Tracking Progress

The Monitoring Process Used in Collaborative Forest Landscape Restoration Projects in the Pacific Northwest

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About the Northwest Fire Science Consortium

The Northwest Fire Science Consortium is part of a national network of consortia established by the Joint Fire Science Program to accelerate the awareness, understanding, and adoption of wildland fire science information by federal, tribal, state, local, and private stakeholders. The geographic region of the NW Consortium includes Oregon and Washington, except for the basin and range of southeastern Oregon.

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Several trends have emerged in recent years that affect the management of the National Forest System, particularly in the western U.S. One is the recognition of landscapes departed from a natural range of variation,[1] especially with implications for wildfire management. Another trend is the economic decline in many rural communities of the western U.S., particularly those based on natural resource activities such as timber production. Finally, there is increasing acceptance of collaborative approaches to forest management. Collaborative approaches endeavor to increase mutual learning among previously polarized parties, find consensus to accomplish objectives, and improve the quality of public participation while addressing recent landscape and socioeconomic concerns.

Within collaborative approaches, monitoring often plays a prominent role and can be used to strengthen communication and consensus among diverse groups by tracking a learning process rather than individual stakeholder interests. This tracking of progress can be used as a part of social learning[2] to serve as a form of social contract among the stakeholder groups. It reflects agreements on how to proceed in landscape management, identifies how well agreements are being met, and serves as a neutral approach for determining effectiveness. Monitoring and learning processes can help diffuse conflict by using field evidence to focus on what is actually happening.

Monitoring has a long history in resource management.[3] Federal land management agencies and partners such as The Nature Conservancy have a long record of monitoring the effectiveness of management actions.[4] However, monitoring has also faced challenges and shortcomings in past efforts with concerns that include: 1) monitoring objectives that are poorly defined and constructed;[5] 2) a lack of broad user and stakeholder involvement in the monitoring process;[6] 3) a lack of institutional funding and support for monitoring;[7] 4) unrealistic monitoring goals and expectations;[8] 5) a lack of prompt reporting on monitoring results to agency leadership and the public;[9] and 6) an approach to monitoring that is solely from a research perspective.[10]

The increasing use of collaborative approaches in federal land management in recent years has presented new opportunities to develop effective monitoring processes.[11] In particular, the development of collaborative groups generated from The Collaborative Forest Landscape Restoration Program, established through Title IV of the Omnibus Public Land Management Act of 2009,[12] has presented an opportunity for building monitoring processes embracing ownership and timeliness in a collaborative model while addressing shortcomings of previous monitoring efforts. This working paper offers guidelines to ensure an effective monitoring plan is developed, and uses the Collaborative Forest Landscape Restoration Projects (CFLRPs) on five National Forests in the Pacific Northwest as a case study for its implementation. It is based on the monitoring process the USDA Forest Service Pacific Northwest Regional Office, Research Station, and CFLRPs have developed to encourage national forests and their CFLRP collaboratives in creating efficient processes for tracking information and monitoring in ways that engage the interests of all stakeholders.

The monitoring process described was developed specifically to address the shortcomings of past monitoring efforts noted above, as well as to guide development of monitoring efforts in the setting of collaborative partnerships. The authors of this paper all played a role in facilitating the development of this process. In this, we saw a key opportunity for collaborative monitoring to cultivate engaged stakeholders that "own" the monitoring process, rather than a small group of agency enthusiasts pursuing the work in relative isolation. The prominent challenge was to establish adequate stakeholder engagement in the process, fostering both collective ownership and responsibility to find consensus within the group. We do not specify monitoring indicators or methods in this paper. Rather, we describe key concepts that form the foundation of the Pacific Northwest CFLRP monitoring framework, provide an example from a collaborative that has completed monitoring question development, and summarize some of the key guiding principles for practical, efficient monitoring that have emerged across CFLRP projects in the region. Together, these represent guidelines for designing an effective, practical monitoring program that strengthens the collaborative landscape restoration program experiment in managing public lands.

Background

CFLRP legislation and monitoring roles

The Collaborative Forest Landscape Restoration Program recognized landscape trends and posed the hypothesis that the sustainability of landscapes could be improved through extensive ecological restoration treatments. Under this legislation, collaborative projects for restoration treatments in national forests are selected by a multi-organizational national panel to meet CFLRP objectives for socioeconomic and environmental outcomes. Collaborative groups, generally called "collaboratives,"[13] are formed to guide implementation of CFLRP projects with broad representation from community interests and partners. Projects are designed to last 10 years.

