8-2020

Cross-Boundary Stewardship for Wetland Integrity and Resilience in the Greater Rocky Mountain National Park Ecosystem

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CROSS-BOUNDARY STEWARDSHIP FOR WETLAND INTEGRITY AND RESILIENCE IN THE GREATER ROCKY MOUNTAIN NATIONAL PARK ECOSYSTEM

by

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A thesis submitted in partial fulfillment
of the requirements for the degree

of

MASTER OF SCIENCE

In

Environment and Society

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2020

ABSTRACT

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Utah State University, 2020

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Long-term monitoring by the Rocky Mountain Inventory and Monitoring Network shows that approximately half of the wetlands in Rocky Mountain National Park (RMNP) are not in reference condition—degraded as compared to a set standard defined for wetland integrity in the park—due to anthropogenic disturbances that often occur beyond park boundaries. Most protected areas, including RMNP, are part of larger ecological systems in which interactions with surrounding lands are critical for sustaining the species and ecological flows present within them. Therefore, more effective stewardship of wetlands within RMNP is likely to be achieved through cooperative efforts among entities that share responsibility for those wetlands. Through semi-structured interviews with federal and state agencies, nonprofits, research organizations, and municipalities and an analysis of these organizations' wetland policies, barriers to and opportunities for cross-boundary stewardship were identified, as well as common

structures used to facilitate work across boundaries. This analysis found that wetlands outside of RMNP are experiencing similar cross-boundary disturbances to those within the park. Managers also anticipate future changes that could affect the ability to steward wetlands under their jurisdiction. Though participants recognize that working cooperatively with neighboring jurisdictions can decrease the effects of boundaries on wetland integrity, they also reported that the most significant cross-boundary challenge is working with others to share information, participate in joint planning and complete projects. Despite these challenges, many entities in the greater RMNP ecosystem have found ways to work together. Through a social network analysis, three types of cooperative interactions were identified: communication, coordination, and collaboration. A framework consisting of seven elements for each interaction was developed from case study findings and cooperative management literature. Based on these findings and the framework presented, recommendations are provided on how to address cooperative management challenges, while taking advantage of opportunities to facilitate cross-boundary stewardship for wetland resilience—withstanding disturbance without a change in structure and composition—at the ecosystem-scale.

(133 pages)

PUBLIC ABSTRACT

Cross-boundary Stewardship for Wetland Integrity and Resilience in the Greater Rocky Mountain National Park Ecosystem

Meghan K. Tait

Approximately half of the wetlands in Rocky Mountain National Park (RMNP) are degraded due to human disturbances that often occur beyond park boundaries. Like most protected areas, RMNP is part of a larger ecosystem with critical connections to surrounding lands. Therefore, more effective stewardship of wetlands within RMNP is likely to be achieved through cross-boundary cooperative efforts. Through interviews with wetland stewardship agencies and organizations and an analysis of their wetland plans and policies, barriers and opportunities for cross-boundary stewardship were identified, as well as common structures used to facilitate work across boundaries. Wetlands outside of RMNP are experiencing similar impact across boundaries as those within the park. Though participants recognize that working cooperatively with neighboring entities can benefit wetlands, they also reported that the most significant cross-boundary challenge is working with others. Despite these challenges, many entities in the greater RMNP ecosystem have found ways to work together. We defined three types of cooperative interactions - communication, coordination, and collaboration – and developed a framework that describes elements of each type. Based on these findings and the framework presented, we provide recommendations on how to address cooperative

management challenges, while taking advantage of opportunities to facilitate cross-boundary stewardship for wetland integrity at the ecosystem-scale.

ACKNOWLEDGMENTS

First, I would like to thank my major professor, Dr. Mark Brunson, for always being encouraging and supportive throughout my research pursuits that have culminated into this thesis. I have been and will continue to be inspired by his passion for science and the scientific process. He always offered practical advice and challenged me with the independence to design and conduct my own research.

I would also like to thank my lab mates, past and present, for being a source of knowledge, wisdom, and community. The past two years would have been much harder without the life and energy you brought to our lab. Along with those in my lab, I would like to recognize the rest of the graduate student community in the Environment and Society Department and the College of Natural Resources as a whole for making my graduate school experience enjoyable and rewarding.

Though I did not spend as much time as I would have liked interacting with my committee members, Dr. Karin Kettenring and Dr. Ole Sleipness, I would like to thank them for their support and kind words along the way. I would also like to recognize the other faculty and staff that have been encouraging and supportive throughout my time at Utah State University. I am thankful to have taken courses that challenged and intrigued me.

Further, I would like to thank everyone who took the time to participate in my research study. Learning about their work and dedication first-hand was inspiring. This

thesis would not have been possible without their willingness to let me join them in the field and engage in fruitful conversation.

To my parents, Cindy and Chris Tait, thank you for always encouraging my passions, no matter where in the world they have taken me. Finally, to my partner, Sean Flounlacker, I am so lucky to have someone by my side that was excited to move across the country not knowing what lie ahead and who is so excited to take on this next journey as we move into the middle of the Pacific Ocean. My parents and Sean have been my support system, always reminding me how proud they are of my hard work and dedication to environmental issues.

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CHAPTER 1

INTRODUCTION

Wetlands are important biodiversity hotspots and provide ecosystem services such as flood attenuation and storage, aquifer discharge and recharge, sediment stabilization and sequestration, carbon storage, water quality enhancement, and nutrient cycling (Mitsch and Gosselink 2007; Schweiger et al. 2019; Sutula et al. 2006). In Rocky Mountain National Park (RMNP), Colorado, USA, wetlands support a majority of the biodiversity, but only make up a small portion of the park (Schweiger et al. 2019). Wetlands in RMNP are made up of a wide variety of types and provide numerous important ecological functions (Cooper and Sanderson 1997; Mitsch and Gosselink 2007; Naiman, Decamps, and Pollock 1993; Stohlgren et al. 1997). The National Park Service Inventory and Monitoring (I&M) Network, which conducts long-term monitoring of wetlands in RMNP as part of its natural resources vital signs monitoring program, has found that approximately half of the park's area classified as wetlands is not in reference condition—degraded as compared to a set standard defined for wetland integrity in the park (Schweiger et al. 2016; Stoddard et al. 2006). They attribute this decline in condition to anthropogenic disturbances, which often occur beyond park boundaries, such as alterations to hydrologic regimes or introduction of species.

RMNP, like most protected areas, is part of a larger ecological system, in which interactions with surrounding lands are critical for sustaining the species and ecological processes present within them (Davis and Hansen 2011). In other words, the scale of the ecological system is larger than the scale of the social organization intended to protect it,

resulting in a social-ecological scale mismatch (Cumming, Cumming, and Redman 2006). Therefore, in order to protect wetlands in RMNP from anthropogenic disturbances, the social-ecological scale mismatch needs to be addressed. This thesis explores ways to address this mismatch through cross-boundary stewardship, which views the protected area as situated within a large ecological system. Additionally, this thesis investigates barriers to and opportunities for cooperative management of wetlands in and around RMNP, as well as common structures currently used to facilitate cooperative interactions. Finally, recommendations will be made to achieve cooperative efforts that account for wetland sustainability while acknowledging the differing missions and goals of land management entities that share stewardship responsibilities of those wetlands.

LITERATURE REVIEW

Threats to Colorado's Wetlands

In Colorado, wetlands cover only about 1.5 percent of the state, but are ecologically and economically valuable (CPW 2018). Wetlands are an important outdoor recreation resource because they provide opportunities for wildlife-based recreation, such as hunting, fishing, and wildlife viewing, and water-based recreation, such as boating and swimming. As much as 90 percent of Colorado's fish and wildlife species depend on riparian and wetland habitat during some stage of their life (Walton-Day 1993). Since the state was first settled, over half of Colorado's wetlands have disappeared, with habitat loss and degradation continuing to be a concern. Current threats to wetlands include residential development, fragmentation from roads, altered native vegetation and hydrological regime, lack of water due to drought and exacerbated by climate change,

and pollution from agricultural and urban runoff (CPW, 2018). Colorado's population grew by 80,000 people or 1.4 percent between 2017 and 2018, making it the seventh fastest-growing state in the country (U.S. Census Bureau n.d.). As population continues to increase, threats to the state's wetlands will intensify.

Wetlands in Rocky Mountain National Park

In RMNP, wetlands provide important aesthetic values and are highly regarded by visitors. Along with alpine tundra, wetlands are likely the most recognizable resource in the park, largely because of their importance to elk, which are perhaps the signature large mammal species in the park (Schweiger et al. 2019). Wetlands also provide critical habitat for beaver, a keystone species currently at very low numbers in the park, and moose, which can have pronounced effects on wetlands and have a growing population. Wetlands only make up approximately 3.8% of RMNP (Schweiger et al. 2019), but include a wide variety of wetland types that are recognized for their numerous important ecological functions (Cooper and Sanderson 1997; Mitsch and Gosselink 2007; Naiman, Decamps, and Pollock 1993; Stohlgren et al. 1997). The National Park Service Rocky Mountain I&M Network conducts long-term monitoring of wetlands in RMNP as part of its natural resources vital signs monitoring program (Figure 1). Vital signs monitored in wetlands include weather and climate; water chemistry; freshwater communities; invasive/exotic plants and aquatic biota; wetland communities; vegetation composition, structure, and soils—including soil structure, erosion potential, and nutrient function; focal species; and landscape dynamics such as connectivity and fragmentation (Britten et

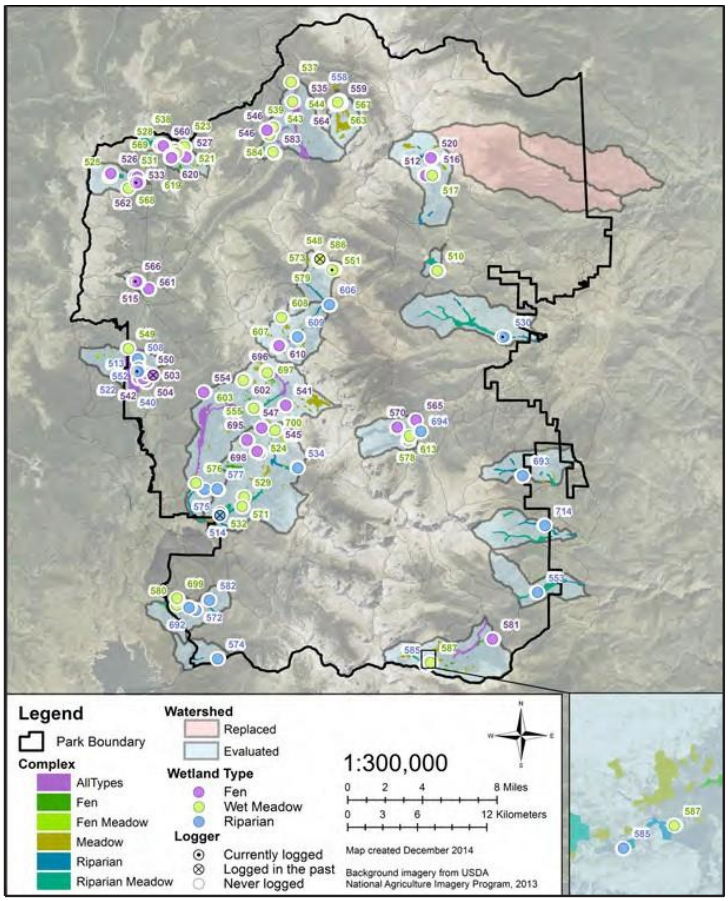

Figure 1. Wetland sites monitored in RMNP by the Rocky Mountain I&M Network. A complex is an area where multiple types of wetlands are present at one site. The color of the complex denotes the dominate type of wetland at that site (Schweiger et al., 2015).

al. 2007). The I&M Network also monitors indictors of anthropogenic disturbance in wetlands.

The I&M Network found that approximately half of the wetlands in the park are not in reference condition due to anthropogenic disturbances, which often occur beyond park boundaries (Schweiger et al., 2016). Wetlands in RMNP are threatened by a complex history of human disturbance including alteration of hydrologic regimes; elimination of elk, wolves, and grizzly bears followed by reintroduction of elk absent their primary predators; and extirpation of beaver (Schweiger et al. 2016). More recently, nonnative moose were introduced to the region and have expanded into the park. These

anthropogenic disturbances influence wetland integrity in RMNP. Ecological integrity is defined using four attributes: (1) ecosystem structure and/or processes are maintained at a predefined baseline level; (2) a system is permitted to change unaffected by human influence; (3) the preservation of an organizing or self-correcting ability of an ecosystem; and (4) the maintenance of ecosystem qualities deemed desirable by society (Wicklum and Davies 1995). Resilience—the amount of disturbance that the system can absorb without a change in structure and composition (Carpenter et al. 2001; Gunderson et al. 2006; Holling 1973) —is also influenced by anthropogenic disturbance. In order for a wetland system to function properly and withstand change, it must maintain integrity and resilience.

The I&M Network measures wetland integrity in RMNP using indicators such as conservatism (a species' degree of fidelity to a specific habitat or range of environmental conditions (Herman et al. 1997; Matthews, Spyreas, and Long 2015)), degree of invasion, and cover of native forbs (Schweiger et al. 2016). These indicators are impacted by anthropogenic disturbances that surpass the boundaries of the park. For example, hydrological alterations play a critical role in influencing conservatism and degree of invasion, but include larger-scale attributes such as total number of diversions in a wetland's watershed and the percentage of a wetland's surface water hydrological network that is upstream of diversions (Schweiger et al. 2016). Water for wetlands in the Western United States, including Colorado, is not guaranteed due to water laws that give priority to water rights holders based on date the water was put into use (Frank et al. 2016; Welsh et al. 2013; Downard, Endter-Wada, and Kettenring 2014). These water rights owners are allowed to build facilities on the land to divert, extract or move water

from a stream or aquifer to its place of use. Since streams and aquifers are often the source of a wetlands' water supply, integrity of the wetland depends on how water rights are allocated and the diversions put in place by water rights holders (Welsh et al. 2013; Downard, Endter-Wada, and Kettenring 2014). Another example is native forb cover affected by elk and moose populations whose ranges span across park boundaries. Due to the scale of these disturbances, stewardship of wetlands should expand beyond park boundaries to maintain integrity and resilience.

For wetlands, anthropogenic factors are often the major pressures affecting both the structural organization and functional characteristics of the ecosystem. Using the Drivers-Pressures-State-Impacts (DPSIR) model, management problems and solutions can be simplified into variables that stress the cause and effect relationships among human activities, the condition of wetlands, and society's response to this condition (Lin, Xue,

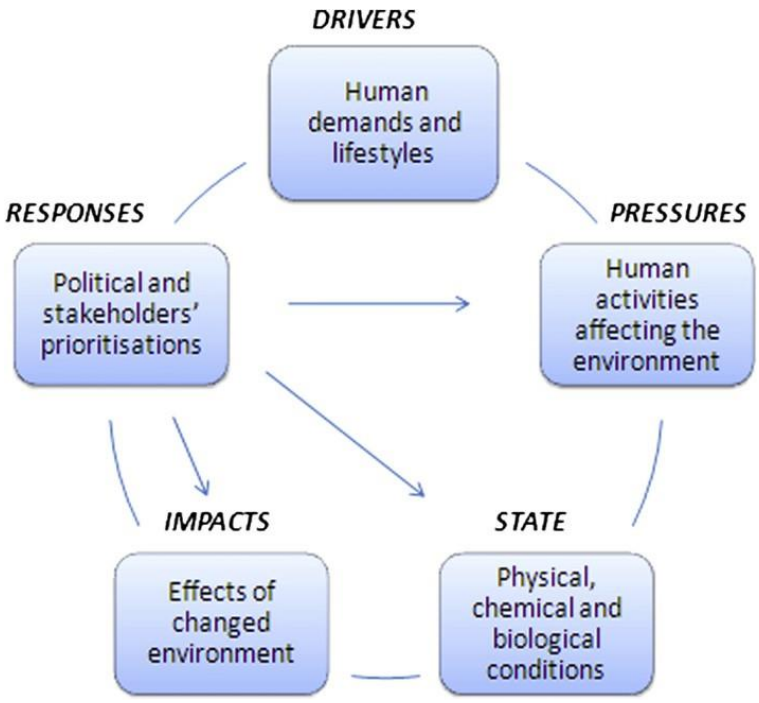

Figure 2. The DPSIR model framework (Sekovski, Newton, and Dennison 2012).

and Lu 2007). This model can be used to trace changes in wetlands over time by looking at the drivers to change and evaluating the impacts of these changes. Within the DPSIR model, drives are defined as underlying factors causing or influencing a variety of pressures on wetlands. Pressures are defined as the variables that directly cause the changes in wetlands. State is the measure of the physical, chemical, and biological conditions within the ecosystem. Impacts describe the effects of changes in wetland states on measures of ecosystem function and response is defined as the efforts of society to solve the problems resulting from changes in wetland function (Figure 2) (Lin, Xue, and Lu 2007; Sekovski, Newton, and Dennison 2012).

