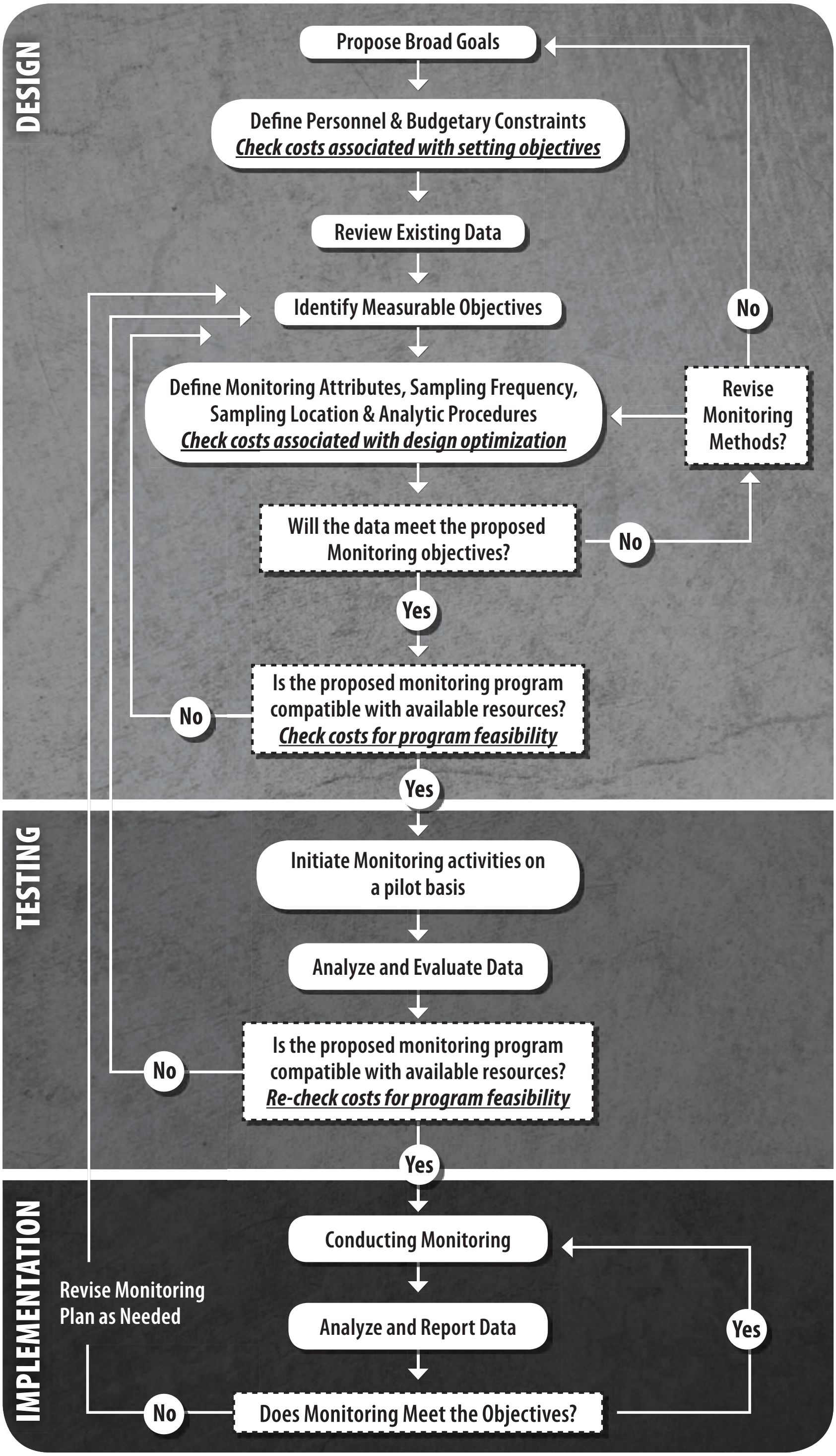


Figure 1. Monitoring program development process (Caughley and Oakley 2001)

In addition to the lead person, the collaborative may want to consider hiring someone (i.e., a monitoring coordinator) to manage monitoring activities, take care of financial issues, and work on administrative issues and reports. Many collaboratives (see case studies that follow) have established monitoring committees. Such groups provide a chance for stakeholders to work together, gather information, solve problems, and provide feedback that can be used in adaptive management decisions. In other situations, collaboratives have found that their members do not have the time and/or skills needed to conduct the multi-party monitoring effort. In such cases, stakeholder groups, if they have the financial resources, are hiring independent contractors to gather and analyze the monitoring data.

Identify Key Concerns and Establish Desirable Conditions

Each CFLR collaborative will have already identified the key issues they hope to address in their project proposal. These concerns typically focus on ecological and economic issues that are undesirable and require improvement in the project area (e.g., the threat of catastrophic fire to forests, communities and infrastructure; loss of wildlife habitat; too many invasive plants; poor economic growth). Social concerns are also important and may include such things as public concerns with smoke from fires and related health issues, loss of recreational opportunities, and loss of biodiversity.

To establish monitoring indicators, a collaborative goes through a process of reviewing their original key concerns and restating them as desirable conditions or goals. For example, a collaborative's key concerns might be:

- Conserve and restore the biological diversity of the ponderosa pine/dry mixed conifer ecosystem, including wildlife
- Maintain and enhance regional and local water and air resources
- Maintain and enhance the regional and local socio-economic situation

- Reduce the potential for catastrophic wildfires
- Restore historic fire regimes and the resilience of the forest system to unforeseen disturbances
- Maintain and increase the level of trust within the collaborative
- Reduce or control invasive species populations.

Working with this list, the collaborative can then begin to assemble a list of key questions for each desirable condition. These questions (e.g., What is the percentage of grass cover following the thinning and burning treatment? What effect have cattle had on aspen regeneration compared to deer and elk? Did we create as many jobs/full-time equivalents (FTEs) as expected?) provide the basis for answering how well restoration and rehabilitation actions have helped move the current conditions toward the expressed desired conditions.

Identify Measurable Indicators

With the desired conditions and their complementary questions in place, the collaborative can move forward to identify measurable indicators. These monitoring indicators can be measures of both quantitative and qualitative information, although it is essential that all partners use consistent monitoring methodologies (including common indicator definitions).

Selecting the correct monitoring indicators is essential and can be a difficult process, if only because there is a tendency within a collaborative to want to collect too much data. The Nature Conservancy recommends selecting indicators that are SMART; that is, the indicators are Specific, Measurable, Achievable, Relevant, and Timed.

Specific: Being specific means that the collaborative knows and agrees upon exactly what will be measured for each of the desired condition, in which geographical area(s) the measurements will take place, by what unit(s) or metric(s), and by whom. Complementary to this guideline is advice from monitoring experts to keep it simple, recognize what is critical to know based on the desired conditions, and obtain only what you need and no more.

Measurable: Since monitoring is all about measuring change, it is vital that baseline information is available and that monitoring metrics used for the project, be they quantitative or qualitative, "fit" well with the initial baseline data so as to avoid uneven (apples and oranges) comparisons. Care should also be taken to minimize variation in the data and to control for sampling errors, both Type I (concluding there is a change when none occurred) and Type II (concluding there is no change even though one has occurred). This no small task and people will often spend more time discussing what to monitor and lose sight of how difficult it really is to measure meaningful change.

Achievable: The collaborative will have to determine not only what changes they expect from the project, but whether they can detect those changes given their human, institutional and financial resources, and the amount of time they have to measure the change (i.e., Are they monitoring short-term or long-term changes?).

Relevant: Throughout the process, the collaborative will have to revisit its goals to ensure that monitoring is focused on what is critical to know and, thus, what is critical to monitor. When considering the relevancy of a proposed indicator, the collaborative should ask: If we know this information, how would we change our management? Or would a manager find this information important 15 years from now? The collaborative will also need to ask: What is minimum change and how important is it? The key, again, is to keep it simple and recognize what is critical to know.

Timed: Monitoring indicators must be identified in terms of how often the measurements will be taken and during which time period(s). This will likely be different and dependent on the nature of the indicator. For example, monitoring of vegetation change might be done several times during the first year following treatment and for years 3, 5, and 10 thereafter. Meanwhile, data about jobs may be taken once every year.

Monitoring indicators require metrics that are consistent in terms of application and meaningful in terms of their ability to measure change. The following is a table of potential indicators and possible metrics used to measure them.

Table 1. Potential Monitoring Indicators and Metrics

Desired Condition	Monitoring Indicator	Unit(s) of Measure	Data Source
Reduce the potential for catastrophic wildfires	Density and spatial pattern of trees across the landscape	Trees per acre, crown cover	Remote sensing information verified by ground sampling
Increased understory productivity	Vitality of the vegetative understory	% cover of native grasses and forbs	Ground sampling
Increased habitat for northern goshawks	Number of northern goshawks, including young	Occupancy rates, births per goshawk pair	Visual observations, sampling of nests
Increased level of trust among collaborators	Active and ongoing participation in the collaborative	Positive responses to survey regarding trust issues	Survey of collaborators
Increased economic growth	Number of FTEs created over time	FTEs created/year	Survey of businesses
Increased public appreciation for restoration efforts	Amount of public awareness	Letters to govt. officials in support, positive responses to survey/focus group	Responses from govt. officials, survey of general public or focus groups
Increased water quantity/quality after restoration treatments	Water levels in streams and lakes, quality in same	Cf/sec flow rate, timing of flows, % volatiles and contaminants	In-stream sampling and stream gauge readouts

(Top) Plot data is collected by measuring off the transect line. (Bottom) Understory data is collected by measuring within a quadrant on a transect line. *Photos courtesy of ERI*

Identify Monitoring and Administrative Costs

During the process of identifying monitoring indicators, members of the collaborative will also need to determine how much it will cost to execute the measurement of each proposed monitoring indicator over the course of the project. These costs should be appraised in whatever metric makes the most sense for the indicator (e.g., dollars, FTEs, hours). Once the costs are determined and a draft budget is complete, a further prioritizing of the indicators will likely be needed. When prioritizing monitoring indicators it is best to work out several funding scenarios in order to maintain, if only on paper, all available options. For example, collaboratives can use a budgetary approach that identifies monitoring indicators that will be used at minimal, medium, and maximum expected funding levels.

Identify and Gather Existing Data and Background Information

In most cases, the project funded by the CFLR Program will have access to existing data and background information about the project area. This information should be tapped since it can provide good baseline data, maps, databases and other information, and may be relatively inexpensive to obtain. It will likely correspond well with data needed for environmental planning for the project. In addition to the federal land manager, sources for such information include state agencies, NGOs, academic institutions, and interest groups. Remote sensing and GIS data as well as Forest Inventory and Analysis (FIA) and LANDFIRE data, census data, and economic inventories and analyses (e.g., Headwaters Economics) are just a few examples of existing data sources.

There can be drawbacks, however, since most existing data was not gathered for the same purposes as those needed by a collaborative. This can result in metrics that do not align with the metrics the collaborative has agreed to use. In addition, there can be concerns about the validity of the data, especially in cases where non-professionals may have gathered it. Furthermore, it may take considerable time and effort to "mine" usable data from reports, scientific articles, and even some databases.

Nevertheless, a collaborative should make the effort to explore what may be already available so that they do not go out and expend scarce resources to capture information that already exists.

Finally, a collaborative will need leaders with past experience or at least good insight into, and partnerships with, federal land agencies to assist with cross-walking multi-party monitoring data to land management corporate datasets. These external datasets can only influence adaptive management when appropriately and continuously cross-walked to the federal partner's datasets.

One method of data collection is measuring the diameter of a tree. *Photo courtesy of ERI*

Selecting the Appropriate Amount of Effectiveness Monitoring

Determining the scale of monitoring efforts and how frequently monitoring will occur during the course of the project is a critical step. These decisions will translate into further decisions about monitoring costs and the appropriate level of monitoring needed to detect meaningful changes in the socio-ecological environment. Perhaps the most important issue is finding a balance between limits of the monitoring budget and having enough replicated measurements to avoid sampling errors. Performing a statistical power analysis using the questions developed by the collaborative or monitoring board as the null hypothesis (i.e., a hypothesis that is presumed true until statistical evidence in the form of a hypothesis test indicates otherwise) can provide both a statistical check and some level of budgetary balance to the process of determining how many measurements are needed and how often they should be measured. This process can apply to economic and social as well as ecological indicators.

Selecting the appropriate level of monitoring affects data quality not only in terms of how many measurements are taken but in terms of how accurately or precisely the data is collected. For instance, given the spatial extent of a landscape-scale project, monitoring at the regional or landscape scale will require remote sensing technology. However, at least in some instances, that data will have to be ground-truthed in order to be certified as accurate (Fraser and others 2005). Likewise, concerns sometimes arise about the data collected by non-professionals (e.g., students, citizen scientists). If non-professionals are part of a monitoring team, they should be trained, given appropriate jobs for their skill level, and have their work checked regularly by professional staff. Having non-professionals on a monitoring team is an excellent idea from the perspectives of building community support, job training, and getting more work done but maintaining the highest level of data quality is always important.

The appropriate amount of monitoring will also take into account how soon changes can be expected or how long is the lag time between the cause (treatment) and the effect (measurable/observable change). Collaboratives and monitoring boards can assess the likelihood of change in ecological, economic, and social areas and develop short-, mid-, and long-term indicators. For example, on the Deschutes Collaborative Forest Project, the collaborative identified the outcomes in this manner: "Long term: The forest achieves desired condition (healthy, resilient, wildfire does not pose a threat to communities).This will take decades in many places. Midterm: The forest is moving towards desired conditions. Desired condition can be defined as: composition, structure and function progresses from departed from the natural range of variability (NRV) to within the range of NRV."

The Uncompaghre Plateau CLFR collaborative was more concerned about measuring broad ecological trends over time rather than statistically comparing different treatment effects for any one time period. In each of the six vegetation types of interest, three 0.5-acre plots—one control and two treatments—were established to measure indicators pertaining to trees, shrubs, understory plants, fuel, and wildlife. These will be re-measured in years 1, 2, 5, and 10 after treatment. The primary interest of the collaborative is to reliably measure and evaluate effects over time rather than statistically account for variability over geographic space. This example illustrates not only the difference between effectiveness monitoring and more research-oriented validation monitoring, but how collaboratives might feasibly develop reliable, if not entirely complete, monitoring information.

Identifying Means of Data Recording, Storage, and Administration

A collaborative will also need to agree on standardized protocols to collect and record their data (e.g., Excel file, .jpg photo file, data form, survey), and then store it in new or existing databases. Standardizing the data will permit easier and better use of the information both in terms of analysis and for writing reports.

It is important to have federal partners participating in multi-party monitoring to more efficiently collect data that can be easily cross-walked or directly inputed to USDA corporate datasets. However, multi-party monitoring provides the opportunity to go above and beyond existing or mandatory federal monitoring. Different partners may have different capacities to store data which may create overlap or inefficient data collection and analysis. Most collaboratives will likely need some administrative support to maintain a database. Collaboratives may have academic partners who are willing to manage data storage and make data available to partners. In addition, some third party services are available for data storage and data mining. For example, the Great Northern Landscape Conservation Cooperative has developed Landscape Conservation Management and Analysis Portal (LCMAP), a data storage and mining service with GIS capability that can be shared across multiple partners through the internet (see resources section for more information).

Prioritize Key Questions Based on Ecological and Socio-economic Issues, Existing Data, and Budget Constraints

In all cases, the monitoring of CFLR projects should be ecologically and socio-economically relevant, statistically sound, and cost effective (Hinds 1984, Caughlan and Oakley 2001). Getting there is not easy, however. It requires giving up any notion of a "wish-list" approach to monitoring, and instead obliges the collaborative to work diligently and strategically, often with the guidance of the designated lead, to refine its monitoring indicators by taking into consideration which changes are most important to know and what changes are statistically possible to know given the available personnel, information, and fiscal resources. To do this, a collaborative will have to identify its key concerns, establish desirable conditions, and decide which questions are most important to answer. Beyond that, a collaborative will need to decide on the techniques and metrics it will use to measure change, and come to terms with the costs and benefits of the various sampling techniques.

Testing and Implementing Monitoring Indicators

Testing how well the monitoring indicators record change on an experimental basis can begin once the collaborative or the monitoring team has gone through the process of selecting, prioritizing, and budgeting for the monitoring indicators. If the indicator works well on a trial basis it can be implemented; if not, then adjustments to the indicator and/or metric are required. Using adaptive management at this stage, while lengthening the process, will help insure that the collaborative obtains meaningful, quality data.

Adaptive Management

Adaptive management should play an integral part in linking monitoring information to ongoing management decision making (see Chapter 6). Adaptive management is the "regulator" in the system because it provides an opportunity for the collaborative, land managers, contractors, and others involved in the project to review the information received from the monitoring effort and make necessary adjustments to the project's initial objectives and/or treatments in order to obtain the desired results. Since it's unlikely that everything will go exactly as planned, employing adaptive management as part of the process provides a point where the collaborative and others can step back and ask: Should we do something different to either change the objective or change our treatment(s) to better meet the objective?

