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Cross-Boundary Stewardship in Protected Area Centered Ecosystems: Perceptions of Success and Characteristics of Cooperative Engagement

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CROSS-BOUNDARY STEWARDSHIP IN PROTECTED AREA CENTERED ECOSYSTEMS: PERCEPTIONS OF SUCCESS AND CHARACTERISTICS OF COOPERATIVE ENGAGEMENT

by

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ABSTRACT

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This research explores various aspects of protected area-centered ecosystem (PACE) Stewardship. A PACE encompasses a management mosaic of various federal and state agencies, non-governmental organizations, and private landowners with different management objectives. Administrative boundaries within the mosaic can affect social dynamics, livelihoods, information flow and ecological characteristics across a landscape. Differing land use objectives and mandates can create barriers to ecological processes and cooperative management activities that cross jurisdictional boundaries. Therefore, the three studies within this dissertation set out to examine cooperative engagement (1) among public land managers, (2) among private land owners and (3) between the two respective groups. This research considered five PACEs, all of which are centered on national parks: Rocky Mountain NP, Grand Canyon NP, Great Smoky Mountains NP, Lassen Volcanic NP and Sequoia-Kings Canyon NP. The first study utilized semi-

structured interviews to better understand characteristics of successful cooperation among public land managers. When defining successful cross-boundary stewardship, managers discussed aspects of two overarching themes: outcome and process. Themes related to process include: *shared power and responsibility, fostering trusting relationships, sharing information, and managing a system rather than a jurisdiction.* Additionally, themes related to outcome include: *project completion, learning, landscape changes, and conflict/risk reduction*. Surveys were employed to explore the private landowner population across three of the five PACEs. The results from the second study suggest that various forms of cooperation among neighbors are underpinned by beliefs about shared objectives and shared need for active management, but also have unique drivers dependent on the given type of cooperative behavior. The findings of the third study suggest that the majority of private landowners living in a PACE are willing to work with public land managers. Additionally, peer-to-peer communication was associated with cooperative engagement among the willing population of private landowners. Collectively, these three studies aim to inform strategies for addressing the challenges associated with managing natural resources that cross socially constructed boundaries.

(160 pages)

PUBLIC ABSTRACT

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Ryan D. Tarver

The legal boundaries of protected areas, such as national parks are established and enforced by humans. Therefore, jurisdictional boundaries are ultimately have human meaning but not necessarily ecological relevance as natural phenomena such as watersheds and wildlife habitat often extend beyond a jurisdictional boundary. When considering the extent of natural system, we find that protected areas only make up part of a given ecosystem. The result is a large expanse of lands that fall under a various ownership types that include both publicly and privately designated tracts of land. This presents a management challenge when attempting to manage at the landscape-scale. Therefore, this research aims to explore cooperation among, and between the various actors living and working within a protected area-centered ecosystem (PACE). Through interviews with public land management officials, we found that successful cooperation is comprised of two overarching components: (1) Process (the ways in which success is achieved) and; (2) Outcome (measures, or evidence of successful cooperation). Additionally, a survey conducted among private landowners provided findings that suggest cooperation is correlated to shared objectives and shared beliefs about the need for cross-boundary management activities. Finally, this research suggests that the majority of private landowners are willing to work with public agencies and

organizations and the importance of peer-to-peer communication in fostering cooperative engagement at the public-private interface.

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CHAPTER I

INTRODUCTION

Protected areas (PAs) are geographically defined landscapes that are managed, "…to achieve long term conservation of nature with associated ecosystem services and cultural values" (IUCN, 2013). In the U.S., PAs such as national parks are managed to serve an increasingly diverse range of social, ecological and economic objectives (Keiter, 2010). However, given that all boundaries are ultimately human constructs (Brunson, 1998), protected areas create socially constructed, artificial boundaries within the larger natural system. The result is a landscape comprised of an increasing number of land tracts owned and managed by a diverse population of stakeholders with differing values, objectives and land management practices. With an array of ownership types comes a multitude of management approaches, objectives and outcomes motivated by an assortment of values, incentives, policies and mandates. Naturally, this leads to differing land uses and management practices on either side of an administrative boundary, which can fragment the natural system and create new ecological zones within the larger ecosystem (Epanchin-Niell et al. 2017). This presents a significant challenge for PA managers as they are tasked with addressing pressures that originate outside of the PA (Machlis & Jarvis 2018; Tricker & Landres 2018; Schwartz et al. 2019). Thus, collaborative conservation efforts are increasingly important for achieving environmental, social, and economic goals among diverse public and private stakeholders working and living within these larger protected area-centered ecosystems (PACEs). The research presented within this dissertation provides insight into aspects of cross-boundary

stewardship by exploring cooperative conservation among, and between public land management officials and private landowners. By studying why participants in cross-boundary stewardship choose to engage in cooperative management activities, and how they characterize success of those endeavors, this research can be useful for guiding landowners and managers as they seek opportunities to achieve the goals of ecosystem conservation.

