EXAMINING THE ROLE OF COLLABORATIVE GOVERNANCE IN FOSTERING ADAPTIVE CAPACITY: A CASE STUDY FROM NORTHWEST COLORADO

by

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THESIS ABSTRACT

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Over the past two decades, the mountain pine beetle (MPB) has killed millions of acres of forest across western North America. In addition to extensive environmental disturbance, the MPB epidemic has deeply impacted human systems, including motivating the formation of novel environmental governance arrangements. In Colorado, the Colorado Bark Beetle Cooperative (CBBC) formed as a collaboration between federal, state, and local stakeholders to address the epidemic. This study used a combination of GIS analysis and qualitative document analysis to understand how the CBBC has responded adaptively to changes in the landscape pattern of MPB damage. I found that the CBBC was able to respond adaptively to changes in the MPB outbreak through shifting their organizational direction and activities. However, the adaptive capacity of the group was constrained by logistical factors, the declining importance of MPB at a national level, and the ways in which the group framed the MPB problem.

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For Jay Allen Haight, in memoriam

TABLE OF CONTENTS

Chapter Page

LIST OF FIGURES

LIST OF TABLES

Table Page

CHAPTER I

INTRODUCTION

Over the past two decades, forests in western North America have experienced multiple native bark beetle outbreaks, resulting in widespread tree mortality (Bentz et al., 2010; Chapman et al., 2012; Jenkins et al., 2008; Raffa et al., 2008). The spatial extent and synchrony of these outbreaks is historically unprecedented, with millions of acres of forests affected from Alaska to Mexico (Aukema et al., 2006; Bentz et al., 2010; Chen, 2014). These disturbances profoundly impact not only forest ecosystems (Adams et al., 2010; Goetz et al., 2012; Jenkins et al., 2008), but also human communities and economies tied to forests and forest products (Davis & Reed, 2013; Flint & Luloff, 2005; Flint et al., 2009; Kooistra & Hall, 2014; Qin et al., 2015).

Native bark beetles are part of natural disturbance regimes in western North American forests and interact with fire, pathogens, and human-induced alteration to shape the structure and composition of forests (Jenkins et al., 2008). However, unlike disturbances such as fire that take place on a time scale of days to weeks, beetle outbreaks progress over seasons to years. Under suitable bioclimatic conditions, bark beetles outbreaks can sweep across vast swathes of forest with few management or containment options once populations have tipped into an epidemic stage (Gillette et al., 2014; Six et al., 2014). Once beetles have entered an epidemic stage, they return to endemic levels only when susceptible tree hosts have been exhausted (Raffa et al., 2008) or when unfavorable climate conditions persist. While these native bark beetles occur at endemic levels in North America and outbreaks constitute a natural part of forest disturbance regimes, evidence suggests that recent high levels of beetle activity are correlated to changing temperature and precipitation patterns associated with global climate change (Allen et al., 2010; Bentz et al., 2010; Chapman et al., 2012; Gillette et al., 2014; Raffa et al., 2008; Williams et al.,

2010). Additionally, forest management practices such as fire suppression, which affect stand age and diversity may have an effect on the susceptibility of forest landscapes to beetle outbreaks (Aukema et al., 2006; Gillette et al., 2014; Jenkins et al., 2008; Six et al., 2014). Raffa et al. (2008) illustrate the numerous thresholds that control the shift of beetle populations from endemic to epidemic states. These thresholds range from micro-level variables, such as host vigor, to meso-level characteristics such as stand composition, to landscape level factors such as climate, terrain and connectivity. While the bioclimatic conditions that control beetle populations are complex, such work suggests numerous ways in which human decision-making might influence the severity of beetle outbreaks. Given the complex and interacting human and ecological systems that shape the character and impacts of bark beetles, the current bark beetle outbreaks can be understood as coupled socio-ecological systems (SES) in which human and ecological systems reciprocally influence one another (Ostrom, 2009).

The mountain pine beetle (*Dendroctonus ponderosae*) (MPB) is one of the most aggressive irruptive native bark beetles in western North America. A recent outbreak of MPB has impacted millions of acres of pine forests in the United States (Figure 1) and Canada (Bentz et al., 2010; Chapman et al., 2012; Hart et al., 2015; Hicke et al., 2012). The MPB attacks several pine species, primarily lodgepole pine (*Pinus contorta*) and ponderosa pine (*Pinus ponderosae*). While the ecological impacts of this infestation are profound and wide-ranging, the spread of the MPB is not just a biological phenomenon. The epidemic is playing out in both a physical and a socio-political landscape. Human actions from global climate change to local forest management practices have helped drive the unprecedented spread of MPB (Bentz et al., 2010; Dale et al., 2001; Raffa et al., 2008), which in turn impacts human communities. The MPB epidemic presents a complex ecological problem with deeply felt social and economic impacts

(Davis & Reed, 2013). Because of the complex, coupled nature of forest landscapes and the social systems embedded within them an examination of the human dimensions of forest insect disturbance is crucial to understanding the MPB socio-ecological system (Flint et al., 2009; Qin et al., 2015).

Figure 1: Map showing forest mortality from MPB from 1997-2012 along with the range of lodgepole and ponderosa pine, the MPB's two main host species

One important dimension to consider when examining the human dimensions of the MPB socio-ecological system is ways in which human communities adapt to MPB induced forest

disturbance. Adaptive capacity is one of the key lenses through which SES have been studied and can be defined as the ability of systems (human or non-human) to respond to or anticipate changes in a manner which mitigates the harm or harnesses the opportunities caused by such change (Seidl & Lexer, 2013; Tompkins & Adger, 2004). Adaptive capacity is often articulated in relationship to resilience, which can be defined as the "capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks" (Walker et al., 2004). Systems with greater adaptive capacity are theorized to also have greater resilience (Walker et al., 2004). In forest SESs, adaptive responses to change or disturbance are constrained by the long life span of trees (Lindner et al., 2010). The long life cycles of forests also entail that human management decisions may have far-reaching consequences. For example, MPB disturbance in North American forests has not only incited a range of management decisions, but also inspired the formation of novel arrangement for forest governance (Davis & Reed, 2013; Flint, 2013; Parkins, 2008). Understanding the adaptive capacity of these responses is a crucial part both of highlighting effective strategies for dealing with large scale, beetle induced forest disturbance and for increasing our understanding of the MPB socio-ecological system as a whole.

In Colorado, one of the states most severely impacted by the MPB, the epidemic has sparked the formation of several place-based forest collaboratives, which engage a range of stakeholders to address issues of disturbance and change in Colorado's forests (Cheng et al., 2015; Flint, 2013). These groups constitute novel collaborative governance arrangements. One such collaborative is the Colorado Bark Beetle Cooperative (CBBC), which operates in northwest Colorado and has been active in formulating responses to the MPB epidemic. The CBBC formed in 2005 as a collaboration between municipal, county, state and federal

stakeholders to address the issue of MPB damage in lodgepole pine forests in northwest Colorado, and remains active to the present day. As an example of a collaborative governance arrangement that has been operating for much of the duration of MPB epidemic in Colorado, the CBBC provides a valuable case study in understanding how such governance regimes have shaped and been shaped beetle induced forest disturbance. The research question guiding this study is: In what ways has the CBBC been able to respond adaptively to changes in the MPB socio-ecological system?

This study will incorporate an exploration of the spatio-temporal spread of the MPB in Colorado and a qualitative document analysis of the CBBC's meeting minutes to understand how the activities, organizational direction, and membership of the CBBC have changed and adapted to the changing spatial extent of MPB damage on the landscape. In this paper I will first give an overview of previous research conducted on collaborative governance arrangements and adaptive capacity (Chapter 2). In Chapter 3, I detail the methods I used to explore the question of adaptive capacity in the CBBC over time. Chapter 4 will give an overview of the landscape patterns of MPB damage over time in both Colorado generally, and the CBBC area specifically. I will then link these spatio-temporal patterns of forest disturbance to themes uncovered in my analysis of the CBBC meeting minutes regarding the group's activities, membership, and organizational direction. These results will then be discussed within the context of adaptive capacity and collaborative governance in Chapter 5, and conclusions will be detailed in Chapter 6.

CHAPTER II
BACKGROUND

2.1 Theoretical foundations of collaborative environmental governance

Governance can be defined as the "structures and processes by which societies share power" (Lebel et al., 2006), and includes the rules, laws, and practices which guide collective decision-making (Ansell & Gash, 2008). Environmental governance can then be construed as the political, social, economic and administrative systems which used to formulate and implement environmental policy (Pahl-Wostl, 2009). The literature on emerging forms of environmental governance suggests such arrangements embody a change in the way decisions over natural resources are made and implemented (Parkins, 2008). The rise of governance as a model for political decision making is seen as an indication of the extent to which governments are increasingly dependent on the engagement of a multiplicity of non-state actors to form and implement policies (Bauer & Steurer, 2014; Pahl-Wostl, 2009).

New forms of environmental governance arising in response to current environmental problems have been variously described as metagovernance (Parkins, 2008), multilevel governance (Davis & Reed, 2013), and cooperative governance (Ansell & Gash, 2008; Cheng et al., 2015); however, all of these terms share similar features of involving multiple stakeholders acting at different scales. Participants in such governance arrangements may be from different public spheres, be combinations of public and private entities, and as well include civil society (Bauer & Steurer, 2014). Ansell and Gash (2008) define collaborative governance specifically as "a governing arrangement where one or more public agencies directly engage non-state stakeholders in a collective decision-making process that is formal, consensus-oriented, and

deliberative and that aims to make or implement public policy or manage public programs or assets."

Much of the scholarly interest in collaborative governance has focused on the potential for such arrangements to respond adaptively to changing ecosystems and environmental disturbance. Adaptive capacity in socio-ecological systems has been defined as the capacity of actors in a system to influence that system's resilience (Walker et al., 2004) and entails "that a system can get better at pursuing a particular set of management objectives over time and at tackling new objectives when the context changes" (Lebel et al., 2006). Folke (2006) suggests that achieving adaptive governance relies on "a diverse set of stakeholders operating at different social and ecological scales in multi-level institutions and organizations" (Folke, 2006). In their review of regional socio-ecological governance systems, Lebel et al. (2006) advance multilevel governance as a means of matching decision-making and learning to appropriate social and ecological scales. Proponents of collaborative governance argue that such arrangements contribute to the adaptive capacity of socio-ecological systems by involving diverse stakeholders at multiple levels to manage uncertainty and difficult social trade-offs (Armitage, 2005; Folke et al., 2005; Gerlak & Heikkila, 2011; Lebel et al., 2006).