For wetlands in RMNP, the drivers, pressures, state, and impacts are monitored by the I&M Network, but the responses by managers within the park and across the park's boundaries need to be better understood. The DPSIR model can also be used to understand the cause and effect relationship of human activities and wetland conditions in other jurisdictions beyond the boundaries of the park to determine if those jurisdictions are experiencing the same changes in wetland structure and function, the drivers of those changes, and their impacts on wetland integrity.

Ecosystem Management

Most protected areas are part of a larger ecological system, in which interactions with surrounding lands are critical for sustaining the species and ecological processes present within them (Davis and Hansen 2011). However, the boundaries of most U.S. protected areas, such as national parks, were established to provide scenic or recreational values rather than to support organisms or ecological processes (Pressey, 1994). Consequently,

many protected areas are not large enough to encompass natural processes, such as hydrologic and ecological connections between wetlands and within watersheds, in their borders (Davis and Hansen 2011). In addition, as ecological flows and some species' distributions respond to changing climates (Parmesan and Yohe 2003), understanding and accommodating movements outside protected-area boundaries becomes more vital.

Interest in connections between national parks and surrounding lands has increased in recent decades as a result of several factors (Hansen et al. 2011), including threats from climate change, and have led many resource professionals to embrace management at larger scales that involve multiple ownerships (Johnson et al. 1999). One way researchers have explored management at larger scales is by defining protected-area-centered ecosystems (PACEs). PACEs have been defined across the U.S. as a way to identify ecologically relevant boundaries that correspond to ecological flows, crucial habitats, effective size, and human edge effects in and around protected areas (Hansen et al. 2011). RMNP is one protected area in the U.S. that has been situated within a larger PACE (Figure 3). Other researchers have defined "greater ecosystems" around protected areas, such as national parks. The Greater Yellowstone Ecosystem is the most prominent example encompassing national parks, national forests, wildlife refuges, Native American reservations, BLM lands, and state and private lands (Glick and Clark 1998). This area was originally labeled as the Greater Yellowstone Ecosystem by researchers that found that the range of Yellowstone grizzlies covered far beyond the administrative boundary of Yellowstone National Park (Craighead 1979). Later, other researchers found that many of the park's other species also utilized habitats outside the park and even the geothermal

features depended on ground water recharge areas well beyond the park's boundaries (Greater Yellowstone Coordinating Committee and Williams 1987).

Just like Yellowstone, the boundaries of RMNP do not encompass the ranges of many species and flows of ecological processes. Connectivity between streams, wetlands, and downstream waters is especially important for wetland processes including chemical, physical, and biological integrity (Leibowitz et al. 2018). Human activities frequently reduce connectivity such as the building of dams, levees, and piping. Streams, wetlands, and the human activities that alter their connectivity often span across multiple jurisdictions. The species that depend on wetlands and the ecological and hydrologic processes that support wetlands extend beyond the boundaries of RMNP and require management at a larger scale involving multiple ownerships. Therefore, more effective stewardship of wetlands within the park is more likely to be achieved through cross-boundary efforts that account for wetland sustainability while acknowledging the differing missions and goals of land management entities that share responsibility for those wetlands. For the purposes of this research, the greater RMNP ecosystem refers to the general area surrounding the park in which there are hydrologic and ecological connections to the park.

Cross-boundary Stewardship

The greater RMNP ecosystem is made up of many different jurisdictions, each with their own boundaries, forming a mosaic of lands owned by different entities and used for different purposes (Figure 3). Administrative borders or boundaries are lines that separate different ownerships, jurisdictions or responsibilities, and often different

management philosophies, goals, and practices (Landres et al. 1998). Imposed for a variety of reasons (e.g. historical, political, economic, or social) boundaries have many intentional and unintentional effects on surrounding lands. When different land-use practices are imposed on different sides of the thin line of an administrative border, a distinct ecological boundary zone is inevitably formed that can filter, block, or concentrate movements of things such as animals, seeds, fire, wind, water, nutrients, and invasive species (Landres et al. 1998; Epanchin-Niell et al. 2017). These effects isolate areas from one another, causing changes in ecological conditions and processes on the lands on either side of the boundary.

Boundaries not only have ecological effects, but also impact the social dynamics of a system. All boundaries are social constructs, marking human-perceived differences in nature and identity of places (Brunson 1998). Social boundaries are typically governed

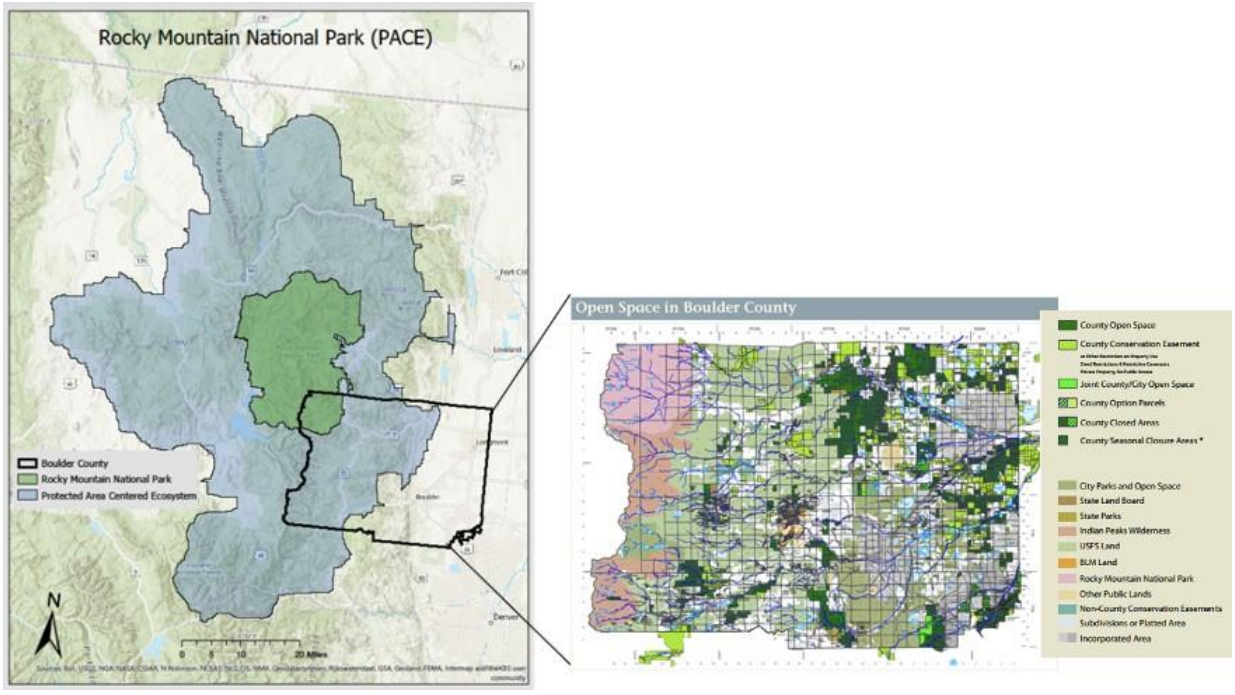

Figure 3. The RMNP PACE contains many different landownerships. The map on the right shows the mosaic of lands owned by different entities in Boulder County, one of the counties within the PACE.

by rules and conventions that define the terms of engagement between actors and organizations they simultaneously separate and connect (Meidinger 1998). Boundaries can make it difficult to coordinate behavior among individuals, organizations, and communities. Where ecological resources are shared, lack of coordination can lead to insufficient, inconsistent, or destructive resource management (Meidinger 1998). Boundaries can also impede and disrupt information flows among organizations, making it difficult for any actor to understand the full state of the system involved or its likely future. Many public agencies have responsibility for aspects of natural ecosystems which differ across boundaries depending of their mandates. "Agency cultures" also differ across boundaries and may place differing emphases on agency loyalty and responsibility to visitors and surrounding communities (Kennedy 1985). This has the possibility to create tensions that are not directed towards the maintenance of agency jurisdictional boundaries, but rather towards adopting an approach to management that is most consistent with each agency's "culture" (Brunson 1998). Jurisdictional boundaries can create problems, but they also perform useful functions.

Boundaries can slow the movement of disturbances and misguided policies from one entity to another, and thereby provide time for adaptive or corrective responses (Morehouse 1995; Naiman and Decamps 1990). Boundaries can also facilitate efficient resource and information flows within organizations and communities by delineating who is permitted and who is required to know about a given matter (Williamson 1985). Finally, boundaries can facilitate clear allocation of management control and responsibility, connecting actors to the consequences of their actions (Meidinger 1998).

Therefore, boundaries should be maintained, while employing cross-boundary stewardship between different actors to mitigate negative effects.

Theory of Cooperative Management

Cross-boundary stewardship requires coordinated behavior, which includes creating shared understandings and values (Meidinger 1998). Cooperation is one strategy for achieving stewardship across boundaries but can take on many different meanings. Researchers among different fields seldom agree on the definition of cooperation and even researchers within the same field have yet to come to consensus on the types of cooperative interactions. Some theorists categorize interaction terms broadly with little regard for definitions that distinguish them from other types of interactions (Keast, Brown, and Mandell 2007), while others describe cooperation, coordination, and collaboration as falling along a continuum of increased interaction (Bryson, Crosby, and Stone 2006; Keast, Brown, and Mandell 2007; McNamara 2012; Thomson and Perry 2006). In the context of natural resources, Plummer and FitzGibbon (2004) explain cooperation as an umbrella term that indicates the sharing of rights and

Table 1. A simple taxonomy of cooperative behaviors (Yaffee 1998).

Behavior Type	Definition
Awareness	Being cognizant of other' interests and actions
Communication	Talking about goals and activities
Coordination	Actions of one party are carried out in a manner that supports (or does not conflict with) those of another
Collaboration	Active partnership with resources being share or work being done by multiple partners

responsibilities rather than part of a continuum. Under the umbrella of cooperation, Yaffee (1998) describes different levels of interaction: awareness, communication, coordination, and collaboration. These levels are arranged into a taxonomy in which the level of effort and interaction increases as one moves down the taxonomy (Table 1). Yaffee's theory of cooperation (1998) will be further discussed in Chapter 2. For the sake of clarity, we refer communication, coordination, and collaboration broadly as cooperation until Chapter 3, in which we more carefully dissect interviewees' relationships.

Cross-boundary Stewardship for Water Resources

Cross-boundary stewardship of water resources, such as cooperative management of water quality and watersheds, has been widely studied in the past decade. Cross-boundary stewardship between federal and state agencies (Kininmonth, Bergsten, and Bodin 2015), nonprofit organizations (Nikolic and Koontz 2008), tribes (Chief, Meadow, and Whyte 2016; Cronin 2005), the local community (Koehler and Koontz 2008), and many other stakeholders has been explored. This research has measured and compared cooperative outputs including plans, projects, and other tangible items generated by cross-boundary efforts (Koontz and Thomas 2006) with governance structures (Diaz-Kope and Miller-Stevens 2015), organizational motivations (Diaz-Kope 2016), and participant interests (Henderson 2000). Scholars have demonstrated positive social outcomes of watershed collaboration, such as increased trust and social capital (Leach and Sabatier 2005; Lubell 2005), but relatively little research has linked outputs with

outcomes such as effects of cooperative outputs on environmental conditions (Koontz and Thomas 2006). Few studies have been conducted on cross-boundary wetland management from a social perspective (e.g., Kininmonth, Bergsten, and Bodin 2015; Olsson, Folke, and Hahn 2004), and more specifically management of montane wetlands, especially cooperation between federal agencies, like the National Park Service, and other stakeholders.

The growing interest in partnerships to sustainably manage water resources, such as wetlands, reflects the growing complexity of management issues worldwide (Margerum and Robinson 2015). One management issue of growing complexity and concern is resilience and integrity of wetland ecosystems. Wetland integrity in RMNP has been heavily influenced since the late 1800s by many factors, including direct human impacts to park hydrology (e.g., building drainage ditches and roads), over-concentrations of elk due to removal of large predators, loss of beaver, and, more recently, introduction of nonnative moose (Schweiger et al. 2019). The increasing role of climate change in altering wetland functions and values has also been recognized as a major impact on wetland integrity and resilience (Baron et al. 2000; Field et al. 2007; Schweiger et al. 2015). Protected area systems focused on wetlands, such as the U.S. National Wildlife Refuge System, cite cross-boundary stewardship as an important mechanism to meet the challenge of global climate change (Griffith et al. 2009). Griffith et al. (2009) states that because climate warming effects will persist for quite some time, the value of partnerships and collaborations for fulfilling the mission of conservation will become even more important than it is currently.

Partnerships are a key component of cross-boundary stewardship, but in practice they are highly complex enterprises that involve substantial investment to develop and maintain (Lubell et al. 2002). Cross-boundary stewardship requires a process of joint information analysis, goal setting, and building consensus for implementation (Huayhuaca and Reid, n.d.; Margerum and Robinson 2015). This can be a significant hurdle because different stakeholders have different needs, missions, and mandates. The challenge facing state and federal agencies is to determine the governance strategies or cooperative structures that will respond to partnership needs, while also confronting declining capacity and budgets (Margerum and Robinson 2015). In Chapter 2, this thesis will focus on addressing this challenge by identifying barriers and opportunities to achieving cross-boundary stewardship for continued wetland integrity and resilience in the greater RMNP ecosystem. Additionally, in Chapter 3, different types of cooperative arrangements used to manage wetlands in the greater RMNP ecosystem will be explored. Finally, in Chapter 4, we will discuss conclusions and make recommendations to achieve cooperative efforts that account for wetland sustainability while acknowledging the differing missions and goals of land management entities that share stewardship responsibilities of those wetlands.

Research Questions

How can cross-boundary stewardship be facilitated between RMNP and entities within the surrounding area to maintain wetland integrity and resilience?

a. What are the barriers and opportunities for cooperative management of wetlands between RMNP and other entities?

b. What cooperative structure can be used within the greater RMNP ecosystem to overcome barriers and take advantage of opportunities?

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CHAPTER 2

BARRIERS AND OPPORTUNITIES FOR COOPERATIVE MANAGEMENT OF WETLANDS IN THE GREATER ROCKY MOUNTAIN NATIONAL PARK ECOSYSTEM

Abstract

Long-term monitoring by Rocky Mountain Inventory and Monitoring Network found that approximately half of wetlands in Rocky Mountain National Park (RMNP), Colorado, USA are not in reference condition due to anthropogenic disturbances occurring beyond park boundaries. Therefore, more effective stewardship of wetlands within RMNP is likely to be achieved through cross-boundary cooperative efforts. Through semi-structured interviews with agencies, nonprofits, research organizations, and municipalities, barriers and opportunities for cross-boundary stewardship were identified. Results show that wetlands outside of RMNP are experiencing similar cross-boundary disturbances to those within the park. Though participants recognize that working cooperatively with neighboring jurisdictions can decrease the effects of boundaries on wetland integrity, they also reported that the most significant cross-boundary challenge is working with others. Based on these findings, we provide recommendations on how to address cooperative management challenges, while taking advantage of opportunities to facilitate cross-boundary wetland stewardship at the ecosystem-scale.

Introduction

Most protected areas are part of a larger ecological system, in which interactions with surrounding lands are critical for sustaining the species and ecological processes present within them (Davis and Hansen 2011). However, the boundaries of most U.S. protected areas, such as national parks, were established to provide scenic or recreational values rather than to support organisms or ecological processes (Pressey, 1994). Consequently, many protected areas are not large enough to encompass natural processes, such as hydrologic and ecological connections, in their borders (Davis and Hansen 2011). In addition, as ecological flows and some species' distributions respond to changing climates, understanding and accommodating movements outside protected-area boundaries becomes more vital (Parmesan and Yohe 2003). Interest in connections between protected areas and surrounding lands has increased in recent decades as a result of several factors (Hansen et al. 2011), including threats from climate change, and have led many resource professionals to embrace management at larger scales that involve working across boundaries with multiple ownerships (Johnson et al. 1999). This is referred to as cross-boundary stewardship and is necessary for many different types of resources, including forest and fire management (Bergmann and Bliss 2004), wildlife (Forbes and Theberge 1996), and water resources (Rickenbach and Reed 2002).

Cross-boundary stewardship requires coordinated behavior between actors to address complex management issues. One management issue of growing complexity and concern is resilience and integrity of wetland ecosystems. While the ecosystem services delivered by wetland are diverse and widely recognized (Mitsch and Gosselink 2007; Schweiger et al. 2019; Sutula et al. 2006), wetlands are often severely fragmented.

Protecting or restoring wetland connectivity often requires interaction among managing agencies since the demarcation of individual governance boundaries rarely reflects broader scale wetland ecological connectivity (Bergsten, Galafassi, and Bodin 2014). Along with connectivity between wetlands, many disturbances effecting wetland integrity occur beyond jurisdictional boundaries of managing entities, requiring cross-boundary stewardship. Protected area systems focused on wetlands, such as the U.S. National Wildlife Refuge System, cite cross-boundary stewardship as an important mechanism to address disturbances that cross protected-area boundaries, including climate change (Griffith et al. 2009). Griffith et al. (2009) state that because these effects from disturbances can persist for quite some time, the value of partnerships and collaborations for fulfilling the mission of conservation will become even more important than it is currently. Despite the urgency for cross-boundary stewardship of wetlands, few studies have been conducted on collaborative wetland management (Kininmonth, Bergsten, and Bodin 2015; Olsson, Folke, and Hahn 2004), more specifically management of montane wetlands, especially collaboration between federal agencies, like the National Park Service, and other stakeholders.