In all CFLRP projects, ongoing ecological and socioeconomic monitoring is meant to play an integral role in making decisions and tracking progress on goals. Monitoring occurs throughout the 10 years of each CFLRP, and then five years beyond that. Projects must include monitoring plans and provide regular reports to national Forest Service leadership on ecological indicators at both landscape and project scales. Monitoring is also intended to ensure that the collaborative's intent, the mutual understanding with the Forest Service, and the requirements of CFLRP-related legislation and funding are met. The collective nature of CFLRP efforts provides a fitting opportunity for monitoring to contribute to learning directed at informing and improving management over time, across scales, and between diverse stakeholders.

Indicators and efficiencies

Monitoring indicators were developed during a 2011 workshop by an integrated group of Forest Service representatives (with Washington Office, Regional office, and National Forest representation) and partners.[14,15] The team identified five categories of monitoring indicators: fire costs, jobs and economics, leveraged funds, collaboration, and a set of ecological indicators. The first four categories are covered through standard annual reporting or existing software-reporting applications, such as the Risk and Cost Analysis Tools (RCAT). The fifth – ecological indicators – is general in nature and considered a related, but separate, effort.

In July 2012, the Deputy Chief of the National Forest System issued direction on the ecological indicator category, which included four national monitoring indicators for CFLRPs across national forests: fire regime, fish and wildlife habitat, watershed condition, and invasive species. The indicators set basic monitoring standards and provide an upward reporting mechanism. They are intentionally broad enough to allow individual projects to set their own desired conditions and to allow specific, detailed monitoring questions that address local stakeholder and site-specific ecological needs. They are also intended to provide a consistent reporting framework for collating data nationally through a good/fair/poor scoring scheme that is made at both project and landscape scale. Existing tools (e.g. LANDFIRE (2010)[16]) and indicators from other USFS frameworks can be mutually useful for CFLRP monitoring. Indicators from the Watershed Condition Framework,[17] for example, are already set up for good/fair/poor scoring, and can be used in assessing progress in watershed improvement for the both the national watershed indicator and local CFLRP monitoring. These efficiencies help make the most effective use of limited funding and other resources in CFLRP monitoring efforts.

Region 6 CFLRP monitoring

In addition to national level reporting on accomplishments and indicators, each CFLRP must develop a local monitoring plan. Five CFLRP projects are located in the Forest Service Pacific Northwest Region (Oregon and Washington; also known as Region 6). Two projects were selected for funding in 2010—Deschutes Skyline (Deschutes National Forest) and Tapash (Okanogan-Wenatchee National Forest)—and the remainder were funded in 2012—Lakeview Stewardship Project (Fremont-Winema National Forest), Southern Blues Restoration Coalition (Malheur National Forest), and Northeast Washington Forest Vision 2020 (Colville National Forest).

Each of the Region 6 CFLRP projects have adopted the approach, concepts, and guiding principles described below for their ecological monitoring efforts, although the collaboratives are in different stages of monitoring implementation. Several collaboratives have made substantial progress in social and economic monitoring while others are just beginning. Implementation of project monitoring varies in progress and with local strengths and weaknesses. Some National Forests in the region have a long history of collaboration with the public while others do not. Forest Service comfort and familiarity with collaboration can influence the speed with which collaborative monitoring plans are developed and monitoring is implemented.

The authors of this paper have all played key roles in developing the Region 6 monitoring process to provide mutual learning, opportunities for integration, and a useful tool for decision-makers. In our work with collaboratives in the region, we sought to create a process that would foster broad ownership of the monitoring criteria indicators and process. We encouraged national forests and their collaborative partners to see monitoring as their effort and not an isolated task delegated to scientists. Although there was Forest Service Regional and Research Station involvement in facilitating the CFLRP monitoring process, there was general consensus among partners in avoiding a "top down," directive approach to monitoring. Forest-level monitoring efforts were developed in a "bottom up" manner with facilitation and support from the Regional office. We believe that combining this locally driven approach with implementation that is mutually agreed-on and driven by the collaboratives can help to ensure local ownership of the process. We also believe local ownership is essential to long-term monitoring, and plays a critical role in building trust among collaborative partners over time. Ultimately, ongoing monitoring is a mutual learning experience that helps build trust and clarify collaborative objectives.[18] The key concepts and principles that we report on here are those that have in our experience been most useful for guiding monitoring processes in practical, meaningful, and effective trajectories over time.

