Social-organizational contextual factors affecting multi-party monitoring in collaborative forest landscape restoration

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Abstract

The Collaborative Forest Landscape Restoration Program (CFLRP) has created the conditions in which collaborative adaptive management (CAM) approaches could be tested. In theory, CAM engages CFLRP stakeholders to: collectively define forest landscape restoration goals, assumptions, and uncertainties; identify restoration options; develop a monitoring strategy to assess restoration effects; implement on-the-ground actions and monitoring measures; deliberate the effects of actions on goals, assumptions, and uncertainties; and recommend changes in goals, assumptions, and actions. We draw on our respective experiences with the Colorado Front Range CFLRP, the Four Forest Restoration Initiative, and the Uncompahgre Plateau CFLRP to examine the social and institutional factors affecting adaptive management in three CFLRP projects. In doing so, we aim to provide insights in the operationalization of CAM and to advance CAM theory to inform policy learning. We identified eight factors categorized under two broad themes: social relational and interactional dimensions and institutional/organizational rules and structures. While much attention has been paid to institutional barriers to CAM, our experiences suggest the critical importance of attending to the social relational and interactional factors affecting the development and institutionalization of CAM practices over a long-term project. We suggest that many of the social factors that can inhibit CAM can be overcome through committed leadership and an attitudinal orientation that embraces uncertainty, monitoring, and learning.

Keywords: collaboration, adaptive management, monitoring, forest restoration

Introduction

Forest ecosystems globally are increasingly vulnerable to degradation or permanent loss due to natural and human disturbances. Natural disturbances, such as fire and insect disease outbreaks are predicted to increase in frequency, size, and severity in the future, with potential for widespread forest mortality and vegetation type change (Alkama and Cescatti 2016; Allen et al. 2010). Historic and ongoing human disturbances, such as intensive forest management, fire suppression, and forest land conversion, have altered forest composition, structure, and functioning in ways that increase their susceptibility to degradation or loss. While there is a general consensus that action must be taken to reduce these vulnerabilities and restore the resilience of forests to disturbances (Chadzon 2008; Messier, Puettmann, and Coates 2013), details concerning the specific types, locations, and intensities of actions are subject to debate, and the consequences of actions are often unknown. Forest restoration programs face additional challenges on multi-use national forest lands, where the governance and administration is fraught with complex and oftentimes conflicting social, institutional, economic, and political factors. With approximately 76% of the world's forests under state ownership and management

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(Whiteman, Wickramasinghe, and Pina 2015), the imperative is high to craft approaches spanning high-level policies to on-the-ground practices to address the uncertainty, complexity, and conflict associated with forest restoration.

A widely-advocated pathway to overcoming these challenges is adaptive management (AM), broadly defined as an approach to natural resource management that emphasizes learning through management based on the philosophy that knowledge is incomplete and perhaps erroneous, but despite this uncertainty, managers and policy makers must act (Allen et al. 2011; Walters 1986). A large body of literature exists on AM, including, but not limited to: conceptual frameworks for structuring AM processes (Allen et al. 2011; Jacobson et al. 2009; Johnson 1999; Lee 1993; Olsson, Folke, and Berkes 2004; Stankey, Clark, and Bormann 2005; Walters and Holling 1990; Williams 2011); AM challenges and barriers (Allen and Gunderson 2011; Hopkinson et al. 2017; McLain and Lee 1996; Susskind, Comacho, and Schenk 2012); AM effectiveness and outcomes (Benson and Stone 2013; Berkley 2013; Caves et al. 2013; Fernandez-Gimenez, Ballard, and Sturtevant 2008; Sabine et al. 2004) and legal-regulatory and governance considerations (Biber 2013; Chaffin, Gosnell, and Cosens 2014; Fischman and Ruhl 2015; Folke et al. 2005; Kallis, Kiparsky, and Norgaard 2009; Schultz and Nie 2012), with particular attention to adaptive co-management governance arrangements (Armitage, Marschke, and Plummer 2008; Berkes 2009; Cundill and Fabricius 2009).

A cross-cutting theme in the literature is the importance of including a broad diversity of stakeholders in AM through a collaborative participation process, herein termed collaborative adaptive management (CAM) (Beratan 2014; Scarlett 2013; Stringer et al. 2006). Collaboration is broadly defined as a process involving two or more actors who voluntarily pool their assets and capacities, constructively work through their differences, and coordinate their actions to achieve goals they could not achieve by themselves (Gray 1989; Wondolleck and Yaffee 2000). While there is broad overlap between adaptive co-management and CAM, a key difference is that, in co-management situations, there is an explicit sharing of power and responsibility over natural resource management between government officials and local users (Berkes 2009). In CAM, power-sharing is not necessarily requisite. Indeed, in the governance and administration of national forest lands, co-management arrangements may be problematic due to legal-regulatory constraints on delegating decision-making power and authority from the state to local users (Coggins 1999). Nonetheless, national forest management is an arena in which CAM is increasingly being applied and shares similar structural and processual features as adaptive co-management. Hence, advances in knowledge and understanding of one context informs the other.

While the practice of CAM is still evolving, with limited empirical evidence of performance over the timeframes necessary to realize outcomes and effects (Fabricius and Cundhill 2014; McFadden, Hiller, and Tyre 2011), there are institutional, social-organizational, attitudinal, and behavioral factors positively associated with CAM performance that can be mapped onto national forest management contexts. At the institutional level, higher-level policy mandates, institutional arrangements, and legal-regulatory frameworks to create the space for individuals to develop, experiment, and adapt CAM (Beratan 2014; Caves et al. 2013; Cheng et al. 2015; Kallis, Kiparsky, and Norgaard 2009). Enacting these requires leadership commitment from key participants (Caves et al. 2013; Greig et al. 2013; Loftin 2014). At the collaborative organization level, successful organizational structures ensure a diversity of ongoing participation, open face-to-face and tele-communications, knowledge sharing and management, work teams, facilitation and conflict management, garnering and administering financial resources, and coordinating actions. (Armitage 2005; Cheng and Sturtevant 2012; Cundill and Fabricius 2009; Greig et al. 2013; Loftin 2014; Pratt Miles 2013). A key organizational structure and function is the presence of boundary-spanning, bridging organizations to connect learning to actions, and visa-versa, across multiple levels of institutions and organizational authority (Allen et al. 2011;

Berkes 2009; Folke et al. 2005; Kallis, Kiparsky, and Norgaard 2009). CAM participants facilitate collaborative progress by bringing an attitude of willingness of all parties to group problem-solving and ensure mutual benefits (Caves et al. 2013), and a dedication to learning (Armitage, Marschke, and Plummer 2008; Benson and Stone 2013; Berkes 2009; Caves et al. 2013; Cundill and Fabricius 2009; Kallis, Kiparsky, and Norgaard 2009; Scarlett 2013). Developing social capital and trust-building constitutes an input and an outcome among stakeholders to promote cooperative social interactions (Berkes 2009; Fernandez-Gimenez, Ballard, and Sturtevant 2008).

There is also a similar suite of institutional, social-organizational, and individual-level factors frustrating CAM. Legal-regulatory, budgetary, and political constraints constitute institutional barriers to government officials' ability to fully implement AM (Allen et al. 2011; Benson and Stone 2013; Munaretto and Huitema 2012). Limited financial and technical resources for monitoring are especially common negative factors (Benson and Stone 2013; Caves et al. 2013; Fernandez-Gimenez, Ballard, and Sturtevant 2008). Even if these barriers are lowered through policy change, government agency participants in CAM processes often exhibit rigidity in organizational missions, routines, practices, and values that inhibit learning and create conflict and confusion among CAM participants (Hopkinson et al. 2017; McLain and Lee 1996; Monroe, Plate, and Oxarart 2013). Further, recent experiences suggest that CAM may apply to only a subset of government agency decisions, leading to unmet expectations of some participants (Allen et al. 2011; Caves et al. 2013). Even when decisions are amenable to CAM, the mismatch in the temporal and spatial scales between resource management decisions and monitoring results can hinder CAM progress (Allen et al. 2011; Cheng et al. 2015; Hopkinson et al. 2017). Within the collaborative group, a common barrier is the lack of clearly defined goals, objectives, and desired conditions (Hopkinson et al. 2017; Susskind, Comacho, and Schenk 2012), with particular problems in the arena of forest restoration (Colavito 2017; Urgenson et al. 2017). This lack of agreement can exacerbate CAM frustrations when the process for how monitoring results are integrated into future management decision-making is not specified (Benson and Stone 2013; Caves et al. 2013). A persistent individual-level factor is the lack of participants' capacity and interest to fully participate and sustain involvement in long-term CAM processes, with government agency staff turnover a particular problem (Allen et al. 2011; Benson and Stone 2013; Fernandez-Gimenez, Ballard, and Sturtevant 2008; Hopkinson et al. 2017; Kallis, Kiparsky, and Norgaard 2009; Monroe, Plate, and Oxarart 2013; Munaretto and Huitema 2012).