In this chapter, we provide an overview of cooperative management and present a case study in the greater Rocky Mountain National Park ecosystem through which barriers and opportunities to achieving cooperative management for wetland integrity and resilience are identified. Additionally, recommendations are provided to overcome these barriers while taking advantage of opportunities to achieve cooperative efforts that account for wetland sustainability while acknowledging the differing missions and goals of land management entities that share stewardship responsibilities of those wetlands.

Theoretical Framework

Cooperation refers to individuals organizing and governing themselves to obtain joint benefits (Ostrom 1990) and indicates the sharing of rights and responsibilities (Plummer and FitzGibbon 2004). In broad terms, cooperation can be considered a spectrum of behaviors from being cognizant of others' interests and actions, talking about goals and activities, taking actions that support those of another entity, and active partnerships with resources being shared or work being done by multiple partners (Yaffee 1998). There is no one right way to accomplish cooperative interactions. Rather, effective cooperation in resource management involves a variety of types of interactions that are implemented at different scales (Mandell and Steelman 2003; McNamara 2012; Yaffee 1998). For some problems, effective cooperation may come from the interactions of a scientist and manager within a single unit or a single agency. For other situations, complex, multiparty, structures may be appropriate.

Cooperation in building working arrangements across boundaries can be understood as a series of forces promoting and restraining appropriate behavior (Yaffee 1998). This model (Figure 4) envisions a cooperative effort as consisting of a center (the collective effort, its goals, resources, and activities) and a periphery (the individuals, groups, and organizations that potentially contribute to the cooperative effort). Each of these groups is pulled by countervailing forces. Some termed centrifugal, because they pull away from the center, encourage individuals to act on their own in a way that restricts or opposes the efforts of the collective. For the purposes of this research, these will be viewed as barriers to cooperation. Others termed centripetal, because they push

the groups toward the center, promote cooperative interaction. For this research, these will be viewed as opportunities for cooperation or ways to overcome barriers and facilitate cooperative interactions. There is an ongoing tension between these forces and the success of cooperative efforts depends on the centripetal, or opportunities, outweighing the often considerable centrifugal forces, or barriers. To promote cooperation across boundaries, managers can seek to foster the forces that facilitate cooperation or minimize those that oppose it.

With some notable exceptions (e.g., Yaffee 1998), much of what has been written about cross-boundary cooperation has not been drawn from empirical data focused on cooperation between multiple public jurisdictions, but rather cooperation amongst private

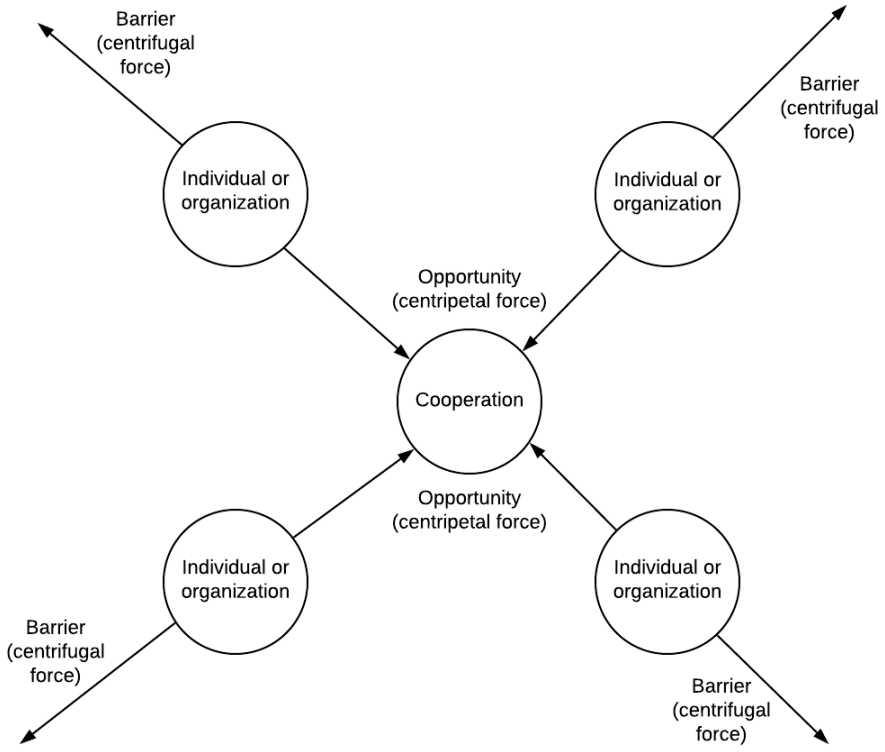

Figure 4. Forces acting on individuals or organizations as barriers to and opportunities for cooperation. Adapted from Yaffee 1998.

landowners (Yung and Belsky 2007; Finley et al. 2006) or between the private landowners and public land management entities (Ferranto et al. 2013; Fischer and Charnley 2012; Fischer, Klooster, and Cirhigiri 2019). Many of these studies examine the factors that affect the development of cooperation. Bergmann and Bliss (2004) identified five key factors affecting cooperation among stakeholders including trust, uncertainty, ideology, power, and land tenure. Research has also examined the outcomes of cooperation, including benefits that actors receive from cooperative arrangements. Fischer, Klooster, and Cirhigiri (2019) found that landowners and forest managers participated in cooperative management to obtain joint benefits, including improved management knowledge and skills, increased access to information and resources, reduced financial and physical burden, and expanded extent of management. In response to the growing body of literature on cross-boundary cooperation and the small number of empirical studies on multi-jurisdictional arrangements, especially for the management of wetland resources, this research aims to add perspectives from state and federal agencies, research organizations, county municipalities, and nonprofits and focusing on a particular resource of concern, wetlands.

Case Study in the Great Rocky Mountain National Park Ecosystem

Rocky Mountain National Park (RMNP), established in 1915, is a ~415,000-acre protected area that straddles the Continental Divide in north-central Colorado (NPS, 2013). Most of the park, just miles from the largest urban area in the Rocky Mountain region, is designated wilderness. Its complex topography and wide range of elevation also results in remarkable ecological diversity. The park shares its borders with three national

forests administrated by the USDA National Forest Service: Arapaho National Forest, Roosevelt National Forest, and Routt National Forest; the cities of Grand Lake and Estes Park; and private, state, and county land. Several river systems originate in the park, including the Colorado River and the Cache la Poudre River (Schweiger et al. 2019). RMNP is also made up of a matrix of watersheds, many of which extend beyond the park's boundaries. Watersheds located on the east and west sides of the park, which would otherwise be naturally separated by the continental divide, are connected by water diversion structures, such as the Colorado-Big Thompson Project.

A few watershed and wetland coalitions operate in the Front Range Urban Corridor, the populated region east of the mountain range that extends through the central portion of Colorado. Each watershed coalition has a unique mission and different stakeholders, but all focus on river and riparian health. Along with watershed coalitions, many agencies and other organizations focus their efforts on wetland integrity throughout the region. For the purposes of this research, the greater RMNP ecosystem refers to the general area surrounding the park, including the Front Range, in which there are hydrologic and ecological connections to the park (Figure 5).

In RMNP, wetlands support a majority of the biodiversity, but only make up a small portion of the park (Schweiger et al. 2019). Wetlands in RMNP are made up of a wide variety of types and provide numerous important ecological functions (Cooper and Sanderson 1997; Mitsch and Gosselink 2007; R. Naiman, Decamps, and Pollock 1993;

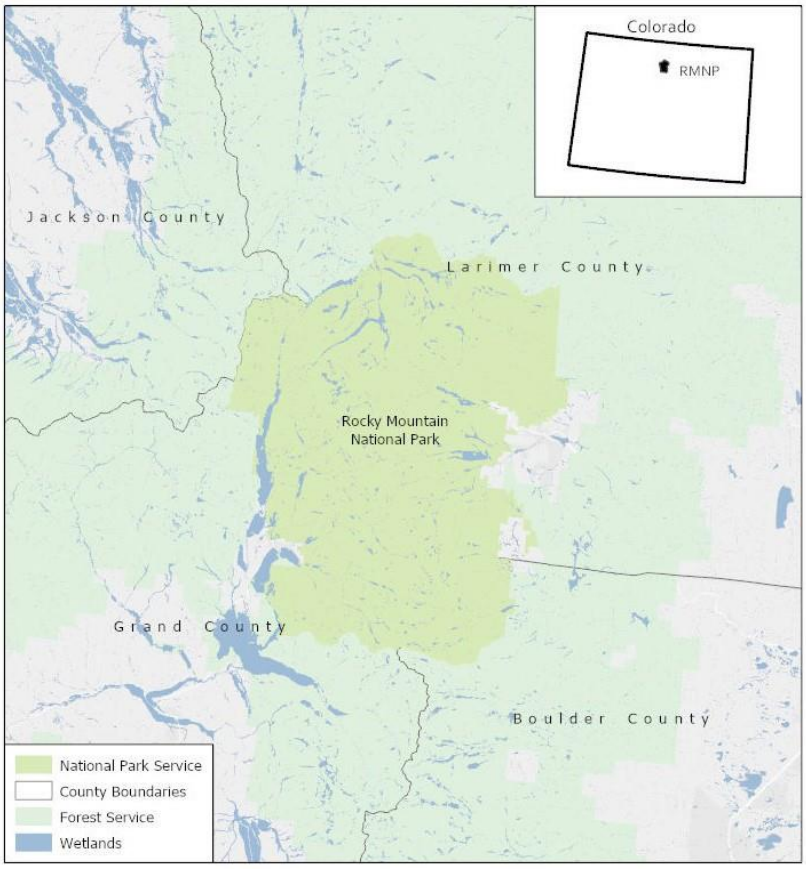

Figure 5. The greater RMNP ecosystem consists of multiple land ownership types, simplified here for visual clarity. Each jurisdiction contains wetlands that are connected by hydrologic, ecological, and manmade processes.

Stohlgren et al. 1997). The National Park Service Inventory and Monitoring (I&M) Network conducts long-term monitoring of wetlands in RMNP as part of its natural resources vital signs monitoring program. The I&M Network found that approximately half of park's area classified as wetland is not in reference condition (Schweiger et al. 2016) due to anthropogenic disturbances, which often occur beyond park boundaries. Wetland integrity in RMNP has been heavily influenced since the late 1800s by many factors (Schweiger et al. 2019), including direct human impacts to park hydrology (e.g. building drainage ditches and roads), over-concentration of elk due to removal of large predators, loss of beaver, and, more recently, introduction of nonnative moose.

A mismatch between the boundaries of the protected area and the ecological processes the area is intended to protect is allowing impacts from anthropogenic disturbances to affect wetland integrity in RMNP. This research explores ways to address this mismatch through cooperative management, which views the protected area as situated within an ecological system that extends beyond its boundaries.

Methodology

We used a qualitative research design characterized by semi-structured interviews and thematic analysis to determine barriers and opportunities for cooperative management within our case study. Semi-structured interviews were used to facilitate an understanding of the topic from the participants' perspective and aid in uncovering the meaning of people's experiences by allowing for the development of rich descriptions and the integrations of multiple points of view (Creswell 2013; Montello and Sutton 2013). Interviews consisted of 22 open-ended questions that inquired about the effects of jurisdictional boundaries on wetland ecological processes and conditions, barriers to cooperative wetland management, and the institutional and social contexts in which cross-boundary stewardship efforts operate (Appendix A). A total of 22 interviews were conducted with representatives from federal and state agencies, wetland research organizations, county municipalities, and non-profit organizations involved in wetland stewardship (Table 2). The selection of interviewees was based on purposive sampling of participants that work directly on wetland management within the study area, which provided an information-rich data set by targeting key actors in each agency and organization (Creswell 2013). In addition, snowball sampling was used, in which

interviewees identified others with special knowledge or experience related to the study questions (Biernacki and Waldorf 1981). Interviews were conducted until saturation was reached, meaning no new information was communicated by the participants (Rudestam and Newton 2015). Five interviews were conducted in person for participants that were available during field work in July 2019. The remaining interviews were conducted over the phone from August-October 2019. With the consent of interviewees, the interviews were tape-recorded, and notes taken. Interview duration ranged from 30 to 75 minutes. Interviews and field notes were transcribed verbatim.

Table 2. Participant profile

Entity-type	Number of interviews conducted	Gender		Years in current position (mean)
		Male	Female	
Federal agency	9	4	5	6
Nonprofit organization	7	4	3	10
State agency	2	1	1	13
Research organization	2	1	1	14
County municipality	2	1	1	9

Data analysis involved generating themes from the data by using a systematic, iterative process to of coding in ATLAS.ti (Creswell 2013; 2009; Miles, Huberman, and Saldana 2019; Saldana 2009; Hwang 2008). This technique utilized an inductive data analysis process that built codes, categories, and themes by organizing data from multiple sources into increasingly more abstract units of information. Transcripts were read and memos (short phrases, ideas, or key concepts) were written to start the initial process of exploring the data. Next, data were described, classified, and interpreted through the

formation of codes (labels attached to units of data that assign symbolic meaning). Coding was divided into two major stages: first cycle and second cycle coding. During the first cycle of coding, concept codes (words or short phases that represent meaning broader than a single item or action) and a priori codes developed directly from interview questions were used. Second cycle coding utilized pattern codes to group information into categories and themes. Pattern codes are inferential or explanatory codes that pull material from first cycle coding into more meaningful units of analysis. Code definitions were developed to ensure consistency and precision throughout the coding process. After coding was complete, data was represented and visualized through networks, diagrams, and matrices of themes and categories. These visualizations helped conceptualize and represent the main findings of the study.

Results

The study findings below highlight key dimensions and themes related to cross-boundary influences on wetland integrity and strategies to facilitate cooperative management to address those influences. Interview excerpts are included to demonstrate these themes. First, participants' descriptions of the effects of jurisdictional boundaries on ecological processes in the wetlands they steward are presented. Second, barriers to developing and maintaining cooperative management are presented with perspectives from different entity types. Third, methods identified by interviewees as ways to overcome those barriers to achieve cooperative management are presented.

Cross-boundary Influences on Wetland Integrity

In RMNP, researchers found that disturbances beyond the park's boundaries are affecting the integrity of wetlands inside the park. To better understand how wetlands in other jurisdictions are affected by cross-boundary disturbances, we asked participants how conditions across boundaries influence the wetlands they steward. Every participant identified disturbances that cross jurisdictional boundaries, impacting the ecosystems they manage, including influences from different water uses and management practices, population growth, and climate change. One participant identified the effects of water diversions on an area under their jurisdiction by stating that "if you are allocating water or taking water out of a river upstream, it does influence the hydrology downstream and it affects wetlands." Another participant responded that "the wildlife crosses boundaries, the water crosses boundaries, and the recreation crosses boundaries." Different management practices of wildlife, water or recreation on different jurisdictions can create ecological integrity concerns. As one participant described,

> There's a lot of fence-line contrast where management on one side of the fence is different from management on the other side. You can really see that in the vegetation, integrity of the soil, and ground surface.

Participants were also asked what future changes they anticipate that could influence their ability to achieve wetland stewardship goals. Climate change and local population growth were identified as major influences on wetland stewardship, including how entities work together to address these issues. One participant expressed her concern,

> We are going to be facing increasing impacts of climate change and we know that wetlands are critical for keeping water on the landscape. We know that they are critical biodiversity hotspots. We know that there are a lot of legacy impacts to wetlands, as well as the ones happening right now. So, I feel like eventually we will wish we did more in terms of working together.

Another participant stated, “I think the growth of Colorado on the Front Range is going to have a huge influence on who we partner with and how we do it, absolutely.”

Participants are also concerned about the increased development that comes with a growing population. One participant describes the impacts of development on water resources,

> Then as water resources become more regulated, which they are going to have to be because of all the growth…people are saying we need to build more reservoirs to store water when there’s an excess. Those kinds of changes in the way water rights are used could really have dramatic impacts on streams and wetland areas.

Participants identified a variety cross-boundary influences on wetlands under their jurisdiction and anticipated future changes that could affect their ability to steward these ecosystems. Though participants recognized that working cooperatively with neighboring jurisdictions can decrease the effects of boundaries on wetland integrity, they also reported that the most significant cross-boundary challenge is working with others.

Barriers to Cooperation

Agencies and organizations face many barriers to developing and maintaining cooperative management arrangements. These barriers including limited resources, differing goals and missions between entities, organizational silos, public perception, and lack of large-scale cooperative programs.

Limited Resources

The barrier identified most often by all agencies and organizations was limited resources including funding, staff, and time. Funding was cited by participants as the

biggest challenge, including limited funding within an entity and restrictions to sharing funding between entities. A participant stated that "sometimes funding is limited to one type of land ownership or another and that can get in the way of working across boundaries." Another participant explained this challenge further,

> When we do projects it just takes a lot to make all of our different monies match. Ducks Unlimited here in Colorado operates primarily off of grants and not off of their own internal funding. So, we've got to wait for their grant cycling schedule to match with grants from my agency or grants from Colorado Parks and Wildlife… It just makes work a whole lot slower.