While the literature on collaborative governance has promoted such arrangements as an adaptive response to failures of state managerialism, collaborative governance has faced criticism on theoretical and practical grounds (Ansell & Gash, 2008; Davis & Reed, 2013). Critics contend that such arrangements entail a devolution of responsibilities away from the state without a concomitant devolution of powers (McCarthy, 2005). Practically, particularly in realms such as forest management, collaborative governance regimes must still confront entrenched government bureaucracies (Cheng et al., 2015). Case studies of collaborative

governance arrangements suggest that while these arrangements can promote inclusion and adaptive problem solving, they are also susceptible to compromising internal and external forces such as process cooption by powerful stakeholders, lack of strong links to bureaucracies with management authority, and adversarial distrust among stakeholders (Ansell & Gash, 2008; Cheng et al., 2015; Walker & Hurley, 2004).

2.2 Successes and challenges for collaborative governance arrangements

Adaptive capacity in collaborative, multilevel governance arrangements has been studied in multiple socio-ecological contexts. Bauer and Steuer (2014) studied a range of regional partnerships in Canada and England as part of novel governance approaches in both countries to facilitate climate change adaptation. In examining differences in programs between the two countries, the authors concluded that partnerships in both England and Canada were able to build adaptive capacities in private and public domain decision-makers and were successful in informing policy. Despite these successes, the authors also found that all partnerships in both countries were limited by a lack of formal norm-setting and rule-making authority. Bauer and Steuer concluded that while these governance arrangements were able to play significant roles in facilitation, because of their relatively weak political status and lack of resources, most were limited in delivering operational adaptive solutions.

Collaborative governance has also been studied previously in relationship to bark beetle outbreaks. Parkins (2008) examined the adaptation strategies of communities in the interior of British Columbia in response to the most recent MPB outbreak, which included the formation of several regional-scale beetle action coalitions. These coalitions worked at a regional scale, with oversight, coordination, and financial support provided by the state, while communities and

municipalities determined local objectives and strategies. Parkins found that the two beetle action coalitions he studied were able to cultivate links to civil society and nongovernmental organizations in a way that helped fill a gap between municipal and provincial level politics. However, Parkins also found that the coalitions failed to significantly involve private partners in core ways, a key consideration in an area so dominated by the forest industry. Parkins also observed that, despite containing elected representatives, these coalitions face challenges of civic engagement due to general public distrust of public sector institutions. These results suggest that, while collaborative institutions can aid adaptive capacity in terms of increasing communication and mobilizing resources across scales of decision-making, such arrangements may still barriers of inclusiveness and legitimacy.

In a long-term case study of the Front Range Round Table, another Colorado based collaborative governance arrangement, Cheng et al. (2015) examined the effects of internal and external forces on social capital, learning and flexibility. These three characteristics are associated with the adaptive capacity of environmental governance regimes, and the authors found that over time each attribute was sensitive to both internal and external changes. In the study, Cheng et al. found that the adaptive capacity of the group was compromised by an inability to translate recommendations for forest restoration into operational management actions by the US Forest Service. The authors point to a lack of inclusion of Forest Service field-staff in the collaborative governance structure of Front Range Round Table as a cause of this disconnect. These results suggest that, while collaborative governance arrangements may be able to generate innovative governance solutions, such arrangements face challenges in implementing solutions when ultimate decision-making authority rests with state bureaucracies.

Understanding the adaptive capacity of collaborative governance arrangements presents a key research direction for understanding the role that these arrangements will play in responding to global environmental change. Using a socio-ecological systems perspective on questions of adaptive capacity requires understanding not only how collaborative governance systems respond to changing social forces, but also how these arrangements are shaped by and respond to landscape changes. Using the Colorado Bark Beetle Cooperative as a case study of a collaborative governance arrangement, this research will examine how the CBBC has changed and adapted to the changing spatial extent of MPB infestation on the landscape.

CHAPTER III

METHODS

3.1 Case study context: The Colorado Bark Beetle Cooperative

The initial participants in the CBBC were the United States Forest Service (USFS), the Bureau of Land Management (BLM), the National Park Service (NPS), the Colorado State Forest Service (CSFS) and the Northwest Colorado Council of Governments (NWCCOG). Initially, the CBBC included five counties: Grand, Summit, Routt, Eagle and Jackson. In 2007, Park, Pitkin, Garfield and Lake Counties joined the Cooperative. From the original participants, the CBBC decided to expand participation in 2007 and again in 2008 to include non-governmental organizations including NGOs, private landowners, water utilities, power utilities, and emergency management.

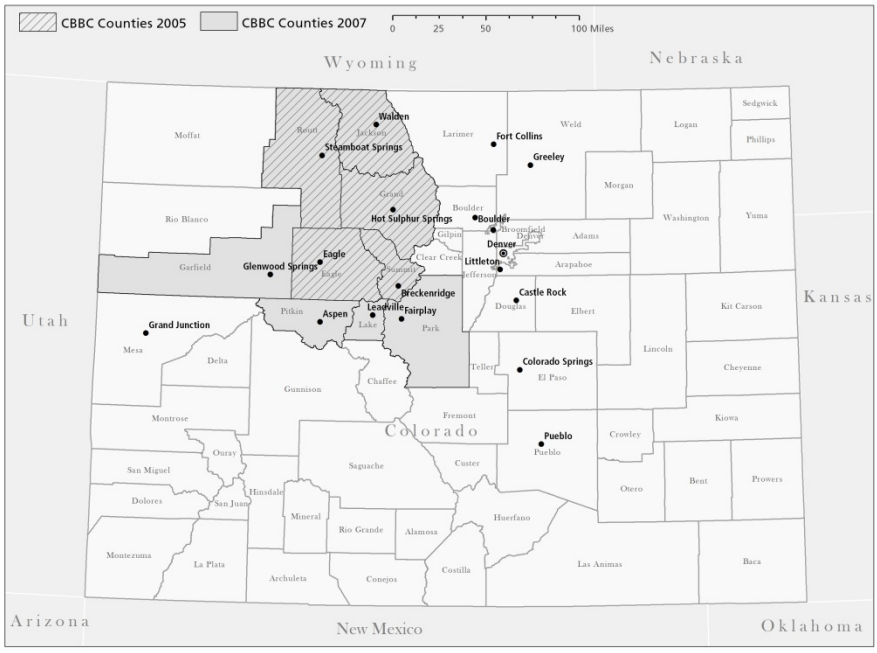

Figure 2: Map showing the CBBC operating area at its founding in 2005 and after 2007

The counties comprising the CBBC contain communities with a diverse range of economic orientations, from high-end resort towns, to amenity-oriented communities, to

communities primarily involved in ranching and logging (C. Flint, Qin, & Ganning, 2012). The CBBC operating area also contains parts of three National Forests (Arapaho-Roosevelt NF, Medicine Bow-Routt NF, and White River NF) and one National Park (Rocky Mountain NP). All of the counties in the CBBC contain a large proportion of forested land, the majority of which is publicly owned (Figures 3 and 4).

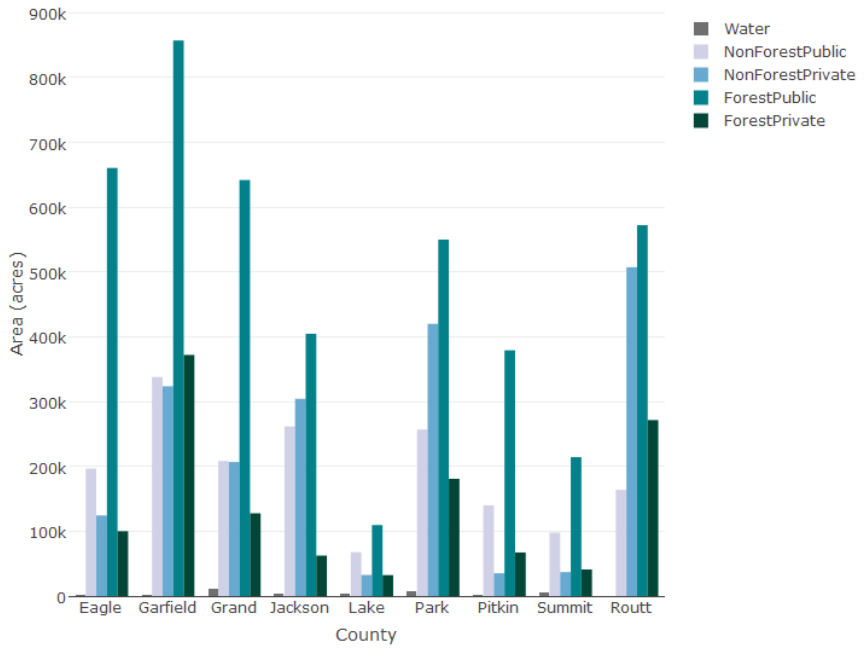

Figure 3: Area of publicly and privately owned forested and non-forested land, and water in CBBC counties

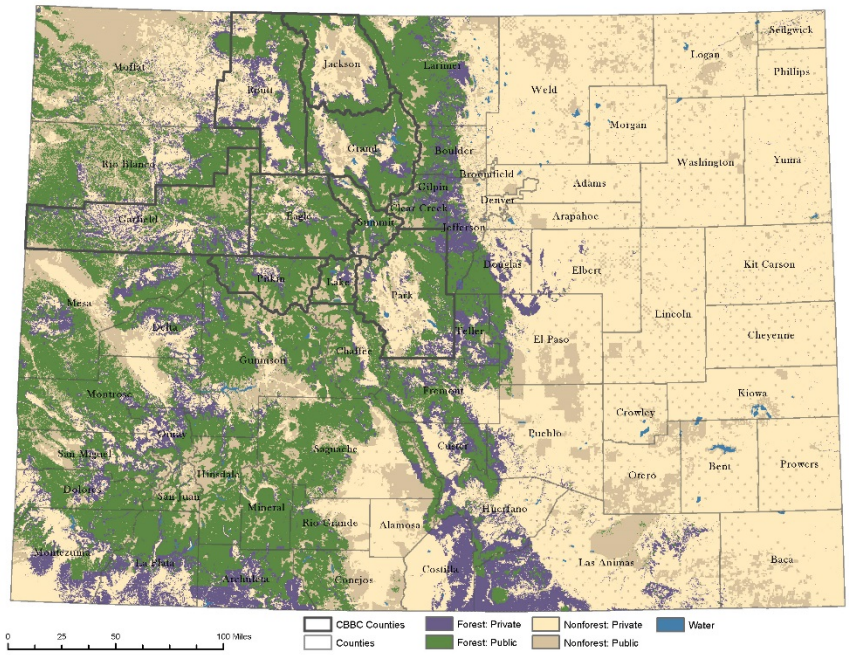

Figure 4: Map of publicly and privately owned forested and non-forested land, and water in Colorado, with CBBC counties outlined in grey

3.2 Methodological approach

This study employed mixed methods to examine the relationship between the spatio-temporal spread of the MPB in Colorado and adaptive changes in the activities, organizational direction, and membership of the CBBC. The spread of MPB induced tree mortality was mapped over time using a geographic information system (GIS), and mortality was compared in different areas (CBBC vs. non-CBBC) and over different forest ownership (public vs. private). To then relate these patterns to changes in the CBBC, I conducted a qualitative detailed document analysis of the CBBC's quarterly meeting minutes from 2007 through 2015. Themes, patterns and key issues where identified from a qualitative coding of the minutes. The content and timing of key passages were analyzed for their relationship to landscape patterns of MPB damage. To understand the relationship between group activities and coded themes and the

spatial extent of MPB on the landscape, the data gathered qualitatively through the CBBC meeting minutes was qualitatively compared to the landscape presence of pine beetle damage.