In sum, the current scholarship on CAM has extensively uncovered a suite of institutional, social-organizational, and individual factors associated with CAM progress or lack thereof. As necessary as these attributes are, they are unlikely to be sufficient to operationalize CAM over time (Kallis, Kiparsky, and Norgaard 2009). The sustainable application of CAM is affected by complex interactions between institutional and social-organizational structures, interpersonal relations, and individual agency and decision-making that vary from place to place (Beratan 2014). On this latter point, the social dynamics of CAM tend to be understudied (Agranoff 2006; Thomson and Perry 2006), and yet may have greater influence on CAM performance than institutional factors (Armitage 2005; Berkley 2013). This is particularly germane to CAM on multi-use national forest lands, where top-down policy mandates and bottom-up, self-organizing collaborative approaches to forest management are expanding (Cheng 2006; Mohammed, Inuoue, and Shivakoti 2017; Petheram, Stephen, and Gilmour 2013)

In this paper, we seek to broaden knowledge about the social factors affecting CAM performance over time by presenting an examination of three case studies in collaborative forest landscape restoration in Arizona and Colorado, USA. In particular we examine the interaction between institutional, social-organizational, social relational, and individual-level factors on collaborative social interactions of participants over time to explain CAM progress (or lack thereof). For this "micro-process" examination

(Moseley and Charnley 2014), we employ a process tracing approach favored in organizational and policy research for its in-depth case study focus and the ability to examine the interplay between institutional, organizational, social relational, and individual agency factors (Bennett and Checkel 2015; Ford et al. 1989). Through this approach, we seek to answer the primary question: In what ways do institutional, organizational, social relational, and individual factors interact to explain differences in CAM functioning and performance across the cases?

The cases are part of the Collaborative Forest Landscape Restoration Program (CFLRP) administered by the US Department of Agriculture-Forest Service (USFS), a novel national-level policy experiment to promote the implementation of forest restoration projects that have been collaboratively-developed using best available science, are at least 20,000 ha in size and have a ten-year implementation window, restore fire-adapted forest ecosystems to be resilient to future wildfires, achieve local community economic development through the use of wood biomass produced from restoration projects, and include a multi-party, collaborative monitoring plan. Initiated in 2009, the CFLRP encompasses 20 projects across the US and has received an annual budget ranging from US$40-55 million to date; project sizes and budgets span a wide range (Schultz, Jedd, and Beam 2012).

Because the cases have operated under the same legal-policy authority and financial resources to promote CAM under similar institutional rules and ecological contexts, they offer a high degree comparability of the local social interactional factors affecting CAM and how they interact with institutional factors. Additionally, because the CFLRP – and the authors' involvement in the projects – span a period of ten years, beginning in 2010, there is an opportunity to trace the process and progress of these cases over time. In this way, we are responding to calls to delve deeper into the operations of CAM (Agranoff 2006; Kallis, Kiparsky, and Norgaard 2009) to advance knowledge and practice of CAM across natural resource management contexts.

Project Summaries

Table 1 below summarizes the geographic context, spatial scale, stakeholder participation, and project weblinks.

Table 1. Descriptive information of the Colorado Front Range, Four Forest Restoration Initiative, and Uncompahgre Plateau Collaborative Forest Landscape Restoration (CFLR) Projects.

CFLR Project	Location	Spatial scale	Partners
Colorado Front Range	Arapahoe-Roosevelt and Pike-San Isabel National Forests, northcentral Colorado	31,600 acres targeted for primarily forest vegetation restoration treatments on 1,085,000 acres of national forest land	39 organizations participating, including: • Federal land and natural resource agencies (6) • State natural resource/environmental agencies (4) • Congressional delegation offices (4) • County governments (9) • Universities (3) • Conservation/environmental organizations (5) • Land/resource user groups (8)

Uncompahgre Plateau	Grand Mesa, Uncompahgre, and Gunnison National Forests, southwestern Colorado	165,000 acres targeted for forest vegetation, road, riparian, Colorado cutthroat trout, and other ecological restoration treatments on 555,000 acres of national forest land	41 organizations participating, including: • Federal land management agencies (4) • State resource agencies (2) • Congressional delegation offices (3) • County governments (4) • Universities (4) • Local high schools (2) • Conservation/environmental organizations (15) • Land/resource user groups (8)
Four Forest Restoration Initiative	Kaibab, Coconino, Tonto and Apache-Sitgreaves National Forests, northern Arizona	2.4 million acres	>45 organizations representing local and state governmental, environmental, conservation and academic organizations, and businesses

Colorado Front Range

Background

The Front Range Roundtable got its start in 2004, providing community input into the Front Range Fuels Treatment Partnership, a joint program of the U.S. Forest Service and the Colorado State Forest Service to reduce the threat of wildfire in the dry forests of Colorado from the Wyoming border south to the Arkansas River. The Roundtable included over two dozen organizations and government entities with a stake in the condition of the forest and met for over two years before producing its report, *Living with Fire: Protecting Communities and Restoring Forests* in May, 2006 (FRFTP Roundtable 2006). The report specified several "recommended actions" and identified 1.5 million acres along the Front Range, on both private and public lands, deserving of treatment for ecological restoration or community protection, including 400,000 acres on which both objectives could be accomplished simultaneously. Unfortunately for the Roundtable, though, 2006 coincided with the irruption of a major mountain pine beetle epidemic in lodgepole pine, outside the zone of concern of the Roundtable, and the focus of forest management turned away from the Front Range for the next few years.

Collaborative Monitoring and Adaptive Management Approach

Passage of the Omnibus Public Lands Act of 2009, which included the authorization of the Collaborative Forest Landscape Restoration (CFLR) Program, presented an opportunity to breathe new life into the Roundtable agenda, and several members collaborated to draft a proposal to be one of the first CFLR projects. Consistent with the law, the first act upon selection was to write a collaborative monitoring plan, and in 2011, the group, which was made up mostly of national forest managers and scientists from various Front Range institutions, produced its *Ecological, Social, and Economic Monitoring Plan* (Clement and Brown 2011), which specified desired trends in forest conditions and the methods that would be used to determine if treatments were moving the forest in the desired direction. The drafting process proved more difficult than expected, as the team quickly realized they were jumping into the middle of a process without having established precise goal statements, desired conditions, or even a detailed description of the nature of treatments, all of which would have made it much easier to write a monitoring plan. In addition, trust between stakeholders and land managers was tested early, when collaborative members raised concerns that treatments were not adhering to protections described in the law, but the group lacked a process for addressing those concerns. Communication was hampered by the fact that field staff, who were responsible for implementing treatments, were not the staff participating in the collaborative. It became clear that a more detailed description of the larger process of project planning and decision-making was needed, and a group formed to craft a model for adaptive management.