Adaptive management context

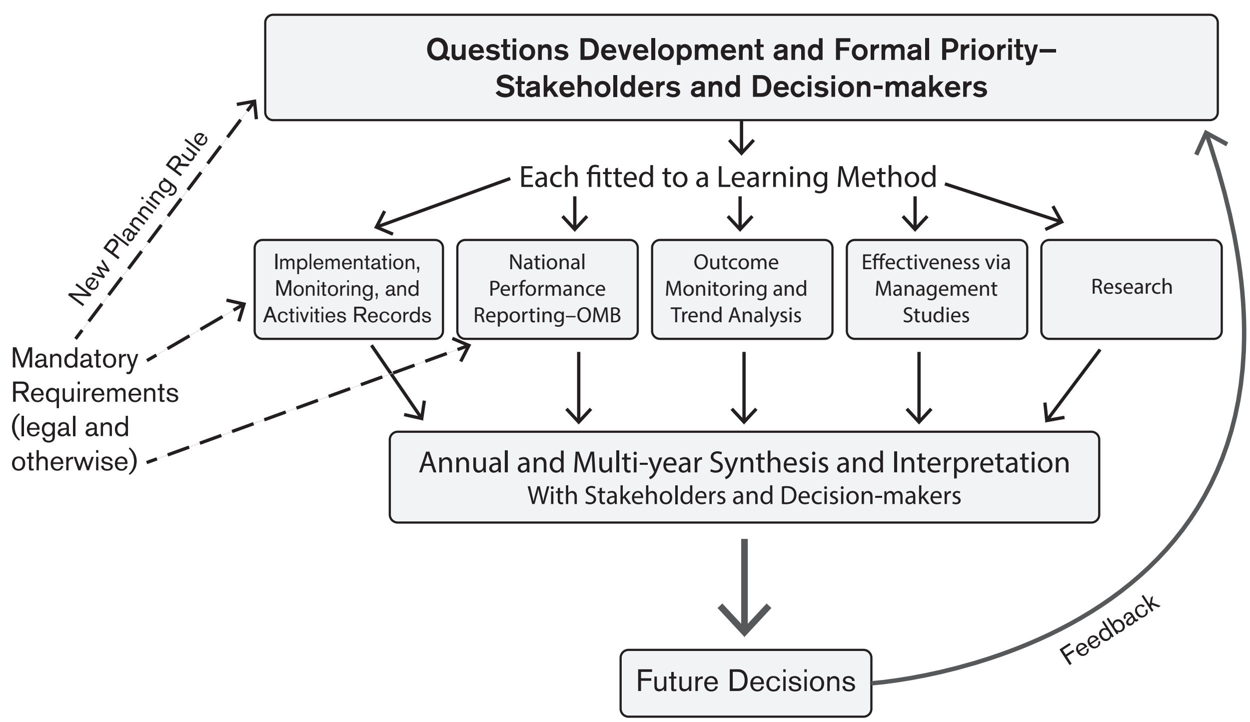
Adaptive management is based on the premise of designing natural resource planning and operational treatments as a learning experience (for a thorough review of the concept see Stankey et al. 2005).[19] Accordingly, the CFLRP monitoring process is intended as a learning process among the collaboratives within an adaptive management context, featuring mutual learning and opportunities for integration.[20] The process is intended to explicitly provide opportunities for education, regrouping, reflection, and adaptation to meet changing needs and/or circumstances. The authors believe that this learning process is effectively implemented in practice with emphases on accountability, frequent reporting, correcting mistakes, prioritizing the use of scarce resources, and collaborative ownership of relatively few but carefully constructed monitoring questions (the process outlined in this paper).

Figure 1 (see page 5) illustrates how the CFLRP monitoring process fits within an adaptive management context. Monitoring questions developed and vetted by the collaborative form the core of the monitoring efforts. Adequate time is necessary to formulate questions and criteria for monitoring within an adaptive management context, and with the participation of the entire collaborative. The collaborative also agrees on the priority and rigor of each question ("formal priority"), as well as the learning method for answering questions.