3.3 Analyzing the spatio-temporal spread of MPB in Colorado

To measure the spread of the MPB over time, aerial survey data of MPB damage from the US Forest Service's Aerial Detection Survey (ADS) (USFS, 1997-2014) mapped with the CBBC area of operation and across public and private forest ownership. The ADS logs tree mortality from a variety of disturbance agents during yearly fly-overs, during which areas of damage or mortality are recorded as polygons. Tree mortality caused by MPB is identified by the change in the color of tree needles from green to red. This change from green to red needles typically occurs a year following successful beetle attach, and thus results in a lag between MPB attack and ADS detection (Chapman et al., 2012). ADS data has been shown to be suitable for measuring forest mortality at scales of 500m or greater (Hart et al., 2015), making it suitable for the scale of this study.

ADS data for MPB mortality was acquired for Region 2 of the US Forest Service. Yearly shapefiles of MPB damage polygons were acquired for each year between 1997 and 2014. Data from 2015 was not yet publicly available at the time of the study. From the Region 2 data set, all damage polygons within Colorado were selected. Because damage polygons did not always adhere to administrative boundaries, this selection method led to the inclusion of some polygons that fell partially outside of the state. From the Colorado ADS data, the area of MPB damage was calculated over time for Colorado as a whole, the CBBC operating area as a whole, and the individual counties within the CBBC area. Area calculations were made by selecting the ADS polygons within an area of interest and summing the area of the selected polygons. A t-test was

conducted to compare the forest area damaged within the CBBC area and the forest area damaged outside of the CBBC area.

Landownership data on forest ownership in the conterminous United States compiled by the U.S. Forest Service (Nelson et al., 2010) was used to calculate area of private and publicly owned forest in the CBBC operating area. This forest ownership data set is a 250m resolution raster dataset prepared by the Forest Inventory and Analysis (FIA) program which classifies areas as public forest land, private forest land, public non-forest land, private non-forest land, and water. The polygons of MPB damage from the ADS data were used to extract the raster landownership data. From the extracted landownership raster, the cell counts of each landownership type were used to calculate the area of public and private forest damaged by MPB over time. To do this, I summed the total number of cells for each forest ownership type, calculated the size of an individual cell in acres, and multiplied that number by the total cell count. In this way I calculated the amount of public and private forestland damaged by MPB in the CBBC operating area from 2005 (the foundation of the CBBC) to 2014 (the last year for which I had ADS data). Additionally, to account for the generally greater proportion of public forestland in the CBBC area, I computed the area of each forest ownership type damaged by MPB as a percentage of the total amount of that forest ownership type in the study area.

3.4 Detailed document analysis of CBBC meeting minutes

To examine the response of the CBBC to patterns of MPB on the landscape, this study employed qualitative detailed document analysis of the CBBC's quarterly steering committee meeting minutes. I coded 25 meeting minute documents from November 2007 to November 2015. These minutes were obtained from the group's website (http://nwccog.org/programs/rural-

resort-region/cbbc/), from the current coordinator of the group, and from a former group facilitator. Meeting minutes were iteratively coded, such that as themes and topics of interest emerged, I returned to earlier coded documents to ensure that the documents were coded consistently and thoroughly.

I employed a combination of structural coding and descriptive coding to elucidate themes and topics in the CBBC meeting minutes. Structural coding applies a conceptual phrase to data segments in order to code and categorize the data along a particular topic of inquiry (Saldaña, 2009). Structural coding was used to identify broadly the activities the group was involved in or discussed. Structural coding was also used to track discussions in the groups minutes about group identity, mission, and internal functioning. For example the following passage from the October 2008 meeting was coded "Membership":

> [It was] pointed out that the old steering committee was made up of intergovernmental bites; Federal Land agencies, state agencies and local government. Now this is a new body and what had been done in terms of chartering and governing needs to start over from scratch. We are re-constituting the steering committee to bring in a broader group of stakeholders.

Descriptive coding was used to capture specific topics of discussion in the minutes, such as "water quality" or "hazards." A full list of codes used can be found in Appendix B. These codes were applied when a passage specifically mentioned a topic, or when the topic could be derived from context.

Additionally, to assess the participation and group membership over time, individuals listed in the attendance list of each meeting were coded into cases with their organizational affiliation (e.g. "Colorado Department of Transportation") attributed. A full list of participants and their organizational affiliation can be found in Appendix C. Additionally, I categorized

organization affiliation into 8 groups (Table 1). These groups were adapted from Cheng et al. (2015).

Organization Type	Description
Academic/Scientific	Research and educational institutions, including colleges, universities and research institutes
Environmental/Recreation	Conservation groups, recreation interest groups, and other collaborative groups
Government	Elected officials, representatives, and members of non-land managing state agencies
Land Manager	Agencies responsible for public land management
Media	Media and news outlets or publications
Private	Private citizens, companies, and consultants
Utility	Electric and water utilities
Wood Products	Timber, wood products, and biofuel industry representatives

Table 1: Classification criteria of organizational affiliation

Together the descriptive and structural coding I conducted formed the basis of a narrative description of the CBBC's adaptive capacity over time. Changes in membership attendance of both individuals and affiliated organizations were plotted over time by meeting date to understand how the composition of the CBBC membership changed with changes in MPB disturbance. The group's operating area was examined both in terms of the spatial extent (e.g. what counties were included) and also in terms of the group's discussion of the geographical basis of their mission. Node frequency was not evaluated quantitatively, but was rather used to guide analysis of important trends and issues in the data. The organizational direction of the group was examined over time through changes the group's actual and proposed activities, and through the discussion of group mission and vision. These findings were related to the landscape pattern of MPB damage both through explicit mention of MPB spread and damage patterns in the minutes, and through qualitatively comparing themes and patterns in group activity with changes in the MPB epidemic.

CHAPTER IV

RESULTS

4.1 Spread of the MPB across Colorado

During the temporal exent of data availability, the MPB epidemic followed a trajectory in Colorado of spreading south and east from Jackson and Grand Counties (Figure 5a and Figure 5b). Yearly additional damage peaked for both the state as a whole and for the CBBC area in 2008, with 1.15 million acres of damage at the state level, of which 872,000 acres were in the CBBC area. After 2008, additional yearly MPB damage decreased at both the state level and in the CBBC area (Figure 6). A t-test conducted comparing the forest area damaged within the CBBC area and the forest area damaged outside of the CBBC area showed that there was not a significant difference in the acres damaged by MPB within the CBBC area versus the rest of Colorado ($t = 0.6$, $p = 0.54$). However, the CBBC area showed a distinct temporal pattern of damage compared with the rest of the state, with beetle damage in the CBBC area peaking earlier than the peak of damage outside of the CBBC area (Figure 6). Between 2003 and 2009, beetle damage in the CBBC operating area accounted for the majority of beetle damage in Colorado. After 2008, the MPB outbreak spread east to the Front Range and it was here that a majority of damage occurred after 2009 (Figures 5a, 5b, and 6).

Breaking down the CBBC area into constiuent counties reaveals that the original five CBBC counties of Summit, Routt, Grand, Jackson, and Eagle account for the majority of MPB damage in the CBBC area (Figure 7).

Figure 5a: Maps showing areas of ADS reported MPB damage in orange from 2005 to 2010. Counties included in the CBBC are outlined in dark grey. Map data courtesy of the USFS, Natural Earth Data, and BLM Colorado