The group's report, *Collaborative Implementation of Forest Landscape Restoration in the Colorado Front Range* (Aplet et al. 2014), provides a cursory introduction to adaptive management and contains a diagram detailing the steps that the monitoring team, now labeled the "Landscape Restoration Team" (LRT), intended to use to carry out collaborative implementation of the CFLR project. The diagram (Figure 1) put the monitoring plan squarely in the center of a larger process that began with a statement of the problem, articulation of desired conditions, identification of treatment areas, and description of treatment methods, and concluded with individual project planning, pre-treatment and post-treatment monitoring, and data evaluation. The team distinguished between implementation monitoring, or an evaluation of whether the project was completed as envisioned (conducted by the Forest Service during or immediately after

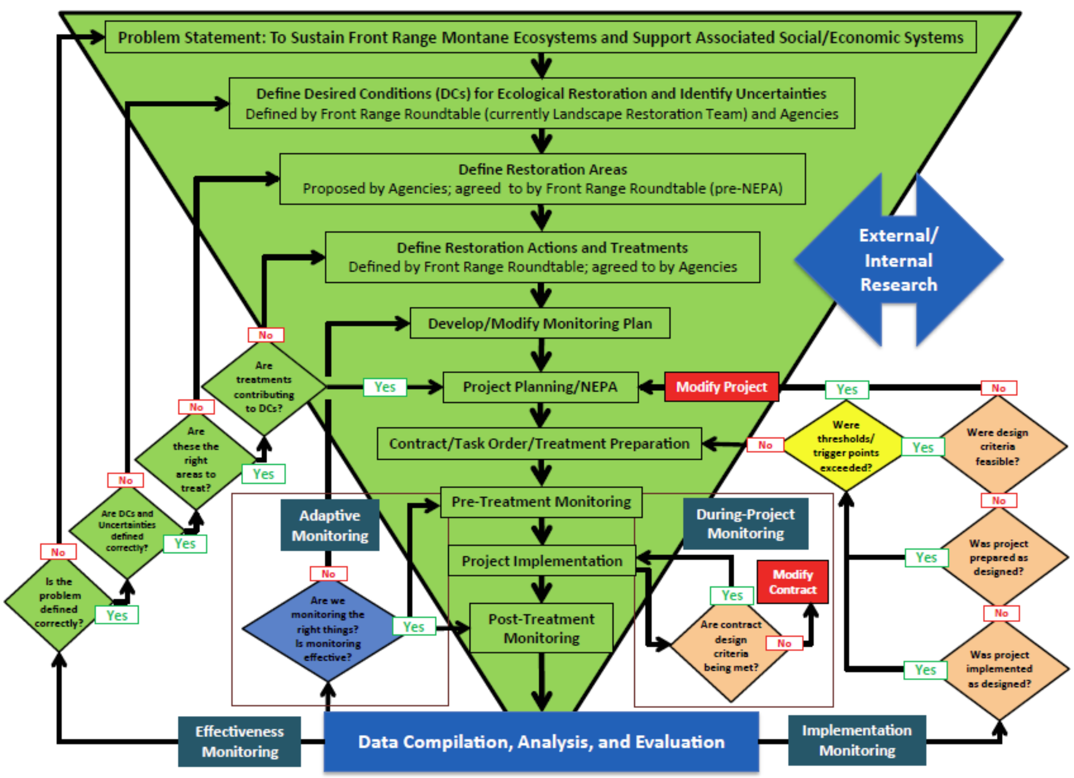

Figure 1. The Colorado Front Range CFLRP adaptive management model.

treatment), and effectiveness monitoring, which determined whether the project was having its intended effect. Effectiveness monitoring aims to address specific questions that feed back to inform specific steps in the CAM process. The diagram also acknowledges the role that research plays in informing adaptive management and the importance of constantly evaluating the effectiveness of the monitoring process itself.

Monitoring of basic "Tier 1" forest inventory data is conducted by the Forest Service using a modified Common Stand Exam protocol, while "Tier 2" variables, including understory plants, wildlife, and overstory heterogeneity, are monitored by ad hoc groups of LRT members using rigorous scientific methods. In some cases (e.g., wildlife), monitoring is conducted through a contract between the Forest Service and a non-profit external to the collaborative, which contributes to a cloud of budgetary and administrative opacity that hangs over the project. The LRT, which also conducts field trips to treatment sites, meets annually to evaluate the data using an evolving set of protocols with the intent of making recommendations back to the Forest Service.

Ongoing issues

In practice, inadequate data and a number of social and institutional barriers have limited progress. Because an existing "Ten-year Stewardship Contract" was already in place at the start of the CFLR program, new project planning was not needed to begin implementation, but modification of treatments has been restricted to those changes that can be instituted within the limits of plans that predate the project. Still, much progress has been made through the informal translation of collaborative recommendations into individual "task orders" as implementation of the stewardship contract has progressed. In 2012, a sub-team of the Roundtable initiated planning for a new 60,000 acre landscape within the CFLR project area, called Upper Monument Creek, that created an opportunity for fresh project design under a new environmental review. As input into the NEPA process, the collaborative prepared a set of recommended actions (UMCC (Upper Monument Creek Collaborative) 2014) and recommendations for adaptive management and monitoring (UMCC (Upper Monument Creek Collaborative) 2016). The final project decision is pending as of this writing.

One of the major challenges faced by the collaborative throughout the project was the lack of a well-articulated, shared model of desired conditions. To address this need, another subgroup was established to synthesize the science related to Front Range restoration in a General Technical Report published by the USDA Forest Service Rocky Mountain Research Station (Addington et al. Forthcoming). That effort proved challenging, as existing literature allowed for a generalized description of desired conditions but lacked the precision to support explicit prescriptions. In addition, staff turnover and retirements, especially among Forest Service participants, eroded group cohesion, trust and shared understanding of collaborative goals and practices, necessitating specific, but elusive, descriptions of desired conditions. It was not until historical stand reconstruction research conducted by several LRT members began to produce results (e.g.,Brown et al. 2015) that the group began to coalesce around desired forest structure.

Four Forest Restoration Initiative (Arizona)

Background

The Four Forest Restoration Initiative (4FRI) is a collaborative, multi-stakeholder effort to restore forest ecosystems on more than 2.4 million acres of national forest land in northern Arizona. The 4FRI Stakeholder Group represents more than 45 local and state governmental organizations, non-governmental, environmental, conservation and business organizations from the Southwest. The project spans portions of the Coconino, Kaibab, Apache-Sitgreaves, and Tonto national forests. Although not formal members of the 4FRI Stakeholder Group, U.S. Forest Service (USFS) personnel collaborate with the stakeholders to achieve common restoration goals.

The 4FRI Stakeholder Group formally coalesced in 2009 to develop a proposal for the congressionally authorized Collaborative Forest Landscape Restoration Program (CFLRP). Many of the stakeholders had been engaged in almost 20 years of smaller collaborative forest restoration efforts in northern Arizona (Egan and Nielsen 2014). In 2010, the project was the largest restoration pilot selected by the CFLRP. Along with the proposal, the stakeholder group developed a structured charter to describe membership roles and responsibilities and expectations for group communication and behavior. Stakeholders were invited to sign; additional groups have joined over the course of the project to reach 45 total signatories. This formal charter includes a rotating chair format that allows stakeholders to serve as chair for 3 months, with a co-chair that rotates to the "hot chair". The reasons were two-fold: 1) to prevent leadership fatigue; 2) to increase trust among an already-divisive group (Egan and Nielsen 2014). Other foundational documents were developed, including the "Path Forward", which captured areas of large consensus among the diverse stakeholders. Areas of consensus were high level, and included statements such as "conserve the native biodiversity" and "protect communities and infrastructures from uncharacteristically severe fire" (The Path Forward, www.4FRI.org/}.

Over the next six years, 4FRI Stakeholder Group and other entities outside of the group worked with the USFS to produce the first EIS, which analyzed approximately one million acres on the west side of the 4FRI landscape located on the Coconino and Kaibab national forests. This EIS ultimately identified almost 600,000 acres for restoration treatments. During this time period, a stakeholder working group (Science and Monitoring Working Group (SMWG), later reconstituted into the Landscape Assessment and Monitoring Working Group – LAM) worked through multiple versions of monitoring and adaptive management plans. The workgroups started with the stakeholders' foundational documents and desired conditions, adding science capacity to develop quantifiable desired conditions or, in some cases, undesired conditions (Matonis et al. 2016). The desire to have an adaptive management plan reinforced the need for quantifiable objectives and identifiable triggers or thresholds where AM would initiate.