While adaptive management is a valuable step, it often needs to be accompanied by field activities where members of the collaborative, land managers, contractors, and others meet to see, experience, and discuss what has

Quick Links

The following organizations provide tools and resources for the development and implementation of a successful monitoring protocol.

National Forest Foundation CFLR Program National Indicators

Headwaters Economics

University of Oregon Institute for a Sustainable Environment, Quick Guide to Monitoring Economic Impacts of Ecosystem Restoration and Stewardship

USDA Forest Service, Southwestern Region Multiparty Monitoring and Assessment Guidelines

USDA Forest Service Inventory and Analysis National Program

White Mountain Stewardship Monitoring Board actually taken place on the land. These events provide the context for the monitoring data and are often essential in helping build confidence and trust within the collaborative as well as to help people better understand why one course of action or another might be taken.

Use of Monitoring Information for Outreach

Developing and maintaining public support is an essential part of a collaborative forest restoration project—and knowing how to share key monitoring information with various groups can be integral in such an effort. In order to use its monitoring information effectively, a collaborative, typically through its communication and/or outreach committee, should identify all the interested parties with which they want to share the monitoring data. A typical list might include: agency personnel, general public, local/regional government officials, non-participating stakeholders, and local/regional interest groups. The collaborative will then have to decide how and who will share the information to these different groups. Information sharing may be accomplished by developing brochures, through e-newsletters, by making presentations, through the local media, or by other means.

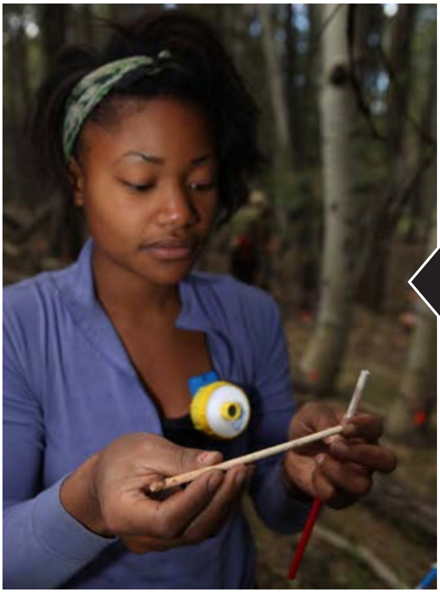
When developing a communication plan that includes monitoring information, a collaborative should consider the following (Moote 2011):

- Who are the potential audiences?
- What outreach mechanisms will be used?
- When and how often will information be shared?
- Who is responsible for organizing and disseminating information?
- What are the key messages?

One word of caution: A communication message should be tested internally and externally (e.g., with a focus group) before its release to the public. Small, but critical, mistakes in publications and/or uneven presentations may lead to unwanted negative publicity. It is much better to "dry run" a media effort than spend time explaining or apologizing for an error or poor performance.

Case Studies

Three case studies help illustrate the basics of developing and implementing a monitoring program for a landscape-scale forest restoration project. They include: White Mountain Stewardship Contract Multi-party Monitoring effort in east-central Arizona; the Deschutes Collaborative Forest Project near the cities of Bend and Sisters, Oregon; and the Uncompaghre Plateau CFLR in southwestern Colorado. See Table 2 for a comparison of each of these landscape-scale, multi-party monitoring efforts.



Researcher Aviana Acid examines a tree core sample.

Photo courtesy of ERI

White Mountain Stewardship Contract Multi-party Monitoring

The White Mountain Stewardship Contract (WMSC), the largest and first ten-year stewardship contract in the United States, is designed to reduce tree density on 150,000 acres of ponderosa pine forest in the Apache-Sitgreaves National Forests (A-S) and help support a local wood products industry. When the contract began in 2004, the A-S convened a multi-party monitoring board whose purpose was to recommend monitoring activities that would assess the ecological, economic, and social impacts of the contract. The monitoring board is composed of more than a dozen members from across the geographic area of the forests, and includes representation or interests in local, county, and state government as well as various resource and business individuals and organizations. To accomplish their mission, the monitoring board went through a process like that outlined in this chapter—listing general concerns, reiterating those concerns in the form of questions, working with specialists to identify ways to measure and answer the questions raised, and then, working within a budget, agreeing on which questions to answer and how, when, and where to have measurements taken. While the actual work of measuring change has been left to experts (ecological studies by employees of the USFS, The Nature Conservancy, and Arizona Game and Fish Department; a small business development center and the primary contractor provide economic information; a private consultant assesses social aspects), the monitoring board maintains oversight of the monitoring activities, allocates money for specific monitoring projects, and provides feedback to the USFS.

A recent summary of the first five years of monitoring various aspects of the WMSC (Sitko and Hurteau 2010) reported findings, lessons learned, and recommendations in the following areas: project administration, ecological effects, economic impacts, and social support. Along with these, the overall lesson learned was the continuing need to improve and evolve the monitoring process: "In the next five years, the Multi-Party Monitoring Board will evaluate and refine its monitoring program and tailor data collection to meet specific information needs and to fill data gaps. We will continue to build on the use of monitoring data to improve planning and treatment designs and project layout" (First Five Years of the White Mountain Stewardship Contract, Executive Summary, p. 4). If the experiences of this pioneering landscape-scale restoration project are any indication, other CFLR project monitoring groups should be prepared to continually improve and tweak their monitoring processes as new values and new data emerge.

Deschutes Collaborative Forest Project

The Deschutes Collaborative Forest Project is located on 145,000 acres in the Deschutes National Forest near the cities of Bend and Sisters, Oregon. The majority (73%) of the landscape is frequent-fire ponderosa pine and dry mixed conifer forest types with the remainder consisting of wet meadows and riparian areas throughout and wet mixed conifer, true fir, and hemlock forests at higher elevations and on north-facing slopes. The goals of the project include restoring forest ecosystems resilience, creating jobs, reducing the risk of high-severity fire in Wildland Urban Interface residential areas, protecting drinking water source watersheds, preserving high-use recreational areas, re-introducing anadromous fish into the Upper Deschutes River, and providing wood fiber to local industries.

There are five collaborative groups, representing numerous organizations and businesses, working together on the Deschutes Collaborative Forest Project. They are the Deschutes Fire Learning Network, Central Oregon Partnership for Wildfire Risk Reduction, Project Wildfire, the Deschutes Provincial Advisory Committee, and Upper Deschutes Watershed Council. Members of these groups held meetings to discuss values they wanted to see or protect on the Deschutes landscape. These values were then translated into goals and treatment projects, which various members of the collaborative agreed to monitor. For instance, the Central Oregon Partnership for Wildfire Risk Reduction Ecosystem Monitoring Committee will undertake qualitative, field-based, post-implementation multi-party reviews of 30 to 45 implemented units across the landscape to assess treatment implementation and effectiveness. The inter-agency Central Oregon Fire Management Services will collect quantitative data to evaluate the effectiveness of treatments in reducing fuel loads and restoring natural vegetation communities and fire regimes. The Deschutes Fire Learning Network will evaluate changes in ecological departure modeled with treatments through time. The Upper Deschutes Watershed Council and Deschutes National Forest will collect data on streamflow, temperature, macroinvertebrate and fish populations, fish passage and screening, and other habitat parameters to evaluate the effectiveness of their watershed restoration activities. The City of Bend will collect water quality data at the intake for its municipal water supply diversion at the outlet of the Bridge Creek Watershed/Drink NEPA planning area during the seven-year period that restoration activities are occurring in that project area. Meanwhile, USFS contract administrators and contracting officer representatives will conduct standard implementation monitoring (Deschutes Skyline Collaborative 2010).

The Deschutes Collaborative Forest Project proposal calls for about $65,000 annually for monitoring, with each of the partner organizations promising to financially support the monitoring effort. The specific amounts each partner organization promised were based on their individual monitoring interests and operating budgets. The USFS is currently not supplying any funding for post-treatment effectiveness monitoring, although they may be using appropriated funds for compliance monitoring and annual reporting. The collaborative calls for increasing wood fiber for industry and creating jobs and in 2012 is developing a socio-economic monitoring plan to assess these desired conditions.

Uncompahgre Plateau CFLR

The Uncompahgre Plateau (UP) CFLR is a landscape-scale project in southwestern Colorado on the Grand Mesa, Uncompahgre and Gunnison (GMUG) national forests. Like the Deschutes CFLR, it is one of the ten recognized CFLR projects that received federal support in 2010 and 2011. The UP CFLR will include active restoration projects on 160,000 acres of USFS land from 2010 through 2020. The goals for the project build on previous work in the area. These goals are largely ecological (e.g., reduce threats from wildfire and invasive species, restore the resiliency and productivity of several native ecosystems) but include the economic goals of supporting local wood products industry, increasing employment opportunities, and retaining a natural resource management-based workforce instead of relying on outside short-term contractors. Project treatments include prescribed burns, mechanical treatments, timber harvesting, invasive species treatments, re-vegetation with native seed, trail and road relocations to reduce sediment, riparian restoration, and improvements for Colorado River cutthroat trout. Multi-party monitoring efforts are proposed for

68,000 acres of the project and the collaborative expects to have an annual average budget of about $109,000 for monitoring purposes (Uncompahgre Plateau Collaborative 2011, p. 3). To that end, the Colorado Forest Restoration Institute (CFRI) received $98,000 for FY11 to lead and coordinate the multi-party monitoring.

This collaborative employs a unique "citizen science" approach for monitoring that involves professional scientists/researchers, stakeholders, citizens, students, and young adults who are receiving training through various jobs programs. A long-term citizen scientist, multi-party ecological monitoring program and workgroup already exist and provide a core group for monitoring. The collaborative uses a monitoring protocol developed by the Grand Mesa workgroup and the CFRI as part of a demonstration project in the area. For the larger project, CFRI has conducted an initial assessment with support of forest specialists, research scientists, the GMUG, and project collaborators. This assessment establishes which vegetation types and mixes will be monitored, the terrain of the candidate areas, candidate areas for treatment, and types of treatments considered. With input from multi-party monitoring meetings, the CFRI has created a plan that includes measurement protocols to be used for the duration of the monitoring project. Data will be analyzed and reported to the multi-party group to allow it to be used for adaptive management purposes. The CFRI will compile, analyze and store the monitoring data (Uncompahgre Plateau CFLR Proposal, p. 4).

Table 2. Comparison of Three Landscape-scale Monitoring Programs

	White Mountain Stewardship Contract	Deschutes Collaborative Forest Project	Uncompahgre Plateau CFLR
Project Size	150,000 acres; after five years, 56,810 acres treated with an additional acres in progress	145,000 acres	160,000 treated acres proposed; (multi-party monitoring on 68,000 acres)
Concerns/ Values	Wildfire; forest health; wildlife habitat; soil compaction; local/ regional economy; social acceptance of restoration.	Wildfire; old growth; public safety; recreation; riparian areas; wildlife habitat; local/regional economy.	Wildfire; native ecosystem resiliency, diversity, productivity; ecosystem structure, composition, and function; old growth; meadows; understory; riparian.
Goals: Ecological	Improve forest stand structure; improve fire behavior; improve wildlife habitat connectivity; enhance avian community; improve black bear habitat; avoid soil compacting; encourage local/ regional wood industry.	Restore resiliency throughout the landscape; use historic range of variation in forest structure and fire return intervals to identify areas needing restoration treatment; decrease the risk of wildfire; restore and enhance riparian areas and fish populations; establish and enhance wetlands; control invasive plants; return prescribed burning were possible; decommission and/ or close logging roads.	Restore ponderosa pine and mixed conifer; restore historic fire regimes; study effects of herbivory on aspen and recent patterns of aspen regeneration; monitor salvage logging and vegetation recovery following wildfire; asses treatment effects on weed populations; riparian (vegetation composition and structure, streambank stability, residual pool depth and frequency); old/large trees; understory re-establishment; landscape-scale issues.

	White Mountain Stewardship Contract	Deschutes Collaborative Forest Project	Uncompahgre Plateau CFLR
Goals: Economic	Help existing wood products industry run at full capacity and encourage new utilization facility development; reduce restoration treatment costs; increase employment.	Help existing wood products industry run at full capacity and encourage new utilization facility development; reduce restoration treatment costs; increase employment.	Help existing wood products industry run at full capacity and encourage new utilization facility development; reduce restoration treatment costs; increase employment.
Goals: Social	Social acceptance of and increased knowledge about restoration treatments.	Yes, but not monitored.	No stated goals, although the charter document for the project includes goals about collaboration and conflict management.
Goals: Project Administration	Track acres treated, jobs created; treatment costs; economic benefits.	No stated goals.	No stated goals.
Treatments	Thinning w/biomass removal.	Thinning w/ biomass removal; non-commercial thinning; prescribed burning; stream channel restoration; wetland enhancement/ creation; riparian thinning; road decommissioning; invasive plant treatments.	Thinning of both ponderosa pine and mixed conifer to specified BAs; aspen exclosures.

	White Mountain Stewardship Contract	Deschutes Collaborative Forest Project	Uncompahgre Plateau CFLR
Metrics	Ecological: Forest vegetation changes: vegetation plot data (fire behavior extrapolated from this data as well some animal habitat info); soil and water quality; "long-established and widely accepted methods" (e.g., Daubenmire plots, stand exams, Ripley's K, patch morph connectivity, songbird surveys, soil compaction) as well as modeling tools. Also had a demonstration site (Eager South). Economics: Annual survey by contractor to determine local business capacity and employment levels; economic analysis by small business development center. Social: Surveys of citizens to determine awareness and support of restoration, perceived threat of wildfire, knowledge of forest and fire ecology.	Ecological: Qualitative, field-based, post-implementation multi-party reviews of sampling; quantitative data collection to assess effectiveness of fuel reduction treatments and restoring natural vegetation; quantitative data about streamflow, fish populations, and related riparian issues; water quality data; stats for acres treated, miles of road decommissioned, trails maintained, miles of streams restored.	Ecological: Data collected in forest treatment areas (overstory, tree regeneration, understory, fuel characteristics) using plot information and photo points; Daubenmire plots used to collect data about forbs, graminoids, and shrubs in treatment areas; aspen exclosures measured using photo points and tallies of aspen height and number in plots w/i exclosures; salvage logging assessment will measure canopy cover of understory species along permanent transects using Daubenmire frame plots, also percent cover of litter, bare soil, downed wood; weed population monitored by visual inspection while driving roadways and from observations by livestock permitees and others; riparian values assessed using Multiple Indicator Monitoring (MIM) protocol. Economic: Biomass-for-energy assessment (supply, transportation, sustainability).

	White Mountain Stewardship Contract	Deschutes Collaborative Forest Project	Uncompahgre Plateau CFLR
Monitoring Board	13-member, multi-party monitoring board. However, the board does not collect the data; data collected by the USFS mainly, also by AZGFD, TNC, U of AZ, private consultants. The monitoring board developed monitoring objectives and related questions, while meeting once monthly; now meet quarterly.	Multi-party committee with USFS contract administrators and contracting officers conducting standard implementation monitoring.	Monitoring Guidance Committee for "operational details." Includes agency personnel, Colorado Forest Restoration Institute, university researchers, and others.
Annual Avg. Budget (est.)	3% of annual overall project budget	$65,000 avg. (proposed)	$108,640 avg. over ten-year life of project

Conclusion

Multi-party monitoring is one of the crucial "bridges" to successful collaborative landscape-scale forest restoration because it provides much needed information for managers while allowing a greater level of participation and transparency for stakeholders. However, developing and maintaining a quality multi-party monitoring program is not without its challenges. These "barriers" include adequate, long-term financial, personal, and organizational resources as well as the means to develop rigorous, directed strategies for obtaining and analyzing key data about meeting project objectives.

- The CFLR projects present a unique opportunity to actualize what many citizens and stakeholders have been calling for – multi-party monitoring that is rigorous and able to inform management decisions through adaptive management.
- Multi-party monitoring is a new form of social organization and coordination. It is a new social process for everyone involved, so it is necessarily iterative and adaptive.
- Effectiveness monitoring has the opportunity to contribute new knowledge about ecological and social-economic systems.
- Monitoring, in and of itself, does not result in adaptive management; a collaborative has to decide to include adaptive management in the overall process.
- Multi-party monitoring groups will have greater success when they coordinate their efforts with federal land management agencies. This means making a serious effort to understand and use the language and approaches of the agencies when establishing and coordinating multi-party monitoring efforts.

References

Caughlan, L. and K.L. Oakley. 2001. Cost considerations for long-term ecological monitoring. *Ecological Indicators* 1:123-134.

Deschutes Skyline Collaborative. 2010. *Deschutes Skyline Landscape: A proposal from the Deschutes National Forest and their collaborators for the Collaborative Forest Landscape Restoration Program*. Bend, OR: Deschutes Skyline Collaborative.

Fraser, R.H., A. Abuelgasim, and R. Latifovic. 2005. A method for detecting large-scale forest cover change using coarse spatial resolution imagery. *Remote Sensing of Environment* 95:414-427.

Hinds, W.T. 1984. Towards monitoring of long-term trends in terrestrial ecosystems. *Environmental Conservation* 11:11-18.