This compels the collaborative to make the difficult decisions on the level of rigor necessary—and the available resources—that can be allocated to each question as a group. After monitoring questions and methods are agreed upon, monitoring information is gathered, interpreted, and reported back to the group.

The information gathered from all steps of monitoring efforts is periodically synthesized and assessed for its value in meeting collaborative objectives, as well as for cost-effectiveness and timeliness. Information can be used to change course, if called for, in an adaptive management context. Collaboratives should use this information for learning about conditions, progress on goals, and re-assessment of the monitoring questions. In this way, monitoring is integrated into the collaborative learning process. Each step of the monitoring process, and each piece of collected information offers opportunities for reflection, corrections, and adaptations to enhance the impact of future efforts. Frequent (at least annually) reporting on information gained on monitoring also helps the collaborative determine whether its collective objectives are being met, and can help build trust among collaborative members, and with the Forest Service.

Figure 1 Adaptive management framework to facilitate a monitoring process



Question development

Choosing what to monitor is established through question development, which forms the basis and foundation for each collaborative's ongoing monitoring process. The questions, when answered, should provide reportable responses to the agreed upon indicators. Questions developed with the full participation of the collaborative are screened by a set of criteria that are also developed by the collaborative, but that may be influenced by other collaboratives within the region (see side box for example). The criteria should be agreed on by the full membership. Ultimately, the questions provide the basis on which monitoring work will be implemented; their development and refinement is critical in shaping the monitoring process and should be completed before actual monitoring work begins. While this process requires adequate time to complete with the participation of the full collaborative, the investment of time in developing the questions as groundwork yields efficiencies in implementing the actual monitoring. Once the monitoring questions are determined, specific monitoring tasks can be allocated by the collaborative to those best suited to do the work, and the monitoring questions can be reviewed based on gathered monitoring data.

Criteria to apply to a question during the question screening process:*

Does the question:

1. meet a core objective of the CFLRP project?
2. meet other specified and agreed upon collaborative goals?
3. facilitate learning (adaptive management)?
4. facilitate the decision-making process?
5. address something new, and if not, what results are currently available?
6. address the appropriate scale?

Is the question:

7. cost effective and practical to implement?
8. outcome focused?
9. adequately representative of social, economic, and ecological issues?
10. agreed upon by the collaborative (i.e., everyone has access to the process, offered input, and is committed to seeing the question through)?

** These questions arose from the development of the Lakeview collaborative monitoring plan, and have generally been adopted by the other four collaboratives in the Region, with modifications.*

The continuum of evidence

A central consideration throughout the development of monitoring questions and process is what kinds of methods are necessary to answer questions, and what resources are necessary to implement those methods. We advocate the principle that not all questions need be answered with the same level of rigor or evidence. The basis of the "continuum of evidence" approach is an evaluation of the level of rigor that is needed to adequately and practically answer each question. The authors see this as a critical consideration, and a reason why classical research methods (narrow hypotheses, ground data, and statistical analysis) are inadequate to a monitoring program that must address a variety of issues for a broad user base (the collaboratives) in a relatively short period of time. The level of rigor for answering a specific question could range from expert panels making judgment calls, to photo monitoring, to a reliance on maps for landscape assessment and modeling, to the rigorous collection of ground data to test statistical hypotheses. In a practical management context, time, funding, and personnel resources matter. In a rapidly changing resource management environment, the approximate answer arrived at quickly is often more valuable than the precise answer a year from now. Because every question cannot be practically answered using the most rigorous methods, a determination of the level or rigor necessary to answer each question with a reasonable balance between available resources and accuracy is essential. This is not a minor point; despite lessons learned from past monitoring effort failures, there is still a tendency to confuse research and monitoring, and to develop individual monitoring components in isolation. Rigor and data intensity will also be driven by public interest, since topics with a high degree of controversy will likely require data-intensive an-

swers to withstand scrutiny. The collaborative process can help work through this process to match interest and methods with the resources available. This approach can also be used in triage processes, where landscapes evaluated for a particular concern are ranked in importance by expert panels, and then more rigorous methods used in specific areas of high interest or controversy, or where greatest uncertainty about outcomes exists. Our experience with the CFLRPs in this paper shows that with limited time, money, and personnel, collaboratives are often only able to allocate rigorous resources for one or two monitoring questions. The continuum of evidence approach helps collaboratives to consider available resources alongside a range of methods for answering questions according to rigor priority.