Collaborative Monitoring and Adaptive Management Approach

The USFS and Stakeholder Working Group collaboratively developed the monitoring and adaptive management plan by taking the desired conditions, and assessing the suite of indicators and metrics that best measure trends towards those desired conditions. To assure that adequate metrics were used to assess trends, the indicators were selected based on attributes that can be easily measured, are precise, sensitive to changes over time, and that satisfy multiple objectives of the monitoring process (Derr et al. 2005; Egan and Estrada-Bustillo 2011; Moote 2013). Once the indicators were selected, triggers (sometimes described by thresholds) were identified that signify a movement towards an undesired outcome; triggers can help indicate whether or not a change in management is advisable. In many cases, the most current scientific knowledge still does not provide sufficient information to identify quantitative triggers; as the project continues, the stakeholder working group intends continued monitoring data analysis to help develop triggers for future management.

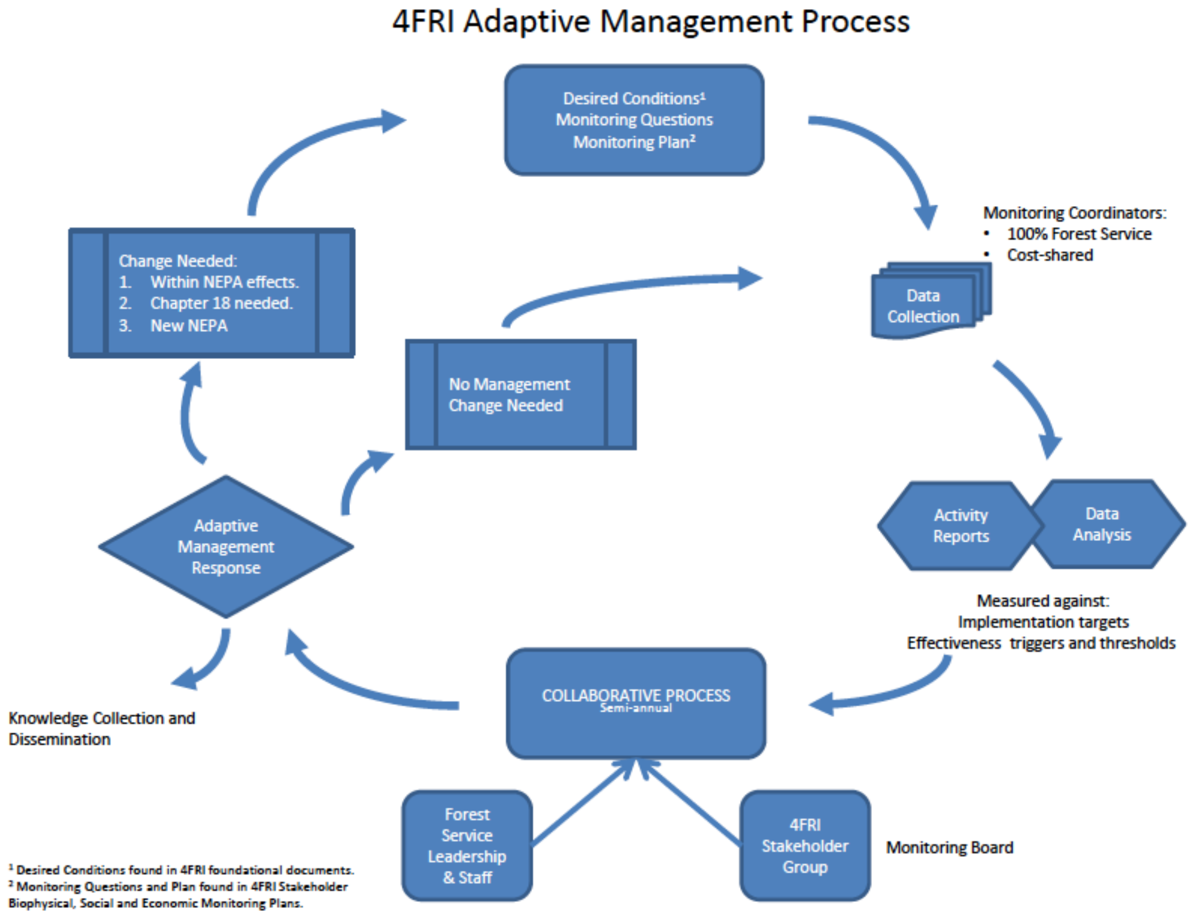

Figure 2. The Four Forest Restoration Initiative CFLRP adaptive management model.

When there was sufficient information to develop a threshold that suggests a trend away from the desired conditions, the stakeholders' plan goes on to describe and outline the potential adaptive management actions. Initially, when a trigger or threshold is reached, the monitoring framework focuses on the need to assess if or how management actions have contributed to the outcomes. Treatments on the 4FRI landscape have not been accomplished at a scale that allows any assessment of the AM plan to date.

Ongoing Issues

The 4FRI Stakeholder Group is process-heavy, due to lack of trust both among stakeholders and between stakeholders and the USFS. The AM and monitoring plan included the designation of a Stakeholder Multi-Party Monitoring Board, to implement the monitoring, and ensure assessments were done for adaptive management, and help with adaptive management recommendations. The intent is for the USFS and the multi-party monitoring board to collaboratively evaluate the monitoring data and other relevant data to establish causal relationships. Based on the evaluation, follow-up actions will be developed. These may include, for example, continued monitoring, collecting more refined data, implementing the existing adaptive management action or developing a new adaptive management action. The Stakeholder group may choose to recommend adaptive management actions to the USFS. USFS staff may also develop new adaptive management actions internally. This is a collaborative process; however, ultimately, the deciding official determines what management actions will be implemented.

Because the 4FRI Stakeholder Group addresses multiple issues associated with such a large, complex project, an increasingly smaller proportion of the group has remained focused on ecological desired conditions, monitoring and adaptive management. A larger proportion of the group continues to focus on on-the-ground implementation barriers and constraints. Within the smaller monitoring and AM sub-group, a predominant issue is the extent to which USFS implementation achieves desired ecological conditions. The largest conflict continues to be the USFS's use of traditional silvicultural techniques and terminology to reach collaboratively developed, ecological desired conditions. For example, use of conventional USFS pest and pathogen treatment terms in prescriptions confound the restoration goals of the collaborative group. However, treatments with restoration terminology often meet management guidelines for pest and pathogens. On the one hand, this issue is a problem of semantics; on the other, it is symptomatic of the kind of social interactions that complicate the 4FRI CAM process. Additional issues are temporal, with the mismatch between long-term ecological responses and the annual funding and reporting requirements of the CFLRP. Landscape questions are acknowledged by this sub-group to take time. However, short-term metrics are continually needed to better communicate progress to local, state and national elected officials and audiences.

Uncompahgre Plateau (Colorado)

Background

The origins of the UP CFLRP can be traced to 2000, when the Uncompahgre Plateau Partnership was created to plan and implement ecological restoration projects on the Uncompahgre Plateau. The principal participants were the Bureau of Land Management, Colorado Division of Wildlife, the Public Lands Partnership, and the USFS. The Public Lands Partnership is a group composed of local leaders from conservation organizations, resource user groups, county governments, municipal governments, state government resource management agencies, and federal government land management agencies. After commissioning a landscape assessment and several research studies to compile data on vegetation conditions and estimate the effects of different management scenarios, a strategic plan was developed in 2001 comprised of five focal areas: forest restoration, invasive plant species control and eradication, native plant conservation and seed production, powerline protection, and wildlife habitat restoration and enhancement.

Forest restoration plans for forests were stalled due to stakeholders' uncertainty and conflict over perceived needs, location, size, and types of actions associated with forest restoration. In early 2007, the district ranger for the Ouray Ranger District of the Grand Mesa, Uncompahgre, and Gunnison (GMUG) National Forest invited a group of individuals representing a broad range of perspectives on forest restoration, including environmentalists, forest products industry representatives, and academic researchers to develop principles guiding their collaborative learning concerning the science, values, and on-the-ground management opportunities and constraints about what forest restoration means and would actually look like in practice. The group met monthly, openly sharing data and information and engaging in frank dialogue about uncertainties and disagreements. A series of citizen science-based, on-the-ground assessments resulted in productive working relationships, a commitment to learning, and trust-building.