Moote, A. 2011. *Multiparty monitoring and stewardship contracting: A tool for adaptive management*. Portland, OR: Sustainable Northwest.

Sitko, S. and S. Hurteau. 2010. *Evaluating the impacts of forest treatments: The first five years of the White Mountain Stewardship Project*. Phoenix, AZ: The Nature Conservancy.

Uncompahgre Plateau Collaborative. 2010. Uncompahgre Collaborative proposal to the Collaborative Forest Landscape Restoration Program..

___. 2011. *Multi-party monitoring for the Uncompahgre Plateau Collaborative Restoration Project*.

Resources

Block, W. M., A.B. Franklin, J.P. Ward, J.L. Ganey, and G.C. White. 2001. Design and implementation of monitoring studies to evaluate the success of ecological restoration on wildlife. *Restoration Ecology* 9:293–303.

Buyantuyev, A. and Jianguo Wu. 2007. Effects of thematic resolution on landscape pattern analysis. *Landscape Ecology* 22:7–13.

Churchill, D., A. Larson, and P. Nelson. 2005. *A Multi-party monitoring protocol for the Cat Creek Stewardship Project*. Pinchot Partnership, Gifford Pinchot National Forest.

Ecosystem Management Initiative. *Measuring progress: An evaluation guide for ecosystem and community-based projects*. University of Michigan School of Natural Resources and Environment.

Forest Guild. *Bluewater Multiparty Monitoring Plan*.

Great Northern Landscape Conservation Cooperation (LCC). Landscape Conservation Mapping and Analysis Portal. Greater Flagstaff Forest Partnership Monitoring Protocol

Herrick, J., G. Schuman, and A. Rango. 2006. Monitoring ecological processes for restoration projects. *Journal for Nature Conservation* 14(3-4):161-171.

Kennedy, P.A., J. Townsend, W.B. Cohen, P. Bolstad, Y.Q. Wang, and P. Adams. 2009. Remote sensing change detection tools for natural resource managers: Understanding concepts and tradeoffs in the design of landscape monitoring projects. *Remote Sensing of Environment* 113(7):1382-1396.

Kennedy, R.E., W.B. Cohen, A.A. Kirschbaum, and E. Haunreiter. 2007. Protocol for Landsat-based monitoring of landscape dynamics at North Coast and Cascades Network Parks: U.S. Geological Survey Techniques and Methods 2-G1. Reston, VA: USGS Publishing Network.

Lausch, A. and A.L. Herzong. 2002. Applicability of landscape metrics for the monitoring of landscape change: Issues of scale, resolution and interpretability. *Ecological Indicators* 2(2):3-15.

Margoluis, R.A. and N. Salafsky. 1998. *Measures of success: Designing, managing, and monitoring conservation and development projects.* Washington, DC: Island Press.

Moseley, C. and L.J. Wilson. 2002. *Multiparty monitoring for sustainable natural resource management*. Eugene, OR: Ecosystem Workforce Program and Hayfork, CA: Watershed Research & Training Center.

National Forest Foundation. CFLRP National Indicators. http://nationalforests.org/conserve/learning/cflrp

Noss, R.F. 1990. Indicators for monitoring biodiversity: A hierarchical approach. *Conservation Biology* 4:355–364.

Pitlz, D., H.L. Ballard, and E.T. Jones. 2006. Broadening participation in biological monitoring: Handbook for scientists and managers. USDA Forest Service, Pacific Northwest Research Station, Portland, OR. PNW-GTR-680.

Reynolds, K. M. and P.F. Hessburg. 2005. Decision support for inte grated landscape evaluation and restoration planning. *Forest Ecology and Management* 207:263-278.

Roccaforte, J.P., P. Fulé, and W.W. Covington. 2010. Monitoring landscape-scale ponderosa pine restoration treatment implementation and effectiveness. *Restoration Ecology* 18(6):820-833.

Roni, P., M. C. Liermann, C. Jordan, and E. A. Steel. 2004. Design considerations for monitoring restoration effectiveness. Pages 13-34 *in* P. Roni, editor. *Monitoring stream and watershed restoration*. Bethesda, MD: American Fisheries Society.

Siuslaw National Forest Stewardship Contracting Multiparty Monitoring Report Fiscal Year 2010. 2012. Philomath, OR: Integrated Resource Management.

Sundstrom, S., C. Moseley, M. Nielsen-Pincus, and E.J. Davis. 2011. *Quick guide to monitoring economic impacts of ecosystem restoration and stewardship*. Eugene, OR: University of Oregon Institute for a Sustainable Environment, Ecosystem Workforce Program.

USDA Forest Service, Southwestern Region. Multiparty monitoring and assessment guidelines.

USDA Forest Service, Inventory and Analysis National Program. Forest inventory and analysis field guides, methods, and procedures.

Chapter 5

Contracting and Implementation

Dave Egan

All landscape-scale forest projects reach a crucial stage with the letting of contracts and the subsequent implementation of the restoration treatments. At this point in the process, the ideas and discussions of the previous steps meets the reality of the actual work on the land. This chapter reviews the procedures used by the United States Forest Service (USFS) when implementing a landscape-scale forest restoration project using stewardship contracts for complex, large timber sales. Understanding these procedures is vital to collaborative groups and individuals who hope to work successfully with the USFS on landscape-scale, collaborative forest restoration efforts, such as those authorized by the Collaborative Forest Landscape Restoration Program.

Planning: Initiating the Implementation Process

The contracting and implementation process begins long before any restoration activities take place in the field. Prior to developing the contract and on-the-ground action, various USFS personnel assess the situation at-hand, prepare cumulative effects analyses, conduct public scoping, prepare requests for proposals or contract bids, and finalize the silvicultural prescriptions, NEPA documents (see Chapter 3), and financing plans. This is typically an extremely involved and somewhat lengthy process that requires significant coordination between the national, regional, forest, and district USFS offices as well as stakeholder and collaborative groups. All of these various elements are critical to the implementation and success of a project, especially one at the landscape scale. The choice of contracting option typically reflects the work that took place in these other activities.

Collaborative groups of stakeholders are often intensely involved in the planning process, influencing and advising the federal land management agency about the issues that concern the collaborative and/or providing technical expertise that the agency needs to make their assessments and complete the necessary NEPA documentation. Support from the collaborative gives the land management agency the backing they need to help avoid lawsuits and to gain the political currency needed for funding landscape-scale efforts.

Contracts: The Bridge between Planning and Implementation

Contracts for landscape-scale forest restoration projects are legal documents that spell out the rights and responsibilities of the land management agency and the approved bidder(s). They serve as a "bridge" between the ideas of the planners and the reality of on-the-ground implementation. If done

“*Existing collaborative groups continue to favor stewardship contracts and agreements as a main vehicle for accomplishing collectively defined desired outcomes. In some locations, stewardship contracting has become the preferred way of doing business and has allowed more work to be accomplished on-the-ground.*

— 2011 Pinchot Institute for Conservation

correctly, the contract brings together the goals of the agency and the collaborative, and packages them into objectives that are realistic and attainable for timber workers and the wood products industry.

In the past, the USFS had basically one tool for complex, large timber sales—a contract account identified in Chapter 53 of the USFS Handbook 2409.18 as either a pre-harvest (FS-2400-6T) or post-harvest (FS-2400-6) contract. In 2003, Congress granted both the USFS and the BLM the authority to use what are known as stewardship contracts (Section 323 of Public Law 108-7). Stewardship contracting provides the agencies with two basic options—either an Integrated Resource Timber Contract (IRTC, FS-2400-13 or 13T) or an Integrated Resource Service Contract (IRSC). These two stewardship contract types have greatly increased the flexibility of contracting options and, although in some ways still experimental, they are the contracts that will now most likely be used on landscape-scale forest restoration projects on federal lands. The following section explains how they work.

Stewardship Contracting

Although stewardship contracts may be the "new kid on the block," a 2011 Pinchot Institute for Conservation report indicates that, "The use of stewardship contracting has increased dramatically over the last year with a 65% increase in the number of contracts and a 73% increase in acres awarded. Existing collaborative groups continue to favor stewardship contracts and agreements as a main vehicle for accomplishing collectively defined desired outcomes. In some locations, stewardship contracting has become the preferred way of doing business and has allowed more work to be accomplished on-the-ground" (p. 1).

There are many reasons for this upsurge in stewardship contracts or agreements, not the least of which are the different features they provide compared to the traditional timber contract. These features include:

- Contract awards can be based on "best value" considerations rather than simply awarding the contract to the highest qualified bidder. This allows the agency to consider factors other than price (e.g., past performance, experience of firm/personnel, use of local work forces, technical approach, understanding of government procedures) when awarding the contract. Less than full-and-open competition (i.e., accepting the lowest bid is not necessary) is also allowed under stewardship contracting.

- Stewardship contracts allow a contractor to perform needed services and obtain "stewardship credits" that they can then use to obtain removed products (e.g., timber, non-timber products, grazing access).
- While receipts from traditional timber sales are sent to the U.S. Treasury, receipts from stewardship contracts can be retained by the agency for use in the same or other stewardship projects. Likewise, stewardship contracts or agreements are exempt from making timber payments to counties, which is a requirement of traditional timber contracts.
- Stewardship contracting sanctions "designation by description" (DxD) silvicultural treatments. This allows land managers to describe an end result rather than actually marking timber for removal or as leave trees. This is a significant benefit to large-scale projects where marking trees would be a time-consuming and expensive endeavor.
- Performance bonds are optional when using an IRTC unlike traditional timber contracts, which require performance bonds. They are required, however, when employing an IRSC where product will be removed.
- Non-profit groups can enter into stewardship agreements to fund and implement stewardship projects.
- Under an IRSC indefinite-delivery, indefinite-quantity contract, the USFS is not required to provide a cancellation ceiling, which is a financial obligation that is escrowed at the time of the contract award to pay a contractor should the agency decide to cancel the contract. Relief from this additional expense makes the project considerably less costly for the agency and, thus, easier to operationalize.
- It is possible to run multiple contracts that can each be up to ten years in length.

Stewardship contracting does, however, require multiparty monitoring to identify the contracting status, accomplishments, and level of collaboration (see Chapter 4).

Federal land management agency contract specialists, after considering the ideas and suggestions of stakeholders as well as the needs of the agency, will determine what aspects of a stewardship contract are most appropriate for the project from the following list (see Figure 1 for complete details):

- Type of contract(s)
    - Integrated Resource Service Contract
    - Integrated Resource Timber Contract
- Multi-year contracting
- Multiple-year contracting
- Best-value contracting
- Trading goods-for-services
- Designation by Description (DxD) or Prescription (DxP)
- Retention of receipts
- Use of retained receipts from another approved stewardship project
- Retention of KV (Kneutson-Vandenberg Act) or BD (brush disposal) from receipts
- Other than full and open contract competition (requires approval of Regional Forester)

Once these decisions have been made, the agency issues a request for proposals (RFP) from any interested contractors and, after a given period of time, makes their selection according to selection criteria identified in the RFP.

Main Provisions of a Stewardship Contract for a Landscape-scale Project

Due to the scope and scale a landscape-scale forest restoration project, the provisions of the contract typically employ a mix of stewardship

Figure 1. Authorities and Procedures Form for Stewardship Contracts

Authorities and Procedures
Trading Goods for Services
Designation by Description or Prescription 1/s
Retention of Receipts
Use of Retained Receipts from Another Approved Stewardship Project
Retention of KV or BD Funds from Receipts (not applicable to an IRSC)
Best Value Contracting
Multi-Year Contracting (cancellation payment to be obligated with award)
Multiple Year Contracting
Other than Full and Open Competition 2/
Non-advertisement with product value exceeding $10,000
Non-USDA Administration of stewardship contracts or agreements
Use of an Agreement
Type of Contract(s) to be used
Integrated Resource Contract(s) - Service
Integrated Resource Contract (s) - Timber
Standard Service Contract(s)

1/ Will require use of Washington Office or regional special provisions. Designation by Prescription is applicable to scaled agreements or contracts only.

2/ Will require special Regional Forester approval - summarize the need for this authority.

contracting and traditional timber contract requirements. The basic outline of such a contract includes:

- Information about the overall project (e.g., location, size, length of the performance period), the intent of the contract (e.g., return the forest to conditions less prone to wildfire and insect outbreaks), type of forest vegetation (e.g., ponderosa pine, mixed conifer), and how the work will be assigned (e.g., task orders, other contractual agreements)
- Information about the work/treatment areas (e.g., size, location) and the types of work expected to occur (e.g., timber removal, road maintenance/decommissioning, treatment of "danger trees")
- Provisions defining Desired Conditions for vegetation types within the project area (e.g., number and diameter size of remaining trees and their spatial arrangement, percentage of openings, the amount of coarse woody debris to be left, percentage of basal area northern goshawk foraging and post-fledgling areas).

This type of contract also describes how the USFS will coordinate with the contractor about all aspects of the contract, with both parties providing lists of their key project personnel. It also provides information about appropriate tree removal methods, road work, slash treatment, and taking preventative measures to protect wetland/riparian areas, survey monuments, meadows, rare plant and animal habitat, and cultural resources. Other provisions require the contractor to detail how they will maintain/guide road access for the general public during the project as well as their plans to clean their equipment and prevent fires, oil/hazardous waste spills, and other possible pollution.

The contract also specifies whether the sale is a Sale by Area or a Sale by Amount. In a Sale by Area, the sale volume is estimated but not guaranteed to the buyer. In most situations, the timber purchaser has the obligation to cut and remove excess volume and pay the current contract fees. Meanwhile, the USFS has no obligation to make up deficits in volume. A Sale by Amount identifies a specific quantity of timber for cutting and

A chipper reduces limbs into biomass chips during a White Mountain Stewardship restoration project in eastern Arizona. This staging area, where cut logs and other small material are taken for loading onto trucks, is called a "landing." Often, these landings become disturbed by machinery and activity and need to be rehabilitated to avoid invasion by unwanted weedy plant species. *Photo courtesy of ERI*

obligates the USFS to mark or designate the full quantity specified. When offering a stewardship contract, goods-for-services can be an option.

Finally, the contract describes the various obligations of the USFS and the contractor in terms of marking trees, inspections and acceptance of work, payments including stewardship credits, minimum and maximum order limit obligations, ensuring proper wage payments, and other federal labor obligations.

The method for paying the contractor or purchaser is determined prior to the contract being advertised. There are two basic sales types: 1) scaled sales and 2) pre-measurement sales. A scaled sale is a direct measurement method whereby the felled logs (i.e. green trees) are measured by volume (i.e, CCF or 100 cubic feet) and the purchaser is paid for the volume taken out of the forest. In pre-measurement sales the volume has been determined by the USFS prior to the advertisement of the contract. There are two types of pre-measurement sales: 1) payment unit sales and 2) lump sum sales. Payment unit sales occur when the USFS decides, for financial or administrative reasons, to subdivide the total sale into two or more payment units and pay the purchaser when the work in that unit is complete. A lump sum sale provides one payment to the purchaser either at the beginning of the work or after all the work has been completed.

Typical Implementation Activities

There are at least six activities that may occur in a large-scale forest restoration project. They are:

- Mechanical removal of trees
- Biomass removal
- Road maintenance/road decommissioning
- Treatment and disposal of "danger" trees
- Control soil erosion and water pollution
- Goods-for-services activities (e.g., invasive plant control/removal, infrastructure repair, meadow restoration, restocking burned-over areas).

(Prescribed burning/broadcast burning, either as a separate treatment or following mechanical thinning, is not included in this list because it is typically done by USFS personnel.)

Mechanical Removal of Trees

The mechanical removal of trees involves four phases of work: 1) identifying trees for removal, 2) developing a site-specific removal strategy, 3) cutting trees, and 4) moving cut trees to a landing for removal by truck to a wood products mill or other type of processing plant (see Box 1 and Box 2).

Identifying Trees for Removal

The contract identifies the silvicultural prescription and may be offered as 1) designation by description, 2) designation by prescription, 3) leave tree mark, or 4) cut tree mark. Designation by description (DxD) is a method used to designate commercial leave or take trees without painting or mark-

Box 1. Mechanical Thinning Strategies

Thinning from below (or low thinning): Remove smaller, weaker trees to favor the larger dominant and co-dominant trees, and reduce the potential for severe fire effects, decrease the susceptibility to mortality from insects and diseases, and increase the ability of larger-size trees to survive low-intensity, ground fires.

Thinning from above (or crown thinning): Remove competing trees in the same crown class to favor desirable dominant and co-dominant trees by reducing crowding within the main canopy.

Conversion thinning: Thinning from below and above to open even-aged stands, allow regeneration to establish and grow, and create subsequent age classes over time.

Selective thinning: Remove large, dominant trees, often those over a specified diameter, to release vigorous, smaller-diameter trees. Stand structures and species compositions created by selective thinning may be limited and, in general, favor shade-tolerant species or trees occupying the intermediate and suppressed crown classes.

Improvement and salvage cutting: Remove specific, undesirable trees from a stand, in particular damaged trees (e.g., from wildfires or storms), snags, or trees susceptible to a certain disease or insect.

Uneven-aged management: Remove some trees in all size classes either singly or in small groups, leaving at least three different age/size classes; typical strategies employed include single-tree selection, group selection, and free selection.