Developing, refining, and implementing monitoring questions: An example

The Lakeview Stewardship Group (LSG) is one of the five CFLRPs in the Region, and was established in the second round of CFLRP creation in 2012. The LSG, however, was created 10 years earlier, and thus already had a long track record of collaboration before it formally became a CFLRP. The group therefore≠≠ grasped the process steps outlined in this paper quickly and began to develop monitoring questions as a group.

The LSG completed their ecological questions formulation process in late 2012, and the final monitoring questions were approved by the full collaborative in February 2013. From an initial list of approximately 65 questions proposed in a July 2012 workshop, the collaborative reduced the list to nine ecological monitoring questions that would be carried forward in the Lakeview CFLRP Monitoring Plan. To filter the proposed questions down to the final ecological questions for data collection, the Collaborative Monitoring Team established and agreed upon question criteria that helped identify the highest-priority questions. Table 1 (see pages 8 and 9) shows the final ecological questions, as well as the goals, indicators (specific metrics), appropriate scale, methods, and the parties responsible for collecting data and reporting on each question. Essentially, this table summarizes some of the main criteria, in addition to the early stages of planning necessary to implement the monitoring for each question. Developed in this format, monitoring is more clearly seen as a comprehensive set of questions rather than isolated efforts, and it is clear to all members of the collaborative (as well as the general public) what is being expected and what is being committed to. The monitoring team began implementing the field monitoring and assessments to address the ecological questions in 2013.

Table 1 Ecological monitoring questions developed by the Lakeview (Stewardship Group) Collaborative (table adapted from Markus et al. 2013)[21]

Question	Question Type: Social/ Ecological/ Economic	Goal	Indicator
#1– How effective are restoration treatments in reducing wildfire risk?	Ecological	To quantify the effectiveness of restoration treatments on reducing fire growth and behavior.	Modeled fire growth a
	Economic	To estimate fire program management cost savings and risk reductions for the CFLR project area.	Expected suppressio
#2– What are the effects of restoration treatments on tree survival/mortality by diameter class, changes in ladder fuels, and fuel loading pre/post treatment(s)?	Ecological	To quantify the effects of restoration treatments on vegetation.	Mortality, Forest Struc
#3– What is the effect of restoration treatments on moving the Forest landscape toward a more sustainable condition that includes the approximate scale and intensity of historic disturbances?	Ecological	To assess whether current restoration treatments have resulted in sustained or improved resiliency/resistance to insect, disease, and drought.	Projection of a stands ease, drought based o
	Ecological	To quantify the scale and intensity of current restoration treatments and their effectiveness at moving the forest landscape towards a more sustainable condition.	Change in FRCC ratin
	Ecological	To quantify and compare the effects of restoration treatments to the historic disturbance regime.	Fire frequency and se
#4– What were the historical within-stand spatial patterns on the Lakeview Stewardship landscape? How well are treatments mimicking historic spatial patterns?	Ecological	To understand historic spatial patterns that will help with future prescription writing.	Individuals, clumps, ar
	Ecological	To achieve fine scale mosaic pattern across the landscape that existed historically.	Individuals, clumps, ar
#5– What are the site specific effects of restoration treatments on focal species habitat within a project area?	Ecological	To incorporate fine-resolution habitat suitability for nesting WHWO into silvicultural prescriptions and thereby guide ecosystem restoration projects within the range of the species.	Levels of tree clusteri tics, and the density a
	Ecological	To verify the effectiveness of restoration treatments for improving habitat for WHWO.	WHWO occupancy, ne
	Ecological	To quantify how restoration treatments impact fish habitat.	Stream channel morp tion, macroinvertebrat vegetation cover
#6– What are the effects of restoration treatments on focal species habitat across the CFLR Project Area?	Ecological	To improve and maintain habitat for WHWO at the stand and landscape scale.	Amount of WHWO ha
	Ecological	To improve habitat for fish and wildlife species within aspen, stream, and riparian areas.	Total acres of aspen c reduction occurred ar enhanced due to in-st
#7– How are restoration treatments impacting ground vegetation and soils?	Ecological	To quantify vegetation composition and response before and after small tree thinning and prescribed fire within riparian corridors.	Riparian vegetation sp ground cover, riparian class, extent of riparia
	Ecological	To quantify how restoration activities such as logging and prescribed fire impact soils	Soil disturbance class
#8– How are restoration treatments (road closures, upland/riparian treatment, etc.) impacting water quality?	Ecological	The desired condition is that watershed condition (at the 6th field watershed) would be maintained in those watersheds currently rated as “good” and improve to “good” in those watersheds currently rated as “fair.”	Watershed Condition
	Ecological	To quantify the miles of road decommissioned across the entire CFLR project area and within riparian zones.	Miles of road decomm in the 6th field waters within riparian areas
	Ecological	To determine how restoration projects affect stream temperature	Stream temperature
#9– Are Forest Prevention Practices effective in minimizing impacts of restoration treatments (including prescribed fire) on invasive plant species (new and/or existing)?	Ecological	To minimize the occurrence of new invasive plant sites and/or expansion of existing sites.	Number of new invasi sion of existing invasi adjacent to veg. mana