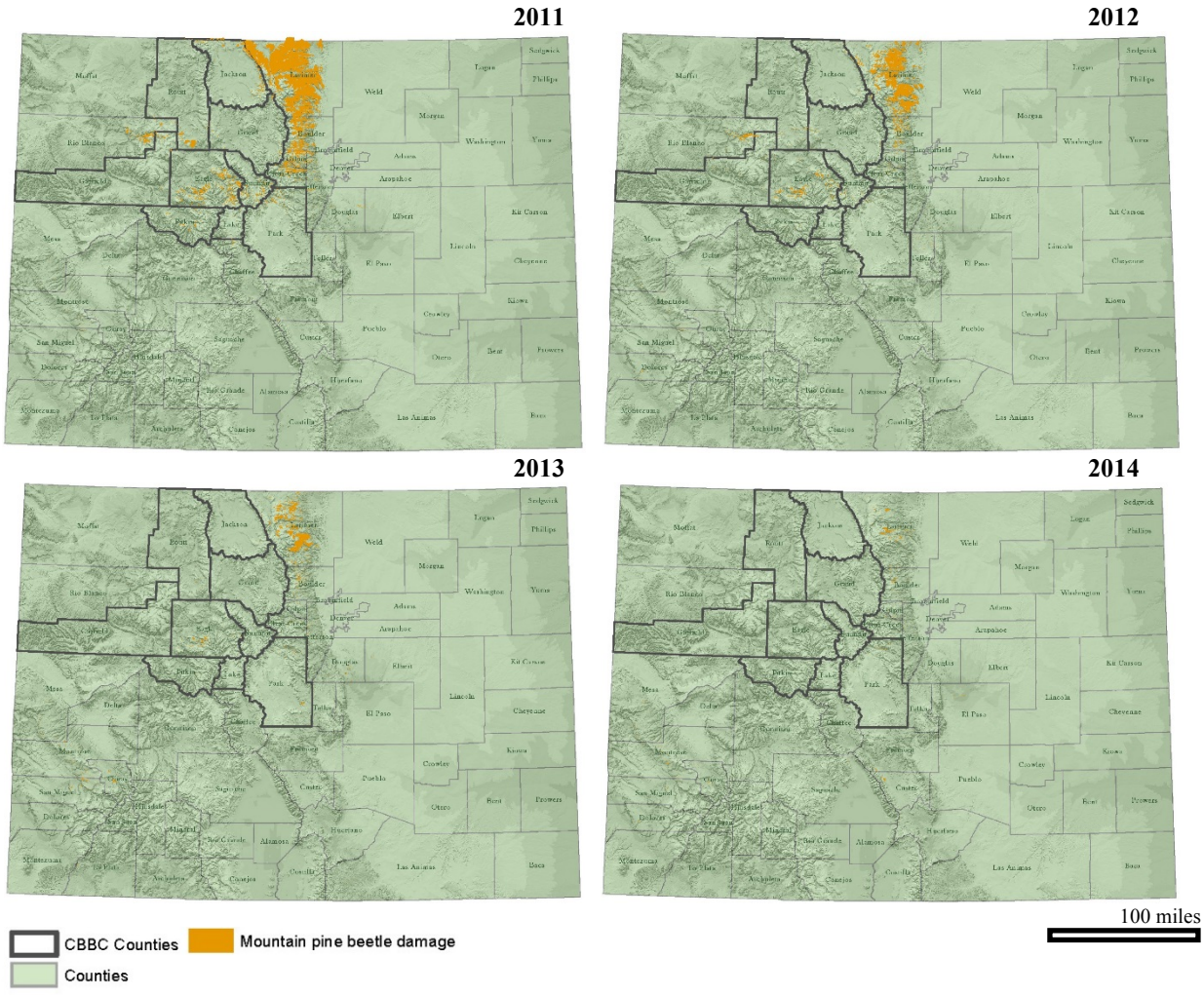

Figure 5b: Maps showing areas of ADS reported MPB damage in orange from 2011 to 2014. Counties included in the CBBC are outlined in dark grey. Map data courtesy of the USFS, Natural Earth Data, and BLM Colorado

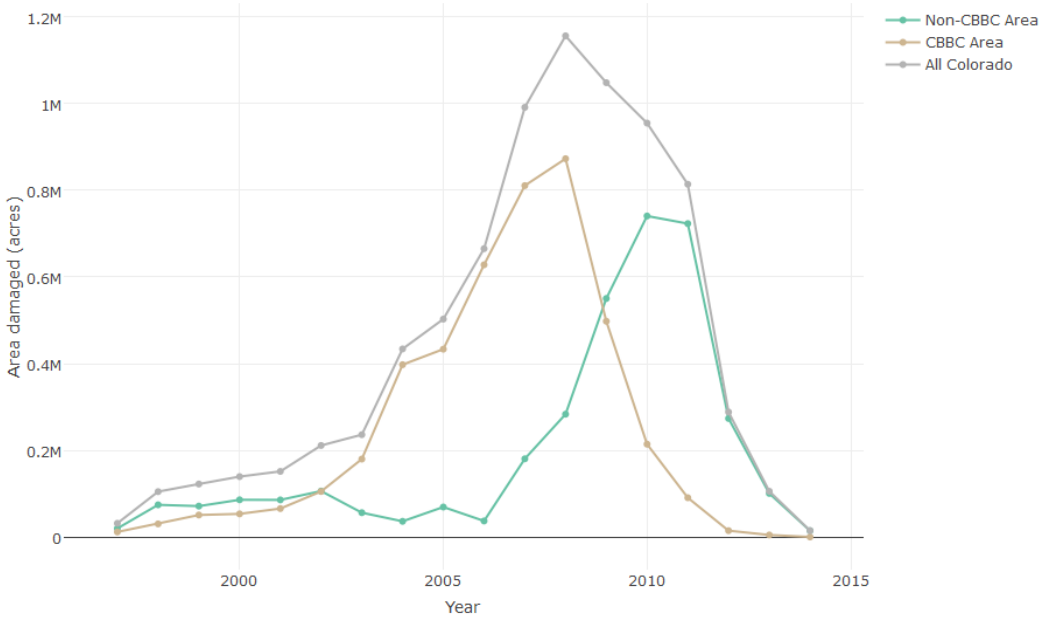

Figure 6: ADS reported MPB damage for all of Colorado (grey), for just within the CBBC operating area (brown), and from outside of the CBBC operating area (green) from 1997 to 2014

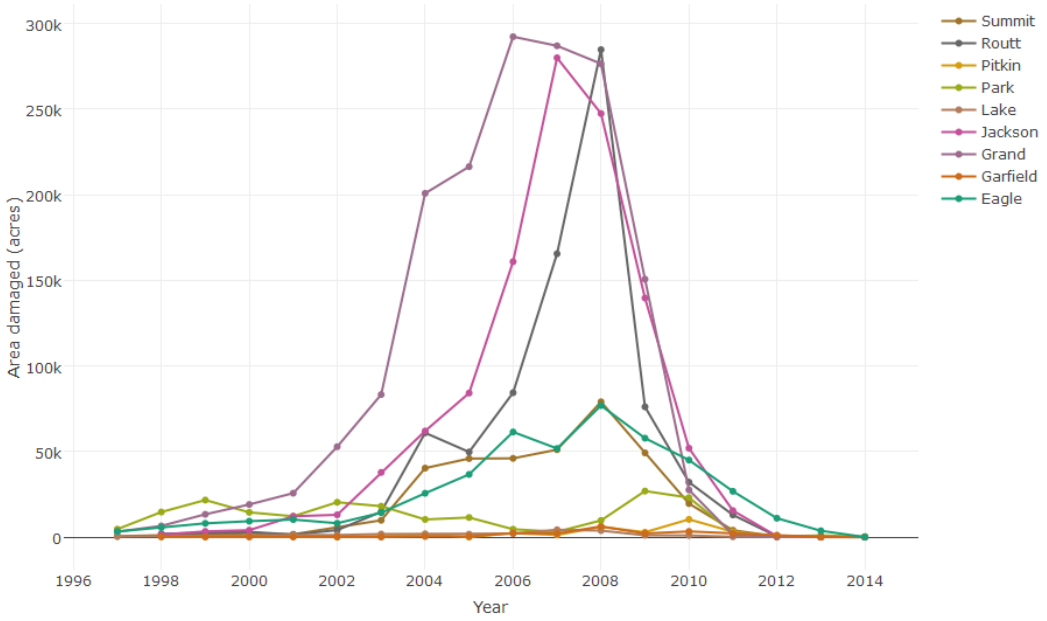

Figure 7: ADS reported MPB damage for each county within the CBBC from 1997 to 2014

Within the CBBC area, the bulk of the area of forest damage occurred on publicly owned forests (Figure 8). Even when accounting for the fact that public forest lands comprise the majority of forested lands in the CBBC opperating area, public forest lands were still experienced MPB damage at a proportionally greater rate than private forest lands did, as shown in Figure 9.

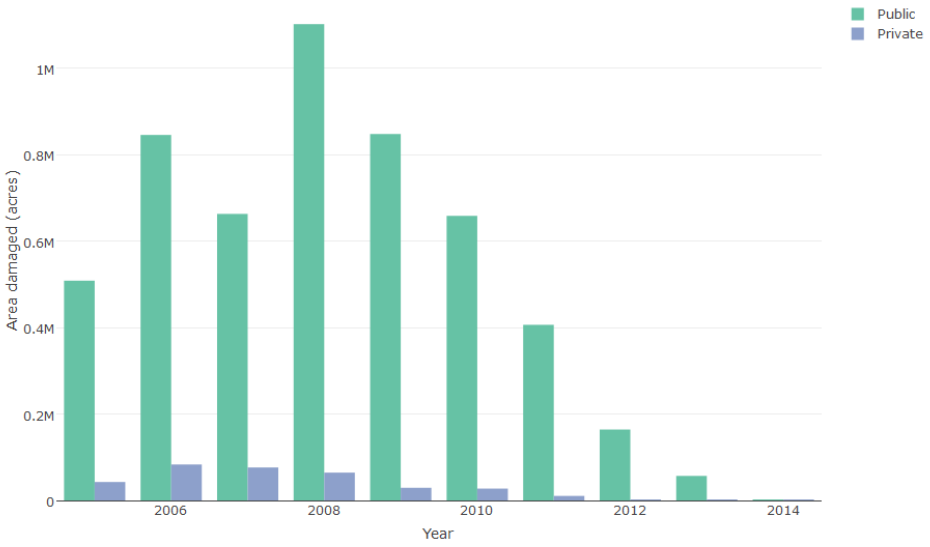

Figure 8: Yearly MPB damage in CBBC operating area from 2005 to 2014 by forest ownership type

These findings show that the CBBC operating area contained the bulk of the MPB damage from the first part of the outbreak in Colorado, and that damage occurred mainly in public forests in the orginal five counties of the CBBC. The second portion of my results will examine the degree to which the membership, area of operation, activities and organizational vision of the CBBC correlates to this spatio-temporal pattern of forest disturbance.