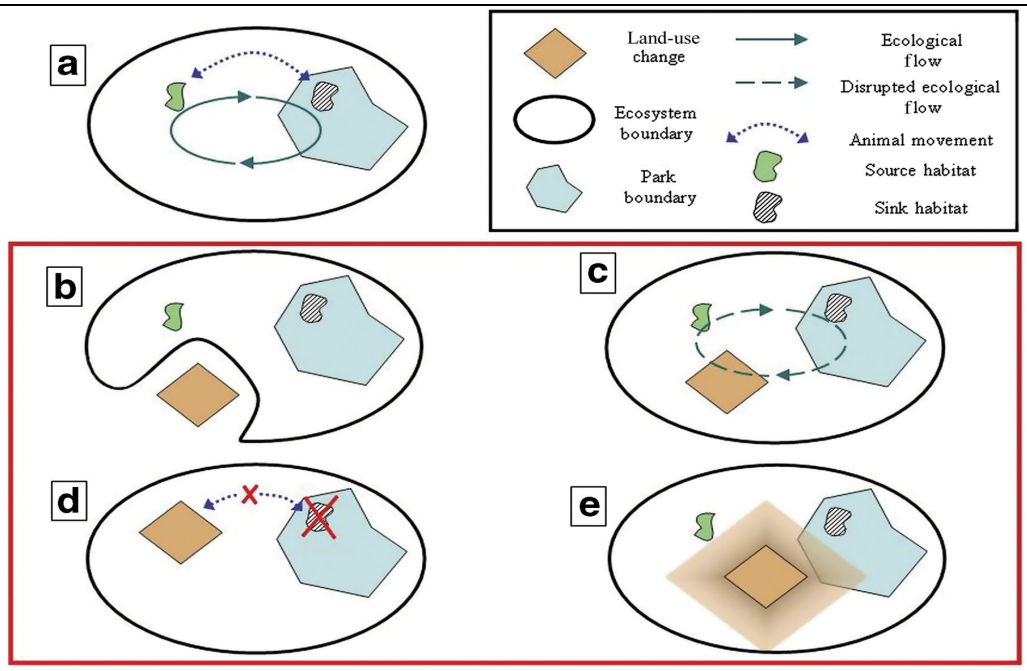
Background

Protected Area-Centered Ecosystems (PACEs)

Recognizing the inherent social and ecological feedbacks between protected areas and the surrounding landscape, Hansen et al. (2011) developed a framework to delineate the geographic extent of Protected Area Centered Ecosystems (PACEs) across the U.S. While this effort focused on several national parks across the U.S., the approach designed by Hansen et al. (2011) has the potential for application across other protected landscapes that have defined jurisdictional boundaries. To establish the boundaries of the larger landscape, Hansen et al. (2011) considered four primary characteristics: ecological flows, crucial habitats, effective size, and edge effects (Figure 1). Specifically, an effort was made to establish boundaries beyond each protected area wherein human activities influence ecological processes that function across jurisdictional boundaries (Figure 1).

Figure 1

The concept of protected area–centered ecosystems. (Hansen et al. 2011)



Mechanism	Description
Effective size	*Human activities may destroy natural habitats and reduce the effective size of the larger ecosystem, which can simplify the trophic structure as species with large home ranges are extirpated. This causes the size of the ecosystem to fall below that needed to maintain natural disturbance regimes, and reduces species richness through the loss of habitat area (b in the figure).*
Ecological flows	*Land use may alter characteristics of the atmosphere (climate, pollution), water (quantity, quality, nutrients, waterborne organisms), and natural disturbance (frequency, size, intensity) moving through the protected area (c in the figure).*
Crucial habitats	*Land use may eliminate or isolate crucial habitats, such as seasonal habitats, migration habitats, or habitats that support source populations (d in the figure).*
Edge effects	*Land use may increase human activity along park borders and result in the introduction of invasive species, increased hunting and poaching, and higher incidence of wildlife disturbance (e in the figure).*

The research outlined within this dissertation is part of a larger National Science Foundation (NSF) research project that leverages the findings of the Hansen et al. (2011) framework to explore both social and ecological aspects of PACE management. This dissertation focuses on social aspects of PACE management. It is important to recognize how administrative partitioning has resulted in an increasingly divided landscape with a growing population of diverse stakeholders.