	Scale: Landscape/ Stand	Methods Approach: Effectiveness/ Implementation/ National Indicator	Methodology	Who collects data
and behavior	Landscape	Effectiveness, National Indicator	FlamMap FARSITE	FS BPMC TNC
n costs with and without treatments	Landscape	Effectiveness, National Indicator	R-CAT	FS
cture and Fuel Loading	Stand, Landscape	Implementation, Effectiveness	FIREMON FFI [25]	BPMC
resistance to wildfire, insects and dis- n past radial growth and other stand data.	Stand	Validation	FS stand exam plot data	BPMC
ng	Landscape	Effectiveness, Validation, National Indicator	FRCC	FS
everity	Stand, Landscape	Effectiveness	GIS analysis	FS
nd openings	Landscape	Effectiveness	Churchill et al. 2012 [28]	TNC BPMC
nd openings	Landscape	Implementation	Comparison to the historic data from stem mapping	TNC BPMC
ng, stand densities, and tree characteris- nd size of openings	Stand	Effectiveness	Churchill et al. 2012 [28]	TNC BPMC FS
esting, and success	Landscape	Effectiveness	Mellen-McClean et al. 2012 [24]	RMRS FS BPMC
hology, stream substrate composi- e populations, riparian and streamside	Site specific	Implementation	Stream cross sections, Wolman pebble counts, macroinvert sampling, photo monitoring	BPMC
bitat within CFLR Project Area	Landscape	Effectiveness, National Indicator	WHWO HSI models	RMRS
or riparian habitat in which conifer nd the total number of miles of stream tream improvements	Landscape	Implementation, National Indicator	GIS analysis	FS
pecies composition, bare ground and and streamside vegetation cover, age an vegetation	Stand	Effectiveness, Photo Points	BPMC line intercept protocols and photo points	BPMC
s	Stand, Landscape	Implementation	FS Soil Disturbance Monitoring Protocols	BPMC
Framework ratings	Landscape	National Indicator	Watershed Condition Framework	FS
nissioned and reduction in road density sheds within the CFLR project area and	Landscape	Implementation, National Indicator	GIS analysis	FS
	Site specific	Effectiveness	Hobo water temperature data loggers	FS
ve plant sites discovered and/or expan- ve plant sites within or immediately agement activities	Stand, Landscape	Effectiveness	Pre and post ocular surveys	FS

Acronyms

FS: Forest Service

BPMC: Biophysical Monitoring Crew

TNC: The Nature Conservancy

RMRS: Forest Service Rocky Mountain Research Station

R-CAT: Risk and Cost Analysis Tools

FRCC: Fire Regime Condition Class

WHWO: White-headed woodpecker

Key monitoring process principles

During development of the Lakeview CFLRP monitoring process, a set of key principles emerged as particularly useful in guiding a learning-focused monitoring program. Many of these principles have also emerged in similar form in the monitoring plans of other collaboratives in the region as their monitoring efforts progresses. Key principles are listed below, and provide valuable direction in conducting monitoring that is based on question selection, learning approaches, and field monitoring techniques that are most likely to influence future decisions.