> Single-tree selection: Remove individual trees of all size classes, more or less uniformly throughout the stand, to promote growth of remaining trees and to provide space for regeneration, especially of shade-tolerant tree species.
>
> Group selection: Remove groups of trees in all size classes with regeneration occurring in the resulting gaps. Smaller openings provide environments suitable for shade-tolerant tree species, while larger openings provide conditions suitable for the regeneration of more shade-intolerant species.
>
> Free selection: Use a combination of group and single tree selection strategies with reserve trees left in all structural stages. Graham and Jain (2004) recommend it for creating clumpy and irregular stand structure preferred by bird species, such as the northern goshawk.

Even-aged management: Remove most or all trees in all sizes classes either singly or as a group; typical strategies include clearcut, seedtree cut, and shelterwood cut.

> Clearcut: Harvest essentially all trees, create open soil, and then re-plant and/or allow natural reestablishment.
>
> Seedtree cut: Remove most of the trees in a forest except for selected, seed-producing trees to foster reestablishment of seedlings.
>
> Shelterwood cut: Use multiple-entry harvest that removes many trees on initial entry but leaves other trees to provide seeds and shade for reestablishment; useful for shade-tolerant tree species. Re-enter to harvest older trees once younger trees have begun to mature.

ing individual trees. The description must include specific information that allows the designation of each tree to be replicated by all parties before and after cutting. Various designation possibilities include: designation by species, by diameter, by spacing, by tree health, or by damage class. The best situation to use DxD is on uniform, green stands of timber of limited species and similar size. The USFS likes to use DxD because it requires less preparation time and little to no paint and is, therefore, less costly for presale than cut or leave tree marking. However, while it may also be the only cost-effective option for landscape-scale treatment projects, DxD requires more sale administration time and greater coordination between the sales administrator, silviculturalist, contracting officer, and the contractor to maintain quality control, especially in multi-species forests. Area-based cruise methods must also be undertaken to establish the parameters for the designation. Loggers often don't like DxD because they feel the prescription is too rigid and makes modifying the contract difficult. Designation by description works in either Sale by Area or Sale by Amount situations.

Designation by prescription (DxP) is a method of designating trees for removal by describing the desired end result of the treatment; for example, retain 40% basal area. It is used to designate commercial timber on scaled sales (i.e., Sale by Amount). In such cases, the purchaser marks the timber at their expense for USFS inspection and approval prior to cutting. The DxP method works well in situations where a more nuanced approach is needed due to the sale having a variety of tree species, tree sizes, and/or tree diameters. It requires administrative time in terms of inspecting the marking prior to cutting and, thus, coordination between the contracting officer and the silviculturalist. However, it also offers greater flexibility in terms of meeting an end result and takes advantage of the contractor's professional skill and knowledge.

A leave tree mark (LTM) is used when the number of trees to cut outnumbers the trees to leave, and, thus, the leave trees are marked since there are fewer of them. A cut tree mark (CTM) is just the opposite, the cut trees are marked because there are fewer of them. There are various ways to decide which trees are leave or cut trees—by species, by diameter, by damage class, number of trees, for example. Either marking method can be used for maintaining groups and/or individual trees, free thinning, and even space thinning. Both require hand-marking individual trees and, therefore, can be fairly time consuming.

Developing a Site-specific Strategy

Across a broad landscape there are various changes in the land that require the contractor to strategize how best to effectively fell and remove the identified trees from the site. A variety of factors come into play when developing this strategy. They include:

- Goals and objectives of the land management agency, as identified in the contract.
- Size of the treatment area: large areas typically require larger equipment and operations to be efficient and productive.
- Average tree diameter: equipment must fit diameter size in order to make operation effective.
- Terrain/slope: flat, non-rocky terrain is the best both in terms of cost-effectiveness (cable yarding and aerial logging are expensive) and for controlling erosion. Steep slopes also pose safety issues for operators.
- Stand density: heavily stocked areas can influence the load size carried to a land, while understocked areas may mean going greater distances to get to cut trees out of the forest.
- Type of cut/marking prescription: Selective cutting takes longer than clearcutting; prescriptions that are unclear to the logger require more time as well.

Cutting Trees

Logging contractors use three basic types of mechanical felling machines to cut trees—1) single-function machines that are only capable of directionally felling a tree, 2) dual-function machines (i.e., feller-bunchers) that can fell a tree and move the cut stem to a pile, and 3) multi-function machines (i.e., harvesters) that can fell, delimb, buck, and place the processed pieces. They may also use chainsaws as the need arises. In such cases, the logger must evaluate a number of factors including tree lean, desired direction of fall, distribution of the crown weight, and the presence of any defects in the stem before felling the tree. Mechanized felling, however, is faster and safer than manual felling. For example, a feller-buncher can fell a tree in 3 to 6 seconds compared to 30 and 90 seconds for a person with a chainsaw. Moreover, feller-bunchers are capable of felling and bunching up to 200 trees per hour in favorable conditions. Mechanical fellers can also delimb a tree at the stump, especially small-diameter trees; larger diameter trees may require the use of a gate, pull-thru, or strokeboom delimber.

Northern Arizona University School of Forestry student paints a leave tree mark (LTM) on a designation by prescription (DxP) restoration treatments at Rogers Lake County Natural Area, southwest of Flagstaff. *Photo courtesy of the School of Forestry, Northern Arizona University*

In specific cases (i.e., in designated Wilderness Areas or areas where noise is a concern), the contract may specify that trees will be cut with handsaws. The contract may also specify the height of left stumps.

Moving Cut Trees

Cut trees are moved from the cutting area to landings using skidders whenever the terrain allows. Cable yarding systems or helicopters are used when logging with chainsaws in areas of steep topography.

The ideal skidding pattern will locate skid trails from the cutting area as directly as possible to the landings to minimize the lengths of trails. However, slope limitations may require a more indirect path to avoid crossing hillsides and other uneven topography. Steep skid trails should include water diversions to keep water from channeling downhill. If the prescription is a partial cut, the skidding pattern should be designed to avoid damage to the residual stand. "Rub trees," which will later be removed, may be left on the inside of corners on trails to protect the remaining stand. The skidding pattern must be defined prior to felling so that fallers will know which direction to drop the trees. Such a plan will significantly reduce the costs and impacts of the whole operation.

Once the skidder reaches the landing, the logs are sorted by species and processed as required. Loading the processed logs onto a truck is typically done using either a front-end or knuckleboom loader.

Biomass Removal

Thinning treatments produce slash that must be removed or treated in order to reduce the likelihood of fire and/or fire mortality to leave trees. Typically the USFS pays for such work using stand improvement or KV funds.

There are three common methods of working with slash: 1) lop and scatter, 2) pile and burn, 3) chipping, and 4) broadcast burning. Lopping involves cutting the slash to specified height above the ground in order to accelerate slash decay and then scattering it to help prevent erosion. Piling can be done by hand or machine. Slash piles should be located out from the dripline and away from the boles of leave trees to avoid damage from pile burning. Minimum and maximum pile sizes and the minimum distance from the pile to closest leave tree are typically specified. Skid trails should avoid groups and clumps, and use the created openings as passageways for moving material to burn areas or landings. Burning slash piles typically leaves the soil either bare or open and often become a site for weedy species, such as mullein (*Verbascum* spp.). Chipping involves the use of mechanized equipment and needs a relatively large, accessible area in which to operate. Slash is fed through a chipper, which then blows the chips onto the forest floor. Whole-tree chippers are available in a wide range of sizes and designs including small, towed, hand-fed models as well as large, self-propelled machines with their own loaders. A whole-tree chipper combined with a delimber-debarker can produce clean quality chips for pulp production. Without debarking, chipping whole trees produces "dirty chips" that are generally a lower-valued energy product. Grinding or mastication is similar to chipping except the tree is reduced through a shredding action into a coarser, irregular-sized fraction biomass. Tub grinders and horizontal grinders cannot produce pulp chips, but may be better suited for economical conversion of logging residues into hog fuel for biomass burning or other purposes (e.g., animal feed and/or bedding, surfacing paths).

Leaving some slash brings benefits to wildlife and the soil. Wildlife, especially small mammals and birds, use slash piles for shelter and other habitat purposes. Slash also helps the soil by providing a mulch that thwarts erosion, provides microsites for seedling establishment, and adds nutrients to the soil as it decays.

Road Maintenance/Road Decommissioning

Most, if not all, landscape-scale forest restoration contracts will have specifications that detail the role of the contractor in maintaining or improving existing road conditions during and at the termination of logging and other operations.

Some contracts, however, may include provisions for decommissioning roads that the agency no longer deems necessary. These roads are often old and often built in poor locations. They may also be abandoned sections of former roads. The main goals of road closure and restoration are to eliminate surface erosion, create a more natural

This decommissioned road has been gated to prevent future vehicular travel and facilitate ecosystem restoration. *Photo by Joseph Trudeau*

Box 2. Ecological Restoration and Fuels Treatment Strategies

Ecological Restoration Strategies

Ecological Restoration Institute Presettlement Model Restoration Treatment Guidelines

Goals: 1) Emulate the uneven-aged forest structure characteristic of the period immediately preceding Euro-American settlement in order to return forest conditions to their natural range of variability; 2) Reduce the risks of stand-replacing, crown fire; 3) Allow the reintroduction of frequent, low-intensity ground fire in order to regulate forest structure; and 4) Promote the growth of understory plants that provide fuel for ground fires and support wildlife.

USFS Goshhawk Guidelines

Goals: 1) Create forest structure to provide nesting, post-fledgling (PFA), and foraging (FA) habitat for the northern goshawk; 2) Reduce the threat of crown fires, 3) Re-establish the structure, patterns and species composition of natural forest conditions within the historic range of variability; and 4) Provide sustainability within a management framework that recognizes multiple resource objectives, including scheduled cutting cycles for the removal of trees of all ages. See Implementing Northern Goshawk Habitat Management in Southwestern Forests: A Template for Restoring Fire-adapted Forest Systems.

Stand Treatment Impacts on Forest Health (STIFH) Model

Goals: 1) Promote forest sustainability by creating a balanced distribution of tree size classes in a clumpy spatial arrangement that emulates historic forest conditions; 2) Reduce the continuity of surface and ladder fuels; 3) Create positive changes in understory cover, wildlife habitat, and hydrological functions, and 4) Develop aesthetically pleasing uneven-aged, multi-species forests.

A Clumpy 40 strategy follows the basic STIFH procedure with the goal of creating a target BA of 40 and a clumpy distribution of uneven-aged trees.

Fuels Treatment Strategies

Goal: Prevent fire from spreading from the ground into the crowns of trees; no restoration goals.

Strategies:

Mechanical thinning to increase crown base height, reduce crown fuel load and bulk density, and remove ladder fuels.

Prescribed or broadcast burning to reduce ground-level fuels such as grasses and coarse woody debris.

Wildland fire use or resource fires to reduce ground-level fuels, such as grasses and coarse woody debris; sometimes more difficult to manage than prescribed burns.

site hydrology, and restore the native vegetation (see ERI Working Paper 12). Although only portions of such a road may be causing problems, the entire road should be treated before closure while its full length is accessible. Restoration also includes placing any streamflow that presently crosses the road back in its natural channel.

Treatment and Disposal of "Danger" Trees

"Danger" trees are live or dead trees that have the potential to fall across roads or onto other infrastructure that may be used by the contractor. Some contracts for landscape-scale forest restoration will include provisions to have these trees cut and removed by the contractor. For example, Appendix C of the RFP for the Four Forest Restoration Initiative Project includes this language concerning "danger trees":

> Danger trees to be felled will be designated in advance by the contracting officer. Trees to be removed will be marked … Use controlled felling to ensure the direction of fall and prevent damage to property, structures, roadway, residual trees, and traffic. Stump heights, measured on the side adjacent to the highest ground, must not exceed 12 inches or 1/3 of the stump diameter, whichever is greater. Higher stump heights are permitted when necessary for safety. Felled snags and trees, which are not marked for removal, will be left in a stable condition such that they will not roll or slide. Position logs away from standing trees so they will not roll, are not on top of one another, and are located out of roadway and drainage structures. Fell, limb, and remove trees, which are marked for removal, that equal or exceed the utilization standards as listed in the contract or Supplemental Specifications. Dispose of merchantable timber designated for removal in accordance with B/BT2.32 Construction Clearing, of the Contract, or as described in Supplemental Specifications (p. 21).

Control Soil Erosion and Water Pollution

Provisions of landscape-scale forest restoration projects typically indicate that the contractor must take all necessary precautions to minimize soil erosion and subsequent sedimentation of nearby water bodies. Such provisions generally discuss the proper use of equipment and the installation of erosion control devices (e.g., fencing, sand bags). There may also be provisions that allow the USFS to install such devices if the contractor fails to do so. This work would then be charged back to the contractor.

Goods-for-Services Tasks

A stewardship contract may also include tasks other than those discussed above. Typical tasks include invasive plant control, wildlife habitat improvement, planting riparian and other vegetation, infrastructure repair, meadow restoration, and restocking burned-over areas.

The work benefits the agency and the land by completing work that is necessary for a healthy, sustainable forest environment. For their part, the contractor not only receives needed work but the agency will deduct the value of the services received from the amount the contractor owes the agency for timber and other forest products.

Conclusion

Collaborative landscape-scale forest restoration projects have been helped immensely by the flexibility and social acceptance of stewardship contracting. In fact, it's unlikely these large-scale projects could be effectively implemented without this new contracting process. Along with changes in silvicultural practices (e.g., emergence of free selection) as well as innovative forestry equipment designed to handle small-diameter logs, this new way of treating overstocked, wildfire-prone forests represents a paradigm shift in federal forest land management. While each collaborative will implement restoration treatments differently according to the situation at-hand (i.e., "no one size fits all"), this triad of inventive contracting and implementation strategies/tools will likely serve as the general framework for all forest restoration projects across the western United States.

References

Lowe, K. 2005. Restoring forest roads. Ecological Restoration Institute Working Paper 12. Flagstaff, AZ: Northern Arizona Univer sity, Ecological Restoration Institute.

Pinchot Institute for Conservation. 2011. The role of communities in stewardship contracting: FY2010 programmatic monitoring report to the USDA Forest Service. Washington, DC: Pinchot Institute.

USFS. 2011. Phase 1 of Four Forest Restoration Initiative Project, Request for Proposals, RFP AG-8371-S-11-0031, Appendix C, Road Maintenance Specifications. Albuquerque, NM: U.S. Forest Service, Region 3.

Resources

Daly, C., C. Moseley, M.A. Moote, and M. Enzer. 2008. Forest Service contracting: A basic guide for restoration practitioners. Ecological Restoration Institute White Paper. Flagstaff, AZ: Northern Arizona University, Ecological Restoration Institute.

Fitzgerald, S. Using Uneven-aged Management as a Restoration Strategy in Ponderosa and Dry Mixed Conifer Forests. Corval lis, OR: Oregon State University.

Graham, R.T.; Jain, T.B. 2004. Past, present, and future role of silviculture in forest management. Pages 1-14 in W.D. Shepperd and L.G. Eskew, compilers. Silviculture in special places: Proceedings of the national silviculture workshop; September 8-11, 2003; Granby, CO. Proceedings RMRS-P-34. Fort Collins, CO: Rocky Mountain Research Station, Forest Service, U.S. Department of Agriculture.

Moseley, C. and E.J. Davis. 2010. Stewardship contracting for landscape-scale projects. Ecological Restoration Institute White Paper. Flagstaff, AZ: Northern Arizona University, Eco logical Restoration Institute.

Red Lodge Clearinghouse. Stewardship Contracting.
USFS. Stewardship End Result Contracting.
Youngblood, A. 2005. Silvicultural systems for managing ponderosa pine. Pages 49-58 in M.W. Ritchie, D.A. Maguire, A. Young blood, tech. coordinators, Proceedings of the symposium on ponderosa pine: Issues, trends, and management.
October 18-21, 2004; Klamath Falls, OR. Gen. Tech. Rep. PSW-GTR-198. Albany CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture.

Chapter 6

Adaptive Management

Dana Coelho, Zachary Wurtzebach, and Courtney Schultz

Adaptive management (AM) is an administrative framework designed to support taking action in the face of uncertainty, while incorporating learning and knowledge generation into an iterative process of planning and decision-making. Within the context of landscape-scale ecological restoration, AM is a necessary approach because of the uncertainties inherent in undertaking restoration at large scales; for providing a structured process for monitoring potentially negative impacts of management actions; and increasing accountability to the general public, land managers, and others investing in restoration projects.

This chapter seeks to provide a clear and actionable guide for implementing AM in collaborative landscape-scale restoration projects. It begins with a discussion of AM in theory and in practice, explores case studies from the Collaborative Forest Landscape Restoration Program (CFLRP), and concludes with a discussion of barriers and bridges to AM in practice.

Key Concepts of Adaptive Management

Researchers and scientists in ecology and conservation biology at the University of British Columbia first advanced the theoretical basis for AM during the 1970s and 1980s (Holling 1978, Walters 1986). They developed the concept because of a perception that the predominant approaches to environmental policy and planning were ineffective at addressing complex and highly uncertain natural resource management challenges. Academics and practitioners from the United States and abroad have since expanded the concept of AM, highlighting five essential components: modeling, experimentation, monitoring, feedback mechanisms, and collaboration.