Participants stated that many federal and state management agencies have lost staff in recent years. This leads to diminished capacity to attend meetings, apply for funding, and work on projects. Reductions in staffing can also lead to local offices being closed, leaving large areas of the state without representation from an agency or organization. As one participant stated,

> It's about having appropriate personnel in appropriate positions across a boundary…If there is no one covering whatever resource in a certain geographic area, there's no one there to collaborate with.

The final resource limitation participants identified was time. This is closely related to staffing reductions and can lead to diminished capacity to apply for funding.

Differing Goals and Missions

Another barrier to cooperation is differing goals and missions between agencies or organizations. Goals and missions of entities often differ in scope, or the extent of subject matter that is relevant to a specific entity. For example, one land management agency may have a dual mandate, to protect natural resources and provide recreation,

while another agency hay have a multi-use mandate. One participant describes differences in scope between missions of wetland stewardship entities,

> We are more focused on ecosystem-level restoration, whereas sometimes you have an organization that might be more singularly focused on wildlife or more singularly focused on even certain species of wildlife.

Goals and missions can also differ in geographic scale. Fulfilling the mission of some organizations requires work across an entire state or region, while the mission of another organization may only require work in one watershed or along one river corridor.

These differing missions can lead to different ways of approaching management, as one participant explains, "I would say it isn't usually the end goal that is so different, it's the methodology on how to get there and the perspective that is brought." In order to work cooperatively, entities need to understand each other's mission and work to find a mutual end goal.

Organizational Silos

The development of organizational silos, or the mindset that you must adhere strictly to the duties within your department or organization, is a barrier to working cooperatively. One participant describes this challenge,

> It's that siloization of each of the organizations. [They] have their own set of rules and regulations and the challenges are those organizations busting out of those and trying to do something that could help the stream or wetland across boundaries.

Organizational silos contribute to the mentality of an organization or agency. One participate questioned, "is there a mentality of working in collaboration and working together or is there an insular mentality where they want to keep to themselves?"

Silos often form in larger agencies and organizations that have hierarchical structures, as one participant describes, “You know the hierarchy when you get up to the federal government, there tends to be sort of more rigidity in what they can and can’t do.” Another participant further describes this challenge,

> These public land management agencies, they don’t have a lot of incentive from their superiors to look across boundaries. They don’t have a lot of experience or don’t expose folks coming through their training [to cross-boundary management]. They get into these positions and then there’s a lot of anxiety and fear of doing things differently.

This also leads to barriers for employees that want to work cooperatively with other entities, but don’t have agency support. As one participant describes, “if they don’t have the support of their organization, a lot of times they might want to do something but might not really be able to.” Organizational silos can potentially be broken down by providing organizational support to work across boundaries.

Public Perception

All challenges to cooperation stated thus far were identified by participants from all types of entities included in this study: federal and state agencies, county municipalities, and non-profit organizations. A barrier unique to federal agencies and county municipalities is public perception. These entities have a responsibility to serve public interests, which creates additional considerations when making cooperative management decisions. One participant describes the challenges to implementing new management practices,

> We’ve definitely gotten inquiries about reintroducing beaver or doing simulated beaver structures, but we need to do it strategically. A lot of really good work in the [organization] happens with pilot studies…

> sometimes it's about helping build acceptance and considering the reaction of the people.

Not only do these entities have to consider the reaction of the public, they often have to implement public outreach programs and comment periods as one participant describes,

> There's certain topics that tend to be more controversial than others and what we have found here is that tends to be more wildlife management based… so that is challenging, and you can address that through communication and education.

This participant further explained, "You have to engage the folks that are interested in being engaged because these are controversial issues and folks want to be heard." Considering public perception can sometimes lead to longer timelines for project development and implementation, creating challenges to working with other entities.

Lack of Cooperative Program

Participants identified lack of a large-scale cooperative program as a barrier to cross-boundary wetland stewardship. In Colorado, there is no state-level program that supports cooperative wetland management for organizations focused on wetland benefits other than wildlife habitat. One participant stated,

> We would like to have some kind of formal wetland coalition or body across the state that meets on an annual basis or some kind of formal wetlands-specific communication. We don't have that yet, but it's a goal.

She went on to say that "reliable funding for a statewide initiative is one of the biggest barriers" to long-term cooperative management of wetlands between diverse organizations. Without a cooperative program that considers a broad set of wetland interests, organizations and agencies lack a channel to share information and discuss management.

Overcoming Barriers to Cooperation

The barriers to cooperative management identified above can be overcome by understanding what benefits agencies and organizations gain from working together, how entities define successful cooperation, and how current cooperative arrangements have prevailed despite the challenges.

Benefits to Cooperation

The benefit to cooperation most often identified by participants was sharing or exchanging resources, such as funding and skills. Funding can be shared by pooling resources between entities, working with entities that have access to additional funds, or applying to grants together. One participant explained the funding benefits her organization provides to partners,

> As a group and partner, we can apply for and acquire grant funding, foundation funding, and maybe pots of money that the city and county aren't able to access or don't have time and staffing to access.

Many grants are awarded based on strength of partnerships and sometimes require matching funds which applicants often obtain by working cooperatively with others.

Along with funding, each organization can also bring a different set of skills to cooperative management, as one participant described,

> Ducks Unlimited has really top-notch wetland engineering capabilities that my organization doesn't have, so as much as possible we rely on Ducks Unlimited to do our engineering.

These additional resources can help entities accomplish more stewardship activities, as one participant explained,

> We try to find partnerships wherever we can recognizing that the more expertise and more funding opportunities that we can have at the table, the more we can hopefully get done.

Participants recognize that not only can they get more done by working cooperatively, but they can also extend the scale of their impact. One participant described their experience working cooperatively to achieve landscape-scale conservation,

> We have had more draw to the area when we worked on a project, say, in northeastern Colorado on the South Platte where there was some Bureau of Reclamation-owned water or lakes and also a state wildlife area. Knowing that we have this kind of larger landscape-scale wetland complex that we are complementing and not just restoring a wetland in the middle of nowhere definitely had an appeal.

Another benefit of cooperative management is learning from other organizations, as one participant explained, "Sometimes they come to the table with really good ideas that you didn't think of because you were in your bubble of doing the same thing you would do." Working with others brings diverse perspectives to management, allowing entities to learn from one another and gain additional skills.

Defining Success in Cooperative Management

Overall, participants used many characteristics to define success in cooperative management. The definition of successful cooperation varied significantly within entity type, illustrating that characteristics used to determine success are based on the individual. Despite this variation, major themes included meeting objectives, open communication, trust between entities, and developing a lasting partnership. The majority of participants stated broadly that meeting their project objectives or the objectives of the group has made cooperative management successful. Improvement in the ecological conditions specific to the entity's goals and missions, such as improvement in wildlife

habitat or water quality, was often mentioned as part of these objectives. One participant explained that along with meeting your own objectives, it is important to understand the objectives of your partners,

> I think a partnership is successful when the parties involved have a good understanding of each entity's goals and objectives and their motivation for being involved. By a better understanding of where each entity comes from, they can find the places where there is overlap.

Honesty, trust, and transparency among partners were also identified as characteristics defining successful cooperation. One participant stated that,

> Building trust is the first thing that makes [a partnership] successful. If you say you're going to do one thing and do another, there goes the partnership right then and there.

Another participant explained that "being able to communicate honestly and openly" is important for cooperative management. He went on to say,

> I have seen situations where you see folks are communicating a lot, but there's a lot of things that aren't being said. It's important you guys are able to be comfortable with each other so that if you do have discrepancies, you can work through that instead of pretending they don't exist because you can't solve a problem that you won't acknowledge.

According to participants from nonprofit organizations, sustainability of the partnership is what makes cooperative management most successful. One participant explained that cooperation is successful "if that partnership endures beyond the project or the policy that we are pushing forward."

Learning from Current Cooperation

Participants that are currently involved in cooperative wetland management shared their experience and offered advice. Participants stated that there is often one

individual or a small group of individuals that lead and maintain the cooperative arrangement. As one participant explained,

> It often comes down to like is there one mover and shaker that is willing to keep everybody organized that comes around the table for meetings and to discuss partnership opportunities both generally and for specific restoration projects.

Many organizations have liaisons to help facilitate connections between agencies and organizations. This often happens at the field level, such as scientists, specialists or "on-the-ground" managers. One participant stated that a wetland stewardship entity has a transportation liaison to help facilitate cooperation between their organizations.

Finding common ground and understanding that everyone is coming to the table with a different perspective are also important aspects of cooperative management, as one participant explained,

> Making sure collaborative partners are on the same page about why they are there regardless of whether they agree or not. Everyone around the table doesn't have to agree about everything, but that people see shared value… and that you can keep communicating.

Another participant stated,

> I think it's great that everyone has different opinions and different visions for the future and then also having an understanding of once you get to the planning part that you might not get everything you want out of it. It's about compromise… and seeing how you can find that common ground.

Discussion

The greater RMNP ecosystem case study findings show that many organizations and agencies are faced with managing the impacts of jurisdictional boundaries on wetland ecological systems, including different management practices and water uses, and are concerned about continuing impacts from climate change, population growth, and

development. One participant explained that when water is taken out of a river or stream, it has negative impacts on the water system downstream, which often includes wetlands. Water for wetlands in the Western United States, including Colorado, is not guaranteed due to water laws that give priority to water rights holders based on date the water was put into use (Frank et al. 2016; Welsh et al. 2013; Downard, Endter-Wada, and Kettenring 2014). This includes domestic, municipal, agriculture, industry, recreation, wildlife, and in-stream water uses. Water rights owners are allowed to build facilities on the land to divert, extract or move water from a stream or aquifer to its place of use. Since streams and aquifers are often the source of a wetland's water supply, integrity of the wetland depends on how water rights are allocated and the diversions put in place by water rights holders upstream (Welsh et al. 2013; Downard, Endter-Wada, and Kettenring 2014). In order to ensure that wetlands have enough water to function, entities must cooperate across boundaries with those that hold water rights for different uses.

Findings also show that entities are willing to work together to address cross-boundary issues but must overcome barriers to developing and maintaining cooperative wetland management. In some cases, the benefits of cooperation outweighed the barriers and participants were able to achieve successful cross-boundary stewardship. From this research, we compiled a list of common challenges and corresponding solutions to assist entities in developing and maintaining cooperative management arrangements (Table 3). The barriers and methods to overcome them identified in this study are consistent with findings from previous research on cooperative management (Yaffee 1998). While many

Table 3. Summary of barriers and potential solutions to overcome barriers and achieve cooperative wetland management. This table shows the challenges and corresponding solutions identified by participants in our greater RMNP ecosystem case study.

Barriers and Potential Solutions to Cooperative Management	
Barriers	**Solutions**
❑ Limited resources	✓ Develop cooperative agreements to share resources ✓ Apply for funding opportunities together ✓ Extend your impact by working with others
❑ Differing missions and goals	✓ Different missions can bring different skills and expertise ✓ Identify overlapping goals ✓ Utilize a boundary-spanner
❑ Organizational silos	✓ Incorporate cooperation into job training ✓ Provide incentives and support ✓ Learn from other organizations
❑ Public perception	✓ Conduct community outreach ✓ Understand requirements and timelines of other organizations
❑ Sustainability	✓ Build trust ✓ Honest and transparent communication
❑ Lack of cooperative program	✓ Develop a boundary-spanning organization

think of partnerships based solely on common interests, building relationships with groups that have needed resources is also critical (Wondolleck and Yaffee 2000). Cross-

boundary issues tend to be large-scale, in which a single entity often does not have enough resources to address on its own. By seeking out cooperative arrangements where funding and staff can be shared, entities can extend their impact to tackle these

cross-boundary issues. Many agencies and organizations develop formal agreements that explain the terms of their arrangement for sharing resources. Obtaining resources together is another option for some entities. Many funding applications consider strength of partnerships when determining awards and require matching funds that can be obtained through cooperation. Though many agencies are faced with staffing reductions or inability to hire, non-profits often have access to a large volunteer base. Seeking out cooperative arrangements with entities that have needed resources can help overcome the barrier of resource limitations. Differences in agency mission are often cited as responsible for the development of boundary effects in the physical environment over time (Landres et al. 1998; Hansen and DeFries 2007), but these same mission disparities also present barriers to efforts that could alleviate the ecological effects of boundaries. Missions and goals between entities often differ in scope and/or scale, but organizations tend to have the same overall goal of wetland stewardship. Identifying these overlapping goals can help entities overcome barriers created by differing missions. When organizations or agencies are focused on different aspects of natural resource stewardship, they also tend to have different skills. Therefore, working cooperatively allows organizations to utilize the expertise of others.

A strong leader or liaison can help agencies and organizations understand the shared value of cooperative management. Creating roles within organizations specifically to facilitate boundary-spanning will allow entities to overcome disparities in their missions or goals. The practice of boundary spanning is defined as working to enable exchange between the production and use of knowledge to support evidence-informed decision making in a specific context, and boundary spanners as individuals or

organizations that specifically and actively facilitate this process (Bednarek et al. 2018). Boundary spanners can be individuals that help organizations or agencies work cooperatively or entire programs dedicated to bringing different entities together. Participants identified the lack of a boundary-spanning organization as a barrier to cooperative management by entities with diverse wetland interests. Though boundary-spanning organizations exist in Colorado, their primary focus is on river health or wetland-dependent wildlife. Wetlands provide many other benefits such as flood attenuation and storage, aquifer discharge and recharge, and nutrient cycling (Mitsch and Gosselink 2007; Schweiger et al. 2019; Sutula et al. 2006). In order to facilitate cooperative management for a larger array of wetland benefits and between entities with diverse mission and goals, a boundary-spanning organization needs to be developed.

Organizational silo is a term often used in business management and public health. In one study of interorganizational collaboration in the public health sector, researchers found that organizations have a tendency to work those most like them, perpetuating the "silo effect" (Bevc, Retrum, and Varda 2015). The silo effect was considered to impede the development of a more collaborative, multi-disciplinary approach to management and administration. Silos or divisions between entities are related to an organization's ideology or culture. Entities may be more likely to adopt an approach to management that is most consistent with their agency's "culture" (Brunson 1998), rather than management developed cooperatively. To overcome this barrier, agencies need to support and incentivize cooperative management. Though many agencies and organizations have developed policies for cooperation (e.g., Executive

Order 13352- Facilitation of Cooperative Conservation), few individuals are provided training on how to work with others to steward resources effectively.

Since municipalities and federal agencies have a responsibility to serve the public, public perception can influence their objectives and activities. Trust and uncertainty contribute to this perception and effect the development of cooperative management between private landowners and public agencies (Bergmann and Bliss 2004). Public perception can also influence how these agencies work with other organizations. Participants stated that before implementing a management plan, they have to build acceptance and trust. This can be achieved by including community outreach as part of your cooperative management strategy. Participants also noted that public perception considerations can lead to longer project timelines. Being aware of the responsibilities and requirements your partners must meet can help overcome this challenge.

Though sustainability of a cooperative arrangement was not presented as a barrier in the results section of this article, participants identified sustainability as a characteristic of successful cooperation. Sustaining a partnership can be challenging, therefore it is included under barriers in Table 3. Cooperative arrangements can be sustained by building trust and engaging in honest and transparent communication. It is well established that trust is necessary in natural resources management, especially when working in cooperation with multiple land ownership types (Bergmann and Bliss 2004; Stern and Coleman 2015). Many agencies and organizations are hesitant to embark on the journey of cooperation if they think the partnership won't last. Honest and open communication about your needs and expectations will help build trust and sustain the cooperative arrangement.

Conclusion

If wetlands and the essential ecosystem services they provide are to be protected into the future, cross-boundary cooperation between multiple entities will be essential. This study's findings indicate that there is a desire and willingness to participate in cooperative management in the greater RMNP ecosystem, but entities face many barriers when developing and maintaining cooperation. In cases where the benefits of cooperation outweigh the barriers, cross-boundary cooperative management can be achieved. This research builds upon the cross-boundary cooperative management literature by examining a wetland-focused case study and incorporating views from many different entity types. Although the particulars reported here might be unique to the greater RMNP ecosystem, we suspect the broad themes have applications in other landscapes and for other resources that exhibit similar landownership patterns.

This research aimed to explore how cross-boundary wetland cooperation could be facilitated. Therefore, most participants in this study were not already involved in multi-jurisdictional wetland-specific cooperation. Future research should be conducted with entities that have successfully implemented ecosystem-scale wetland cooperation to learn more about the challenges and opportunities they faced. In addition, research should be conducted in other locations in need of cooperative wetland management to determine if the same themes are found. Finally, this research focused on cross-boundary stewardship centered on RMNP. Research on cross-boundary cooperation should be conducted with other national park and protected area centered ecosystems.