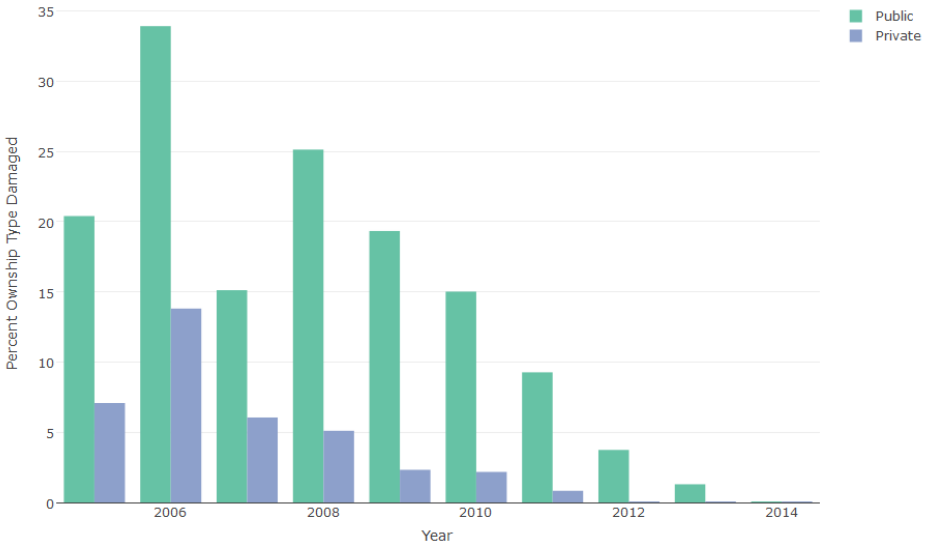

Figure 9: Yearly MPB damage by forest ownership type as a proportion of the total amount of public and private forests in CBBC operating area from 2005 to 2014 by forest ownership type

4.2 CBBC Membership and meeting participation

At its founding in 2005, the CBBC was composed of federal land agencies, state agencies, and local governments. The initial participants in the CBBC were the United States Forest Service (USFS), the Bureau of Land Management (BLM), the National Park Service (NPS), the Colorado State Forest Service (CSFS) and the Northwest Colorado Council of Governments (NWCCOG). The original steering committee sunset in December of 2007, and the same year the steering committee was reconstituted to include a broader group of stakeholders. These additional stakeholders included NGOs, private landowners and water utilities. In 2008, emergency management and the Western Area Power Administration (WAPA) joined the CBBC. In the summer of 2008, the Colorado Forest Restoration Institute (CFRI), became involved with the CBBC to help facilitate the group's growth and expansion. The CFRI is a research institute housed at Colorado State University that is focused on forest restoration

and wildfire mitigation. Also included in the CBBC membership at this time were representatives from the timber and wood products industries, and Colorado Mountain College.

My examination of the CBBC meeting minutes documents showed that, over the course of my study period from 2007 to 2015, the CBBC had 138 unique attendees at their meetings. These attendees represented 70 different parent organizations (Table 2).

Organization Type	Number of Attendees	Number of Organizations
Academic/Scientific	11	5
Environmental/Recreation	12	9
Government	38	23
Land Manager	43	4
Media	2	2
Private	15	14
Utility	8	5
Wood Products	9	8
Total	138	70

Table 2: Types and number of meeting attendees and organizations participating in CBBC meetings from 2007 to 2015

Over time, land management agencies and government representatives have accounted for the majority of CBBC meeting attendees (Figures 10 and 11). Figure 10 is a stacked bar chart showing the number of attendees at each meeting, with the number of individual from each organizational category (see Table 1) color coded. This figure shows that the years 2009 and 2010 have the highest meeting attendance, while attendance declined in 2012 and 2013 and reached a low in 2015 (Figure 10). Figure 11 shows the proportion of the total attendance accounted for by each organizational category.

While land management agencies such as the USFS comprised a large portion of attendees, individual representatives from these organizations typically did not have consistent meeting attendance: the the most consistently attending participant attended 52% of meetings sampled, while the average participant attended 11% of meetings sampled. Concern about USFS attendance was reflected in the July 2012 minutes: "At past CBBC meeting, the supervisors from all 3 forests would attend. They do not all attend meetings now. Concern was expressed that they are not all hearing info from the CBBC" (Steering Committee Meeting Minutes, July 2012).

4.3 Role of parent organizations and CBBC relationship to other collaboratives

Throughout its existence, the CBBC meetings have served as a space of information sharing. Nearly all meetings included a section entitled "CBBC member activities updates" in which members shared updates, tools, and research from their parent organizations. In this way, the CBBC was able to connect membership with the activities and direction of their constituent organizations. Information was disseminated about funding sources, treatment activity, conferences, and lobbying and outreach activities. Land management agencies disseminated information about forest treatments, as well as suggesting funding and grant opportunities. Researchers, environmental groups, and USFS and CSFS foresters provided research and insights on forest ecology and regeneration. Municipal and county representatives presented local projects and gave feedback on community concerns. Members from utilities highlighted concerns about infrastructure, while representatives from timber and wood products industries discussed developments in markets for beetle-killed wood.

Such moments also allowed the CBBC membership to discuss and hone the CBBC's own organizational goals in comparison to the efforts and activities of other groups. Throughout the

meeting minutes, CBBC members expressed a desire for the group to not duplicate the efforts of other groups and sought to explore where possible synergies existed between CBBC objectives and the goals of other groups. For example, in the October 2008 minutes, concern was expressed over forming a working group within the CBBC to address water quality: "There are two working groups - Watershed Protection Working Group on the west slope and on the front range a group called the Front Range Watershed Wildfire Protection Group – seemed like a duplicate effort to start another group through the CBBC" (Steering Committee Meeting Minutes, October 2008).

Over the course of its history the CBBC has engaged with other collaboratives in addition to providing a forum for membership to exchange news and information from parent organizations. In some cases, this has involved working jointly or supporting the efforts of collaboratives. Occasionally, the CBBC discussed helping other collaboratives to form, as in the November 2007 minutes: "Beetles are active in 2 counties in southern Wyoming now – they need to start their own collaborative – how do we interact with other collaboratives?" (Steering Committee Meeting Minutes, November 2007). However, the CBBC primarily interacted with preexisting collaboratives. With the initiation of the Governor's Forest Health Advisory Council (FHAC) in 2009, the CBBC engaged in more formal collaboration with other Colorado forest groups. The CBBC was an active member of the FHAC from its initiation in 2009 until its formal dissolution in 2012, including participating in the development of the Lodgepole Pine Zone of Agreement (LPP ZOA). The LPP ZOA was a working group convened by the FHAC to identify stakeholder areas of agreement where treatment of MPB affected lodgepole pine should occur.

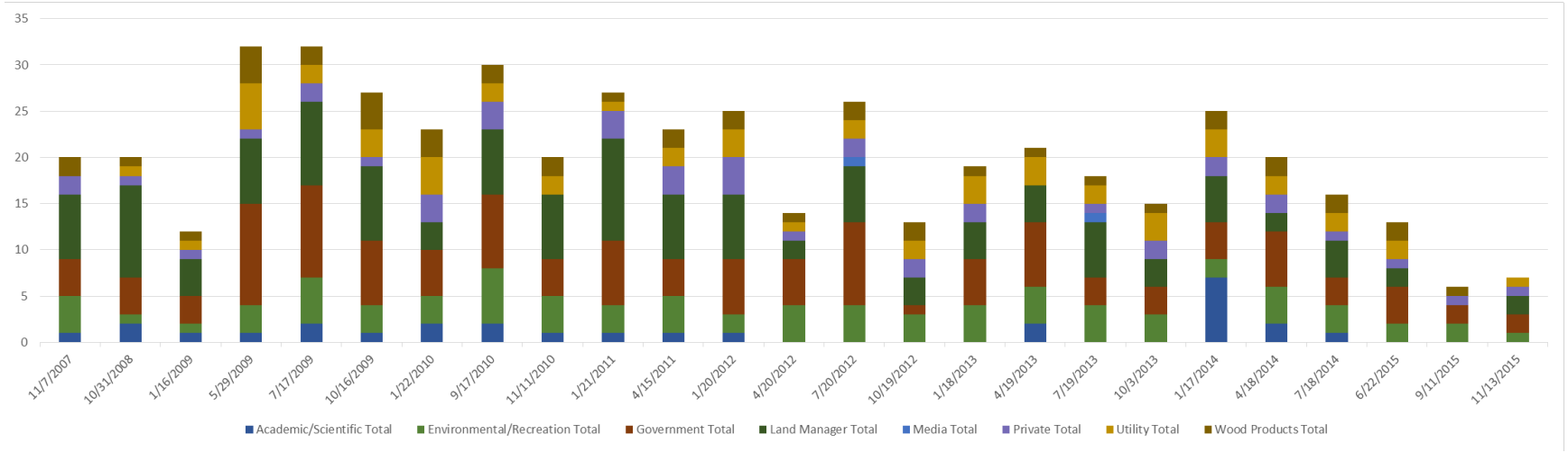

Figure 10: CBBC Steering Committee meeting attendance. Color indicates type of attendee affiliate organization

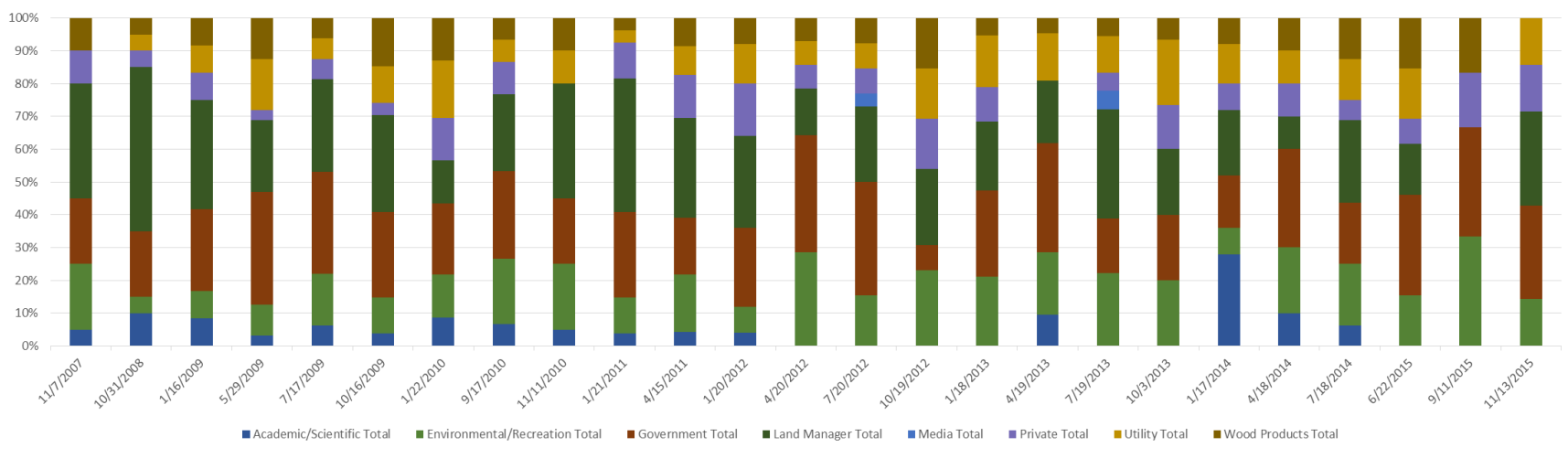

Figure 11: Proportion of CBBC meeting attendance by affiliated organization type

One of the mandates to arise from the January 2010 meeting was to "[w]ork cooperatively with other Colorado place based collaboratives…It is Important to get the FHAC to work in DC for the CBBC and other Colorado collaboratives (they'll provide the statewide focus)" (Steering Committee Meeting Minutes, January 2010). The CBBC's engagement with other collaboratives was thus employed both as part of the group's objective of developing zones of agreement, and as a way to leverage greater power at the national level.