Modeling

Modeling is essential to AM for several reasons: 1) clarifying what is known about a resource system, 2) generating and testing hypotheses about expected outcomes, and 3) helping decision-makers evaluate the utility of different options (Walters 1986, Walters and Holling 1990). Conceptual models articulate causal relationships among system variables and identify key assumptions; they can also help define objectives and goals (Jakeman et al. 2009). Once this qualitative picture is established, a quantitative model can be developed and used to predict and represent the effects of management actions through assignment of probabilities to different expected outcomes. This can help managers and decision-makers articulate and quantify how much is known and with what degree of certainty. When outcomes are observed on the ground, they can be compared with expectations and contribute to improving both the model and future management practices. Modeling should be an ongoing and iterative process of development, validation, use, and evaluation (Nichols et al. 1995, Nyberg 1998, Williams 2012).

Experimentation

In their earliest publications about AM, Holling and Walters made the case that it is a rigorous, iterative process that essentially treats management policies as experiments (Holling 1978, Walters 1986). Others have maintained that experimentation is the most effective means of reducing uncertainty when working with natural resource systems (Lee 1994, Gunderson 2000).

Experimentation can take many forms but is defined by the use of controls, replication, and randomization. Controls are necessary to eliminate the "noise" created by environmental variation. Without them, there are few means of distinguishing the effects of natural variables from the effects of management (Walters and Holling 1990). Replication across a landscape is also important, as it can increase the statistical power of statements about observed effects. It can also mitigate localized or contextual influences (e.g., microclimates, soil structure, aspect, slope, elevation) on detected effects (Lindenmayer et al. 2001). Randomized selection of locations for treatments and/or monitoring within treatment areas also reduces the bias any researcher or manager may bring to the experiment.

Monitoring

Monitoring provides the means for learning and reducing uncertainty over time within an AM framework (McLain and Lee 1996, Ringold et al. 1996). As outlined in Chapter 4, monitoring is the systematic collection of information to measure progress toward desired outcomes. In the context of landscape-scale restoration, project goals and monitoring objectives may be ecological, social, and/or economic. Multi-party monitoring may be an effective way to meet project goals while strengthening social support for restoration, building trust, and reducing conflict (Fernandez-Gimenez et al. 2008, DeLuca et al. 2010). While flexibility is desired in AM, monitoring questions and methods must be measurable, consistent, and comparable over time in order to provide a clear picture of trends and long-term changes in resource conditions. This is especially important when monitoring landscape-scale variables and effects on slower ecosystem processes that may take decades to discern with any statistical significance (Moir and Block 2001, Lindenmayer and Likens 2009). Good monitoring is also expensive, and a system for prioritizing questions is essential in order to effectively use limited funds and maximize benefits over time.

“

Successful AM requires that data be collected and interpreted in a usable way … Some collaborative groups employ monitoring coordinators or consultants to aggregate and analyze data from various sources, as well as make suggestions for improving collection and storage methods.

Feedback Mechanisms

Monitoring must be linked to decision-making through a defined feedback process that includes trigger points that identify a need to change management activities or direction (Lyons et al. 2008, Nie and Schultz 2012, Williams 2012). Defining trigger points prior to the implementation of restoration treatments allows for transparent discussions about the amount of data and funding that will be required to detect effects, the amount of risk or precaution that stakeholders and managers are willing to tolerate, and when changes in management actions should be required before having to make potentially difficult decisions. Without a defined feedback process, projects may embrace AM but fail to appropriately balance flexibility with the accountability and rigor necessary to ensure that legal standards are upheld and monitoring data are used to inform management actions. Ultimately, these factors can be critical to maintaining stakeholders' trust.

Collaboration

Adaptive management was initially thought of as a process involving only scientists, policy specialists, and land managers (Kusel et al. 1996). However, researchers and practitioners are now highlighting the importance of broader collaboration with stakeholders. In the context of AM, a more inclusive process helps: 1) define appropriate goals and objectives for the AM process, 2) develop and prioritize monitoring indicators and trigger points, 3) build and maintain institutional support and capacity, and 4) provide oversight and accountability for implementing monitoring and AM over time (Lee 1994, Brunner and Clark 1997, Failing et al. 2004, Schultz and Nie 2012). Collaboration may also allow managers to leverage resources and share responsibility for monitoring with supportive citizens and organizations or create innovative governance structures to support project implementation across legal jurisdictions. It also contributes to a greater shared understanding of resource systems through social learning and the co-production of knowledge (Gunderson et al. 1995, Folke et al. 2005, Cheng and Sturtevant 2012). Therefore, although collaboration is not necessary to implement AM, it is central to building an effective AM framework in practice.

Various Approaches to Adaptive Management

Land managers and policymakers define AM in a multitude of ways, making it necessary to understand each of several different approaches: trial-and-error, adaptive mitigation, passive AM, and active AM (Table 1; Halbert 1993, Lee 1999, Schultz and Nie 2012). Some approaches (i.e., trial-and-error, adaptive mitigation) are characterized by an emphasis on flexibility in meeting goals or avoiding detrimental impacts, while others (i.e., passive and active AM) promote learning about ecological processes and responses to management action through some combination of modeling, experimentation, monitoring, feedback mechanisms, and/or collaboration (Karkkainen 2003, Ruhl and Fischman 2010, Nie and Schultz 2012). Much of this variation can be attributed to the challenges and incentives faced by land managers.

These approaches have different inherent levels of flexibility and accountability. Flexibility and discretion allow managers to be innovative in achieving objectives and avoiding negative effects, especially in light of rapidly changing environmental, social, and budgetary conditions. Flexibility may also increase trust and reduce conflict with stakeholders as managers are better able to respond to their concerns (Lachapelle et al. 2003). However, managers must be aware that without mechanisms to ensure accountability, AM may be perceived as a smokescreen for open-ended and discretionary decision-making, particularly where levels of mistrust are high (Doremus 2001, Schultz and Nie 2012).

The myriad approaches to AM taken by federal agencies can also lead to miscommunication and unmet expectations. For these reasons, agencies must work toward transparency and stakeholder involvement, be clear about what kind of process they are using, build in scientific rigor to the extent possible, and generally build in measures that add accountability and stakeholder oversight in any adaptive decision-making process.

Trial-and-Error

At one end of the AM spectrum is "trial-and-error" management (Walters

Botanists collect understory data. *Photo courtesy of ERI*

and Holling 1990). Using this method, managers adjust actions incrementally and in an *ad hoc* manner in response to detected effects. However, this approach lacks a clear monitoring framework, structured feedback loops, modeling, and experimentation. In other words, there are no formal mechanisms for learning or incorporating learning into future decisions. While it provides flexibility, trial-and-error management has the potential to be a waste of time and resources in that it leads to the implementation of a series of mitigation measures without necessarily improving management outcomes (Schultz and Nie 2012). In fact, it may prove to be "maladaptive," moving a project farther from desired outcomes rather than closer to them (DOI 2009).

Adaptive Mitigation

Adaptive mitigation (or contingency planning) involves monitoring whether resources reach pre-determined thresholds that trigger a change in management (Ruhl and Fischman 2010, Schultz and Nie 2012). It allows managers flexibility and discretion in determining the best way to meet goals and avoid or recover from negative impacts. Triggers have the potential to drive politically unpopular but necessary actions, such as costly mitigation measures or reductions in extractive use. However, triggers also can be used in ways that lack transparency and accountability, particularly when planners fail to link triggers to statistically valid thresholds and/or fail to include enforceable requirements that particular mitigation measures be taken or include specific language about the combination of measures that might be triggered (BLM 2008, Nie and Schultz 2012, Schultz and Nie 2012).

Passive Adaptive Management

Passive AM is distinguished from adaptive mitigation by its use of modeling and the integration of monitoring into an iterative decision-making framework. Models are typically generated from historical data and used to determine an optimal management strategy, which is then improved by incorporating monitoring information. Passive AM can inform project planning and implementation but often lacks field-based experiments and may lack collaboration (Walters 1986, Williams 2011). Compared to active AM, it is more focused on determining whether projects are achieving desired management outcomes than on reducing system uncertainty or evaluating the effectiveness of various treatment types (Walters 1986, Williams 2011). To be done effectively, passive AM requires extensive historical data and a high degree of confidence in ecological responses to management. It works best in situations where there is less environmental variation and where system dynamics are well understood (Gregory et al. 2006). Despite its emphasis on improving management, passive AM still must be scientifically robust to advance learning and inform future decisions.

Active Adaptive Management

Active AM is the only model that fully incorporates modeling, experimentation, monitoring, and feedback mechanisms into an iterative decision-making process. Instead of presupposing the optimal management strategy, active AM uses models to generate multiple hypotheses about ecological responses to management and tests these hypotheses by applying different prescriptions across a landscape as controlled experiments (Walters 1986, Gunderson 2000). Monitoring is used to determine which alternatives offer the best means of achieving desired conditions and how closely outcomes conform to modeling predictions and hypotheses. By updating models with monitoring results at defined decision points, managers can increase their confidence in the predicted effects of each alternative, reducing uncertainty over time (Nyberg 1998, Williams 2011). Designing an active AM approach to produce statistically significant results is especially important if a collaborative group hopes to apply lessons learned in one area to other areas.

For example, the Five Rivers Management Plan in coastal Oregon used an active AM approach. In the face of uncertainty about how best to convert plantation stands of Douglas fir into late-successional habitat, land managers selected and tested three prescriptions: two treatments hypothesized different ways to achieve desired conditions and one “passive” prescription was used as a control. These prescriptions were each replicated randomly in four locations across the landscape to ensure that the observed results from the different treatments were statistically significant. In addition to providing a foundation for extensive future research, the project illustrates that institutional structures—such as new roles for researchers, specialists and managers—can be readily developed to facilitate AM on a landscape scale (Bormann and Kiester 2004).

Table 1. Approaches to Adaptive Management

	Trial-and-Error	Adaptive Mitigation	Passive AM	Active AM
Modeling	No	Maybe	Usually	Yes
Experimentation	No	Usually not	Usually not	Yes
Monitoring	Informal	Yes, but quality varies	Rigorous	Rigorous
Feedback	Informal	Toolbox of Options	Rigorous	Rigorous
Collaboration	Maybe	Maybe	Maybe	Maybe
Flexibility	Yes	Yes, but extent depends on legal context (see Schultz and Nie 2012)	Relatively less, but depends on legal context	Relatively less, but depends on the legal context
Learning	Minimal, if any	Often minimal, due to lack of controls/ experimentation	Some learning, but limited due to lack of experimentation	Yes
Accountability	Minimal, if any	Depends on legal context (see Schultz and Nie 2012)	Relatively more, but depends on legal context	Relatively more, but depends on legal context

Examples in the Collaborative Forest Landscape Restoration Program

Landscape-scale forest restoration is a management experiment being undertaken across the United States in the context of significant uncertainty. The Collaborative Forest Landscape Restoration Program (CFLRP) has invested more than $100 million to support this experiment and provides a national structure within the U.S. Forest Service (USFS) to monitor and facilitate learning across projects (see www.fs.fed.us/restoration/CFLRP; also Schultz et al. 2012 for a history and overview of the program). This section highlights examples of how a few of the first ten projects funded under the CFRLP are approaching AM (see Schultz and Coelho 2012). No one project presents a perfect approach that is immediately transferable to other locations, but each builds on the concepts and examples presented to paint a more complete picture of how AM can be applied to landscape-scale restoration and the challenges that lie therein.

Four Forest Restoration Initiative

The Four Forest Restoration Initiative (4FRI) is an effort to restore ecosystem structure, composition, and processes across 2.4 million acres of ponderosa pine forest in northern Arizona. Four national forests (Coconino, Kaibab, Tonto, Apache-Sitgreaves) are working together with an active stakeholder group to develop a restoration program that will mechanically thin and/or prescribe burn about one million acres over the next 20 years. The first NEPA document covers an area of roughly 750,000 acres and will identify enough areas for treatment to support a ten-year stewardship contract that guarantees 30,000 acres/year of mechanical thinning.

The 4FRI stakeholders have developed biophysical, social, and economic monitoring plans with input from the USFS. The biophysical monitoring plan focuses on measuring treatment effectiveness and specifies indicators based on desired conditions developed by stakeholders and the USFS. The plan identifies the time interval for monitoring each indicator, the appropriate spatial scale, and the range of observed values that would trigger an adaptive management response. Monitoring goals are organized into tiers to indicate their priority.

The 4FRI collaborative is developing a multi-party monitoring board with a committed liaison from the USFS. This governance structure has the potential to provide effective oversight of monitoring in a way that is transparent and collaborative. The board will discuss monitoring priorities, funding, and trigger points for adaptive changes; establish clear roles, responsibilities, and expectations; and document decisions in NEPA and other documents.

The 4FRI collaborative is faced with several barriers to fully implementing AM. One issue identified through interviews with participants is confusion as to where the line is drawn between research and monitoring. Some agency personnel shared that they would not invest in control plots as a part of treatment or monitoring because it would constitute "research" and, therefore, could not be funded through CFLRP or related accounts. However, monitoring without controls precludes any enhanced understanding of causality. A member of the 4FRI stakeholder group added that "the more scientific rigor that you can bring on the front end to what you decided you are going to monitor, the better off you are," and that, ultimately, what matters is whether monitoring is directly supporting the project's AM goals.

There are also a variety of perceptions about what will constitute AM for the 4FRI project. Some USFS staff indicated that simply having a variety of treatment options to use across the landscape is a kind of AM. However, some stakeholders expect a more active approach that involves robust monitoring, controlled and replicated experiments, and changes in management based on monitoring information applied at defined decision or trigger points.

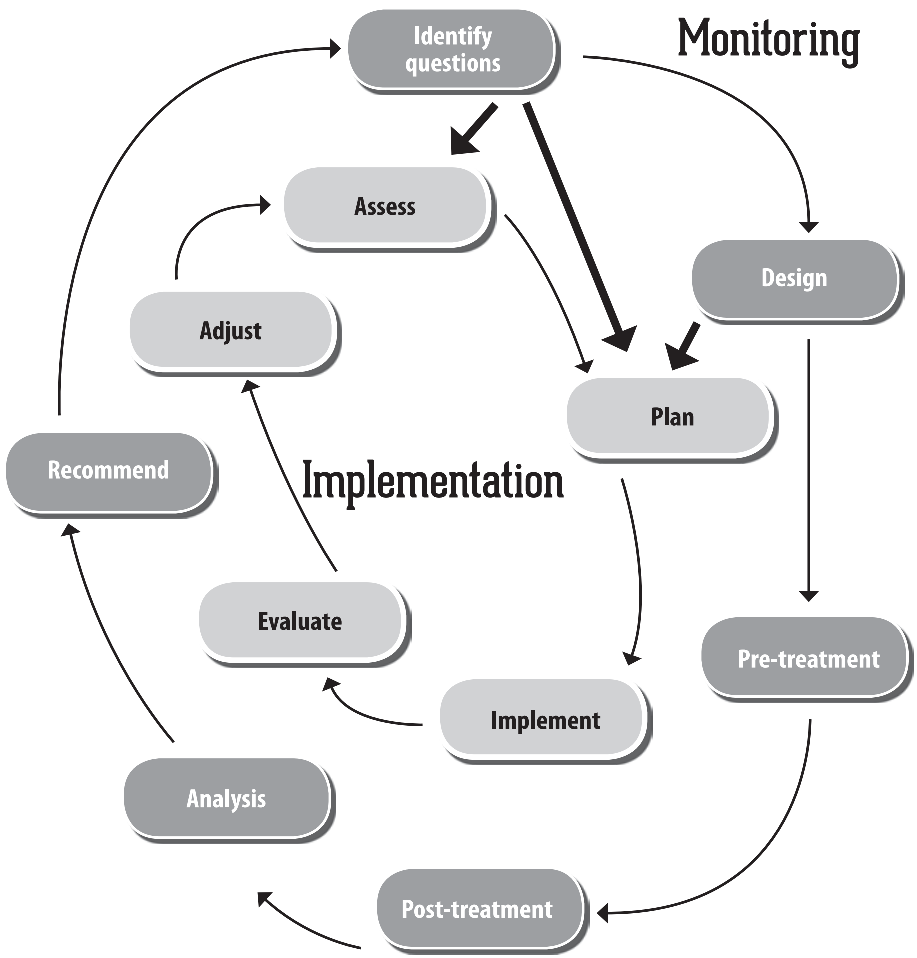
Southwestern Crown of the Continent

The Southwest Crown of the Continent (SWCC) project is located in northwestern Montana. It is a 1.5-million-acre landscape across the Lolo, Flathead, and Helena national forests and is part of the broader Crown of the Continent ecosystem. Project goals are to restore forested lands in a way that improves ecological, social, and economic conditions.