The collaborative learning culminated in the 2008 report, *Historic forest structure on the Uncompahgre Plateau: Informing restoration prescriptions for mountainside stewardship* (CFRI 2008) containing results from the citizen science assessment and recommendations for action. In early 2009, the USFS initiated a forest restoration project proposal to translate this report's concepts into on-the-ground management action, the 17,000-acre Uncompahgre Mesas Forest Restoration Project. The "Unc Mesas" project proposed up to 3,000 acres in mechanical and manual tree harvesting, and up to 12,000 acres in prescribed, management-ignited fire. Despite the aggressive scale and intensity of proposed actions, the proposal and its accompanying environmental assessment did not encounter any objections or litigation and was actively endorsed by all participants involved in the collaborative learning.

Collaborative Monitoring and Adaptive Management Approach

Once the Unc Mesas project decision was finalized, the collaborative learning group set about drafting a multi-party monitoring strategy in Fall 2009 and Winter/Spring 2010 outlining monitoring goals, on-the-ground desired condition for biophysical and socio-economic attributes, and measurement methods. During this process, the Congressional law authorizing the Collaborative Forest Landscape Restoration Program was enacted. Completion of the multi-party monitoring strategy was put on hold while the USFS and the collaborative group developed a proposal to compete for CFLRP funding. After being named a recipient of CFLRP funds in Fall 2010, the collaborative group resumed its work on the monitoring strategy, which was completed in May 2011 (CFRI 2011). In addition to the contents drafted in Winter 2010, the completed multi-party monitoring strategy included a description of people responsible for the monitoring, data management and archiving plans, and a plan for communicating findings to the collaborative group, USFS decision-makers, and the public. Monitoring of restoration treatments is conducted by a combination of USFS and other natural resource government agency specialists, the Colorado Forest Restoration Institute at Colorado State University, and interns from local high schools. An initial list of seven monitoring topics were selected based on a funding level of 10% of total annual project funding (see furtherCFRI 2011).

The choice was made by the collaborative learning group not to organize into a formal, structured group, but to leave participation open and informal, with no defined membership or organizational structure. As a result, unlike the Colorado Front Range and 4FRI CFLRP, the Uncompahgre CFLRP does not have a formally adopted adaptive management process. Since the Uncompahgre CFLRP's inception, annual monitoring meetings have been conducted involving participation from a diversity of organizations and interests. Meetings are convened jointly by the Colorado Forest Restoration Institute, the Uncompahgre Plateau Partnership, and the USFS. Attendance has averaged about 30 individuals. In addition to the annual monitoring meetings, annual field trips have been conducted every summer to bring interested and affected parties to project sites to review restoration treatments, learn about operational constraints that affect the translation of restoration concepts to on-the-ground management activities, and visualize monitoring results at plot locations. In recent years, the field trips have allowed stakeholders to witness the evolution and adaptation of forest restoration treatments, including the results of prescribed fire.

Ongoing Issues

Similar to the Front Range CFLRP, one of the persistent challenges facing Uncompahgre CFLRP adaptive management is interpreting monitoring results. On the one hand, there has been general agreement that monitoring results indicate a trend towards desired conditions at the stand scale (spatial scales of about 500-1000 acres) specified in the 2008 *Historic forest structure* report (CFRI 2008). On the other hand, a critique from a segment of the participants has emerged that, at the landscape scale, the forest restoration treatments may have little effect, may be unnecessary, and may lead to undesirable long-term ecological effects based on historical ecological assessments across large spatial and long temporal scales. As of this writing, this uncertainty and conflict remains unresolved.

FIndings

We identified eight factors categorized into two broad themes. The first theme and four factors relates to social relational and interactional factors; the second theme and four factors encompasses institutional and organizational structural factors. Our findings are generally consistent with the growing body of scholarship on CAM and related inquiry in adaptive co-management contexts. However, because of the unique policy, institutional, and place-based local social, cultural, economic, and ecological dimensions associated with multi-use national forests, we uncover several novel findings concerning the "micro-processes" of CAM related to this context (Moseley and Charnley 2014).

Social relational and interactional factors

In a broad sense, CAM is a type of venue within which humans interact and enter into a relationship. AS with any social relations, CAM is often fraught with conflict and confusion, but also collaboration and synergy.

1. Path-dependence of social relations and interactions

We draw on organizational studies to define path-dependence as the accumulated events, decisions, and routines over time that influence the current structure and behavior of a social group (Schreyogg and Sydow 2011), and justify the use of process tracing to uncover evidence of this influence. Across our cases, the history and current status of relationships and interactions among stakeholders, both prior and throughout the CAM process, strongly explain CAM functioning and performance. The dynamic across our cases is a microcosm of larger patterns of interactions and relationships rooted in distrust, especially between environmentalists and the USFS, but also among non-governmental stakeholders, stemming from legal, political, and social conflict over commercial logging on national forest lands in the late 1980's and early 1990's (Daniels and Walker 1995; Mohai and Jakes 1996; Nie 2004; Shindler and Cramer 1999; Wondolleck 1988).

Although by the time the CFLR Program was initiated in 2010, stakeholders across the political spectrum generally agreed on the need for restoration to reduce the vulnerability of long-term forest degradation or loss from wildfires, distrust among managers and stakeholders has persisted (Allen et al. 2002; Cheng et al. 2016; DellaSala et al. 2003; DellaSala et al. 1995). One manifestation of this as a social factor affecting CAM is the level of detail demanded by stakeholders concerning the locations, spatial scale, type, and intensity of USFS management interventions, and the detail demanded for monitoring metrics, thresholds, and transparency for subsequent adaptive management decisions by USFS officials.

This social dynamic is expressed in contrasting ways between the 4FRI and the Uncompahgre Plateau CFLRPs. The 4FRI is latest and largest-scale collaboration effort involving the USFS and stakeholders in the US Southwest to find common ground around ecosystem-based forest restoration and management (Egan and Dubay 2013; Vosick 2016). Some of the most successful litigants of the USFS have been engaged (Egan and Nielsen 2014). While the process has been collaborative, the history of conflict and distrust has led to a high level of detail in CAM process rules demanded by collaboration participants. In turn, this has resulted in a slow-moving, intensive negotiation process, wherein items like the diameter limits for tree harvesting take many months before an agreement is achieved. Additionally, the range of topics the 4FRI Stakeholder Group has addressed is impressively detailed (see further http://www.4fri.org/documents.html). More germane to CAM, the level of statistical rigor demanded by stakeholders has resulted in a detailed and involved monitoring plan.

While similarly detailed, the CAM process developed by the Colorado Front Range CFLRP involves a different dynamic, not necessarily stemming from conflict and distrust, but due to the composition and motivations of participants engaged in the CAM. The Colorado Front Range CAM primarily involves natural resource professionals with extensive scientific and technical training; few, if any, individuals from the general public or nearby communities have been regularly engaged. An interesting dynamic is how CAM participants see the Colorado Front Range CFLRP as a way to apply and test theories of ecosystem-based forest restoration. Due to the fuzziness of "restoration" as both concept and practice, the CAM process has been a constant contestation of different theories and assumptions, with participants often speaking past each other due to lack of clarity regarding spatial and temporal scale. To resolve differences, participants have used the CAM process as the venue through which to specify metrics and measures with a high degree of detail, and through which highly technical analytical approaches are being applied (Cheng et al. 2015). While not involving legal and policy conflict, these contests nevertheless have been challenging and tested the working relationships of CAM participants; it may have also had the effect of driving off individuals who may otherwise have been interested in CAM, but are ambivalent about the contestations over scientific and technical details.

Trust has been identified by researchers as an important social factor affecting, and an outcome of, collaboration in natural resource management, but is not clearly tied to outcomes (Beierle and Konisky 2000; Hahn et al. 2006; Leach and Sabatier 2005; Selin et al. 2007; Smith et al. 2013; Stern and Coleman 2015). Furthermore, the path-dependence of interactions and relationships is often lumped within a broader category of antecedent conditions in collaborative governance (Thomson and Perry 2006), but warrants closer analysis as an important influence on the development and functioning of any social organization (Schreyogg and Sydow 2011). Long-term inquiry from the inside of collaborative processes adds knowledge about how trust interacts with institutional and organizational structures and processes, and with individual-level agency, relationships, and interactions.