During this time, the CBBC continued to lobby independently for their own objectives, but committed as an organization to "cooperate with all Colorado place based forest collaboratives and with the Governor's Council [FHAC]. The CBBC will not compete for reallocation of existing funding, but rather will work with other forest collaboratives and the Governor's Council to obtain additional funding for the state of Colorado."(Steering Committee Meeting Minutes, January 2009).

After the dissolution of the FHAC, the CBBC became part of the "Collaborative of Collaboratives," a group meant to replace the FHAC as a place for forest groups to discuss forest health issues of mutual concern in Colorado. However, this group does not appear to have been particularly active after 2012. The CBBC has continued to engage other collaboratives, both in having members of other collaborative groups attend steering committee meetings but primarily through conferences and meetings.

4.4 Area of operation

At it's founding, the CBBC included five counties in northwest Colorado: Grand, Summit, Routt, Eagle and Jackson. In 2007, Park, Pitkin, Garfield and Lake Counties

joined the Cooperative. Four of the original five CBBC counties fall within the region served by the Northwest Colorado Council of Governments, which includes Jackson, Grand, Eagle, Summit, and Pitkin Counties. While the CBBC expanded into these four additional counties in 2007, Figure 7 shows that the majority of MPB damage in the CBBC area occurred in the five counties originally included in the CBBC. In part because of the involvement of county and municipal governments, the CBBC operating area was defined on a county basis. However, the definition of where the CBBC operated remained a point of debate throughout the meeting minutes. This discussion focused on the precise nature of the label "place-based," and whether the area of CBBC should be defined politically (through counties), or ecologically through either a focus on MPB as a disturbance, or lodgepole pine and high altitude forests as an ecological unit of area. From the November 2007 minutes: "[A]re we geographic or species specific? – place based (need to focus attention on the short term)… we need to stick to the problems caused by bark beetles or it will get too huge…risk reduction across a 10 county area will have to address more than beetles" (Steering Committee Meeting Minutes, November 2007). The debate over how the group's geographic area of concern should be defined related not just to where the CBBC should conduct research and outreach activities, but also shaped how the group defined their organizational mission in relation to their advocacy efforts. For example, in the January 2010 meeting, a member asked: "if it is CBBC's job to ask for support for other types of trees. The group agreed that the MPB was the CBBC's focus and that ours is a compelling story which we need to use to get more funding for whole state" (Steering Committee Meeting Minutes, January 2010). In November 2010, the group added a fifth object to their mission statement, stating, "the

CBBC will develop and promote a vision for the short, mid, and long term high elevation forest landscape" (Steering Committee Meeting Minutes, November 2010).

As the CBBC shifted towards an increased focus on human community resilience, the discussion of their geographic area of operation identified communities within the nine CBBC counties as the main concern of the CBBC. While the operational focus of the CBBC became communities within its nine county area, the environmental embeddedness of these communities within the forest remained important. This is exemplified in the April 2014 minutes: "The group was charged with addressing the realities of communities in disturbed forests – what are the hazards and values of the communities and what is there still to be done about them? The end result would be focused, collaborative actions for further mitigation" (Steering Committee Meeting Minutes, April 2014).

4.5 Activities and Organizational Direction

The CBBC began in 2005, during a period of steadily increasing damage, and the initial objectives of the group were to:

- Protect homes, communities, human life and property
- Protect watersheds and water supplies
- Protect infrastructures and other important resource and social values

As part of these objectives, much of the CBBC's initial work focused on hazard mitigation and developing zones of agreement among stakeholders for where forest treatments should occur. In November 2007 meeting minutes, the role of the CBBC was described as "being a conduit for information, getting resources enabling local groups to

get chainsaws running in areas of consensus" (Steering Committee Meeting Minutes, November 2007). Also during this time, the CBBC committed to operating as a collaborative (as opposed to a cooperative) and to reach decisions using a process of consensus. Throughout the group's history, the consensus decision-making process has been constructed by the CBBC as a way to deliver "win-win" solutions to treatment decisions. For example, in the November 2007 meeting, zones of agreement are described as a means of "consensus building, manag[ing] conflict and solv[ing] problems. Everybody at table benefits, collaboration is a way to generate support and public and NGO buy-in for decisions" (Steering Committee Meeting Minutes, November 2007). Collaborative mapping, in which stakeholders convened to identify priority areas for treatment, constituted an important component of developing operational zones of agreement. The diversity of CBBC membership was used to both question and legitimize the consensus process as a means of developing zones of agreement. For example, in the September 2010 meeting it was asked, "Isn't this group supposed to have all the representatives at the table? Shouldn't this group be empowered and have the "right" to create the vision. If not, we need to widen our participation. CBBC is a leadership organization and needs to lead the way" (Steering Committee Meeting Minutes, September 2010).

In 2007, the group discussed adding a fourth objective to address community sustainability and adaptation to disturbance. Ultimately, the group adopted a fourth objective to "Develop community resilience to adapt to disturbance driven ecosystems" (Steering Committee Meeting Minutes, November 2007). However, while community resilience was added as an objective during this time, the main focus of CBBC activity

during this period was lobbying to get additional funds for mitigation and to remove administrative barriers to conducting treatments. In the earlier years of the group's history, the CBBC advocated for additional funding for MPB treatment, particularly around areas of critical infrastructure. "The power line infrastructure disaster potential re-frames the bark beetle issue in the D.C. mind. Prior to this they just thought it was too bad for Colorado forests but now when whole regions could be affected, this enlarges the implications of the bark beetle issue" (Steering Committee Meeting Minutes, October 2008). In 2009, a year after the epidemic peaked in Colorado, the CBBC was able to successfully lobby for the USFS to commit $30 million to address bark beetle in the Rocky Mountain region. Additionally, the USFS directed Rick Cables, the Regional Forester for Forest Service Region 2 (which includes Colorado), to divert $10 million from the regional budget to spend on beetle issues. From January 2010 minutes: "Rick [Cables] has given the CBBC a lot of credit for getting the $40 million and has been a great advocate for CBBC" (Steering Committee Meeting Minutes, January 2010). After 2009 the CBBC continue to lobby the state and federal legislatures, particularly on issues of forest management and fire policy. However, as the additional yearly damage from the beetle declined pressing for beetle related funding became more difficult, particular after 2012 when the bark beetle incident was declared officially over.

Throughout the study period, the group engaged in advocacy at a number of different spatial scales, including briefing local, state and national politicians, and lobbying for the passage of beetle and forest related legislation at state and federal levels. As exemplified in this objective of November 2010 meeting to "bring in the newly elected officials up to speed, where the past politicians were," the CBBC worked

throughout the course of the epidemic to promote the group's interests and vision to elected officials. Advocacy for particular policies or pieces of legislation was typically directed towards state and federal officials, while municipal and county officials were involved to help inform what local concerns the CBBC should advocate for. For example, during the November 2015 Steering Committee Meeting:

> There was discussion about bringing the 9 CBBC counties to the table by developing more focused policy objectives. At the state level, we could focus on the WRRP [Wildfire Risk Reduction Program], and the FLAME [Federal Land Assistance, Management, and Enhancement Act] and PREPARE [Preparedness and Risk Management for Extreme Weather Patterns Assuring Resilience and Effectiveness] Acts at the federal level. The CBBC will work on bringing BOCC's/managers to a spring meeting to agree on the important pieces of this legislation and how to best support them.

While the CBBC struggled to continue to secure substantial MPB related funding after 2009, tracking and advocating for forest related legislation remained a core activity throughout the group's history.

The changing nature of the beetle epidemic affected both the CBBC's primary activities and the group's guiding vision. Following their success in lobbying for substantial funding for beetle mitigation in the region, the CBBC began discussing shifting their work away from beetle specific projects and towards issues of landscape ecology. This is reflected in the addition of a fifth objective to the CBBC's list of organizational objectives in 2010: "the CBBC will develop and promote a vision for the short, mid, and long term high elevation forest landscape" (Steering Committee Meeting Minutes, November 2010). Moving into 2010, with the acres of additional beetle damage decreasing, the CBBC grappled with questions of organizational scope, mission, and

direction. This discussion centered around shifting away from the group's early heavy emphasis on hazards mitigation. From the September 2010 Steering Committee Meeting:

> The CBBC seems to be moving towards larger landscape thinking, like wildlife issues, watershed restoration, recreation, etc. Currently the group is functioning on a mitigation basis. Maybe it's time to look at that mission and make additions/changes. How long does the CBBC focus on bark beetle?

As part of this shift in orientation from mitigation towards a more encompassing landscape oriented vision, the group identified the problem facing them as one of calculating which social problems (such as hazards facing infrastructure and property) would demand intervention in disturbed forests. This is summed up in the November 2010 Steering Committee Meeting:

> Where and when do social values trump ecological values? There is not ecological justification for a "bunch of monkeying around in the forest" however there are social values that it is appropriate. Our task is to define where at the short, mid, long term social values trump ecological values. What social values are more important to us then allowing the forest to do what is has always done?

As the additional yearly damage inflicted by the MPB began to decline in northwest Colorado, the CBBC debated continuing to focus exclusively on the beetle, versus reconstituting their mission to address forest health more broadly. During the period from 2010 to 2013, the group engaged in repeated discussion of developing a vision for the "future forest" that could be used to communicate with the public, to prioritize treatment applications, and to generally shape the activities and priorities of the group. The discussion of northwest Colorado's "future forest" became part of the work of the CBBC's Vision Committee, which aimed to develop conceptual tools for optimizing social values, patterns of forest regrowth, and forest management interventions. From the July 2012 Steering Committee Meeting:

> "The Vision Committee's work is predicated on the assumption that forest management resources will remain limited, requiring prioritization of treatments to optimize social benefits…It's a dollar saved where the trajectory of naturally regenerating forests align with desired future conditions. Conversely, where regenerating forests appear to be on a trajectory in conflict with desired future conditions suggests where near term management actions should be investigated. Ultimately, this analysis will determine where on-the-ground forest management projects will be implemented to shape the future forest to meet desired conditions."