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CHAPTER 3

EVALUATING AND DEFINING COOPERATIVE MANAGEMENT STRUCTURES FOR CROSS-BOUNDARY WETLAND STEWARDSHIP

Abstract

Wetlands are highly valued for providing a range of ecosystem services. Accordingly, societies have established various institutional arrangements to ensure protection and flow of those services. In contemporary wetland management, entities must determine which arrangements best achieve societal goals, especially when wetlands occupy and/or are affected by activities in multiple ownerships. This research evaluates and defines wetland stewardship arrangements in a case study in the greater Rocky Mountain National Park ecosystem, Colorado, USA through semi-structured interviews with wetland stewardship entities and an analysis of these organizations' wetland policies. Through the development of a social network, we defined three types of cooperative interactions—communication, coordination, and collaboration. A framework consisting of seven elements for each interaction was developed from case study results and cooperative management literature. Patterns of interactions based on entity-type were identified and recommendations provided to determine the type of interaction best suited to an entities' mission or goals.

Introduction

Wetlands are highly valued for providing a range of ecosystem services (Zedler and Kercher 2005; Horwitz and Finlayson 2011). Accordingly, societies have established various institutional arrangements (e.g., 1971 Ramsar Convention) to ensure protection and flow of those services (Zedler and Kercher 2005; Xu et al. 2019). A challenge for contemporary wetland management is to determine which arrangements can best achieve societal goals, especially when wetlands occupy or are affected by activities in multiple ownerships. This research proposes a framework for understanding cross-boundary wetland stewardship, based on a case study from Rocky Mountain National Park, Colorado, USA.

Ostrom (1990) provides a threefold classification of potential strategies for natural resources management. According to her classification, resources may be controlled by a centralized government, exchanged using a system of private property, and/or managed through collaborative actions (Ostrom 1990). The final category is gaining recognition as a distinct model for environmental management (Bodin 2017), but there is little consensus on the terminology, structure, or activities that make up these cross-boundary interactions.

Cross-boundary stewardship requires coordinated behavior, which includes creating shared understandings and values (Meidinger 1998). Cooperation is one strategy for achieving stewardship across boundaries but can take on many different meanings. Researchers among different fields seldom agree on the definition of cooperation, and even researchers within the same field have yet to come to consensus on the types of cooperative interactions. Some theorists categorize interaction terms broadly with little

regard for definitions that distinguish them from other types of interactions (Keast, Brown, and Mandell 2007). Others describe cooperation, coordination, and collaboration as falling along a continuum of increased interaction (Bryson, Crosby, and Stone 2006; Keast, Brown, and Mandell 2007; McNamara 2012; Thomson and Perry 2006). In the context of natural resources, Plummer and FitzGibbon (2004) explain cooperation as an umbrella term that refers to increasing participation by civil society rather than part of a continuum. Under the umbrella of cooperation, Yaffee (1998) describes different levels of interaction that are arranged into a taxonomy in which the level of effort and interaction increases as one moves down the taxonomy.

Cooperation, communication, coordination, and collaboration are the terms most commonly used in natural resources to refer to interactions between different agencies and organizations (Yaffee 1998; Plummer and FitzGibbon 2004; Bodin 2017). Few studies within natural resources management address the empirical differences between these terms. Yaffee (1998) provides a rough taxonomy of cooperative behaviors to distinguish between awareness, communication, coordination, and collaboration, but each behavior is only accompanied by a short definition. While this taxonomy is a good start to defining the different terms, it does not provide any information about the structure of these interactions or how to develop and maintain them. A broader focus is needed to understand the different elements that characterize each type of interaction. McNamara (2012) uses insights from inter-organizational theory and education literatures to provide further insights into these terms. Interaction terms are distinguished using 10 elements: design, formality of the agreement, organizational autonomy, key personnel, information sharing, decision making, resolution of turf issues, resource allocation, systems thinking,

and trust. While McNamara (2012) uses a slightly different configuration of interaction terms along the continuum than researchers in natural resources, her description of elements for each term aligns well with the definitions in Yaffee's taxonomy (1998). Therefore, through the combination of McNamara's elements and Yaffee's taxonomy, characteristics of these different types of cooperative interactions can be applied to a natural resources context while bridging limitations from previous work.

To further characterize cross-boundary cooperation, it is important to recognize not only the types of cooperation but the actors who are engaged in that cooperation. Networks are a common method researchers use to represent interactions between actors across boundaries. They refer to the development of linkages between organizations or individuals. Research has identified social networks as a common and important factor in cases where different stakeholders have come together to effectively deal with natural resources problems (Olsson, Folke, and Hahn 2004; Gunderson et al. 2006; Folke 2006; Bodin and Crona 2009). Social networks can improve collaborative governance processes by facilitating, (i) the generation, acquisition, and diffusion of different types of knowledge and information about the systems under management (Crona and Bodin 2006; Schusler, Decker, and Pfeffer 2003), (ii) mobilization and allocation of key resources for effective governance (Carlsson and Sandström 2008), (iii) commitment to common rules among actors fostering willingness to engage in monitoring and sanctioning programs (Dietz, Ostrom, and Stern 2003), and (iv) resolution of conflicts (Hahn et al. 2006). However, all social networks are not created equal (Bodin, Crona, and Ernstson 2006). On the contrary, the structural pattern of relations or interactions of a

social network can have a significant impact on how actors actually behave and the activities in which they partake.

Linkages between actors in a network can be seen as existing on a continuum ranging from 'loose' linkages to more lasting structural arrangements and relationships (Hall 1999). Emerging recognition of the importance of social networks for outcomes in natural resource management has resulted in an increase in empirical studies analyzing the structural characteristics of these networks (Bodin and Crona 2009). Analyzing networks of various stakeholders helps tease apart how social structures, created by patterns of interactions, enhance or hinder management strategies. This chapter utilizes qualitative social network analysis to distinguish between interactions within a social network of wetland stewardship and develop a framework for cooperative management.

The purpose of this chapter is to propose a framework using results from a case study on cross-boundary wetland stewardship in the greater RMNP ecosystem. The first section begins with an introduction to the case study followed by results. The second section proposes a framework for distinguishing among cooperative interactions and provides examples from the case study to support framework elements.

Case Study in the Great Rocky Mountain National Park Ecosystem

Rocky Mountain National Park (RMNP), established in 1915, is a ~415,000-acre protected area that straddles the Continental Divide in north-central Colorado (NPS, 2013). Most of the park, just miles from the largest urban area in the Rocky Mountain region, is designated wilderness. Its complex topography and wide range of elevation also results in remarkable ecological diversity. Wetlands support a majority of this

biodiversity, but only make up a small portion of the park (Schweiger et al. 2019). The National Park Service Inventory and Monitoring (I&M) Network conducts long-term monitoring of wetlands in RMNP as part of its natural resources vital signs monitoring program. The I&M Network found that approximately half of park's area classified as wetland is not in reference condition (Schweiger et al. 2016) due to anthropogenic disturbances, which often occur beyond park boundaries. Wetland integrity in RMNP has been heavily influenced since the late 1800s by many factors (Schweiger et al. 2019), including direct human impacts to park hydrology (e.g. building drainage ditches and roads), over-concentration of elk due to removal of large predators, loss of beaver, and, more recently, introduction of nonnative moose.

The park shares its borders with three national forests administrated by the USDA National Forest Service: Arapaho National Forest, Roosevelt National Forest, and Routt National Forest; the cities of Grand Lake and Estes Park; and private, state, and county land. A few watershed and wetland coalitions operate on the Front Range, each with a unique mission and different stakeholders, but all focus on river and riparian health. Along with watershed coalitions, many agencies and other organizations focus their efforts on wetland integrity throughout the region. RMNP managers are looking for ways to develop cooperative wetland management to address the impacts from cross-boundary disturbances. For the purposes of this research, the greater RMNP ecosystem refers to the general area surrounding the park, including the Front Range, in which there are hydrologic and ecological connections to the park.

Methodology

We used a qualitative research design characterized by semi-structured interviews and document collection to identify and classify cooperative arrangements within the case study. Semi-structured interviews were used to facilitate an understanding of the topic from the participants' perspective and aid in uncovering the meaning of people's experiences by allowing for the development of rich descriptions and the integrations of multiple points of view (Creswell 2013; Montello and Sutton 2013). Interviews consisted of 22 open-ended questions that inquired about current cooperative arrangements and the institutional and social contexts in which cooperative stewardship efforts operate (Appendix A). A total of 22 interviews were conducted with representatives from federal and state agencies, wetland research organizations, county municipalities, and non-profit organizations involved in wetland stewardship. The selection of interviewees was based on purposive sampling of participants that work directly on wetland management within the study area, which provided an information-rich data set by targeting key actors in each agency and organization (Creswell 2013). In addition, snowball sampling was used, in which interviewees identified others with special knowledge or experience related to the study questions (Biernacki and Waldorf 1981). Interviews were conducted until saturation was reached, meaning no new information was communicated by the participants (Rudestam and Newton 2015). Five interviews were conducted in person for participants that were available during field work in July 2019. The remaining interviews were conducted over the phone from August to October 2019. With the consent of interviewees, the interviews were tape-recorded, and notes taken. Interview duration ranged from 30 to 75 minutes. Interviews and field notes were transcribed verbatim.

In addition to interviews, agency or organization policy documents and strategic plans were compiled from corresponding websites and official online portals. After documents and plans were downloaded from each organization, they were searched for sections containing the words “wetland,” “riparian” and “partner.” These sections were then copied into blank word documents to be analyzed. These data was obtained from each agency or organization with which an interview was conducted.

Interview and document transcripts were analyzed using ATLAS.ti (Hwang 2008) to determine the existence and type of cooperative action among agencies and organizations using a systematic, iterative process (Creswell 2009; 2013; Miles, Huberman, and Saldana 2019). This technique utilized an inductive data analysis process that built codes, categories, and themes by organizing data from multiple sources into increasingly more abstract units of information. Transcripts were read and memos (short phrases, ideas, or key concepts) were written to start the initial process of exploring the data. Next, data was described, classified, and interpreted through the formation of codes (labels attached to units of data that assign symbolic meaning). Coding was divided into two major stages: first cycle and second cycle coding. During the first cycle of coding, concept codes (words or short phases that represent meaning broader than a single item or action) and a priori codes developed directly from interview questions were used. Second cycle coding utilized pattern codes to group information into categories and themes. Pattern codes are inferential or explanatory codes that pull material from first cycle coding into more meaningful units of analysis. Code definitions were developed to ensure consistency and precision throughout the coding process.

After coding was complete, data were represented and visualized with a network. The network visualization contained links between all entities in which interactions were identified. These links were then classified based on the level of interaction along the cooperation continuum using insights from McNamara's (2012) framework and Yaffee's (1998) taxonomy.

Case Study Results

Social Network

Social networks consist of nodes representing individuals or entire organizations and links representing social interactions between those individuals or entities (Figure 6). The social network produced from the findings of this research consists of all entities in the greater RMNP ecosystem involved in wetland stewardship including federal and state agencies, county and city municipalities, nonprofits, and research organizations (Figure 7). Each agency and organization is represented by a social node consisting of a unique three letter code. Interactions between entities are represented by links with the color of the link corresponding to the type of interaction. The social network shows the

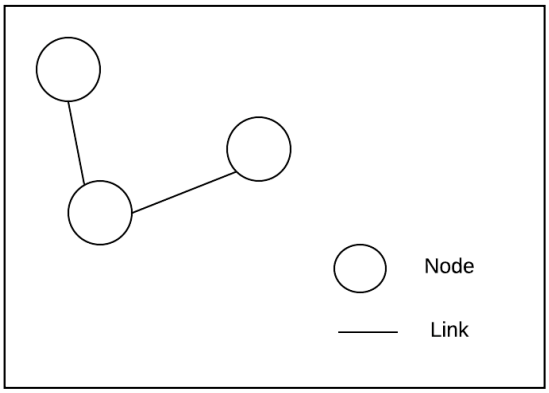

Figure 6. Example of nodes and links in a social network. In this study, nodes represent agencies or organizations involved in wetland stewardship and the links represent the social interactions between them.

complexity of social interactions between wetland stewardship entities and the different levels in which these interactions occur. All entities or nodes in the greater RMNP network have at least one link. This may have occurred due to our sampling method, which prompted participants to point to other individuals involved in wetland stewardship in the area potentially excluding entities without connections but is an important finding.

The classification of interaction types was developed based on results from this study, as well as past cross-boundary cooperation literature. Cooperative interactions include collaboration, coordination, and communication. Links were designated as each cooperative interaction type based on elements of consultation, agreement, design, organizational autonomy, key personnel, decision making, and resource allocation. Links were classified as unknown when there was a lack information for the elements above, therefore the type of interaction could not be determined. Regulatory interactions were determined based on participants' description of the interaction. For example, one participant discussed their interaction with the EPA and Army Corps of Engineers as a "permitting relationship." Another participant states that "the group that we work with regularly is the Army Corps of Engineers mostly because of the regulatory and permitting process." These entities are not working together to share information, resources or responsibly, but rather due to regulatory and permitting laws. Therefore, these links were placed into a separate category of interactions.

Cooperation, communication, coordination, and collaboration are common terms used by natural resource professionals to describe interactions between entities. The National Park Service (NPS) and U.S. Forest Service use the term cooperation to refer to

any interaction in which they share information or work with other agencies and organizations. In the 2006 NPS Management Policies, cooperation is defined as pursuing opportunities across administrative boundaries for natural resource management in a way that maintains and protects park resources and values. Examples of activities involved in cooperation are also described in the policies,

> Cooperation may also involve coordinating management activities in two or more separate areas, integrating management practices to reduce conflicts, coordinating research, sharing data and expertise…and providing essential habitats adjacent to or across park boundaries.

A group organized by a local municipality in the greater RMNP ecosystem also uses the term cooperation to generally refer to working with others.

Under the general term *cooperation*, entities include actions such as sharing data and information. One interview participant referred to communication to describe a cooperative restoration project in which the entities shared information, but there was "not a lot of working together." Another participant described communication interactions as "where people are willing to come to the table to share ideas and information." A participant gave an example,

> We actually also provide technical assistance to other parks…I had someone call me last week from [a park] like 'hey can you help me on designing an ungulate exclusion fence?'… [We] try to learn about what they did that was successful or some pitfalls.

When participants discussed cooperation beyond just information sharing, such as planning with other entities, they used the term *coordination*. One participant described river restoration after a fire,

> It was very clear that the impacts would start on one jurisdiction but would be felt or received on another jurisdiction so that was the impetus for

> bringing people together to talk about where we should be planning and coordinating work.

Another participant explained the activities involved in coordinated interactions,

> U.S. Fish and Wildlife Service has jurisdiction over endangered species and so we coordinate with them on that….The fish and wildlife service is involved in the Greenback Cutthroat Trout restoration project…They are involved in some of our survey work for the Mexican Spotted Owl.

These activities go beyond sharing data and information and involve planning and coordinating projects between entities.

The final category of cooperation is *collaboration.* Participants used the term collaboration to describe frequent communication, sharing resources and expertise, and working together on the same land to implement projects. A participant described the collaborative work that her organization does with a stakeholder group,

> It kind of runs that full arch because they participate with us in the general planning. Then, as we are choosing and funding projects, the relevant partners to those projects will continue to work with us on those projects and for some, we work very closely on the ground to implement the work together.

Another participant described collaborative efforts between her organization and other entities,

> We will basically share funding and technical resources so we will collaborate on grants together…Ducks Unlimited has really top notch wetland engineering capabilities that my organization doesn't have so as much as possible we rely on Ducks Unlimited to do our engineering.

She further described their collaboration,

> Then probably two or three times a year we just decide we've got enough going on, let's go meet real quick for a couple hours and just lay out our game plan for the next few months. So, we do have some more formal meetings, but general everybody has everybody's cell phone number and we are constantly talking.