2. Contestation over "restoration" goals, practices, and metrics of success

In each of our cases, the definition of "restoration" and how to measure its attainment has been and continues to be a source of tension. In this sense, restoration functions as a "boundary concept" that promotes the initial convening and organizing of stakeholders, but then becomes problematic for CAM due to its lack of precision and ambiguity. A boundary concept is rhetorical device that create alliances across knowledge and professional domains, while still protecting the authority and legitimacy of participants' home domains (Mattor et al. 2014; Mollinga 2010). Across our cases, there is broad agreement among participating stakeholders about vulnerabilities of forest ecosystems and the associated ecosystem services to undesirable changes. However, its utility as a boundary concept in CAM when stakeholders attempt to translate broad concepts into actions in specific locations.

The ambiguity surrounding restoration practice influenced social interactions across the three cases. For example, in the Colorado Front Range CFLRP, a smaller sub-team primarily composed of scientists and technical staff of the USFS formed the Landscape Restoration Team to parse the details of what restoration treatments might look like and how treatment effects are monitored and measured. This self-selecting group communicates at a highly abstract level because of the lack of spatially-extensive empirical research of forest conditions and fire history. It also has become isolated from the larger Front Range Roundtable. This lack of shared learning and communication between the smaller sub-team and the larger Roundtable has complicated the ability of the Roundtable to communicate the success of the Front Range CFLRP project.

At a root, individual level, the problem of ambiguity of restoration goals, practices, and metrics of success is manifested in the different – and oftentimes divergent – reference points stakeholders bring into the CAM process (Kahneman 1992; Switzer III and Sniezek 1991). Reference points are essentially mental models about a subject against which all other options are compared and contrasted. In the case of CAM in forest restoration, stakeholders possess an understanding of what restoration means, why it is needed, what it looks like in practice, and what outcomes can be expected. Reference points come from one's biographical personal and professional experiences, training, and accumulated knowledge, and the norms of the professional or organizational environments to which one is most strongly affiliated. (Kahneman 1992; Switzer III and Sniezek 1991). As such, what one knows is a strong reflection of who one is relative to a dominant social group – one's social group identity (Cheng and Daniels 2005).

This identity-based expression of contested reference points is prevalent in the 4FRI case, where the organizational affiliations and identities of stakeholders are strongly associated with different reference points and subsequent "anchoring" behavior. Anchoring refers to the rhetorical position a stakeholder advances to strategically steer a collective decision process in his/her favor (Kahneman 1992; Switzer III and Sniezek 1991). Specific topics such as limiting harvesting of trees below a target tree diameter, developing and naming silvicultural prescriptions, what constitutes desired forest structural conditions, and the appropriate role of private enterprise in managing public lands are influenced by anchoring behaviors of CAM participants. In turn, the contestation between stakeholders are not solely over technical details, but are expressions of one's social identity – one's anchoring behavior is a manifestation of who one is at a core cognitive and emotional level. This attention to social identity is infrequently considered in examinations of conflict and collaboration in natural resource management, but has been identified as a foundational factor affecting social relations across society (Ashmore, Jussim, and Wilder 2001; Brewer 1993; Dovidio, Gaetner, and Validzic 1998; Hogg et al. 2004; Northrup 1989).

3. Composition and consistency of participation

The long timeframes involved in CAM is affected by the capacity of participants to sustain consistent engagement. For the Colorado Front Range and the Uncompahgre CAM processes, prior case studies have demonstrated changes in, and concerns over, participant composition and attendance since 2010 (Mattor 2013a, 2013b). Turnover in key USFS personnel is a persistent and well-known issue facing collaborative governance on US national forests (Cheng et al. 2016; Moote and Becker 2003). Collaboration is a time-intensive, long-term, relationship-oriented social process. Developing share understanding about issues, values, risk-perceptions, and priorities for action can take many months and even years of constant face-to-face interaction. Due to the USFS's organizational practice of moving personnel to gain new experiences and transfer lessons learned within the organization (Chojnacky 2012), CAM participants can find themselves constantly needing to get to know new people and to revisit the background and logic of how the CAM process came to be. Similar personnel turnover issues are experienced by participants besides the USFS. Hence, prior shared understandings and agreements may or may not be honored, leading to frustration, process back-tracking, and potential for distrust. The vulnerability of CAM to participation turnover is well-known among practitioners, but not well documented in research literature.

In the Colorado Front Range CFLRP, there have been five separate field foresters in charge of designing and implementing on-the-ground forest restoration treatments, e.g., forest vegetation removal through mechanical or manual methods. New field foresters did not always get to know the full history and rationale of collaborative discussions about operationalizing restoration. In fact, field-level personnel were rarely involved in the collaborative group; mostly program-level officials with administrative rather than implementation functions participated. Consequently, the "hand-off" of results to the individuals who actually implement projects was not clearly and transparently made. Even when field-level implementers were engaged, like on the Uncompahgre, the process of incorporating monitoring results into subsequent project prescriptions was opaque. Hence, on-the-ground treatments did not always correspond to stakeholder expectations of what restoration would look like. Additionally, the USFS staff officers overseeing all natural resource functions on national forests in the project area that helped initiate the Colorado Front Range project have departed and, with them, a high level of institutional knowledge about the project. Lastly, the supervising officers with decision-making authority on the national forests have turned over.

Not only has this turnover within the USFS affected the CAM process for the reasons outlined above, it has led to lapses and gaps in communication and expectations within the agency that has affected the CAM's functioning and performance. For example, new field foresters were unaware that they were supposed provide pre-treatment monitoring data to the Colorado Forest Restoration Institute, the lead monitoring entity in the CAM process. As a result, there were several years where pre- and post-treatment data were not compiled, analyzed, and reported back to the CAM group. Personnel turnover also affected the Colorado Forest Restoration Institute. This, in turn, affected consistency in communications, learning, information sharing, and overall CAM functioning. That individual-level turnover could have such an impact has come as a surprise.

4. Extra-processual communication and advocacy

Across our cases, we found that CAM tends to be an open, porous process, where participants are free to communicate with one another outside of the CAM process and, on occasion, to strategically go "above the heads" of local USFS officials to advocate for certain positions or resources at the national level. This was most evident in the 4FRI case, where some members of the 4FRI Stakeholder Group interacted with USFS officials at a higher level of the command chain to achieve certain ends. This "venue-shopping" occurs frequently in the public policy arena (Pralle 2003) and can have lasting impact on CAM processes, especially when such activities are not transparent or do not adequately represent the preferences of all CAM participants.

Institutional and organizational structural factors

We define institutions as the rules (formal and informal) humans devise to govern behavior in repetitive and structured situations (Ostrom 2005). Institutions lend stability and predictability to human affairs. Organizational structure is a recognizable assemblage of roles and activities of humans to achieve a collective aim; it represents the allocation of labor, resources, expectations, and accountability across humans working under a common mission.

5. Degree of transparency of USFS operational decisions

In any principal-agent situation, the agent enjoys an asymmetry in information (Shapiro 2005); this why principals (the general public) who don't know much about a topic area need trained and experienced agents (government agencies) to act on their behalf in certain public policy matters. In turn, agents protect their role relative to principals by preserving this asymmetry in order to maintain this reliance. CAM relies on co-producing shared knowledge (Cundill and Fabricius 2009; Scarlett 2013), thereby breaking down this asymmetry. Across our cases, we found differences in the extent to which this is occurring and the ways in which increased or lack of transparency affects social relations and interactions. For example, on the Uncompahgre Plateau CFLRP, all stakeholders review, and are invited to suggest alternatives to, planned USFS implementation projects, monitoring activities, and budgets associated with implementation and monitoring during the annual stakeholder meeting. Initially, USFS staff were resistant to allowing this to occur. Over time, this open sharing and deliberating of activity and budget allocation has become an expected routine. Stakeholders are no longer in a position to feeling left in the dark or always questioning motives, but to take part in resource allocation decisions that propagates an ethos of openness and transparency.