The approach the SWCC has taken to monitoring and AM emphasizes stakeholder engagement throughout project planning and implementation. It is question-based, meaning that monitoring projects and methods are chosen to shed light on areas of uncertainty including fire and fuels dynamics, biodiversity, soil and water quality, economic effects, and social issues. Different methods are used for data collection and analysis based on geographic and temporal scale as well as expectations for its use (e.g., communication, scientific publication, updating management actions) and statistical validity. Governance of the SWCC includes a steering committee and several topical sub-committees, including one focused on monitoring. Project design criteria and desired conditions are informed by restoration principles developed by the Montana Forest Restoration Committee, a collaborative group that formed to help guide restoration of Montana's national forests. These principles indicate a broad acceptance of AM, commitment to collaboration, and agreement that ecological restoration is tightly linked with social and economic sustainability.

The SWCC collaborative sees monitoring as a parallel and ongoing process that works alongside project planning and implementation, rather than an after-the-fact component or single step in a management cycle. As stated in their CFLRP proposal: "Monitoring will be used in an adaptive management framework to ensure that forest restoration treatments meet ecological, social, and economic objectives" (USFS 2009). To implement this approach, the collaborative group first identified monitoring questions, which were then used to develop the monitoring plan. As the project moves through the implementation, evaluation and adjustment phases, monitoring follows a path of pre-treatment and post-treatment monitoring, analysis, and recommendations to inform future action (Figure 1, Davis 2012). From here the cycle begins again, allowing for a continuous flow of information collected at various points in time and across the project landscape. This kind of iterative and parallel approach to monitoring can assist active AM by clarifying the decision-making structure and key points where monitoring information will be fed back into planning to most effectively achieve desired conditions.

Figure 1. SWCC Adaptive Management Cycle



The SWCC also has one of the only experimental treatment designs within the CFLRP that has been written into a NEPA document. It is a response to one of the project's key areas of uncertainty: management within mixed conifer habitat types. In the Dalton Mountain Project on the Lincoln Distrct of the Helena National Forest, the USFS and the collaborative are developing an experimental design that includes multiple replicated and randomized treatments as well as untreated controls to explore how to best meet the project's stated purpose and need (USFS 2012). The project scoping document states that: "Using this approach will also strengthen the learning and collaborative adaptive management of restoration in the mixed severity fire regime" (USFS 2012).

The open communication, trust, and clear organization of collaboratives in the project landscapes and the region are contributing to the project's success under the CFLRP and influence how they deal with uncertainty and conflict. As one stakeholder shared: "We've come a long way toward trust and a common understanding … we respect one another's perspectives, even though they may be totally different."

Colorado Front Range

The Colorado Front Range CFLRP project was born out of the Front Range Roundtable (FRRT), a group convened after the Hayman Fire in 2002, to discuss and define a way forward to restore a landscape that is important for local and regional drinking water supply, recreation, and private residences. The project landscape is 1.5 million acres within the lower montane zone along the eastern slope of the Rocky Mountains. Extensive historical reconstruction data are being used, and more are being collected to inform restoration objectives and treatment methods.

The approach to monitoring is driven by major points of uncertainty and a commitment to AM and collaborative learning. According to participants in the collaborative, some of the challenges this project faces are uncertainty about funding (long-term and year-to-year); where treatments will occur on the landscape and, therefore, where to set up monitoring plots; how to approach social and economic monitoring; interacting influences of climate change and bark beetles; and how to articulate desired future conditions in a quantitative manner.

The FRRT is taking steps toward a proactive AM approach by developing a framework to guide the use of implementation and effectiveness monitoring information at different points in the planning and implementation process (Schultz and Coelho 2012). Depending on the questions asked, monitoring results will inform site-specific prescriptions, NEPA planning, or larger questions of desired conditions and project objectives. To this end, a landscape-scale NEPA process is being undertaken for projects within the Upper Monument Creek watershed on the Pike National Forest. The goal of this "adaptive NEPA" is to construct an EIS and decision document in a way that allows for adaptation to new information and approves alternative management approaches within a single "agency action." As one stakeholder explained, doing this involves a number of challenges:

> *How do you write a NEPA document that accommodates the kind of change that you intend to implement as a result of monitoring? How do you write those [desired future conditions]… so they're sufficiently detailed to meet the NEPA requirements and inform the public of your intentions, but don't box you into a situation where you have to reenter a NEPA process every time you want to make a change?*

To develop this "adaptive NEPA," the group is exploring Landscape Conservation Forecasting to model ecological systems and their departure from historic ranges of variability, model outcomes of various restoration strategies, and project return on investment for each strategy (Low et al. 2010). They are also discussing, but have yet to design, management experiments to test different ideas about how best to achieve restoration across different forest types. This discussion is occurring within a collaborative space convened by The Nature Conservancy.

As the Colorado Front Range CFLRP project continues to grow and become more complex, the group is running into challenges related to the collection, analysis, and use of monitoring data. Multiple projects are being carried out by the USFS, Colorado Forest Restoration Institute, and FRRT members.

Barriers to Effective Adaptive Management

There are a number of challenges that agencies and stakeholders face when approaching AM. The most prominent of these barriers include: insufficient capacity, problems with organizational culture and structure, inadequate or uncoordinated data collection, and challenges associated with conforming to existing legal requirements.

Capacity

Many of the most significant barriers to AM are related to the ability of agencies and stakeholder groups to provide the time, personnel, and funding needed to determine appropriate restoration objectives and monitoring questions, develop a rigorous monitoring program that includes feedback mechanisms, and coordinate among many different stakeholders (Walters 1997, Lee 1999). Monitoring is especially vulnerable to a lack of resources and is often the first program cut when budgets shrink (Doremus 2008). This is especially problematic for the long-term monitoring needed to track changes and trends at the landscape scale (Moir and Block 2001, Nichols and Williams 2006). Legislation, like the Forest Landscape Restoration Act provides an avenue to correct this bias by explicitly requiring monitoring as a condition of receiving funding.

Organizational Culture and Structure

Adaptive management represents a new way of conceptualizing management and decision-making (Stankey et al. 2003). AM requires managers to openly acknowledge the uncertainty inherent in management objectives, prescriptions, and the systems being restored (Smith 2009). However, if an agency's culture is more focused on outputs than providing the time and resources necessary to evaluate and improve management actions, agency personnel may find it difficult to justify allocating resources to a project where the outcomes are acknowledged to be uncertain (Allan and Curtis 2005). It may also be challenging to justify the short-term risk inherent in an active AM strategy, despite its long-term benefits (Stankey et al. 2003).

Institutional structures also present challenges to applying AM at the landscape scale. Since most natural resource agencies, including the USFS, are characterized by a hierarchical chain of command, there is a strong tendency for top-down decisions that can limit flexibility, participation, and innovation at the local level (Johnson 1999, Allan and Curtis 2005, Jacobson et al. 2006). In light of these challenges, managers should be clear and transparent about the uncertainties and risks to be balanced in any decision. Managers at higher levels can also offer clear guidance, support, and incentives for AM in the field to encourage experimentation and long-term learning.

Inadequate or Uncoordinated Data Collection

Data collection systems that are deficient or lack organization create added challenges for otherwise sound AM programs. For example, if the USFS collects different data across ranger districts, if resource specialists collect data using different methods and if corporate databases are incompatible with certain types of data or collection methods, then the design and implementation of a robust and cost-effective monitoring program are limited. Moreover, the learning and adaptation that could come from using that information are compromised. Successful AM requires that data be collected and interpreted in a way that they are useable, often by multiple parties (Doremus 2008).

Various database solutions are being proposed to create a home for data collected under multi-party monitoring programs. For example, the Uncompahgre Plateau CFLRP project in southwestern Colorado is employing CitSci, which is a support system for citizen science-based monitoring. Other groups (e.g., 4FRI, SWCC, and FRRT) employ monitoring coordinators or consultants to aggregate and analyze data from various sources, as well as make suggestions for improving collection and storage methods.

A high school student takes tree height measurements for the Uncompahgre Plateau project. The UP project incorporates citizen science-based monitoring into its AM plan. *Photo courtesy of ERI*

Conforming to Existing Legal Requirements

Guaranteeing that AM conforms to substantive and procedural legal standards, such as those found in the Endangered Species Act (ESA), NEPA, and Federal Advisory Committee Act (FACA), is a significant barrier to AM. Under the ESA, AM may, or may be perceived to, impose risks that violate the precautionary standards of the law (i.e., not placing a listed species in jeopardy; Volkman and McConnaha 1993, Doremus 2001, Stankey et al. 2003). However, AM has been successful in cases involving the ESA, such as the Northwest Forest Plan and in Biological Opinions for operation of the Sacramento and San Joaquin River System (Ruhl and Fischman 2010, Schultz and Nie 2012).

Under NEPA, managers must describe in an EIS (or Environmental Assessment for less complex actions) all possible adaptive measures they may undertake and ensure that any future effects are within predicted ranges. This may be challenging given uncertainties, and agencies may be reluctant to undertake AM if future management adjustments might require supplemental analysis (see Chapter 3, also Schultz and Nie 2012). However, management changes will not always require NEPA supplementation. It is possible to write NEPA documents with monitoring commitments that are enforceable over time, not only by requiring supplementation, but also by requiring monitoring data to be available before new actions are taken (Blumm and Bosse 2007, Schultz and Nie 2012).

Finally, the requirements of the FACA may pose barriers to the formal participation of collaborative groups in federal agency decision-making, especially in the early stages of the NEPA process (Benson 2009). Likewise, FACA may, or may be perceived to, limit agency representation on committees, such as those discussing monitoring and desired conditions under the CFLRP. However, there is ample room for stakeholders and agencies to work together on developing and implementing AM frameworks and monitoring plans, as long as federal land managers retain their formal decision-making authority and facilitate an inclusive public involvement process (see Chapter 1).

Data is collected for a wetland restoration project. *Photo courtesy of ERI*

Bridges to Effective Adaptive Management

There are several ways to overcome the barriers to effective use of adaptive management in landscape-scale forest restoration projects. These suggested bridges, which are supported by findings in the AM literature and by the experiences of participants in CFLRP projects, include: incorporating key components of active AM, embracing and employing collaborative AM, and developing effective channels of communication.

Incorporating Key Components of Active Adaptive Management

If a project plans to use an AM approach, such an approach will be most effective if it is implemented in a scientifically robust manner and in accordance with the key components of active AM. This means using models, conducting experiments; developing a sound monitoring program; pre-defining how monitoring information will be used; identifying trigger points that will cause a change in management actions, including mechanisms to ensure monitoring information actually feeds back into decision-making; and making decisions in a collaborative manner. These elements are especially important considering the high degree of stakeholder involvement in forest restoration programs such as CFLRP.

Develop Collaborative Governance for Adaptive Management

Successful AM approaches are increasingly being characterized as collaborative AM, a process whereby stakeholders play a critical role in defining objectives, interpreting data, and feeding information back into decision-making (Susskind et al. 2012). Inclusive and collaborative processes can encourage social learning, build political support, foster effective communication, and develop appropriate and scientifically rigorous monitoring and management approaches. In practicing collaborative AM, it is important to:

- be inclusive and encourage active participation in as many steps of the process as possible, especially defining shared goals and objectives.
- encourage partnerships with third parties (universities, non-governmental organizations, local industry, etc.) and engage a diverse and representative group of citizens and stakeholders.
- define a collaborative structure (e.g., roles and responsibilities, decision-making processes, funding) before beginning a project. It does not necessarily have to be formal (e.g., an independent monitoring board), but it should be explicit. Many groups have found it useful to have a monitoring coordinator who works to coordinate the monitoring and AM process across jurisdictions and among participants.
- cultivate champions who will sustain the energy, investment, and atmosphere of honesty and openness within and across organizations that is needed to be successful.

Develop Effective Channels for Communication and Adapting Management Actions

Transmitting what is learned through AM between different levels of management, across jurisdictions, and among stakeholders is both challenging and absolutely necessary. For instance, if there are problems or surprising results observed through multi-party monitoring, there need to be clear mechanisms by which managers can understand this information and adapt their approaches. Some suggestions from real projects include:

- Build a scientifically sound monitoring program based on clear and measurable questions. It may also include elements such as collaborative oversight of project planning and implementation, as well as annual reporting of actions, outcomes, and effects.
- Make sure monitoring occurs and information is used by linking monitoring to specific decisions and legally enforce-

able documents (e.g., a Record of Decision, Finding of No Significant Impact, or Incidental Take Permit under the ESA), defining clear triggers and timelines, and developing implementable mitigation measures or action alternatives. It is also important to identify funding needs early and plan for them in annual budget cycles.

- Develop and agree to an AM framework that defines triggers early in the planning process, links monitoring and implementation, and clarifies when, how, and at what scale monitoring information will be used to inform management actions.
- Maintain forums and means for effective communication and oversight, such as hiring a professional facilitator and/or monitoring coordinator to manage and provide consistency for group interactions.

References

Allan, C. and A. Curtis. 2005. Nipped in the bud: Why regional scale adaptive management is not blooming. *Environmental Management* 36(3):414-425.

Benson, M. 2009. Integrating adaptive management and oil and gas development: Existing obstacles and opportunities for reform. *Environmental Law Reporter* 39(10).

BLM (Bureau of Land Management). 2008. Pinedale Anticline Project Area Supplemental Environmental Impact Statement and Record of Decision. Washington, DC: Bureau of Land Management.

Blumm, M.C. and S.L. Bosse. 2007. *Norton v. SUWA* and the unraveling of federal public land planning. *Duke Environmental Law and Policy Forum* 18:105-160.

Bormann B.T. and A.R. Kiester. 2004. Options forestry: Acting on uncertainty. *Journal of Forestry* 102:22-27.

Brunner, R.D. and T.W. Clark. 1997. A practice-based approach to ecosystem management. *Conservation Biology* 11:48-58.

Cheng, T. and V.E. Sturtevant. 2012. A framework for assessing collaborative capacity in community-based public forest management. *Environmental Management* 49:675-689.

Davis, C. 2012. Developing Monitoring Questions for the South western Crown Collaborative. Power Point Presentation.

DeLuca, T.H., G.H. Aplet, B. Wilmer, and J. Burchfield. 2010. The unknown trajectory of forest restoration: A call for ecosystem monitoring. *Journal of Forestry* 108(6):288-295.

DOI (Department of the Interior). 2009. *Adaptive Management: The U.S. Department of the Interior Technical Guide*. Washington, D.C.: Department of the Interior.

Doremus, H. 2001. Adaptive management, the Endangered Species Act, and the institutional challenges of "new age" environmental protection. *Washburn Law Journal* 41:50-89.

___. 2008. Data gaps in natural resource management: Sniffing for leaks along the information pipeline. *Indiana Law Journal* 83:407-461.

Failing, L., G. Horn, and P. Higgins. 2004. Using expert judgment and stakeholder values to evaluate adaptive management options. *Ecology and Society* 9:13.

Fernandez-Gimenez, M., H.L. Ballard, and V.E. Sturtevant. 2008. Adaptive management and social learning in collaborative and community-based monitoring: A study of five community-based forestry organizations in the western USA. *Ecology and Society* 13(2):4.

Folke, C., T. Hahn, P. Olsson, and J. Norberg. 2005. Adaptive governance of social-ecological systems. *Annual Review of Environmental Resources* 30:441-473.

Gunderson, L.H. 2000. Ecological resilience: In theory and application. *Annual Review of Ecology and Systematics* 31:425-439.

Gunderson, L.H., C.S. Holling, and S.S. Light, eds. 1995. *Barriers and bridges to the renewal of ecosystems and institutions*. New York: Columbia University Press.

Gregory, R., D. Ohlson, and J. Arvai. 2006. Deconstructing adaptive management: Criteria for applications to environmental management. *Ecological Applications* 16:2411-2425.

Halbert, C.L. 1993. How adaptive is adaptive management? Implementing adaptive management in Washington State and British Columbia. *Reviews in Fisheries Science* 1:261-283.

Holling, C.S., ed. 1978. *Adaptive environmental assessment and management*. London: John Wiley & Sons.

Jacobson, S.K., J.K Morris, J.S. Sanders, E.N. Wiley, M. Brooks, R.E. Bennetts, H.F. Percival, and S. Marynowski. 2006. Understanding barriers to implementation of an adaptive land management program. *Conservation Biology* 20(5):1516-1527.

Jakeman, T., S. Chen, L. Newham, and C. Pollino. 2009. Modeling and adaptive environmental management. Pages 173-187 in C. Allan and G.H. Stankey, eds., *Adaptive environmental management: A practitioner's guide*. Dordrecht, Netherlands: Springer.

Johnson, B.L. 1999. The role of adaptive management as an operational approach for resource management agencies. *Conservation Ecology* 3:8.

Karkkainen, B. 2003. Whither NEPA? *NYU Environmental Law Journal* 12:333-363.

Kusel, J., S.C. Doak, S. Carpenter, and V.E. Sturtevant. 1996. The role of the public in adaptive ecosystem management. Pages 611-624 in *Sierra Nevada Ecosystem Project: Final Report to Congress, Volume II*. Davis, CA: Center for Water and Wildland Resources, University of California.

Lachapelle, P.R., S.F. McCool, and M.E. Patterson. 2003. Barriers to effective natural resource planning in a "messy" world. *Society & Natural Resources* 16(6):473-490.