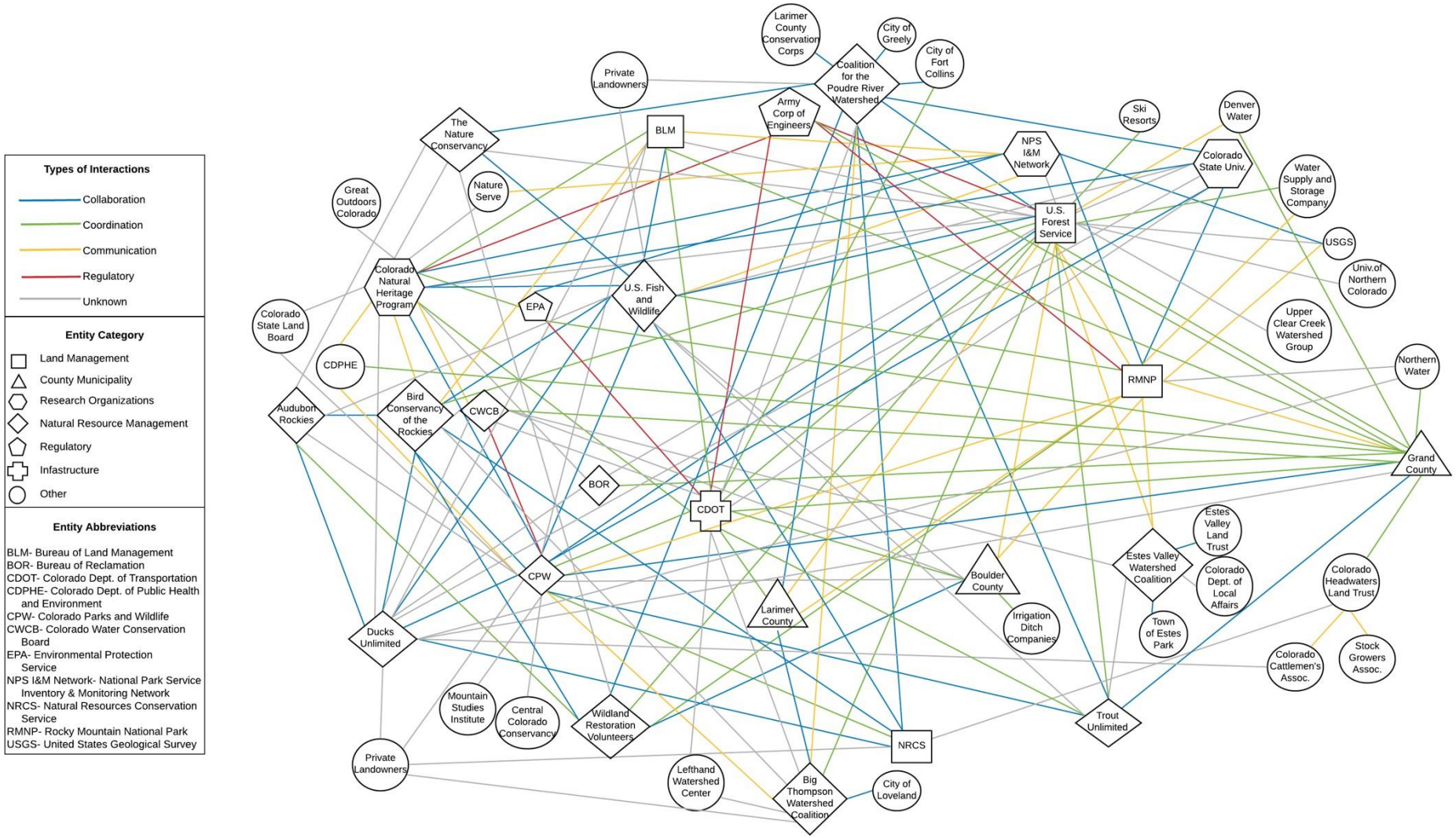

Figure 7. Overview of all social connections between agencies and organizations working in wetland stewardship in the greater RMNP ecosystem.

Collaborative interactions included sharing information and joint planning, as well as working closely together to implement projects by sharing resources and working on the same land.

Interaction Patterns

Entities within each node of the social network were split into categories based on their mission and role in wetland stewardship. Then, the number of links for each type of interaction were counted and averaged across entities within each category (Table 4).

*Table 4. Mean number of links corresponding to each cooperative interaction type and the mean total number of links by entity category. The sample size (n) is the number of organizations or agencies within each category of entities from which the means were calculated. *Includes cooperative, regulatory, and unknown interaction types. There is an average of three unknown links for each entity category.*

		Number of Links (mean)			
		Communication	Coordination	Collaboration	Total*
Entity Category	Land management (n=4)	3.8	3.5	2.5	14
	Resource management (n=13)	0.9	1	3.9	9.8
	Municipality (n=3)	1.7	4.7	1.7	9.3
	Research organization (n=3)	2	1	4	11.3
	Regulatory (n=2)	0	1.5	0.5	4.5
	Infrastructure (n=1)	0	9	0	16

Land management entities are responsible for stewarding a tract of land or working with private landowners to assist them in land stewardship. Resource management entities have the responsibility to steward a specific natural resource such as water or wildlife. Patterns occurred in the types of cooperative interactions present between different categories of entities. With the exception of resource management and research organizations, the majority of entities' interactions occur at the communication or coordination level. Though the infrastructure entity has the highest total number of links, most are coordination interactions. Land management entities also have a large total number of links, with the majority of interactions occurring at the communication and coordination level. Resource management and research organizations have fewer total links, but a significant number of their interactions are collaborative.

When entities are categorized based on their role in wetland stewardship (Figure 8, Appendix B), we see similar patterns (Table 5). Most interactions in these entity categories also occur at the coordination level. With the exception of land conservation and regulation entities, most categories have a similar number of total links. While most of these links are classified as coordination, entities focused on fish and wildlife conservation have the highest number of collaboration interactions. Interactions by river and riparian focused entities are also mostly collaborative. A few entity categories in Table 4 and 5 have small sample sizes, therefore broad conclusion s cannot be made for interactions of those agencies and organizations. In addition, we found that entities that own or administer specific lands have a higher number of total links when compared to entities that do not own land. The majority of links for landholding entities are

categorized as communication or coordination, whereas entities that do not own land are involved in more collaborative interactions.

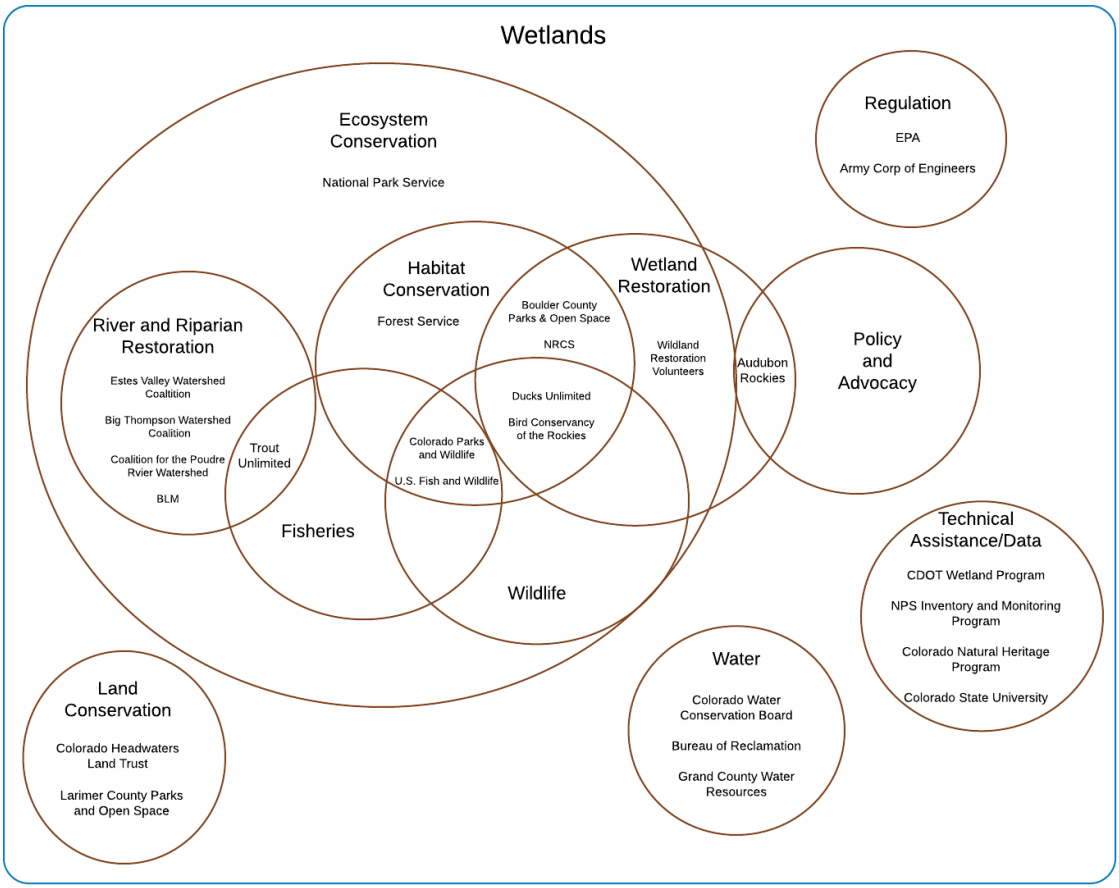

Figure 8. Agencies and organizations in the greater RMNP ecosystem categorized by their role in wetland stewardship.

*Table 5. Mean number of links corresponding to each cooperative interaction type and the mean total number of links by role of entity in wetland stewardship. The sample size (n) is the number of organizations or agencies within each category of entities from which the means were calculated. *Includes cooperative, regulatory, and unknown interaction types. There is an average of three unknown links for each entity category.*

		Number of Links (mean)			
		Communication	Coordination	Collaboration	Total*
Role of Entity in Wetland Stewardship	Fish and Wildlife Conservation (n=6)	1	1.2	5.3	12.2
	Wetland Habitat Restoration (n=5)	3	3.2	2.6	12.4
	Technical Assistance (n=4)	1.5	3	3	12.5
	River and Riparian Conservation (n=4)	1.8	1	3.8	9.5
	Water Management (n=3)	0.7	4.3	0.7	9
	Land Conservation (n=2)	2	1	1	4.5
	Regulation (n=2)	0	1.5	0.5	4.5

Discussion

Cooperation is an umbrella term that incorporates a variety of interactions associated with relationships between two or more individuals or organizations. Under this umbrella is a continuum of interactions- communication, coordination, and collaboration. A framework consisting of seven elements for each interaction along the

continuum was developed using results from this research to build upon previous work by McNamara (2012) and Yaffee (1998) (Table 6). Many elements are consistent with McNamara's (2012) work in the inter-organizational theory literature, where the "3 C's" are most often used. The first element, *consultation*, is the extent to which participating entities produce and communicate information needed to accomplish the cooperative objective. *Agreement* refers to the agreed-upon determination of roles and responsibilities of each participating entity in the cooperative effort resulting in either a formal or informal agreement. *Design* is defined as the administrative structure that supports the

Table 6. Elements distinguishing among cooperative interactions- communication, coordination, and collaboration. Adapted from McNamara 2012 and built upon based on results from this research.

Element	**Communication**		**Coordination**	**Collaboration**
	Formal	*Informal*		
Consultation	Basic information shared	Basic information shared; often on a project-basis	Joint planning through formal channels	Open and frequent communication through formal and informal channels
Agreement	Formal agreement	No agreement	Formal agreement	Informal and formal agreements
Design	Work within existing structures	Work within existing structures	Centralized control through hierarchical structures	Shared power arrangement
Organizational Autonomy	Fully autonomous, but policies to govern cooperation are developed	Fully autonomous; policies to govern cooperation are not developed	Semi-autonomous; policies to govern the cooperative arrangement may be developed by higher authorities	Not autonomous; policies to govern the cooperative agreement are developed jointly by participants
Key Personnel	Implementation of partnership based on higher authorities	Implementation of partnership occurs at lower levels; leaders are not involved	A boundary spanner may be used to foster linkages	Implementation of partnership based on the participants; convener may help bring participants together
Decision Making	Independent decision making	Independent decision making	Centralized decision making	Participative decision making
Resource Allocation	Information is exchanged	Information is exchanged	Resources exchanged to achieve individual goals	Resources exchanged or pooled in support of collective goals

cooperative effort. *Organizational autonomy* is defined as how independently each of the partnering entities operates and how cooperative arrangements are developed. *Key personnel* refers to the individuals within entities that have the responsibility for implementing the interaction. *Decision making* is the way in which consensus is reached to move ahead on goal implementation of the cooperative arrangement. *Resource allocation* is the measure of each organization's independent contributions as well as procedures that enable cooperation. Communication, coordination, and collaboration are described below using these seven elements. While each interaction is treated separately below, communication, coordination, and collaboration are viewed as a continuum, therefore overlapping characteristics do exist.

McNamara's (2012) framework contained other elements including resolution of turf issues, systems thinking, and trust. Many discussions of cooperation, cite resolution of conflicts as a reason for interaction between entities or an element of how these interactions are carried out (McNamara 2012). In this study, conflict did not play a major role in cooperation between entities. Systems thinking and trust elements were not directly explored in this study.

Communication

At one end of the continuum, communication is defined as an interaction between entities in which they work together by talking about goals and activities, but chose to work within their existing structures and policies to serve individual interests (Yaffee 1998; McNamara 2012). There are two types of communication: formal and informal. McNamara (2012) found that consultation, information sharing, and agreements at this

end of the continuum usually are developed through informal channels. She also found that implementation of communication interactions occur at lower levels, meaning administrators are not involved. Results from this case study concur with these findings but reveal another form of communication that consists of formal consultation and agreements and is implemented by administrators or higher authorities. Entities remain fully autonomous in both interactions, but policies to govern the cooperative arrangement are outlined in the agreement in formal communication interactions. Informal communication often does not require an agreement between entities because the decision to work together is based on the participants whom recognize opportunities to share information and build capacity (Keast, Brown, and Mandell 2007). In both types of communication interactions, organizations retain independent structures and multi-organizational decisions are not made. Only information is exchanged between entities; other resources are not exchanged in communication interactions.

Coordination

Coordination is placed in the middle of the continuum and is defined as an interaction between entities in which actions of one party are carried out in a manner that supports those of another (Yaffee 1998), but operating procedures of those parties remain independent (McNamara 2012). Elements of coordinative interactions found in this case study support findings from previous research (McNamara 2012; Mandell and Steelman 2003; Keast, Brown, and Mandell 2007; Honadle and Cooper 1989). Mandell and Steelman (2003) identified two different types of coordination—intermittent and permanent. In intermittent or *ad hoc* coordination, entities come together to work on a

specific task and disband when that task is accomplished. These entities may reconvene when another project or task arises, but the amount of time in-between coordination varies. It could be a few weeks, months, or years. In permanent coordination, interactions between entities are more consistent, therefore more formal consultation channels are used to facilitate the ongoing exchange of information. Participants in this study often held regularly scheduled meetings with entities to coordinate efforts. During these meetings, entities would discuss and plan management objectives and activities. Joint planning between entities is an element that distinguishes coordinated interactions from communication interactions in which only information is shared (McNamara 2012).

In coordinative interactions, organizations are semi-autonomous, as some outside assistance is needed from other entities to accomplish goals. While organizations remain separate, some structural linkages occur to contribute a specialized skill or resource to a specific action (Keast, Brown, and Mandell 2007). Along with information, resources are exchanged to create mutually beneficial relationships that enhance each organization's abilities to achieve goals. Entities included in this case study shared information, funding, personnel, and expertise to meet individual goals in coordinative interactions. Since resources are exchanged between entities, coordination often requires a formal agreement. Many entities utilize a boundary spanner to help foster linkages between participants (Mandell and Steelman 2003). The practice of boundary spanning is defined as working to enable exchange between the production and use of knowledge to support evidence-informed decision making in a specific context, and boundary spanners as individuals or organizations that specifically and actively facilitate this process (Bednarek et al. 2018). Boundary spanners can be individuals that help organizations or agencies

work cooperatively or entire programs dedicated to bringing different entities together. In this study, a convener brought entities together and created a space for coordination in some interactions. Other coordinative interactions were facilitated through a boundary spanner. For example, an infrastructure entity hired a wetland specialist to coordinate with other organizations on data collection, management, and restoration efforts.

Collaboration

At the other end of the continuum, collaboration is defined as active partnerships with resources being shared or work being done by multiple partners (Yaffee 1998). Collaborative interactions occur between entities that work together to pursue goals based on shared interests and a collective responsibility for tasks that cannot be accomplished individually (McNamara 2012; Plummer and FitzGibbon 2004). Open and frequent informal consultation between entities, as well as formal meetings, are common elements of collaboration. Participants in this case study stated that they use text messaging to communicate with collaborators on a daily or weekly basis. They also stated that more formal meetings are utilized on a monthly or yearly basis to develop and plan projects. Agreements between entities involved in collaboration are also informal and formal. Informal agreements may be used to support the evolving nature of collaboration; changes are made as interactions grow, partners change or the problem focus shifts (Bryson, Crosby, and Stone 2006). In addition, partners may formalize social norms and agreements that establish over time to generate stability (Imperial 2016).

In collaboration, a structure of shared power is developed jointly by participants to address collective interests. Entities relinquish some autonomy to the cooperative

arrangement in order to establish shared rules and decide on a collective purpose (Bryson, Crosby, and Stone 2006). For public agencies, these interactions are more likely to occur at a programmatic level and within the boundaries of an entity's legal authority (McNamara 2012). Imperial (2016) and Margerum and Robinson (2015) found that organizations participating in water resource collaboration are involved in actions at different levels: operational or organizational, policy-making, and institutional. Entities in this case study collaborated on program operations such as implementing restoration projects, policy-making including development of strategic plans and protocols and institutionalizing shared policies through MOUs. Participants involved in the collaborative arrangement play a key role in implementation of cooperation and make decisions collectively through a participative process. The participants implementing collaboration are often "on-the-ground" managers, scientists, and specialist rather than administrators.

Resources are exchanged or pooled between entities to meet collective goals. This includes personnel, expertise, funding, and working on the same land. Some public agencies have restrictions on how resources can be shared between entities so pooling of resources may not be possible. McNamara (2012) found a similar challenge in collaborative coastal management. In her case study, every participant contributed resources to the protection of coastal resources, but individual entities controlled the utilization of their resources. Exchanging resources to meet collective goals and working together on the same land are distinguishing elements of collaboration from coordination.