Administrative partitioning refers to the division of U.S. lands by establishing socially constructed boundaries. The result is a landscape comprised of an increasing number of land tracts owned and managed by a diverse population of stakeholders with differing values, objectives and land management practices. Various U.S. legislation has influenced the partitioning of lands that surround protected areas. The Homestead Act of 1862 provided free parcels of land to promote settlement in the west (Schamel & Potter, 1997); the Forest Service Administration Act of 1897 and the Transfer Act of 1905 established the US Forest Service (USFS) (Cheever, 1996); the Taylor Grazing Act of 1934 provided guidelines for livestock grazing on public lands managed by the Bureau of Land Management (BLM) (Brody, 2003); and the National Park Service Organic Act of 1916 established the National Park Service (NPS) (Cheever, 1996). These pieces of legislation resulted in partitioning of U.S. open lands that are now under federal, state, county, municipal, tribal and private ownership. The patchwork of ownership across undeveloped lands has resulted in a management mosaic (Epanchin-Niell et al., 2010).

With an array of ownership types comes a multitude of management approaches, objectives and outcomes motivated by an assortment of values, incentives, morals and mandates. For example, NPS, USFS, and BLM all manage expanses of lands within each PACE and each of these federal agencies has differing missions and mandates. For example, the NPS mission to *preserve* unimpaired natural and cultural resources (NPS, 2006) differs from the USFS mission to *sustain* the health, diversity, and productivity of the nation's forests (USFS, 2018). While similarities exist between these agency missions, they also reflect a multi-use vs. preservation approach to natural resource management. Naturally, this leads to management practices that are far from uniform across the management mosaic of a PACE (Holcomb et al., 2011). The activities on a given parcel of land may include recreation, agriculture, cultural preservation, ecological conservation, resource extraction and environmental restoration. Over time, differences in land management approaches can alter the vegetation, soils, biodiversity and ecological connectivity across a landscape. Put simply, there is likely a positive relationship between administrative partitioning and ecological fragmentation (Aslan et al., 2021).

In summary, PACEs are large landscapes that encompass multiple jurisdictions, some governmental and some private, whose activities influence the dynamics of ecological and social interactions within that larger landscape. Land management jurisdictions are defined by administrative boundaries and can affect the social dynamics, livelihoods, flow of information and ecological characteristics across a PACE. Furthermore, administrative partitioning influences the social and ecological connectivity of the landscape. The objectives for jurisdictions within a PACE may differ due to the values, incentives or mandates of an agency or individual. The differing objectives of the

jurisdictions within a management mosaic can create barriers that influence the connectivity of a PACE. A lack of ecological and social flows within a PACE may lead to fragmentation of the landscape. Ultimately, this type of fragmentation can cause social and ecological divergence, which in this research project is defined as; "the degree to which adjacent parcels within a management mosaic differ in type of ecological community characteristic." (National Science Foundation grant 1617309).

Social-ecological systems

Social ecological systems (hereafter, SES) consider the interconnectedness and feedbacks between society and ecology. SES as a term began showing up in academic literature during the 1970s (Ratzlaff, 1970; Holling 1973; Cook et al., 1976). Over the next several decades, the SES concept received a growing amount of attention, but lacked an agreed-upon definition. Broadly, SES was a term used to convey social-ecological relationships that extended beyond the field of ecology. One of the first definitions of the SES concept comes from Cherkasskii, *(1988):*

> *... consisting of two interacting subsystems: the biological (epidemiological ecosystem) and the social (social and economic conditions of life of the society) subsystems where the biological subsystem plays the role of the governed object and the social acts as the internal regulator of these interactions.*

It was not until the late 1990s that a framework to better understand and systematically study the concept was published by Berkes and Folke (1998). This framework explored the idea of integrating institutional resilience with ecological

resilience to foster mutually beneficial outcomes. Specifically, the framework highlighted the interconnectedness of five focal elements: ecosystem, people and technology, local knowledge, property rights, and institutions. Berkes and Folke (1998) argued for a balance of traditional ecological knowledge (TEK) and scientific ecological knowledge in making resource management decisions. To date, the work published by Berkes and Folke (1998) is one of the most cited pieces of SES literature. The key component of their definition is that SESs are, "…*linked systems of people and nature, emphasizing that humans must be seen as a part of, not apart from, nature." (*Berkes & Folke, 1998*).*

Ostrom (2007) introduced a framework that challenged the simplicity of previous frameworks that argued against the presumption that "scholars can make simple, predictive models of social-ecological systems (SESs) and deduce universal solutions, panaceas, to problems of overuse or destruction of resources" (Ostrom, 2007). To address these challenges, Ostrom offered a new multitier framework that addressed the complex, multivariate, non-linear, cross-scale nature of a SES. The primary attributes of this framework included: the resource system, the resource units generated by that system, the users of the system, and the governance system. Furthermore, it recognized that SES are nested systems influenced by larger social, economic, political and natural systems. Within the context of this research, this highlights how actors (e.g., landowners and managers) living and working within a PACE can be affected by processes at various scales. Therefore, my research design includes questions that ask about the influence of natural and social processes taking place beyond the scope of a single jurisdiction. In other words, the insight from Ostrom (2007) supports the idea that activities taking place

on a given parcel are influenced by, and have influence on, the activities occurring on the other side of a jurisdictional boundary.