Conversely, on the Colorado Front Range CFLRP, the lack of budget allocation transparency has left stakeholders feeling "on the outside looking in," thereby eroding trust. The USFS is not completely open about how the money has been spent and about who was actually making the decisions. There are stakeholders who know much more than others about this budget allocation and who benefit from the lack of transparency. On this latter point, the USFS contracts with entities to carry out on-the-ground forest restoration treatments and perform monitoring data collection, compilation, analysis, and reporting. However, these contracts have been conducted outside of the CAM process and have frustrated openness. The lack of transparency and deliberation creates a sense of insiders and outsiders within the CAM. Without a well-defined structure and collectively-defined set of rules, this problem continues to persist.

While much of the CAM literature focuses on the importance of social learning among participants, the operational mechanics of CAM can either foster or frustrate openness. Questions about budget and contracting decisions carry immense importance to CAM functioning and performance.

6. Mismatch between the temporal and spatial scales of project planning, implementation, and monitoring

Scale mismatch is identified as a pathology of environmental governance and management (Cumming, Cumming, and Redman 2006), and our case studies mirror this problem in CAM contexts. We uncovered three patterns of mismatching across our cases. First, meaningful monitoring results were only generated after several projects are completed, ranging from 3 to 5 years for post-treatment vegetation response. Meanwhile, implementation continues to proceed in order to spend annual CFLRP funding allocations, resulting in a mismatch in temporal scales in the implementation-monitoring-adaptive management loop. It wasn't until the first project of the Uncompahgre CFLRP was over half-way completed that monitoring data were collected, analyzed, and reported to the collaborative process. By that time, new projects had been planned that were informed by general restoration concepts developed by the collaborative group, but not informed by any empirical monitoring data from prior restoration projects. Over time, as long there is sustained investment in monitoring, the temporal mismatch may be overcome.

Second, monitoring data were collected primarily at the forest stand scale using conventional forestry sampling and measurement techniques to collect information about trees, plant cover, and fuels. These data are then aggregated and presented through descriptive statistics as non-spatial means. However, across our cases, a primary question is the extent to which forest treatments resulted in the spatial complexity and heterogeneity across large spatial extents that was likely common in forests prior to Euro-American settlement logging and grazing, and fire suppression policies throughout the 20th century. Monitoring results at the stand scale are ill-suited to advance learning, deliberation, and adaptive management at these larger spatial scales.

The third scale mismatch refers to scales of decision making processes. At one scale is the operational field decision level, where USFS field foresters and contractors make decisions about silvicultural prescriptions and adjust forest operations to work through physical constraints (e.g., steep slopes, water features, habitat for sensitive wildlife or plant species). Little to no engagement by CAM participants occurred at this decision level. In the 4FRI case, the disconnect between CAM participants' recommendations for restoration treatments and actual outcomes is an ongoing source of frustration.

A second decision level is project planning and design, where decisions about specific locations, types, and intensities of forest treatments will occur. The USFS must perform an assessment of environmental impacts of the proposed treatments, conduct public involvement, and go through internal agency review and interagency consultations. This often takes 12-24 months. Over the course of all three of our CFLRP projects, project plans were developed based on broad concepts of forest restoration, but because of the timelag associated with monitoring results, did not incorporate any empirically-based knowledge about restoration treatment effects. Implementation of these projects has varied across our cases, with the Uncompahgre CFLRP being the furthest along with implementation, monitoring results, and adapting results into forthcoming project design. At the same time, CAM participants have a lower demand for level of detail and rigor regarding treatment prescriptions and monitoring activities due to the path-dependence of social relations and interactions, and the composition of participants. New projects incorporating up-to-date restoration concepts in the Colorado Front Range CFLRP have yet to be implemented and monitored; USFS personnel turnover has delayed completion of project analyses and decision documents, causing a degree of frustration among CAM participants.

The third level is at the strategic, large-landscape scale, where decisions focus on the need for restoration based on a broad scale assessment of historical ecology, future vulnerabilities, social and economic values, and the degree to which restoration sustains the ecological integrity of landscape (Wurtzebach and Schultz 2016). By law, the USFS is supposed to develop and revise these landscape-scale planning documents – termed Land and Resource Management Plans or "forest plans" – every 10-15 years. In reality, for each of our cases, the forest plans were last revised in the early to late 1990s. The three CFLRP projects and the CAM processes associated with the projects are operating under dated assumptions and strategies. A major opportunity exists, however, especially for the Colorado Front Range and Uncompahgre CFLRPs, where their respective national forests are anticipated to be undergoing revision of their forest plans in the next 3 years. This presents the next opportunity to link CAM at higher levels of planning and decision-making. However, over the course of the CFLRP projects, the dated assumptions and management direction in existing forest plans has been a barrier to the USFS being able to fully engage and implement ideas generated by the non-agency CAM participants.

7. Degree to which boundary-crossing processes, participants, and objects exist within and across the CAM group, participating stakeholder entities, and the USFS

Boundary spanning is a central normative and practical concept in CAM (Berkes 2009; Cheng et al. 2015; Folke et al. 2005). It refers to people, structures, and processes that cut through disciplinary, jurisdictional, social group, ideological, and organization's functional boundaries in ways that promote knowledge production, transfer, and learning, communication and coordination of ideas and actions, pooling resources, and joint accountability. In the context of CAM boundary spanning is essential because CAM is oftentimes a new structure and process that struggles to fit into existing institutional and organizational structures and processes (Biggs, Westley, and Carpenter 2010; Olssen et al. 2006), some which may be either ambivalent or even hostile to CAM, keeping collaboration at an "arms length" even if individuals within those organizations are generally supportive (Butler 2013; Butler, Monroe, and McCaffrey 2015).

As noted above, the turnover in participation of USFS personnel affects one important boundary spanning dimension. The turnover and lack of integration of new participants in the CAM process can set back relationships, learning, and adaptive management progress. On the other hand, new participants can step in as effective boundary spanners, opening up new possibilities for CAM to make progress. This variability – and vulnerability – of CAM processes to participation turnover is an indicator that CAM is a long way from being institutionalized; institutionalization of behavioral rules and expectations provides stability and predictability, regardless of the individuals in the role or position. The open question is the extent to which the CAM process itself has sufficient endurance and influence from the bottom-up on existing institutional and organizational structures and processes to become institutionalized (Butler, Monroe, and McCaffrey 2015; Cheng et al. 2015; Schultz, Coehlo, and Beam 2014).

If "restoration" is a problematic boundary concept, "collaborative adaptive management" fares no better. Despite having written monitoring and adaptive management plans specifying principles and general process, the practice of CAM continues to be a collaborative learning and adaptive management endeavor at best or a source of conflict and continued distrust at worst. One issue affecting all three of our cases is lack of clear, transparent "contact points" – the process in which monitoring results, collaborative learning outcomes, and suggestions for management changes are transferred and connected to tasks, responsibilities, and activities of USFS personnel, budgets, and work plans. In all three cases, there has been plenty of dialogue and deliberation in meeting rooms, through e-communications, and on field trips. Many monitoring summary documents have been produced by the Colorado Forest Restoration Institute and the Ecological Restoration Institute. However, it is very opaque is to how these discussions and documents have been utilized and incorporated into the operating plans of USFS personnel and functional programs. As a result, the lack of a clear "hand-off" system leaves many CAM participants puzzled and frustrated about where, who, how, and when their collective efforts are actually making a difference.

A third boundary spanning dimension in CAM is data stewardship. Data collected as a direct result of collaboratively-developed monitoring plans can be considered boundary objects – tangible or virtual artifacts that occupy the shared space between groups or organizations and can facilitate independent actions and interactions among those groups (Mollinga 2010). Progress towards durable boundary objects is being made, with the Colorado Forest Restoration Institute contributing to data stewardship for the Colorado Front Range and Uncompahgre CFLRP projects, for example (Cheng et al. 2015; Cheng and Randall-Parker 2017). However, the type and structure of data being collected for the CFLRP projects are not wholly commensurate with USFS data systems. Institutional data access and security issues have not been addressed to the point where there is true sharing of data, analyses, and results. Again, turnover of key personnel across CAM participants contributes to the lack of progress on creating legitimate boundary objects from the monitoring in ways that are transparently and effectively affecting subsequent management discussions and decisions. Further, because monitoring tends to be among the first functions to be deprived of funding in USFS and other natural resource agencies when allocation choices are made (Schultz, Coehlo, and Beam 2014; Schultz and Nie 2012), the uncertainty in the durability of the CFLRP monitoring functions casts serious concerns that CAM in all three of our cases can endure and become institutionalized.