Patterns of Cooperative Interactions

Each type of cooperative interaction will not be effective in all settings and may pose challenges for certain types of agencies and organizations (Mandell and Steelman 2003; Keast, Brown, and Mandell 2007; McNamara 2012; Margerum and Robinson 2015). We found patterns in the types of cooperative interactions utilized by different entity categories. Entities that own or manage specific tracts of land tend to have missions that focus on the condition of that particular tract of land, but not necessarily the larger landscape. These entities also tend to be governmental, which means they are subject to laws and regulations that may restrict their ability to share decision authority with other entities. For example, the Federal Advisory Committee Act does not allow the government to sit down with non-agency citizens to craft decisions together in a non-public setting. Everyone must have the opportunity to participate, but ultimately a decision rests with a single individual in the agency who must show that they have considered multiple viewpoints. Accordingly, the land-holding and land management entities tend to feel obligated to make their own decisions. Therefore, communication and coordination interactions are more common for land-holding and land management entities than collaboration.

Entities that are responsible for natural resources that cross jurisdictions, such as fish, wildlife, and water, have more geographically dispersed mandates and are reliant on working with others to make choices that support their resource stewardship objectives. Therefore, it is more common for resource management entities to collaborate since they often need to work with multiple land-holding entities simultaneously to achieve their landscape-scale goals. Within resource management, entities have responsibilities for

resources that vary in scope and geographic scale. Fish and wildlife and technical assistance entities may have more interaction with others than entities with responsibilities for riparian and river resources simply because their missions span a variety of habitats over a larger area and thus, likely more separate jurisdictions. Similarly, land conservation entities are likely to focus on only their particular tracts of land, explaining why they have fewer connections to other agencies and organizations.

Infrastructure entities, such as those responsible for highways and utilities, are more likely to engage in coordination because the resources under their responsibility cross boundaries. Therefore, infrastructure entities often need to work with multiple land-holding entities to achieve their landscape-scale goals. In contrast to natural resource management entities, infrastructure entities are less likely to collaborate. This is potentially due to the fact that their missions are more disparate than land and resource management entities.

In summary, elements of communication and coordination interactions align with the missions and objectives of land-owning and land management entities, therefore these entities may obtain more benefit from these interactions than they would collaboration. In comparison, collaboration may not only be beneficial, but necessary for resource management entities to fulfill their mission and achieve objectives. Entities that conduct research and provide technical assistance also need collaborative interactions to achieve their goals due to the geographic scope and scale their objectives often require.

Summary and Conclusion

Cross-boundary stewardship has gained recognition as a necessary and effective method for managing natural resources at a larger scale (Ostrom 1990). Networks are one way to represent interactions between actors across boundaries and research has identified social networks as a common and important factor in cases where different stakeholders have come together to effectively deal with natural resources problems (Olsson, Folke, and Hahn 2004; Gunderson et al. 2006; Folke 2006; Bodin and Crona 2009). The structural pattern of relations or interactions of a social network can have a significant impact on how actors actually behave and the activities in which they partake.

This chapter presented a social network of interactions in the greater RMNP ecosystem and evaluated its structural patterns. We focused on cooperative interactions to inform a framework that distinguishes between communication, coordination, and collaboration. It is important to understand different types of cooperative interactions so that natural resource managers can develop and implement the interaction that is most effective for their situation. To fill gaps from previous research in the definition and structure of cooperative interactions, we applied seven elements from McNamara's (2012) findings to a natural resources context. These elements include consultation, agreement, design, key personnel, organizational autonomy, decision making, and resource allocation. Certainly, there are other variables that may be important for making distinctions between different types of interactions. Further research should be conducted to evaluate the elements presented here and uncover other elements that may be important.

The greater RMNP ecosystem social network was also used to determine the connectedness of entities and types of cooperative interactions that were most commonly utilized in wetland stewardship. This network showed that there is high connectivity among entities in this case study, but that most interactions occur at the lower levels of cooperation—communication and coordination. Social networks should continue to be developed for systems in wetland conservation and in other natural resources contexts using this framework as a foundation to evaluate cooperative structures.

For managers, cooperation can take on different structures and it is important to find the type of cooperative interaction that works best for your particular situation. Involvement in different types of interactions can also assist entities in overcoming barriers. Communication interactions don't require participative decision making or the development of joint power structures, therefore entities can learn from one another without having a collective mission. Coordination allows entities to share resources and carry out actions in a manner that supports others, overcoming potential resource barriers while allowing entities to implement projects separately. Collaboration involves developing collective goals and exchanging resources to help accomplish those goals. Collaboration also involves building relationships through open and frequent communication which can impact the sustainability of cooperation through the development of lasting partnerships. While our results showed that communication and coordination are the most common types of cooperative interactions, there are many benefits to collaborative management. Though collaboration is often viewed as the goal or the only way to effectively work together, collaboration is not always possible or necessary. Being aware of the barriers entities face, benefits of working together, and

different elements of cooperative management structures allows managers to develop and implement effective cross-boundary strategies.

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CHAPTER 4

CONCLUSION

Synthesis of Results

In RMNP just as in the rest of the arid West wetlands support a majority of the biodiversity, but only make up a small portion of the land (Schweiger et al., 2019). Wetlands in RMNP are made up of a variety of types and provide numerous important ecological functions (Cooper and Sanderson, 1997; Mitsch and Gosselink, 2007; Naiman et al., 1993; Stohlgren et al., 1997). The National Park Service Inventory and Monitoring (I&M) Network, which conducts long-term monitoring of wetlands in RMNP as part of its natural resources vital signs monitoring program, has found that approximately half of the wetlands in the park are not in reference condition (Schweiger et al., 2016) due to anthropogenic disturbances such as alterations to hydrologic regimes or introduction of species, which often occur beyond park boundaries.

The anthropogenic disturbances impacting wetlands in RMNP are due to a mismatch between boundaries of the protected area and the ecological processes the area is intended to protect. Using an exploratory, qualitative, case study approach, this thesis examined ways to address this mismatch through cross-boundary stewardship which views the protected area as situated within a large ecological system. Data were drawn from 22 semi-structured interviews with key informants working in wetland stewardship in the greater RMNP ecosystem, and a variety of wetland policy and strategic planning documents from agencies and organizations interviewed. Key informants included representatives from federal and state agencies, nonprofits, research organizations, and

county municipalities. Through thematic analysis, we identified barriers to and opportunities for cross-boundary stewardship, as well as common structures used to facilitate work across boundaries.

We found that wetlands outside of RMNP are facing similar cross-boundary disturbances to those inside the park, including hydrological alterations and effects from different management practices. Managers also anticipate future changes that could affect their ability to steward wetlands under their jurisdiction, including impacts from climate change and population growth. Though participants recognize that working cooperatively with neighboring jurisdictions can decrease the effects of boundaries on wetland integrity, they also reported that the most significant cross-boundary challenge is working with others. Five main barriers to cooperative management were identified: (1) Limited resources including lack of funding within an entity and restrictions to sharing funding between entities, diminished capacity due to staffing reductions, and limited time; (2) Differing goals and missions between agencies and organizations including the scope and scale of an entities' objectives; (3) Organizational silos, manifested as strict adherence to the duties within one's department or organization, leading to an insular mentality; (4) Public perception (for entities that have a responsibility to serve community interests), creating additional considerations when making cooperative management decisions; and (5) Lack of a large-scale cooperative program in which there is funding and support for entities with diverse wetland interests to work together.

Our results also suggest that barriers to cross-boundary management identified above can be overcome by understanding which benefits agencies and organizations gain from working together, how entities define successful cooperation, and how current

cooperative arrangements have prevailed despite the challenges. Benefits to cooperative management include sharing resources, such as funding and skills, extending your impact by working with or near others, and learning from the agencies and organizations you interact with. Participants used many characteristics to define success in cooperative management. Definitions of successful cooperation varied significantly within entity type, illustrating that characteristics used to determine success are based on the norms within their particular organization. Despite this variation, major themes included meeting objectives, open communication, trust between entities, and developing a lasting partnership. Finally, participants currently involved in cooperative wetland management shared their experience and offered advice. Participants stated that there is often one individual or a small group of individuals that lead and maintain the cooperative arrangement. Many organizations have a liaison or boundary spanner to help facilitate connections between agencies and organizations. This often happens at the field level among scientists, specialists or on-the-ground managers. Finding common ground and understanding that everyone is coming to the table with a different perspective are also important aspects of cooperative management. A strong leader or boundary-spanner can help entities overcome barriers and find common ground.

Though agencies and organizations face barriers to cross-boundary stewardship, many entities in the greater RMNP ecosystem have found ways to work together. Through the development of a social network, we defined three different types of cooperative interactions- collaboration, coordination, and communication. These interactions fall along a continuum of increased integration and stronger relationships

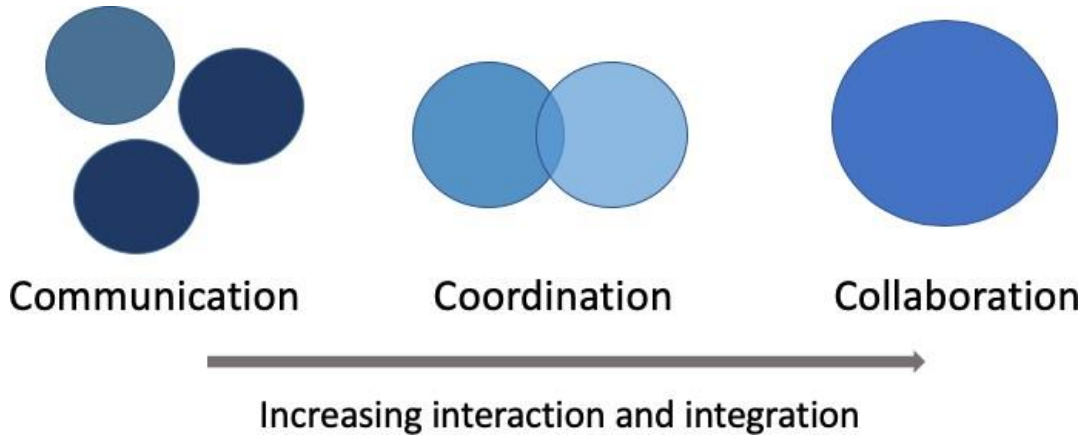

Figure 9. Continuum of cooperative interactions.

from communication to collaboration (Figure 9). A framework consisting of seven elements for each interaction along the continuum was been developed from case study findings and cooperative management literature (McNamara 2012; Yaffee 1998). Elements include, (1) *consultation*, or the extent to which participating entities produce and communicate information, (2) *agreement*, referring to the agreed upon determination of roles and responsibilities of each participating entity, (3) *design*, defined as the administrative structure that supports the cooperative effort, (4) *organizational autonomy*, or how independently each of the partnering entities operates, (5) *key personnel*, referring to the individuals that have the responsibility for implementing the interaction, (6) *decision making*, or how consensus or agreement is reached, and (7) *resource allocation*, defined as the measure of each entities' independent contributions.

These seven elements were used to define the three cooperative management interactions. *Communication* is split into two types, formal and informal. In both types of communication, entities work together by sharing basic information, chose to work

within their existing structures and policies to serve individual interests, and multi-organizational decisions are not made. Formal communication is implemented by higher authorities and involves formal consultation and agreements. Informal communication is implemented by lower-level personnel, does not require an agreement, and the decision to work together is based on participants' recognition of opportunities to share information and build capacity. *Coordination* is defined as an interaction in which actions of one party are carried out in a manner that supports those of another, operating procedures of those parties remain independent, formal consultation is used to participate in joint planning, resources are exchanged to meet individual goals, and implementation is often based on a boundary-spanner. *Collaboration* is defined as an interaction in which resources are being shared or work is being done by participants to support collective goals, open and frequent communication is utilized, power and decision making is shared by participants, and implementation happens in the field between on-the-ground managers.

In this case study, the most common cooperative interactions were communication and coordination, but our findings show that different types of entities are involved in different interactions. Entities that own or manage specific tracts of land tend to have missions that focus on the condition of that particular tract of land, but not necessarily the larger landscape. These entities also tend to be governmental, which means they are subject to laws and regulations that may restrict their ability to share decision authority with other entities. Therefore, communication and coordination interactions are more common for land-holding and land management entities than collaboration. Entities responsible for resources that cross jurisdictions, such as fish,

wildlife, and water, have more geographically dispersed mandates and are reliant on working with others to make choices that support their resource stewardship objectives. Therefore, it is more common for resource management entities to collaborate since they often need to work with multiple land-holding entities simultaneously to achieve their landscape-scale goals. In summary, elements of communication and coordination interactions align with the missions and objectives of land-owning and land management entities, therefore these entities may obtain more benefit from these interactions than they would collaboration. Whereas, collaboration may not only be beneficial, but necessary for resource management entities to fulfill their mission and achieve objectives.

Recommendations for Future Research

This research supports and builds upon previous studies on cross-boundary stewardship to identify barriers to and opportunities for cooperative management and develop a framework to distinguish between cooperative interactions. While the barriers and opportunities identified support previous research, this case study is limited in scope. More research is needed on cross-boundary management of other protected-area centered ecosystems, as well as other wetland systems. While watersheds are often the topic of research (Koehler and Koontz 2008; Diaz-Kope and Miller-Stevens 2015; Leach and Sabatier 2005; Lubell et al. 2002), very few studies focus on cooperative management of wetlands (Kininmonth, Bergsten, and Bodin 2015; Olsson, Folke, and Hahn 2004). Though wetlands are part of a watershed, they are a unique and highly vulnerable part of the system that require special attention. Along with wetland systems, we suspect that the

board themes presented in this thesis have applications to other landscapes and for other resources that exhibit similar landownership patterns.

The framework generated from this study is designed to help researchers and practitioners distinguish between different cooperative interactions using seven elements developed by McNamara (2012). The conceptual clarity of communication, coordination, and collaboration provided by this framework can help researchers continue to develop cross-boundary cooperation theory in a manner that is comparable and cohesive. It will also allow greater communication between researchers and managers by defining terms that used most commonly by the agencies and organizations these studies are intended to help. Finally, a consistent and clear distinction between cooperative interaction terms will allow managers to develop and implement interactions that are most effective for their situation. While this framework is intended to be transferable to other social-ecological systems, further research should be conducted to evaluate its elements and uncover others that may be important. In addition, social networks should be described for other systems to determine if the same interaction types found in the greater RMNP ecosystem network are present, as well as determine if there are other types of interactions.

The goal of this research was to determine how to facilitate cross-boundary stewardship in greater RMNP ecosystem. Therefore, most participants in this study were not already involved in multi-jurisdictional wetland-specific cooperation. Future research should be conducted with entities that have successfully implemented ecosystem-scale wetland cooperation to learn more about the challenges and opportunities they faced, as well as the governance structures used for successful implementation.

Recommendations for Management

Results from this study show that wetland stewards in the greater RMNP ecosystem are facing similar cross-boundary disturbances, which presents opportunities to work together to reach wetland stewardship goals. Though participants stated that working together is the biggest cross-boundary challenge, we identified potential solutions to overcome barriers and achieve cooperative management (Table 7). Along

Table 7. Summary of barriers and potential solutions to overcome barriers and achieve cooperative wetland management. This table shows the challenges and corresponding solutions identified by participants in our greater RMNP ecosystem case study.

Barriers and Potential Solutions to Cooperative Management	
Barriers	**Solutions**
❑ Limited resources	✓ Develop cooperative agreements to share resources ✓ Apply for funding opportunities together ✓ Extend your impact by working with others
❑ Differing missions and goals	✓ Different missions can bring different skills and expertise ✓ Identify overlapping goals ✓ Utilize a boundary-spanner
❑ Organizational silos	✓ Incorporate cooperation into job training ✓ Provide incentives and support ✓ Learn from other organizations
❑ Public perception	✓ Community outreach ✓ Understanding requirements and timelines of other organizations
❑ Sustainability	✓ Build trust ✓ Honest and transparent communication
❑ Lack of cooperative program	✓ Identify a leader ✓ Develop a boundary-spanning organization

with these solutions, participants involved in current cooperative stewardship offered advice on successfully working across boundaries. They said that there is often one individual or a small group of individuals that lead and maintain the cooperative arrangement. Many organizations have a liaison or boundary-spanner to help facilitate connections between agencies and organizations. Boundary-spanners usually hold positions at the field level, such as scientists, specialists or on-the-ground managers. Participants also stated that finding common ground and understanding that everyone comes to the table with a different perspective are important aspects of cooperative management. Everyone doesn't have to agree on every aspect of a project or management action but having a share vision and compromising are important for successful cooperation.

Cooperative management can take on different structures, and it is important to find the type of cooperation interaction that works best for the particular situation. Communication requires the least amount of integration and interaction. Formal communication is often used to consult with entities where formal agreements are required, and interactions involve higher authorities. Informal communication occurs when the decision to work together is based on the recognition of opportunities to share information and build capacity. Coordination involves a higher level of interaction and integration. This cooperative interaction is utilized when some outside assistance is needed from other entities to accomplish goals. Entities involved in coordination participate in joint planning and share resources to accomplish individual goals. Collaboration occurs between entities that work together to pursue goals based on shared interests and a collective responsibility for tasks that cannot be accomplished

individually. Resources are exchanged to meet collective goals and entities relinquish some autonomy in order to establish shared rules and decide on a collective purpose. Though there are distinguishing characteristics of each type of cooperative interaction, it is important to remember that these interactions occur along a continuum, therefore there is flexibility in how each arrangement is carried out.