However, this future forest visioning was hampered by a lack of clarity on what the purpose and temporal range of such vision should be. Even as the CBBC attempted to operationalize a vision for the future forest based on a trajectory of forest regeneration, there was some support within the CBBC for moving towards engaging more with the project of (human) community resilience. The debate between these two directions for the CBBC is evidenced in the Steering Committee Meeting from October 2012:

> There was a good deal of discussion about what exactly the Vision Group's charge is: to develop a vision for what CBBC ought to be doing in the next 5-20 years, or, to articulate a vision for what the forest should look like in 100 years. Some suggested that the [CBBC] must first articulate a long-term vision for the forest before it can determine what CBBC ought to be doing in the near to mid-term. Others felt that the work plan laid before the group was the process of developing that vision through engagement with the community

In 2014, in part because of this direction uncertainty and it part because of the sharp decline in MPB activity and the perception that the MPB epidemic as such was largely over, the CBBC debated sunsetting entirely. This concern is reflected in the January 2014 minutes, "After a productive early history with the crisis phase of the bark beetle epidemic, the CBBC has been struggling to find its next focus" (Steering Committee Meeting Minutes, January 2014). However, the group decided to continue, and shift the mission away from the recent MPB epidemic specifically and towards future forest

disturbance and community resilience in the CBBC operating area generally. In a facilitated visioning session that occurred at the beginning of 2014, the group defined their problem focus as "Inevitable and ongoing forest disturbances pose hazards to human communities embedded in forested environments and these hazards threaten community resiliency" (Steering Committee Meeting Minutes, January 2014). In this meeting, resilience was defined as "the capacity of a system to absorb and recover from a disturbance" (Steering Committee Meeting Minutes, January 2014). The issue of resilience is framed as one of educating and preparing communities for inevitable future forest disturbance: "Disasters will occur, how ready are they [communities]? The beetle may be gone but the problem has not gone away. The general public does not understand the connection back to the forest" (Steering Committee Meeting Minutes, January 2014). In 2015 the CBBC began to formulate a position for a community resilience coordinator, to help communities in their area develop tools to become more resilient to forest disturbance. In the context of this focus on community resilience, in the June 2015 meeting, the group articulated their role as facilitating the following:

- Assist communities and private industry in understanding their risks and hazards
- Continue to be an advocacy group to the feds on topics related to wildfire and other related issues
- Provide assistance to local governments (and other entities) as a clearinghouse for resources that are available to help them reach their goals, especially in the area of funding sources
- Provide assistance through supporting letters for grants, etc.
- Review CWPP's [Community Wildfire Protection Plans] and make recommendations for updates, enhancements etc.

This shift towards community resilience, while constituting a fairly substantial change in organizational direction for the CBBC, continued to draw on areas with which the group had been active and successful in for a long time, such as advocacy, and information sharing

CHAPTER V

DISCUSSION

One of the key normative assumptions about collaborative governance arrangements, such as the Colorado Bark Beetle Cooperative, is that such regimes possess a greater adaptive capacity (Folke et al., 2005; Lebel et al., 2006; Pahl-Wostl, 2009). Adaptive capacity can be defined as the ability of a system to "experiment and foster innovative solutions in complex social and ecological circumstances" (Armitage, 2005). These results suggest that the CBBC has adapted its activities and organizational focus in response to the changing pattern of MPB damage and concurrent shifts in policy opportunities. Over time, the CBBC has been able to demonstrate some of the advantages of collaborative governance arrangements in promoting adaptive capacity, such as flexibility, diverse membership, and ability to operate across multiple scales. However, the group has also faced some of the challenges typical to collaborative governance, such as difficultly moving from direction-setting to implementation, lack of monitoring mechanisms, and difficulty developing durable structures of implementation with key management bureaucracies.

5.1 Membership, parent organizations and collaboration

One of the ways in which the CBBC exhibited positive qualities associated with increased adaptive capacity was by the inclusion and representation of a broad range of stakeholders. This diversity not only allowed the CBBC to serve as a clearinghouse of information from a variety of parent organizations, but also legitimized the CBBC's consensus making process around developing zones of agreement for where forest

treatment should occur. The CBBC was able to function in some ways as a bridging organization between private stakeholders, local government, state legislators, and state and federal land management agencies. This function was crucial to the CBBC making connections to pursue policy agendas at the local, state, and federal levels, and allowed the CBBC to sensitize state and federal legislators to the CBBC's concerns while gathering input and concerns from local and municipal government. This trend is part of what made the CBBC able to work flexibly across scales.

However, while the CBBC was able to leverage its diverse set of stakeholders to adapt to changing social and ecological circumstances, the group also faced challenges in maintaining durable ties to key decision-making structures in land management bureaucracies. This is reflected in the decline of consistent USFS personnel attendance after 2009 and related concerns about the ability of the CBBC to connect with forest supervisors. While the USFS now includes collaboration into its process for forest management, the mechanism through which CBBC identified management priorities could translate into on the ground treatments was unclear. This issue was compounded by a lack of monitoring capacity on the part of the CBBC for any of their activities, including treatment implementation. Monitoring has been identified as a key component of learning and accountability in collaborative governance arrangements, and a lack of robust monitoring protocols can hamper a group's ability to adapt (Armitage, 2005; Cheng et al., 2015; Lebel et al., 2006).

5.2 Area of operation

The spatial analysis of the spread of MPB across Colorado shows that the CBBC operating area coincided with the initial epicenter of the outbreak in the state (Figures 3a and 3b). One of the theorized mechanisms through which collaborative governance regimes increase adaptive capacity is by matching decision making and learning to appropriate social and ecological scales (Lebel et al., 2006). While the CBBC seems to have encompassed an area of high MPB damage in Colorado, the group's on-going debate on how to define the geographic area in which they operate suggests that matching the ecological and social concerns is not always straightforward. While the political boundaries (counties) chosen by the CBBC to define their geographic scope do not necessarily correlate to ecological phenomena controlling the MPB outbreak, there group was clearly constrained by political and logistical reasons for this choice. Additionally, the designation of the nine county operating area did not limit the CBBC in pursuing activities across scales and with implications outside of their own location.

The ability to work flexibly across scales is another pattern in the activities of the CBBC that is characteristic of systems with higher adaptive capacity. This is seen both in the multiple areas and scales at which the CBBC pursued projects and policy objectives, in the incorporation of diverse stakeholders from a range of spatial scales, and in the way that the CBBC was able to pivot their entire organizational vision from different scales across the history of the group. Previous studies have shown that incorporating knowledge across scales and connecting actors at different scales can positively impact adaptive capacity (Pahl-Wostl, 2009).

5.3 Activities and Organizational Direction

While the CBBC was able to flexibly change their guiding vision with changes in the type and extent of MPB damage, the group also faced some difficultly in moving from a direction-setting phase to an implementation phase. Collaborative organizations have been described as moving through phases of problem-setting, direction-setting and implementation, and previous studies have identified difficultly in moving from direction-setting to implementation as a key challenge presented to the success of collaborative governance (Cheng et al., 2015). Other studies have described this movement from problem setting, to direction setting, to implementation as cyclical rather than linear (Ansell & Gash, 2008), a trend which is exhibited by the CBBC. Particularly after the peak in beetle activity, the CBBC experienced a period of cyclical direction setting, finally settling on a focus on community resilience at the end of the study period.

Throughout this iterative direction setting, the response of the CBBC to the MPB outbreak was shaped by the way in which the group defined the problem of MPB disturbance. Throughout each stage of the group's development, the issue of MPB disturbance in Colorado forests has been framed as inevitable and unpreventable. The result of this framing was a consistent focus on influencing or altering social systems, from federal legislation to community wildfire plans, rather than addressing potential underlying causes of the outbreak such as climate change. This makes sense given the organizations scope, let alone the ability of a regional group such as the CBBC to affect such a complex problem as global climate change.

5. 4 Limitations and directions for future study

Because of the nature of the document data I employed, this study was able primarily to tease out trends in member inclusion and broad discussions of group vision and direction. Because I was analyzing meeting minutes from the steering committee (as opposed to working groups, which met separately), the patterns I found relate more to the overarching organizational concerns and less to the nitty-gritty details of project implementation. Another limitation of the steering committee meeting minutes as a data set was that, although it was possible to capture the diversity of attendees at these meetings, the minutes themselves were written in a summative way, which obscured individual voices and concerns within a discussion. Additionally, more than collative connections to and from ecological processes on the landscape were difficult to draw given the constraints of my data. Further research could employee a diversity of data sources and methods to tease out the connections between the CBBC's organizational direction, implementation directives, and actual changes and treatment on the landscape.

The CBBC exhibited facilitating and inhibiting characteristics with regards to adaptive capacity. While the group faced challenges, particularly around organizational vision and direction as the MPB epidemic waned in intensity, this study suggests that the flexible, multi-scalar nature of the CBBC will allow for continued relevancy and adaptation as Colorado's forests continue to change.

CHAPTER VI

CONCLUSION

Collaborative multilevel governance arrangements such as the Colorado Bark Beetle Cooperative are an increasingly response for addressing complex environmental problems. Because of the increasing prevalence of such governance arrangements, it is crucial to understand the ways in which such arrangements adapt and change over time. This study has examined some of the challenges and benefits of collaborative arrangements in the context of a changing landscape of forest disturbance. As societies continue to face complex socio-ecological problems that reach across spatial and political scales, understanding how collaborative governance regimes change in response to changes on the landscape can provide insight into the ability of such arrangements to respond nimbly and flexibly to environmental disturbances.