Local (CFLRP) ownership is a "bottom up" process; regional and multiparty involvement is based on mutual agreement. This premise is based on the idea that people do not value what they do not own. It is important for collaboratives to develop their own monitoring plans and programs. USDA Forest Service Regional and Research Station personnel, in collaboration with partners, have developed a set of indicators and provided guidance, but these are not overly restrictive and allow much leeway in their implementation; their emphasis is on insuring the core ecological and socioeconomic goals of legislation enabling the CFLRP projects are met.

Emphasis on full collaborative ownership of the monitoring questions. It is crucial that the full range of interests in the collaborative have an opportunity to participate in the CFLRP monitoring process including line officers (Forest Service decision-making authority). Involvement of decision-makers is important, since they can help insure the questions asked will produce answers useful to future decisions. Excluded parties may be uninformed, reluctant, or critical participants in later efforts. The process should facilitate an environment of mutual learning and successive refinement rather than one of opposition or blame. In this way, the group owns failures as well as successes.

Criteria that are developed by the collaborative to screen proposed questions to a manageable list. Criteria for evaluating CFLRP monitoring questions include elements ensuring practicality, meeting core CFLRP goals and requirements, addressing scale, and representing a mix of ecological, social, and economic questions. Collaboratives in the region have invested most of the initial effort in monitoring at developing and implementing ecological monitoring plans. This may reflect the traditionally strong expertise of resource managers in this area. Collaboratives are now beginning to develop and implement plans for social and economic monitoring. In some cases, outside expertise is helping to design and complete social and economic monitoring. Ultimately, persistence in thorough vetting of the monitoring questions will help to ensure practical, timely monitoring outcomes.

Allowance of enough time to refine the question thoroughly and carefully. Experience thus far suggests that investing time and patience during the question development and refinement process will result in stronger, better-supported outcomes later on. The final list of questions should represent a firm monitoring commitment by the collaborative, rather than a "wish list."

Commitment by all partners to see the final monitoring questions implemented. Collaborative members that understand and are committed to seeing the monitoring questions answered have greater incentives to consider costs and ensure timely reporting.

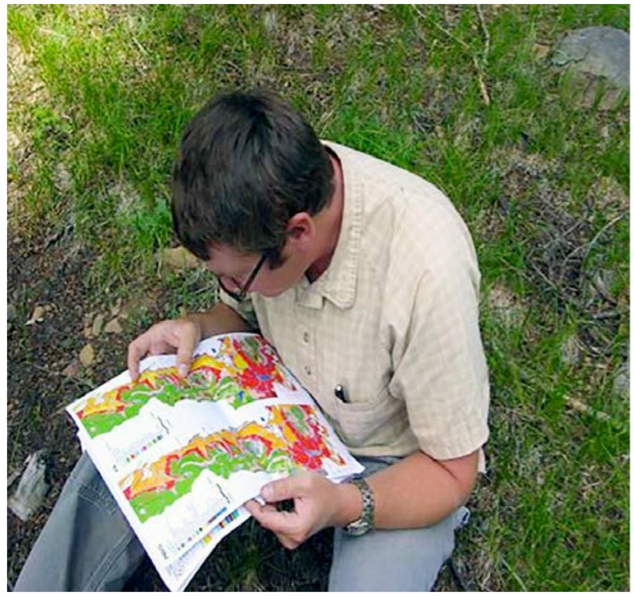
Consideration of cost and time effectiveness during question development and refinement. The process of refining the questions eliminates duplicates and identifies similar questions that can be combined. Omissions also become evident. Time and funding will constrain what is truly possible, and the question development and refinement processes must consider these constraints to produce the most appropriate and practically possible monitoring questions.

Emphasis on timely reporting of monitoring findings in clear language. Lack of timely reporting has been a shortcoming of many previous monitoring efforts. With time delays, issues and priorities may change. Partners can also lose energy and focus if reporting is delayed for years. A goal to have all parties understanding "how we're doing," at frequent intervals (at least annually) maintains momentum and interest, which are proven key ingredients for success.

Importance of line officer involvement and ownership to help ensure questions designed to facilitate management decisions. Line officer involvement can help foster success because they will be aware of and encouraging monitoring questions that can be used to shape practical decisions. If line officer support is absent or unclear, support for the monitoring effort may fail or be disavowed over time.