Lee, K.N. 1994. *Compass and gyroscope: Integrating science and politics for the environment*. Washington, DC: Island Press.

___. 1999. Appraising adaptive management. *Conservation Ecology* 3:3.

Lindenmayer, D.B., C.R Margules, and D.B. Botkin. 2001. Indicators of biodiversity for ecologically sustainable forest management. *Conservation biology* 14(4):941-950.

Lindenmayer, D.B. and G.E. Likens. 2009. Adaptive monitoring: A new paradigm for long term research and monitoring. *Trends in Ecology & Evolution* 24(9):482-486.

Low, G., L. Provencher, and S. Abele. 2010. Enhanced conservation action planning: Assessing landscape condition and predicting benefits of conservation strategies. *Journal of Conservation Planning* 6:36-60.

Lyons, J.E., M.C. Runge, H.P. Laskowski, and W.L. Kendall. 2008. Monitoring in the context of structured decision-making and adaptive management. *The Journal of Wildlife Management* 72:1683-1692.

McLain, R.J. and R.G. Lee. 1996. Adaptive management: Promises and pitfalls. *Environmental Management* 20:437-448.

Moir, W.H. and W.M. Block. 2001. Adaptive management on public lands in the United States: Commitment or rhetoric? *Environmental Management* 28:141-148.

Nichols, J. D., F.A. Johnson, and B.K. Williams. 1995. Managing North American waterfowl in the face of uncertainty. *Annual Review of Ecology and Systematics* 26:177-199.

Nichols, J.D. and B.K. Williams. 2006. Monitoring for conservation. *Trends in Ecology & Evolution* 21:668-673.

Nie, M. and C. Schultz. 2012. Decision-making triggers in adaptive management. *Conservation Biology* 26:1137-1144.

Nyberg, J.B. 1998. Statistics and the practice of adaptive management. Pages 1-7 in V. Sit and B. Taylor, eds., *Statistical methods for adaptive management studies*. Victoria, BC: British Columbia Ministry of Forests, Research Branch. Land Management Handbook 42.

Ringold, P.L., J. Alegria, R.L. Czaplewski, B.S. Mulder, T. Tolle, and K. Burnett. 1996. Adaptive monitoring design for ecosystem management. *Ecological Applications* 6:745-747.

Ruhl, J.B. and R.L. Fischman. 2010. Adaptive management in the courts. *Minnesota Law Review* 95:424-484.

Schultz, C. and D. Coelho. 2012. *Preliminary report: The design and governance of multi-party monitoring under the Collaborative Forest Landscape Restoration Program.* Fort Collins, CO: Colorado Forest Restoration Institute, Colorado State University.

Schultz, C., T. Jedd, and R. Beam. 2012. The Collaborative Forest Landscape Restoration Program: A history and overview of the first projects. *Journal of Forestry* 110:381-391.

Schultz, C. and M. Nie. 2012. Decision-making triggers, adaptive management, and natural resources law and planning. *Natural Resources Journal* 52: 443-521.

Smith, A.C. 2009. Lessons learned from adaptive management practitioners in British Columbia, Canada. Pages 39-57 in C. Allan and G.H. Stankey, eds., *Adaptive environmental management*. Dordrecht, Netherlands: Springer.

Stankey, G.H., B.T. Bormann, C. Ryan, B. Shindler, V.E. Sturtevant, R.N. Clark, and C. Philpot. 2003. Adaptive management and the Northwest Forest Plan: Rhetoric and reality. *Journal of Forestry* 101:40-46.

Susskind, L., A.E. Camacho, and T. Schenk. 2012. A critical assessment of collaborative adaptive management in practice. *Journal of Applied Ecology* 49(1):47-51.

USFS (United States Forest Service). 2009. Southwestern Crown of the Continent Collaborative CFLRP Proposal.

___. USFS. 2012. Dalton Mountain forest restoration and fuels reduction project scoping document. Lincoln, MT: Helena National Forest, Lincoln Ranger District.

Volkman, J.M. and W.E. McConnaha. 1993. Through a glass, darkly: Columbia River salmon, the Endangered Species Act, and adaptive management. *Environmental Law* 23:1249-1272.

Walters, C. 1986. *Adaptive management of renewable resource*. New York: Macmillan Publishing.

___. 1997. Challenges in adaptive management of riparian and coastal ecosystems. *Conservation Ecology* [online]1(2):1.

Walters, C.J. and C.S. Holling. 1990. Large-scale management experiments and learning by doing. *Ecology* 71:2060-2068.

Williams, B.K. 2011. Adaptive management of natural resources: Framework and issues. *Journal of Environmental Management* 92:1346-1353.

___. 2012. Reducing uncertainty about objective functions in adaptive management. *Ecological Modeling* 225:61-65.

Conclusion

Amy E.M. Waltz

This handbook was created to explore current opportunities for landscape management on federal lands, as well as the barriers and some of the innovative bridges being developed. Landscape-level planning has been the focus of research, modeling, and land management for decades. However, recent large disturbance events, including wildfire and insect-caused mortality, occurring at scales of 100,000s of contiguous acres have raised awareness and support for more active management across entire landscapes to restore ecosystem resilience and sustainability.

The concept for this handbook was developed largely in response to the passage of the Collaborative Forest Landscape Restoration Act (CFLRA) in 2009. Landscape level management, collaborative partnerships, and innovative contracting and implementation on federal landscapes over the last two decades contributed greatly to the initiation of this legislation and the bi-partisan funding support. This act and the funded program, known as the Collaborative Forest Landscape Restoration Program (CFLRP), provide the largest supported national effort for landscape restoration. More importantly, the program sets the stage for management changes that do not require special funding authority.

Themes of Barriers and Bridges

Re-occurring themes of barriers and bridges emerge from this collection of chapters. Many of the barriers listed in these chapters are related to scale. Over time, humans have modified what are now current federal forested landscapes at large scales. Most recently (within the last century), these modifications include the removal of fire from fire-adapted systems, the reduction of old-growth trees, unevern-aged stands, and changed tree composition due to logging in many of our current-day national forests. In addition to scale, new tools and collaborative partnerships create changing paradigms for federal land management.

Each preceding chapter provides some bridges to these barriers.

- **Collaborative partnerships** can create strange bedfellows (Chapter 1). In many cases, collaboration brings together people and organizations that have often been at odds, if not out-right conflict, with each other. Innovation, and now some experience, has shown that when multiple stakeholders can communicate values and find common ground, projects have a higher chance of success. However, it can be challenging to move past a history of mistrust. Bridges for this barrier include innovative authorities, like the CFLRP, which help the U.S. Forest Service (USFS), as well as stakeholders and citizens, re-interpret their traditional roles in federal land management. The results from examples in Chapter 1 are increased flexibility in project planning, implementation, monitoring, and increased trust.
- This is further elaborated in Chapter 3, "**Planning and NEPA**," where the collaborative process in landscape planning and management is identified as the major innovative component of the CFLRP. However, it is not meant to replace current legal standards and guidelines. This chapter discusses potential methods to plan at landscape scales. Key to success is the integration of collaborative engagement at more than just the legally designated "public scoping and comment period." This results in increased trust as stakeholders and resource professionals work to describe landscape management goals and the implementation needed to meet goals.
- While all chapters in this book are closely linked, Chapter 2 "**Ecological Economics**" and Chapter 5 "**Contracting and Implementing**" may be more co-dependent than any of the other topics. A barrier common to restoration projects across the nation is lack of complete funding. The CFLRP, for example, funds only implementation of the project, including some monitoring, but no project planning. However, planning at landscape scales with multiple stakeholders or partner agencies as collaborative partners can significantly increase planning

time. These planning costs for projects are covered by the USFS administrative unit. However, the CFLRP requires leveraged funds and provides innovative indicators and tools to show cost benefits of landscape-scale restoration work (Chapter 2). Implementation of restoration treatments will not produce commercially viable products on every acre; however, use of stewardship contracting (Chapter 5) is an innovative bridge to maximize the value of goods available in a landscape project to pay for services on other acres and to meet landscape restoration goals. Most importantly, the stewardship contract authority changes the perspective of how we look at contracts on our forests: instead of basing contracts on what is leaving the forest, contracts emphasize what is left and our desired end result.

- Chapter 4 "**Adaptive Management**" and Chapter 6 "**Multiparty Monitoring**" are also closely linked. We cannot achieve adaptive management without strategic and SMART monitoring. Effectiveness monitoring of forest treatments on federal landscapes has been challenging to assess in the past. Federal funding cuts to land management and a lack of effectiveness metrics for accomplishments have led to a de-emphasis of effectiveness monitoring. This handbook illustrates how the legislation creating the CFLRP and the collaborative multiparty monitoring mandated by both this program and stewardship contracting create a bridge for this barrier. The ability to prioritize appropriate indicators and select quantifiable metrics to assess those indicators will be key to measuring success or failure for today's landscape-level projects. Appropriate adaptive management relies on these monitoring components. However, the specific AM approach can be determined by assessing how a specific collaboration works—who are the partners, what are the monitoring gaps and the levels of uncertainty? Adaptive management is not a boiler-plate plan easily adopted by landscape efforts. Chapter 6 develops the idea that there are different approaches to adaptive management that can be determined by understanding both the ecological and social components of a landscape. A challenge for many landscape-level efforts is "closing the adaptive management loop" with a defined feedback process and appropriate decision-maker "buy-in" to impact future project implementation. Suggested bridges include collaborative participation in the adaptive management governance, as well as established lines of communication (Chapter 6).

Future Work and Applications

The chapters in this handbook relate specifically to how the funded CFLRP sites are addressing challenges. The examples presented share the diversity of landscapes, collaborative partners, and restoration strategies currently in play. These projects will continue to provide "lessons learned," including successes and failures, for years to come. The continuing challenge will be to recognize change as innovative opportunity and to continue to revise the ways we collaborate, plan, fund and implement projects, monitor, and adapt. This handbook takes a much-needed step to compile these innovations and will be revised.

In addition to the guidelines in this handbook, additional networking tools are now available to encourage learning across administrative units and across multi-stakeholder collaborative partnerships. Efforts to restore landscape-level resiliency are diverse and occur across the country, although the obstacles each effort faces have remarkable similarities. The ability to connect and learn from other sites can increase efficiency and will make each project stronger. The National Forest Foundation along with the National Office of the U.S. Forest Service hosts web-based Peer Learning Sessions for the CFLRP as well as other topics related to CFLRP, including landscape restoration approaches, collaboration and multi-party monitoring (http://www.nationalforests.org/conserve/peer). An off-shoot of these webinars is a National Monitoring Network that provides landscape examples for setting desired conditions, selecting indicators, developing metrics and triggers and thresholds. Collectively, these peer-learning platforms, along with growing stakeholder networks, will provide future projects with guideposts to collaboration, planning, monitoring, implementation, and adaptive management for landscape-scale restoration projects. Future handbooks will also highlight these examples and provide an even deeper set of lessons to share.

About the Contributors

DAVE BREWER worked as a field soil scientist, range conservationist, and range and watershed program manager during his multi-decade career with the U.S. Forest Service in Arizona and New Mexico. During that time, he was also involved in writing numerous environmental assessments and impact statements for Forest Service projects. From 2006-2012, Dave served as a program coordinator with the ERI Agency Outreach Team. In that capacity, he advised the Four Forest Restoration Initiative Team on various aspects related to developing environmental impact statements for that landscape-scale restoration project. Dave also teaches a class about writing environmental impact statements for the Northern Arizona University School of Forestry.

DANA COELHO is a PhD student at Colorado State University studying collaborative natural resource management, particularly the new U.S. Forest Service Collaborative Forest Landscape Restoration Program (CFLRP). She has worked for the Forest Service since 2007, serving as Program Manager for the Western Forestry Leadership Coalition and a Presidential Management Fellow. She holds a Master of Science in Sustainable Development and Conservation Biology and a Master of Public Policy from the University of Maryland. Her bachelor's degree is in Urban and Environmental Planning from the University of Virginia.

W. WALLACE "WALLY" COVINGTON is the executive director of the Ecological Restoration Institute and Regents' Professor of Forestry for Northern Arizona University. He has received national and international recognition for his work in forest ecosystem health, restoration ecology, and fire effects on forest ecosystems. Dr. Covington presents invited testimony before congressional and state natural resources committees and provides continuing education at all levels from the Washington Offices of conservation agencies (e.g., the U.S. Forest

Service, the Bureau of Land Management, and the National Park Service) to the field level. His work on restoration of ecosystem health and natural resource conservation is cited often in scientific journals and national news media.

DAVE EGAN has been involved in ecological restoration since the mid-1980s as both practitioner and writer/editor. He formerly worked on the journal *Ecological Restoration*, and has co-edited several books, including *The Human Dimensions of Ecological Restoration* and *The Historical Ecology Handbook.* Dave currently resides in the southwestern United States and serves as a consultant writer/editor for the Ecological Restoration Institute at Northern Arizona University.

EVAN E. HJERPE is an ecological economist for The Wilderness Society in Boise, Idaho. He has taught forest economics and forest management at Northern Arizona University and maintains a research focus on the economics of ecological restoration. Evan is a co-editor of *Human Dimensions of Ecological Restoration* and author of the recent Wilderness Society report, *Seeing the Tongass for the trees: The economics of transitioning to sustainable forest management*.

COURTNEY SCHULTZ is an assistant professor of natural resource policy in the Department of Forest and Rangeland Stewardship at Colorado State University. She has conducted research on the intersection of science, policy and law in several major areas, including large-scale wildlife conservation planning and the development of monitoring and adaptive management plans by federal agencies in various contexts. She is currently investigating how learning, innovation, and policy change take place in the context of developing and implementing large-scale, collaborative, and adaptive forest restoration projects.

WINDY SELIG has a M.S. degree in Forestry, with special focus on collaboration in forest restoration. Windy's research topics include ecological restoration collaboration in southwestern forest ecosystems, power dynamics in collaborative forest restoration, and analyzing and identifying barriers to conducting successful collaborative processes. Windy is currently completing a Case History of the Four Forest Restoration Initiative (4FRI). She worked closely with 4FRI providing collaborative support to leadership and the stakeholder group and provided facilitation in smaller working groups. Windy also facilitated and co-led the Parashant Partnership on the Grand Canyon Parashant National Monument.

AMY E.M. WALTZ is a research ecologist with a background in ecological restoration in ponderosa pine ecosystems. She received her PhD in biology from Northern Arizona University. From 2005 to 2011, Amy worked with Deschutes National Forest staff to augment monitoring efforts on federal fuel reduction projects and to assess landscape conditions. In that position, she also coordinated the Deschutes Fire Learning Network and co-led the successful proposal for the Deschutes Collaborative Forest Project. In her current position as the program director of science outreach at the Ecological Restoration Institute, Amy works with stakeholder groups and land management agencies to assess research gaps, accomplish research through the Institute, and develop outreach products.

ZACHARY WURTZEBACH is an M.A. student in political science at Colorado State University, where he is currently researching the use of adaptive management and collaboration in natural resource management. He holds a B.S. in Resource Conservation and a B.A. in History from the University of Montana.

Resources

Articles, Article Series, and Legislation

Egan, D., ed. 2007. The conservation and restoration of old growth in frequent-fire forests of the American West. 2007. *Ecology and Society*.

Ellenwood, M.S., L. Dilling, and J.B. Milford. 2012. Managing United States public lands in response to climate change: A view from the ground up. *Environmental Management*, published online March 22, 2012.

Feurt. C.B. 2009. Collaborative learning strategies to overcome barriers to science translation in Coastal Watershed Management: A Final Report Submitted to The NOAA/UNH Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET).

Fleischman, F. 2008. Bureaucracy, collaboration and coproduction: A case study of the implementation of adaptive management in the U.S.D.A. Forest Service.

Fulé, P.Z., J.E. Crouse, J.P. Roccaforte, and E.L. Kalies. 2012. Do thinning and/or burning treatments in western USA ponderosa or Jeffrey pine-dominated forests help restore natural fire behavior? *Forest Ecology and Management* 269:68-81.

Kerr, A. 2012. *Ecologically appropriate restoration thinning in the Northwest Forest Plan Area: A policy and technical analysis.* Published by Conservation Northwest, Geos Institute, Klamath-Siskiyou Wildlands Center, and Oregon Wild.

Stephens, S.L., J.D. McIver, R.E.J. Boerner, C.J. Fettig, J.B. Fontaine, B.R. Hartsough, P.L. Kennedy, and D.W. Schwilk. 2012. The effects of forest fuel-reduction treatments in the United States. *Bioscience* 62(6):549-560.

Title IV of the Omnibus Public Land Management Act of 2009.

Books, Book Chapters, and Reports

Arno, S. and C. Fiedler. 2005. *Mimicking nature's fire: Restoring fire-prone forests in the West*. Washington, DC: Island Press.

Climate Central. 2012. The age of western wildfires. Princeton, NJ and Palo Alto, CA: Climate Central.

Graham, R.T., A.E. Harvey, T.B. Jain, and J.R.Tonn. 1999. The effects of thinning and similar stand treatments on fire behavior in Western forests. Gen. Tech. Rep. PNW-GTR-463. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Polinko, A. and K. Waring. 2011. Forest monitoring: Current conditions and future predictions. Flagstaff, AZ: Northern Arizona School of Forestry.