8. Government agency standard operating procedures and practices are hard to overcome

In *Essence of decision: explaining the Cuban Missile Crisis* (Allison 1971), Graham Allison brought to light the impact of “standard operating procedures” (SOPs) in organizational processes on the ability of the leadership in the John F. Kennedy Administration to fully identify and consider implications of a broad range of potential responses. Rather, SOPs are artifacts that accumulate over time in large, complex, bureaucratic organizations to intentionally constrain choices and decisions of organizational actors so that their behaviors are predictable and consistent. Regarding the USFS, numerous treatises critical of the agency’s limited range of choice sets and decisions have been written and do not need further elaboration here (see further Behan 2001; Clary 1986; O'Toole 1988; Twight 1983). In the context of CAM in our three cases, we have encountered in our own experiences and through the process tracing approach, patterns where individual staff struggle with forest restoration concepts brought forward by the CAM participants because the concepts are not easily and efficiently categorized under existing USFS silvicultural prescription guidance which serve as a sort of ‘drop-down menu’ of limited choices of what to call a prescription.

Space does not permit the numerous examples that we can describe. What matters more is that, whether an individual operational field forester is supportive, ambivalent, or antagonistic to CAM participants’ input on forest restoration prescriptions, institutional rules and organizational structures set a critical anchor from which subsequent individual behaviors stem. Across our cases, we found different behavior and on-the-ground outcomes. For example, in the Colorado Front Range, a new USFS silviculturist arrived on a national forest at the inception of the CFLRP and took it upon himself to close the gap between the collaborative group’s competing visions of what restoration should look like and the choices USFS foresters have in developing prescriptions for contractors, going so far as to publish a refereed journal article about this (Underhill et al. 2014). In the Uncompahgre CFLRP case, the forester in charge at the outset of the project was hesitant to follow the prescriptions advanced by the CAM group, indicating that by removing trees below a certain threshold, “a forest isn’t a forest anymore.”

Discussion and Implications

The CFLRP presents an opportunity to examine the institutional, organizational, social relational, and individual factors affecting CAM functioning and performance over time in the context of multi-use national forest lands. In our examination of three CFLRP cases, we drew on our long-term involvement and project documents to advance observations and explanation “from the inside” (Agranoff 2006; Thomson and Perry 2006), and employed a process tracing approach to identify the ways in which factors interacted to affect CAM functioning and performance. While our findings are tentative and require further validation through the application of more systematic methods and independent observations, we conducted “member checking” of our approach and findings with participants of each case study (Creswell and Miller 2000; Morse et al. 2002).

One contribution our examination makes to the broader body of knowledge about CAM is that, while certain institutional, social-organizational, and individual attributes are essential to initiating CAM, its functioning and performance overtime is a product of individuals interacting with one another to create new institutional rules and organizational structures, but simultaneously interacting with existing rules and structures, and affected by path-dependent social relations and interactions. In short, rules and structures are necessary but insufficient explanations of CAM progress. This comports with general theories of collaboration in general, wherein the concept model of context → process → outcomes has been well defined (Ansell and Gash 2008; Bryson, Crosby, and Stone 2006; Thomson and Perry 2006). However, what occurs inside those arrows is a new domain of inquiry and requires attention to the micro-processes of how new ideas are transformed in actual behaviors (Moseley and Charnley 2014).

A second key finding is that the variation across even a small number of cases suggests that top-down policies and mandates for CAM only go so far. Higher-level policies and institutions can create the conditions in which CAM can emerge and develop, but sustaining CAM functioning and performance over time relies on the capacity of the CAM participants to institutionalize CAM structures and practices in the face of counter-vailing institutional, organizational, and social-relational forces. We offer several recommendations for conveners and participants of CAM processes, several of which are consistent with existing knowledge and some of which may be new additions:

- Simply describing a generalized adaptive management process diagram is insufficent. The process has to be described in detail concerning expected roles, activities, behaviors, decision points, triggers, and timeframes – especially where confusion, conflict, and distrust is high.
- Time, resources, and people need to be allocated to craft constitutional chartering documents for CAM specifying:
    - A process and timeframe for when monitoring results are evaluated and interpreted, and when/how they would be expected to be used by whom and what decision level.
    - A process and timeframe for CAM participants to review budget allocation decisions for upcoming year implementation projects and monitoring activities. This would need to specify the ‘decision space’ CAM participants can influence as allowed by policy.
    - A process and timeframe updating the collaborative monitoring plan, including findings and recommendation from the collaborative group so that it is a “living document.”
- To mitigate the effect of participant turnover, a core group of individuals should be designated to document and communicate the history, key concepts, and current status of CAM so that new participants have a frame of reference and know where and how to plug in.
- Leadership from the USFS, the home organizations of stakeholders, and within the CAM group is essential to encourage and support participation by key individuals to close gap between collaborative group and operational, field-level implementers.
- In forest treatment prescription documents, operational field foresters should provide brief citations and explanations referring to monitoring results and documents to demonstrate why and what prescriptions change (or not change). This helps close the gap between CAM participants and implementers and fosters trust.
- Cross-CFLRP learning effort to affect change in USFS silviculture guidelines to provide more flexibility to implementers.

Concerning the transformation of USFS institutional rules and organizational structures to promote sustainable CAM, we suggest:

- Agencies need to embrace (and be allowed to embrace) uncertainty to be allowed to learn with adaptive management. This, in turn, depends on a high degree of support from stakeholders – or, as practitioners term, “social license” – to free USFS personnel to experiment and take some risks.
- Further guidance is needed in position descriptions, work plans, and performance evaluations concerning the expected roles, expected behaviors, and responsibilities relative to CAM processes.

- Maintain and grow the community of practice of USFS planners and non-agency stakeholders engaged in integrating adaptive management concepts in environmental impact assessment frameworks and documents (https://www.fs.fed.us/pnw/about/programs/fsd/NEPA/index.shtml).

As managers, stakeholders, scientists, and policy-makers continue to call for collaborative, adaptive management-type approaches to address the future uncertainties and vulnerabilities to ecosystems and ecosystem services from human and natural disturbances, there is a need for researcher-practitioner partnerships to surface and deliberate the ways in which different CAM approaches result in planned and unintentional outcomes. While a predominant approach has focused on governance structures and processes, institutional rules, and organizational structures, there is need to expand the number and diversity of longitudinal case studies using methods such as process tracing.

Look forward, our experience and examination leads to ask two practical questions with potential theoretical implications. First, what is the appropriate spatial and temporal scale, and level of decision-making, for CAM? CAM places a high demand of time, commitment, and focus on participants. The geographic scale of an ecosystem management program has a strong effect on collaborative learning, planning, and management (Cheng and Daniels 2003, 2005). Practical issues such as travel time, the ability to meet regularly face-to-face, and a shared "sense of place" are no small matters; as shown in our case studies, such social relational and interactional dynamics factor strongly in CAM functioning and performance and are spatial scale-dependent.

Further, CAM processes likely function differently at different levels of decision authority. Although our examination did not explicitly surface this, it is worth noting that each one of our cases is organized around a decision level, from the ranger district level (Uncompahgre), to the national forest levels (Colorado Front Range), to multiple national forests (4FRI), thereby attracting the attention and involvement of the regional and national offices. While our cases are unique to multi-use national forests in the US, these decision levels are common across large government bureaucracies overseeing the use and management multi-use national forests.

In sum, the successful functioning and performance of CAM persists as an important topic of investigation. CAM marks the latest approach in the evolution of ecosystem management and ensuring the sustainability of social-ecological systems for future generations. Critical and systematic transdisciplinary research from multiple perspectives will continue to shed light on the promise and pitfalls of these efforts.

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