Questions that are designed as part of a learning process. The value of a mutual learning process in an adaptive management context has been well-illustrated,[22] and maintaining a focus on learning and improvement throughout the monitoring process will lead to efforts and results that are ultimately more relevant and successful.

Use of the "continuum of evidence" to answer questions, i.e., making decisions about the appropriate level of methodological rigor necessary to answer each question. The continuum spans from expert panels to GIS overlays, photomonitoring, assessment methods such as Fire Regime Condition Class, and quantitative, replicated data from monitoring with statistical tests. Part of effective science in a management context is using the appropriate level of evidence needed to make a decision. Some monitoring can be accomplished by less intensive methods like expert panels or photo monitoring. Landscape assessment can provide a good framework for some types of monitoring, and quantitative data collection can be statistically rigorous if that level of rigor is necessary. Constraints of timeliness and funding will likely mean that in order to answer all questions, only one, two, or at most a few questions can receive rigorous data collection and analysis.



While sorting out the level of rigor appropriate for answering each monitoring question can be arduous and time- consuming, it is well worth the effort to identify the most efficient approach and ensure that all questions are answered in a timely manner. Collaboratives may also find assistance from outside resources. For example, Rowland and Vojta (2013) can provide guidance on organizing vegetation and wildlife habitat monitoring,[23] Mellen-Mclean et al. (2012) provides a standard approach to monitoring white-headed woodpecker habitat,[24] and Lutes et al. (2009) (the FIREMON protocols) is widely accepted for use in monitoring fuels treatment effectiveness.[25]

Specific monitoring work that is allocated only after the final list of questions is agreed on. Monitoring work that starts before the questions have been refined and agreed-on may result in isolated, fragmented efforts that do not answer core questions or meet collaborative goals—common shortcomings in past monitoring efforts. Full collaborative support of the questions and the methodological rigor necessary to answer them both individually and as a group will help to ensure that all questions are answered as expected for reporting requirements and direction in future efforts.

Application to other efforts

Given the attention to trends that are pervasive across the National Forest System, CFLRP monitoring may also apply to other types of forest management projects, including those that seek to manage wildfire risk. The standards involved (i.e., full ownership by members throughout the process, timely reporting in clear language, and full engagement of all decision-makers) are relevant and applicable to a wide variety of current natural resource management monitoring scenarios, including Forest Plan revision. We are encouraged that many features of the monitoring process mentioned in this paper are included in the monitoring section (219.12) of the 2012 Forest Planning Rule,[26] which:

- includes language on science-based adaptive management;
- focuses on key monitoring questions;
- uses scale as a screening criterion;
- emphasizes timeliness, practicality, and cost-effectiveness;
- seeks to identify and monitor key ecosystem processes; and
- mentions multi-party monitoring.

Consistent frameworks play a key role in successful collaborative resource management projects,[27] and the process outlined in this paper establishes such a foundation. As the demands and expectations of the national forests grow, and resources of people and funding become increasingly scarce and scrutinized, monitoring that is realistic, timely, and that answers key questions will likely find an increasing role in shaping natural resource management.

Conclusion

Monitoring plays a key role in collaborative efforts addressing critical landscape and social trends and concerns. For effective monitoring efforts that strengthen consensus and communication between diverse stakeholders, monitoring must be thoughtfully and inclusively conducted. Monitoring that is not may fall victim to some of the same shortfalls of previous monitoring efforts, erode mutual trust, or threaten continued support in an era of constricted spending for federal land management. Accordingly, CFLRP monitoring must actively focus on treatments that achieve core CFLRP goals while also strengthening the social contract between collaboratives and the Forest Service. The process described in this paper was developed to focus on a relatively small set of key indicators in order to implement a practical and timely monitoring program capable of using results in an adaptive management context to evolve with changing conditions.

The monitoring framework outlined in this paper presents a process to make monitoring practical, useful across contexts, adaptable, and ultimately—successful over time. Properly done, the process can lead to measures of success that are attainable and that meet the needs of all collaborative members. It can also serve as a framework for sharing information and coordinating efforts, as individual collaboratives may benefit from sharing resources and protocols to promote efficiency. By considering the challenges and shortcomings of past monitoring efforts, focusing on the key features described, and ensuring full ownership among all stakeholders, CFLRP monitoring can be efficient, valuable, and effective in strengthening collaborative restoration in public land management.

Endnotes

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