Stankey, G.H., R.N. Clark, and B.T. Bormann. 2005. Adaptive management of natural resources: theory, concepts, and management institutions. Gen. Tech. Rep. PNW-GTR-654. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

USFS. 2007. Wood biomass utilization desk guide. United States Department of Agriculture Forest Service National Technology & Development Program 2400—Forest Management.

USFS. 2008. Forest Service Handbook. FSH 2409.19 Renewable resources handbook, Chapter 60-Stewardship Contracting.

USFS. 2002. Forest Service Handbook. FSH 2409.18. Timber sale preparation handbook, Chapter 10-Sale Program Development-Gate System

USFS. 2002. Forest Service Handbook. FSH 2409.17. Silvicultural practices handbook, Chapter 8-Silvicultural examinations, prescriptions, and evaluations

USFS. 2012. Increasing the Pace of Restoration and Job Creation on Our National Forests. Washington, DC: United States Department of Agriculture Forest Service.

USFS. 2012. People restoring America's forests: 2012 report on the Collaborative Forest Landscape Restoration Program.

Westley, F., S.R. Carpenter, W.A. Brock, C.S. Holling, and L.H. Gunderson. 2002. Why systems of people and nature are not just social and ecological systems. Pages 103-119 *in* L.H. Gunderson and C.S. Holling, ed., Panarchy: Understanding transformations in human and natural systems. Washington, DC: Island Press.

Executive Summary: The First Five Years of the White Mountain Stewardship Project

Websites

Collaborative Forest Landscape Restoration Program (CFLRP)
Ecological Restoration Institute e-Library
Forest Guild: Woody Biomass Removal Case Studies
FY 2011 CFLRP Annual Reports
Landscape Conservation Management and Analysis Portal (LCMAP)s
National Forest Foundation
Red Lodge Clearinghouse
Stewardship End Result Contracting
Tools for the Restoration Economy
USFS NEPA Procedures and Guidance
USFS Partnership Resource Center
U.S. Institute for Environmental Conflict Resolution

Glossary

Adaptive management: An approach to natural resource management that studies and monitors the effects of policies, plans, and actions for the purpose of learning and adjusting future management actions.

Assessment or analysis area: The geographic area included within the scope of a broad-scale assessment or local analysis.

Avoided costs: In economics, an expense that will not be incurred if a particular activity is not performed.

Biodiversity: The variety of life and its processes. Biodiversity includes the diversity of landscapes, communities, and populations (genetic variation). Also called biological diversity or biotic diversity.

CCF: A measure of wood volume; 100 cubic feet equals 1 CCF.

Collaboration: A process where individuals and groups with different interests come together to address management issues and create agreements.

Co-management: A formal process with a focus on shared power among government authorities or between an agency and one or more user groups. Participation is limited to people with legal authority and decision-making capacity.

Community of interest: A social group that shares common perspectives, vulnerabilities, and preferences with respect to resource management issues (e.g., hunters, anglers, permittees, and environmentalists).

Community of place: A social group bounded by geographic locality.

Compliance monitoring: A process that documents whether or not treatments or practices were applied in such a way as to meet the requirements of the supporting legislation, funding agency, or some identifiable best management practice; also known as implementation monitoring.

Consensus: Point at which competing interest groups reach agreement on, for example, policy matters or environmental conflicts.

Cooperative Conservation: As defined in Executive Order 13352 as "Actions that relate to use, enhancement, and enjoyment of natural resources, protection of the environment, or both, and that involve collaborative activity among federal, state, local, and tribal governments, private for-profit and nonprofit institutions, other nongovernmental entities, and individuals."

Contingency planning: Monitoring whether resources reach pre-determined thresholds that trigger a change in management actions; does not fully investigate the causal relationships between management actions and environmental effects, however.

Crown cover: The ground area covered by the crowns of trees or woody vegetation as delineated by the vertical projection of crown perimeters. It is commonly expressed as a percent of total ground area.

Closed tree canopy: A class of vegetation that is dominated by trees with interlocking crowns (generally forming 60 to 100% crown cover).

Desired future condition: A statement describing a common vision for a specific area of land or type of land within the plan area. Statements of desired conditions should include the estimated time required for their achievement.

DBH: Diameter at breast height, a measure of tree diameter determined at the standard height of 4.5 feet.

Disturbance: A discrete event or process that affects or influences the structure, composition, or function of a system. Natural disturbances include drought, floods, wind, fires, insects, and pathogens. Human-caused disturbances include actions such as recreational use, livestock grazing, mining, road construction, timber harvest, and the introduction of exotic species.

Disturbance regime: A disturbance that occurs with some regularity within a system; maybe co-evolved with the system components, for example, a frequent fire regime.

Ecosystem: A complex of interacting plants and animals (including humans) with their physical surroundings. Ecosystems are isolated from each other by boundaries that confine and restrict the movement of energy and matter. For example, an ecosystem could be recognized at a watershed scale by designating an area of common drainage (i.e., topography determines movement of water).

Ecosystem function: The processes by which the constituent living and nonliving elements of ecosystems change and interact. The term ecological function is often used in reference to the role or specific contribution of an entity to system behavior.

Ecosystem management: A concept of natural resources management wherein human activities are considered in the context of economic, ecological, and social interactions within a defined area or region over both the short and long term. Its purpose is to meet human needs while maintaining the health, diversity, and productivity of ecosystems.

Ecosystem processes: Ecological functions such as photosynthesis, energy flow, nutrient cycling, water movement, disturbance, and succession.

Ecosystem restoration: Actions taken to modify an ecosystem for the purpose of re-establishing and maintaining desired ecological structures and processes.

Ecosystem goods and services: The suite of direct benefits (i.e., without any other input) provided by nature to humankind, including fresh air, water purification, recreational opportunities, wildlife habitat, and biodiversity.

Ecosystem structure: The physical and biological attributes as well as the spatial arrangement of the living and nonliving elements within an ecosystem.

Effectiveness monitoring: A type of monitoring that evaluates whether management activities have been successful in moving a set of existing conditions toward a set of desired future conditions; that is, it involves measuring condition change over time relative to management actions. It answers the basic question: Did the actions taken have the desired result on the condition(s) of concern? Establishing an effectiveness monitoring protocol will likely be one of the major efforts for any collaborative forest restoration group.

Facilitation: The process in which an independent facilitator assists a group to constructively discuss a number of complex, potentially controversial or contentious issues.

Facilitator: A third-party, neutral person who helps collaborative groups effectively engage to reach specific goals.

Fire hazard: The level of ignition threat posed by the kind, arrangement, volume, condition, and location of a forest or other ecosystem; can also be used to assess the difficulty of wildfire suppression.

Forest health: A condition wherein a forest has the capacity across the landscape for renewal, for recovery from a wide range of disturbances, and for retention of its ecological resiliency, while meeting current and future needs of people for desired levels of values, uses, products, and services.

Forest: In general, an area or biotic community dominated by trees of any size (usually, at least 10 percent of the area is covered by trees). If distinction is made to woodlands, forests are composed of taller, more closely-spaced trees.

Fuels: The organic materials that support ignition and spread of a fire (duff, litter, grass, weeds, forbs, brush, trees, snags, and logs).

Fuel treatment: The re-arrangement or disposal of fuels to reduce the fire hazard by mechanical thinning, mastication, or prescribed burning.

Ground rules: Rules that establish open and fair procedures for parties to follow when working together in a collaborative setting.

Heterarchy: A social arrangement in which the organizational structure is only partially ordered, and where power is inclusive and information flows more or less openly; networks or webs with nodes are examples of heterarchies.

Hierarchy: A social arrangement in which the organizational structure is clearly defined (top-down), and there are a defined chain of command, identifiable roles and responsibilities, and differential access to decision-making and information based on position within the organization; bureaucracies, corporations, military organizations are examples of hierarchies.

Historic Range of Variability (HRV): The variation in spatial, structural, compositional, and temporal characteristics of an ecosystem during a reference period prior to intensive resource use and management. Often used with Natural Range of Variability.

Human dimension: An integral component of ecosystem management that recognizes people are part of ecosystems; that people's pursuits of past, present, and future desires, needs, and values (including perceptions, beliefs, attitudes, and behaviors) have and will continue to influence ecosystems; and that ecosystem management must include consideration of the physical, emotional, mental, spiritual, social, cultural, and economic well-being of people and communities.

Implementation monitoring: See compliance monitoring

Issue: A point of discussion, debate, or dispute regarding an environmental effect in a proposed action under the National Environmental Policy Act.

Landscape: A heterogeneous area composed of a cluster of interacting ecosystems that are repeated in similar form throughout the area. Forest landscapes usually range from hundreds to thousands of acres and are the result of geologic, edaphic, climatic, biotic, and human influences.

Major vegetation types: Plant communities that are characteristic of the macroclimate and geology of the region or sub-region; typically named after the dominant plant species.

Management scenario: A description of future conditions expected to result from the general implementation of a broad resource management strategy. Management scenarios are developed to explore the biological and social implications, tradeoffs, and uncertainties of ecosystem management rather than present a range of options for site specific adoption (management alternatives).

Monitoring: A component of adaptive management in which information is collected to track system behavior and its response to management.

Multi-party monitoring: A process for assessing the effectiveness of stewardship contracting in meeting the goals of Title 16, United States Code, section 2104 Note that involves the Forest Service, cooperating Federal, State, and local agencies, tribal governments, local communities, nongovernmental organizations, and any interested groups or individuals.

Multiple year contract: A contract for procurement of supplies or services over several designated program years that requires establishment of a renewal option for each program year after the first year. The renewal option must be exercised to continue the contract for each designated program year after the initial year. An integrated resource service contract may be a multiple-year contract.

Multi-year contract: A contract for the procurement of supplies or services over several designated program years that does not require establishing and exercising an option for each program year after the first year. A multi-year contract may provide that performance under the contract during the second and subsequent years of the contract is contingent upon the appropriation of funds and may provide for a cancellation payment to be made to the contractor if appropriations are not made. For the purposes of stewardship contracting, a multi-year contract may be extended up to ten years. Multi-year contracts should not be confused with multiple year contracts. An integrated resource service contract may be a multi-year contract.

Native species: Species of plants and animals that are indigenous to the plan area or assessment area.

NEPA: National Environmental Protection Act; U.S. Forest Service policy and procedures for implementing NEPA and the Council on Environmental Quality regulations (40 CFR chapter V) are described in Chapter 1950 of the Forest Service Manual and Forest Service Handbook 1909.15, Environmental Policy and Procedures Handbook (See 36 CFR 200.4 for availability).

Networks: Loosely defined, heterarchically structured groups of individuals with overlapping interests or responsibilities, who engage in informal communication over extended periods of time.

Partnerships: Generally long-standing and place-based groups, who serve to identify issues, gather information, generate management options, and develop recommendations for restoration projects within a specified geographic area.

Plan area: The geographic area of National Forest System lands covered by an individual land and resource management plan. The area may include one or more administrative units.

Productive capacity of ecological systems: The ability of an ecosystem to maintain primary productivity including its ability to sustain desirable conditions such as clean water, fertile soil, riparian habitat, and the diversity of plant and animal species; to sustain desirable human uses; and to renew itself following disturbance.

Old growth: A late stage of forest succession in which trees have reached a mature condition. Although the specific characteristics of old-growth stands vary with species composition and history, some commonly expected attributes on productive sites include–an abundance of large trees at least 180 to 200 years old; a multi-layered canopy dominated by large overstory trees with moderate to high canopy closure; numerous trees with broken tops, also numerous snags and large logs (i.e., coarse wood debris).

Outcomes: Identified end results; consequences that may affect environment, economy, stakeholders, and affected groups.

Plan area: The geographic area of National Forest System lands covered by an individual land and resource management plan. The area may include one or more administrative units.

Planning committees and advisory councils: Groups of invited experts who provide advice and/or help developing guidelines and plans for other organizations, such as government agencies.

Prescribed fire (or burning): The intentional burning of forest fuels under conditions specified in an approved plan to meet management objectives and confined to a predetermined area; ignition may be either the result of a scheduled management activity or from other sources (e.g., lightning).

Productive capacity of ecological systems: The ability of an ecosystem to maintain primary productivity, including its ability to sustain desirable conditions such as clean water, fertile soil, riparian habitat, and a diversity of plant and animal species; to sustain desirable human uses; and to renew itself following disturbance.

Reference landscapes: Places identified in the plan area where the conditions and trends of ecosystem composition, structure, and processes are deemed useful for setting objectives for desired conditions and for judging the effectiveness of plan decisions.

Resilience: The ability of an ecosystem to maintain or restore biodiversity, biotic integrity, and ecological structure and processes following disturbance.

Responsible official: The agency officer with the authority and responsibility to oversee the planning process and make decisions on proposed actions.

Restoration forestry: The application of treatments to approximate historical [stand] structure and ecological process in forest communities that for centuries were shaped by distinctive patterns of fire.

Reviewing officer: The supervisor of the responsible official; prepares the Record of Decision.

Scale: The degree of resolution from a spatial or temporal perspective at which ecological and social processes, structures, and changes across space and time are observed and measured.

Silvicultural prescription: A silvicultural prescription is a written document that describes management activities needed to implement treatments or treatment sequences. The prescription documents the results of an analysis of present and anticipated site conditions and management direction. It also describes the desired future vegetation conditions in measurable terms. The desired condition is a basis for treatment, monitoring, and evaluation.

Site specificity: A goal to establish plans that are derived from data specific to a give site or area.

Social and economic sustainability: Meeting the economic, social, aesthetic, and cultural needs and desires of current generations without reducing the capacity of the environment to provide for the needs and desires of future generations, at local, regional, and national levels.

Species: Any member of the animal or plant kingdom that is described as a species in a peer-reviewed scientific publication and is identified as a species by the responsible official pursuant to a plan decision, and must include all species listed under the Endangered Species Act as threatened, endangered, candidate, or proposed for listing by the U.S. Fish and Wildlife Service or National Marine Fisheries Service.

Stakeholders: A person or group with a direct interest, involvement, investment, or perspective about a particular issue or activity (e.g., forest restoration).

Stand basal area (BA): A measure of forest density that is equal to the sum of the cross sectional area of trees at breast height on an acre of land. It is also equal to the BA of a tree of average diameter multiplied by the number of trees per acre.

Stratification system: A methodology of site analysis that structures data into appropriate layers or strata of information (e.g., Geographic Information Systems).

Stratum/Strata: Stratum indicates a single layer of data within a stratification system or Geographic Information System; strata indicate two or more layers of data within such a system.

Thinning: The silvicultural practice of removing selected trees in a stand to reduce competition for light, water, and nutrients in order to promote the growth and survival of the remaining trees.

Threshold: The point at which there is an abrupt change in an ecosystem quality, property or phenomenon, or where small changes in an environmental driver produce large responses in the ecosystem.

Tiering: A process used by federal agencies when developing an EIS that focuses on issues which are ready for a decision, and places those that have already been decided or are not ready for a decision in a lower level of consideration (see CEQ NEPA Regulations 40 CFR 1508.28).

Treatment: This term describes any of a set of management activities that can assist the prompt recovery of forestlands. Management actions include any combination of live, dead, and dying wood removal, or disposal (with or without commercial value) by any feasible method, including but not limited to logging, piling, masticating, and burning, for site preparation. In addition, planting, seeding, and monitoring for natural regeneration without site preparation are appropriate management activities designed to foster the prompt recovery following wildfire. Treatments also include follow-up activities to control vegetation that competes with desired trees during the early establishment period, usually 1 to 5 years after establishment using any viable method that meets Land and Resource Management Plan direction.

Trial-and-Error management: A strategy wherein agencies adjust management decisions incrementally and in an *ad hoc* manner based on monitoring results. However, this strategy does not employ any clear monitoring framework or schedule, or structured feedback loops.

Trigger: A type of pre-negotiated commitment made by an agency within an adaptive management or mitigation framework specifying what actions will be taken if monitoring information shows x or y. They are predetermined decision points that are built into the decision-making framework (i.e., NEPA documents) at the outset (i.e., if this, then what).

Validation monitoring: A research-oriented form of monitoring that requires rigorous sampling designs, and extensive data collection and analysis, and serves as a follow up to effectiveness monitoring. It seeks to answer the questions: Did our basic assumptions prove true? What caused the changes we identified during effectiveness monitoring to occur? Designed to help the agencies and Congress determine whether the basic thinking for supporting the programs was sound and whether future changes need to be considered.

VSS class: A classification scheme that indicates a forest community's structural stage with VSS1 being the earliest structural stage and VSS 6 being the oldest stage with the largest trees.

Sources

Helms, J.A., ed. 1998. *The dictionary of forestry*. Bethesda, MD: Society of American Foresters.

USFS. Title 36: Parks, Forests, and Public Property CHAPTER II: FOREST SERVICE, DEPARTMENT OF AGRICULTURE, PART 219: PLANNING, Subpart A: National Forest System Land and Resource Management Planning: Definitions, 219.36 - Definitions.