APPENDIX A

LIST OF ACRONYMS

ADS	Areal Detection Survey
BLM	Bureau of Land Management
BOCC	Board of County Commissioners
CBBC	Colorado Bark Beetle Cooperative
CDOT	Colorado Department of Transportation
CDOW	Colorado Department of Wildlife
CDPW, EM	Colorado Department of Public Works, Emergency Management
CFRI	Colorado Forest Restoration Institute
CSFS	Colorado State Forest Service
CSU	Colorado State University
DNR	Department of Natural Resources
FHAC	Forest Health Advisory Council
FHTF	Forest Health Task Force
FIA	Forest Inventory and Analysis Program
LPP ZOA	Lodgepole Pine Zone of Agreement
MPB	Mountain Pine Beetle
NFF	National Forest Foundation
NPS	National Park Service
NWCCOG	Northwest Colorado Council of Governments
USDA	United States Department of Agriculture
USFS	United States Forest Service
USGS	United States Geological Survey
WUI	Wilderness Urban Interface

APPENDIX B

CODEBOOK

Name	Description
Themes	Topics of interest
Biomass utilization	Discussion of the use (e.g. sale, processing, marketing) of forest biomass, either from beetle-killed timber or from mitigation/treatment removed biomass
Climate Change	Discussion of climate change/ global warming
Energy	Discussion of issues related to energy and energy production (e.g. power lines).
Fire	Discussion of issues related to forest or wild land fire
Forest Industry	Discussion of forest products or timber industry
Infrastructure	Discussion of infrastructure, e.g. power lines, roads
Hazards	Discussion of hazards/ hazardous conditions resulting from fire or beetle-kill
Resilience	References to the concept of resilience, particularly ecological resilience. Used mostly to mean the ability of a system to recover from disturbance, sometimes used to denote the ability of a system to resist change/disturbance
Treatment and Mitigation	Discussion of issues related to treatment of forests to reduce the impact of disturbance or prevent /reduce the likelihood of future disturbance,
	Thinning: Selectively removing trees from a forest
	Restoration: Activities designed to return an ecosystem to a pre-disturbance state
	Pheromones: Pheromone traps which are meant to capture mountain pine beetles
	Mitigation: Activities designed to reduce the severity or impact of disturbance
	Clear-cutting: Cutting down large areas of trees
Vulnerability	References to the concept of vulnerability, a measure of how susceptible a system is to harm or disturbance
Water Quality	Discussion of issues relating to water quality & watershed
Wildlife	Discussion of issues related to wildlife or wildlife conservation
WUI	Wild land-Urban Interface: The term refers generally to areas where human habitation or development abuts or intermingles with wild or uninhabited areas.
Activities	Activities undertaken or discussed by the CBBC
Research	Activities related to designing and conducting research
	Monitoring: Research related to ecological monitoring
	Mapping: Research related to GIS analysis and mapping
Partner Organizations	Catch all for reference to activities of any non-CBBC organizations
Outreach	Activities related to public outreach and education
	Tools: Outreach related to the development and distribution of tools for community use (could be maps, data products, methods of evaluation)
	Field Trips: CBBC member visits to field sites or communities of interest
	Education: Outreach related to the creation, dissemination, or implementation of educational materials or workshops
	Conferences & Meetings: CBBC attendance at conferences or meetings
	Bridging: Activities related to bridging between government agencies, research institutions, and the public

Internal Activities	Activities related to the internal operation of the CBBC
	Mission & Vision: Activities related to the formation, articulation and dissemination of the CBBC mission and vision
	Membership & Roles: Activities related to group membership, participating organizations, and group roles and positions
	Budget & Funding: Activities related to budgeting, fundraising, and funding
Advocacy	Activities related to lobbying and advocacy at local, state or national levels
	Farm Bill: Advocacy related to the Farm Bill
Misc.	Uncategorized nodes
WBBS & BBI	Western Bark Beetle Strategy and Bark Beetle Incident. The BBI management organization was put in place in 2007 for the Rock Mountain Region. USFS Chief directed the development of the WBBS in 2009 to be a regional strategy for dealing with the bark beetle epidemic
FHAC	Forest Health Advisory Council. Created by Governor Ritter in 2008 "for the purpose of bringing together relevant state and federal agencies, local government representatives and key stakeholders to identify short term action that will improve Colorado's approach to forest heath and to develop and implement a long term strategy for sustaining the state's ...forest resources" - EO B00408

APPENDIX C

CBBC PARTIPANT LIST

Name	Affiliation	Organization Type
Abbie Cobb	NWCCOG	Government
Alan Hanson	Summit County Planning Dept	Government
Allen Bacher	Colorado Mountain College	Academic/Scientific
Alton Scales	Colorado Mountain College	Academic/Scientific
Amanda Bucknam	CSFS	Land Manager
Beth Huron	CSU Extension	Academic/Scientific
Bill Jackson	USFS	Land Manager
Bjorn Dahl	Dahl Environmental Services	Private
Bob Sturtevant	CSFS	Land Manager
Brad Piehl	JW Associates	Private
Bruce Ward	Choose Outdoors	Environmental/Recreation
Bryan Martin	Colorado Mountain Club	Environmental/Recreation
Buck Sanchez	USFS	Land Manager
Cal Wettstein	USFS	Land Manager
Carina Wyborn	University of Montana	Academic/Scientific
Carl Spaulding	Renewable Fiber Inc	Wood Products
Caroline Byus	Eagle River Water and Sanitation District	Government
Cary Green	USFS	Land Manager
Casey Cooley	Division of Parks and Wildlife	Government
Charlie Henry	Private Forest Land Owners	Private
Chris Dahl	NPS	Land Manager
Christine Scanlan	CO Legislature	Government
Chuck Dennis	CSFS	Land Manager
Chuck Vale	CDPS, EM	Government
Clint Kyhl	USFS	Land Manager
Craig Magwire	USFS	Land Manager
Dan Gibbs	Summit County BOCC	Government
Dan Schroder	CSU Extension	Academic/Scientific
David Wheeler	USFS	Land Manager
Don Carroll	USFS	Land Manager
Don Kennedy	Denver Water	Utility
Drew Hoehn	RWB Fire District	Government
Gary Severson	NWCCOG	Government
Glenn Casamassa	USFS	Land Manager
Gloria Jones	CDOT	Government
Grete Gansauer	CO Wildlife Federation	Environmental/Recreation
Heather Provencio	USFS	Land Manager
Howard Hallman	FHTF	Environmental/Recreation

Ian Lyle	Representative Scott Tipton	Government
Jack Taylor	Private Citizen	Private
Jackie Parks	USFS	Land Manager
Jan Burke	USFS	Land Manager
Jan Cutts	USFS	Land Manager
Jan Hackett	CSFS	Land Manager
Jason Browne	Xcel Energy	Utility
Jeff Kitchens	BLM	Land Manager
Jeff Witcosky	USFS	Land Manager
Jennifer Scott	Grand County DNR	Government
Jerry Andrew	Lake County Forest Health Task Force	Environmental/Recreation
Jerry Otero	Senator Udall	Government
Jessica Clement	CFRI	Academic/Scientific
Jill Ozarski	Senator Udall	Government
Jim Webb	Private Forestry Consultant	Private
Joani Matrenga	CO Energy Office	Government
Joe Duda	CSFS	Land Manager
Joe Pandy	Mountain Parks Electric	Utility
John Burke	Blue Knight Group	Wood Products
John Dickinson	Ecowood Sales	Wood Products
John Mack	NPS	Land Manager
John Rich	Jackson County BOCC	Government
John Ring	BLM	Land Manager
June Walters	NWCCOG	Government
Kate Jerman	USFS	Land Manager
Katherine Timm	CSFS	Land Manager
Kim Scott	RWB Fire District	Government
Kristen Pelz	CFRI	Academic/Scientific
Liz Lile	USGS	Government
Liz Mullen	NWCCOG	Government
Lyle Laverty	The Laverty Group	Private
Marcus Selig	NFF	Environmental/Recreation
Mark Mathis	Confluence Energy	Utility
Martha Delporte	USFS	Land Manager
Mary Ann Chambers	USFS	Land Manager
Mary Chapman	Private Landowner	Private
Mary Mitsos	NFF	Environmental/Recreation
Matt Sugar	NWCCOG	Government
Matt Tansey	CSFS	Land Manager
Matt Thompson	Town of Breckenridge	Government
Meridian Taussig	CSFS	Land Manager
Michael Swenson	Swenson Communications	Private
Michael Wasgott	Philips & Jordan, Inc.	Private

Michael Stantiers	Prodigy	Private
Mike Babler	The Nature Conservancy	Environmental/Recreation
Mike Eckhoff	CSFS	Land Manager
Mike Jolovich	Ranch Creek Ltd	Private
Mike Lester	CSFS	Land Manager
Mike McHugh	City of Aurora	Government
Nancy Fishering	Colorado Timber Industry Association	Wood Products
Nate Williamson	NPS	Land Manager
Nissa Erickson	Representative Polis	Government
Noah Koerper	Senator Bennet	Government
Paige Blankenbuehler	Summit Daily News	Media
Pam Caskie	NWCCOG	Government
Pam Motley	West Range Reclamation	Wood Products
Patti Clapper	Pitkin County BOCC	Government
Patti McGuire	Private Consultant	Private
Paul Evangelista	CSU	Academic/Scientific
Peech Keller	USFS	Land Manager
Peter Runyon	Eagle County BOCC	Government
Peter Grosshuesch	Town of Breckenridge	Government
Phil Cruz	USFS	Land Manager
Rachel Lunney	NWCCOG	Government
Randy Piper	GreenWay, LLC	Wood Products
RE Vann	USFS	Land Manager
Rich Cooksey	USFS	Land Manager
Rich Dziomba	Blue Knight Group	Wood Products
Rich Edwards	CSFS	Land Manager
Rob Davis	Forest Energy Corporation	Wood Products
Robert Post	USFS	Land Manager
Ron Cousineau	CSFS	Land Manager
Ron Turley	WAPA	Utility
Ronnie Jordan	Philips & Jordan, Inc.	Private
Rusty Collins	CSU Extension	Academic/Scientific
Sally Edwards	Xcel Energy	Utility
Sandy Briggs	FHTF	Environmental/Recreation
Sara Duncan	Denver Water	Utility
Scott Fitzwilliams	USFS	Land Manager
Shane Briggs	CDOW	Government
Shanna Koenig Camuso	NWCCOG	Government
Sloan Shoemaker	Wilderness Workshop	Environmental/Recreation
Steve Johnson	Global Loggers	Wood Products
Steven DeWitt	The Lodgedpole Project	Media
Suzanne Oneill	CO Wildlife Federation	Environmental/Recreation
Ted Wang	NWCCOG	Government

Terry Hamm	Xcel Energy	Utility
Tim Reader	CSFS	Land Manager
Tim Seeling	Grant writer	Private
Todd Hagenbuch	Senator Bennet	Government
Tom Clark	Town of Kremmling	Government
Tom Upsler	CDOW	Government
Tom Adamson	BLM	Land Manager
Tom Fry	The Wilderness Society	Environmental/Recreation
Tom Nesler	CDOW	Government
Tony Cheng	CFRI	Academic/Scientific
Tony Vorster	CSU	Academic/Scientific
Trudy Kareus	Senator Bennet	Government
Vince White-Petterutti	VWP (Consultant)	Private
Wendy Jo Haskins	USFS	Land Manager

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