Involvement in different types of interactions can assist entities in overcoming barriers. Communication interactions don't require participative decision making or the development of joint power structures, therefore entities can learn from one another without having a collective mission. Coordination allows entities to share resources and carry out actions in a manner that supports others, overcoming potential resource barriers and silo-ization. Collaboration involves developing collective goals and exchanging resources to help accomplish those goals. Collaboration also involves building relationships through open and frequent communication which can impact the sustainability of cooperation through the development of lasting partnerships. While our results showed that communication and coordination are the most common types of cooperative interactions, there are many benefits to collaborative management. Though collaboration is often viewed as the goal or the only way to effectively work together, collaboration is not always possible or necessary. Being aware of the barriers entities face, benefits of working together, and different elements of cooperative management structures allows managers to develop and implement effective cross-boundary strategies.

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APPENDICES

APPENDIX A

INTERVIEW PROTOCOL

Thank you again for agreeing to take part in this interview. I know your time is valuable, so I don't want to take any more of it than absolutely necessary, but I hope you'll be able to help us gain a thorough and nuanced understanding of cross-boundary stewardship of wetland ecosystems in the Rocky Mountain region.

To begin, we have a few basic questions about your own engagement in wetland management:

1. How would you describe your current role with regard to wetland stewardship activities in this region?
2. How long have you been engaged in wetland stewardship in this region?
3. (*If applicable*) You've described your own role with regard to wetland stewardship; now could you please describe the role of the organization you serve? What are the organization's wetland management objectives?

As you know, the purpose of our research is to document the effects of jurisdictional boundaries on wetland ecological processes and conditions, and to understand how those effects can be influenced by multi-landowner collaborations that seek to achieve cross-boundary stewardship. To help us do this, we need to learn about the wetland cross-boundary collaborations in this region. The next few questions focus on this topic:

4. What sorts of data do you use to assess environmental conditions (e.g., GIS/remote sensing, plant or soil surveys, etc.)? Do you monitor conditions across your boundaries?
5. Do conditions across a boundary from the wetlands you manage ever influence your management objectives or activities on property under your jurisdiction? How?
6. What do you see as the significant cross-boundary challenges that you face in regard to wetland stewardship, and why do you think so?
7. How are you addressing these challenges (recognizing that you may not be able to address all of them)?
8. Which other organizations or individuals, if any, are working with you on wetland stewardship activities? (NOTE: If you are involved in more than one collaboration, please list the partners who are involved in each separate collaborative effort.)
9. What activities are the partnerships engaged in? (Again, treat each collaboration separately.)
10. For each of the partnerships you've listed, how long have they been in existence? (NOTE: These may be either informal arrangements or formal partnerships.)
11. How often do the partners in these efforts communicate, either through formal meetings or informal contacts and conversations?
12. How does the partnership define success or failure of its efforts? How were these criteria selected (e.g., through group discussion, or defined by statute/regulation)?

What are the key pieces of information you used to make decisions regarding success or progress toward the partnership's goals?

13. Are there any collaborative partnerships that you or your organization formerly were involved with, but are no longer active? Why have those activities ceased?
14. What do you see as the biggest barriers to achieving cross-boundary collaboration or management of cross-boundary wetland resources?

We're getting near the end of our interview, but I have a few more questions I need to ask in order to better understand the institutional and social contexts in which your cross-boundary stewardship efforts operate:

15. Generally speaking, how different do you believe your management objectives are from those of your immediate neighboring lands, including both those with whom you collaborate and those you do not?
16. Do you feel that your neighbors – agencies and organizations as well as private landowners – generally agree on the importance of your [or your organization's] conservation and/or management objectives?
17. How would you describe the general willingness of your neighbors to collaborate on cross-boundary issues?
18. How often do your neighbors contact you for information about land management, either generally or specific to activities on adjacent land?
19. Do you regularly consult your neighbors regarding activities on your land that's adjacent to theirs?

20. If you do not have the opportunity to regularly communicate with any of your neighbors, where (if anywhere) do you go to obtain information about what's happening on their land?
21. Have you noticed changes in the region that are likely to influence your ability to achieve wetland stewardship goals across boundaries?
22. What sort of future changes do you anticipate that could influence your ability to achieve wetland stewardship goals across boundaries?

APPENDIX B

SUMMARY OF WETLAND STEWARDSHIP ROLES

National Park Service

The National Park Service's mission is to preserve unimpaired natural and cultural resources and values of the National Park System for the enjoyment, education, and inspiration of this and future generations. The National Park Service policy for wetlands states that natural and beneficial values of wetlands must be preserved and enhanced. They implement a "no net loss of wetlands" policy and strive to achieve a long-term goal of net gain of wetlands through restoration of previously degraded areas. One way Rocky Mountain National Park works to restore wetlands is through management of elk and revegetation of wetland areas. This includes building exclosure fences to keep elk out of revegetated areas to allow for growth and regeneration. The Park Service also monitors wetlands to inform management through the Inventory and Monitoring Program.

The National Park Service strives for ecosystem preservation. Rocky Mountain National Park is tasked with preserving the headwaters of the continental divide and its associated habitats. The park is the source of the Colorado River, Big Thompson River, and the Cache la Poudre River. Data needs outlined in the park's foundational document include climate change adaptation and habitat implications, map of migration routes for avian and other species that traverse the park, and beaver habitat and reintroduction.

To fulfill the Park Service's mission, parks cooperate with partners to extend the benefits of natural and cultural resource conservation and outdoor recreation. By working

cooperatively through both formal and informal lines of communication and consultation, the Service will better achieve park management objectives and the protection of park's natural resources.

Forest Service

The Arapaho-Roosevelt National Forest Management Plan includes policies for water resources, hydrological function, and riparian and wetland areas. For water resources, the Forest Service's policy is to work cooperatively with national, state, and local interests to protect water related values in perpetuity. Policies for wetland areas include avoidance of impacts or mitigation where impacts to wetlands cannot be avoided. Policies also include procedures for wetland and riparian monitoring and restoration. In these areas the goal is to maintain biodiversity, composition, special habitats, and landscape linkages. Species of special interest in wetland and riparian habitats include Wilson's warbler, Boreal toad, Greenback Cutthroat Trout, and Colorado River Cutthroat Trout. One of the Forest Service's specific goals in the Cameron Pass Geographic Area, northwest of RMNP or 65 miles west of Fort Collins on Highway 14, is to maintain healthy willow communities in areas used by moose.

Natural Resource Conservation Service (NRCS)

NRCS has a Wetland Reserve Easement Program in Colorado which is designed to restore and protect wetland on private property. These easements provide habitat for fish and wildlife, ecosystem services, and opportunities for education, scientific, and recreation activities. NRCS also has a Cutthroat Trout Initiative in Colorado. Through

this initiative, NRCS is working with landowners and partner organizations to improve habitat conditions across the native cutthroat trout landscape. Project partners work together to develop on-the-ground projects that restore stream and riparian systems. NRCS's goals include landscape-scale conservation and building partnerships across boundaries.

Bureau of Land Management (BLM)

The BLM's Riparian Program is an integral component of their landscape restoration initiative. This program supports projects that enhance aquatic ecosystems and the associated habitat for fish species. Through the Riparian Program, the BLM works with a variety of conservation partners.

U.S. Fish and Wildlife

The mission of the U.S. Fish and Wildlife Service is to work with others to conserve, protect, and enhance fish, wildlife, plants, and their habitats for the continuing benefit of the American people. As the principal federal partner responsible for administering the Endangered Species Act, the Fish and Wildlife Service works to recover listed species, prevent imperiled species and habitat from becoming more imperiled, and protect vulnerable resources. They administer the National Wildlife Refuge System, including the Arapaho National Wildlife Refuge, which includes important waterfowl production areas. In Colorado, waterfowl production areas are located in the Prairie Pothole Region. Fish and Wildlife also administers Joint Ventures to build partnerships for bird species and habitat conservation. Two Joint Ventures

operate in Colorado: Prairie Pothole and Intermountain West. Finally, the Fish and Wildlife Service is the principal federal agency tasked with developing the national wetlands inventory to provide information to the public and natural resource managers on the status and trends of wetlands in the U.S.

The U.S. Fish and Wildlife Service also acquires wetland easements on private lands. Partners for Fish and Wildlife is a program of the Service that works with private landowners and conservation partners to prevent the need for further listing of species as endangered or threatened due to habitat loss. They work to restore and enhance wetland and riparian habitats throughout Colorado contributing to landscape-scale conservation.

Bureau of Reclamation

The Bureau of Reclamation's mission is to manage, develop, and protect water and related resources in an environmentally and economically sound manner. In Colorado, the Bureau of Reclamation works in the western part of the state. Their activities developing projects to store, and transport water can impact wetlands and associated habitats.

Colorado Parks and Wildlife

Through coordinated landscape-scale conservation actions, Colorado Parks and Wildlife and its partners ensure that Colorado's wetland and riparian habitat is sufficient to support self-sustaining populations of desired wildlife species and to provide wildlife associated recreation. The Wetland Wildlife Conservation Program conserves wetland and riparian habitats and their ecological functions for the benefit of wildlife by planning

and delivering conservation actions on a landscape scale. The program facilitates voluntary, incentive-based conservation and management of priority wildlife species whose populations depend on wetlands or riparian areas. This may be accomplished through protection of these habitats by easements or acquisition or through habitat restoration, enhancement, and creation actions. Priority wetland and riparian species include waterfowl, primarily ducks, and declining or at-risk species that are dependent on wetlands or riparian areas during part or all of their life cycle.

Colorado Parks and Wildlife also administers local Focus Area Committees targeted toward wetland conservation in important waterfowl areas and other wildlife. Membership of these committees includes agency and NGO biologists, scientists, educators, landowners, and recreationists. These committees generate, evaluate, and prioritize funding proposals for wetland projects, serve as a source for local wetland knowledge, conduct education and outreach, provide a forum for wetland conservation discussions, and develop a strategic plan.

Estes Valley Watershed Coalition

The Estes Valley Watershed Coalition was originally created in 2013 to restore the integrity and resilience of the Estes Valley Watershed by educating the community, engaging volunteers, and implementing sustainable solutions. Though they still work on river and riparian restoration, they have started a new initiative called The Wandering Wildlife Society. This new initiative supports the protection of wildlife habitat through community engagement and education.

Big Thompson Watershed Coalition

The Big Thompson Watershed Coalition's mission is to protect and restore the ecological health of the Big Thompson Watershed for the use and enjoyment of our community today and for future generations. This coalition primarily works with private landowners, the city of Loveland, and Larimer County to restore river and riparian habitat along the Big Thompson River.

Coalition for the Poudre River Watershed

The Coalition for the Poudre River Watershed's mission is to improve and maintain the ecological health of the Poudre River watershed through community collaboration. They work to achieve this mission by focusing on three key themes: watershed resilience, river restoration, forests and fires, and post-fire restoration. Though their focus is on the watershed as a whole and they don't specially restore wetland areas, this organization's work indirectly benefits wetland systems. The Coalition for the Poudre River Watershed is a collaborative entity to works to bring diverse stakeholders together for selection, planning, and implementation of projects.

Colorado Headwaters Land Trust

The Colorado Headwaters Land Trust operates in Grand County to preserve and steward open lands within the headwaters of the Colorado River. Their goal is to work with private landowners to acquire purchased or donated conservation easements to protect river and riparian habitat, including wetlands. The Colorado Headwaters Land

Trust is one of the few organizations on the west side of RMNP involved in wetland stewardship.

Boulder County

In Boulder County, the Parks and Open Space Department holds responsibility for conservation of natural, cultural, and agricultural resources and providing public uses which reflect sound resource management and community values. The Parks and Open Space Department owns and manages land, including large wetland complexes, which they work to preserve, restore, and monitor. They also provide public outreach, partnerships, volunteer opportunities to increase awareness and appreciation of Boulder County's open space. Their 2020 strategic plan includes goals for riparian restoration, climate change adaptation, and increased collaboration.

Larimer County

Larimer County's Natural Resources Department manages open spaces and water-based recreation areas and fosters responsible land stewardship through weed management and healthy forest practices. The Natural Resources Department provides indirect benefits to wetlands through river conservation and restoration. They work to manage, improve, and restore river and associate riparian habitats along the Cache la Poudre, Big Thompson, and Little Thompson rivers. Larimer County works with partners in land conservation and management efforts.

Grand County

Grand County's water resource management team works on policy and science issues involving water quality and quantity in Grand County to ensure that adequate supplies of high-quality water are available for all uses. This team works with federal, state, private, and nonprofit stakeholders on projects to conserve and restore water resources. Grand County also initiated Learning by Doing, a partnership between east and west slope water stakeholders. Learning by Doing is lead by a management and technical committee which oversees and advises on the group's efforts and activities. The group's activities consist of habitat restoration, water quality enhancement, and the development and implementation of an aquatic monitoring program.

Wildland Restoration Volunteers

Wildland Restoration Volunteers is a nonprofit organization that provides an opportunity for people to come together, learn about their natural environment, and take direct action to restore and care for the land. Their restoration projects include wetland and stream areas, native species planting, invasive plant removal, and threatened plant and animal species protection. Wildland Restoration Volunteers works with land managers to recruit and handle all communication with volunteers, lead crews and manage projects, write grants to help fund projects, do technical design work, and conduct site monitoring of restored sites. They have worked with dozens of local, state, and federal land agencies and land trusts.

Ducks Unlimited

Ducks Unlimited conserves, restores, and manages wetlands and associated habitats for North America's waterfowl. They work with state and federal agencies and other nonprofit organizations to develop and implement projects. These projects include installation of water infrastructure, vegetation planting to provide habitat for waterfowl and other wetland species, such as moose, and ecosystem restoration. Ducks Unlimited works across Colorado from the Rocky Mountains to the Prairie Pothole Region. One of their current goals is to develop partnerships with public land management agencies, like the National Park Service.

Bird Conservancy of the Rockies

The mission of Bird Conservancy of the Rockies is the conservation of birds and their habitats through an integrated approach of science, education, and land stewardship. Their strategic plan outlines major goals including: generating and sharing cutting-edge scientific data to advance knowledge and inform effective bird conservation; immersing children and adults in nature and foster stewardship values across generations; and enhancing, restoring, and conserving bird habitat and improve overall landscape health working in partnership with others. A part of their land stewardship goals, the Bird Conservancy helps landowners enhance wetland areas and associated wildlife habitat. They also work with public land entities to support a network of biologists working in partnership to help deliver habitat restoration and management in priority landscapes and provide technical assistance to land managers and decision-makers about land-use planning. Finally, it is the goal of the Bird Conservancy of the Rockies to invest in key

partnerships with state and federal agencies, universities, and other nonprofit organizations and work across political and jurisdictional boundaries to advance bird conservation.

Trout Unlimited

Trout Unlimited works to conserve, protect, and restore Colorado's cold-water fisheries and their watersheds. This organization participates in river advocacy, habitat restoration, and reintroduction of native trout. Trout unlimited indirectly benefits wetlands through river and riparian restoration projects. They work closely with agencies, other non-profit organizations, private landowners, academic institutions, and communities to implement on-the-ground actions.

Audubon Rockies

Audubon Rockies uses science, advocacy, education, and on-the-ground conservation to protect birds and their habitat. Their Western Rivers Program works to find collaborative solutions to create healthier rivers for birds, wildlife, and people. This program involves riparian and wetland restoration projects across Colorado to improve ecological functioning and environmental resilience. Audubon Rockies works with city, county, and nonprofit partners to reach their goals.

Colorado Department of Transportation (CDOT)

The mission of CDOT's wetland program is to provide technical assistance for transportation project develop and construction with the goal of an overall benefit to

aquatic ecosystems. Through this program, CDOT develops procedures for collecting wetland data, works with partners to map wetlands, and utilizes a wetland banking system. CDOT works closely with agencies and municipalities to ensure proper wetland conservation and mitigation.

Colorado Natural Heritage Program

Colorado Natural Heritage Program's (CNHP) mission is to advance the conservation of the state's native species and ecosystems through science, planning, and education. As a Colorado State University program, they conduct scientific research to inform sound conservation decision-making. CNHP is recognized state- and region-wide as the leading resource on wetland classification, identification, condition analysis, and education for local and state governments, agency personnel, conservation partners, consultants, and private citizens. They provide modeling, mapping, monitoring, and planning services, as well as climate data and modeling. All of their data, services, and reports can be found on the Colorado Wetland Information Center website (https://cnhp.colostate.edu/cwic/). CNHP's work is conducted collaboratively with a wide variety of partners in all sectors of wetland stewardship.

Colorado Water Conservation Board

Colorado Water Conservation Board is part of the Colorado Department of Natural Resources. This board represents each major water basin, Denver, and other state agencies in their joint effort to use water wisely and protect water for future generations. They developed the Colorado Water Plan to balance a productive economy, vibrant and

sustainable cities, viable and productive agriculture, strong and healthy environment, and robust recreation and tourism industries. The Colorado Water Conservation Board is an important factor in wetland stewardship because they are the state agency tasked with overall ecosystem health including watershed health, rivers, and endangered species. To ensure watershed protection and restoration, the Colorado Water Conservation Board administers the Colorado Watershed Restoration Program, Fish and Wildlife Resources Fund, and Colorado Healthy Rivers Fund.