Cross-boundary cooperation

Cross-boundary cooperation is a central focus for the proposed research, and therefore it is important to provide a brief overview of the concept and define its use within this research. Broadly, cooperation involves shared rights and responsibilities among actors seeking mutually beneficial outcomes (Ostrom, 1990; Plummer & FitzGibbon, 2004). As a general concept, cooperation can take many forms and involves a range of behaviors depending on the needs and interests of the cooperators. The taxonomy of cooperative behavior as shown in Table 2 from Yaffee (1998) provides conceptual definitions that guide the proposed research. Note, within this research the term "cooperative engagement" refers to any type or level of cooperative behavior between two or more actors, but it is important to recognize this can take on many forms.

Table 1

A taxonomy of cooperative behavior. (Yaffee, 1998).

Behavior Type	**Definition**
Awareness	Being cognizant of others' 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

In terms of cross-boundary resource management, much of the attention is given to collaboration, especially for studies focused on large, land-owning agencies involved in landscape-scale management activities (López-Hoffman et al. 2010). Many studies have highlighted the advantageous facets of collaborative conservation efforts (Mattsson et al., 2019; Rodrigues & Gaston, 2002; Bladt et al., 2009). The idea is that collaboration can foster mutually beneficial outcomes that would otherwise not be possible. Collaborative efforts are of particular importance when managing natural resources that cross jurisdictional boundaries to avoid a spatial mismatch between the ecological system and the management jurisdictions (Guerrero et al., 2013). For example, large watersheds often have headwaters in a given jurisdiction, but the larger natural system may cross several jurisdictional boundaries. Therefore, sufficient cooperation among management jurisdictions is vital for maintaining ecological integrity and achieving agency and organizational objectives.

Furthermore, it is important to recognize the management structures across the patchwork of ownership types within a PACE. The largest expanses of land within a PACE are owned and managed by federal agencies (NPS, USFS, BLM), all of which operate on hierarchical top-down systems where mandates, policies, statutory requirements, objectives and approaches to management are defined at the highest level and "passed down" through the chain of command (Fraser et al., 2006). Alternatively, private landowners and many NGOs often take a bottom-up approach to influence policy by identifying and addressing land management challenges at the local scale (Fraser et al., 2006).

In practice, several challenges arise when managing natural resources at the landscape scale. First, as mentioned in the introduction, the geographical extent of a PACE includes a diverse range of landowners with unique management missions, mandates, and objectives (Landres et al. 1998). Given that all boundaries are ultimately human constructs (Brunson, 1998), differing land-uses on either side of an administrative boundary can fragment the natural system and create new ecological zones within the larger ecosystem (Epanchin-Niell et al. 2017). Additionally, landscape-scale management requires more resources and logistical coordination than independent management efforts (Westing, 1998). Also, ecological timescales rarely align with funding cycles of a given agency and therefore evidence of "success" may not be realized until long after the collaborative effort takes place.

The flow of information between agencies, NGOs and private landowners is crucial for generating a more effective management approach across a given PACE. In the context of land management, social connectivity involves the flow of information across jurisdictional boundaries. This is the foundation for developing management plans for collaborative conservation activities that span socially constructed boundaries.

Social connectivity

Social connectedness is believed to influence human well-being, institutional development, and cooperative decision-making (Brunckhorst, 2002). Pretty (2003) placed social capital as a central aspect of social connectivity within resource-dependent communities. Broadly, social capital refers to resources available to individuals and groups through their social ties and networks (Bourdieu, 1986). The social capital

concept has been widely applied, consistently reviewed, and continually debated over the past two decades. While this research does not attempt to test the theory of social capital or argue for any one of the many definitions offered, it does pull from the core concepts that provide insight for the social aspects of cooperative natural resource governance. Specifically, this research is informed in part by concepts of cognitive social capital, which aims to assess individual perceptions of trust, reciprocity, and support (Harpham et al., 2002).

Social exchange theory (SET) provides useful insight for operationalizing aspects of social capitol and connectivity in a cross-boundary stewardship context. Broadly, SET provides a model for understanding cooperative participation at the level of the individual (Jacobs, 1970; Searle, 1990; Wilson, 1997). SET posits that cooperation involves an expectation of reciprocity between actors (Molm, Takahashi, & Peterson, 2000). Such expectations are formed through social norms, a sense of interdependency, and in some cases the rules of a formal agreement (Cropanzano & Mitchell, 2005). Further, reciprocity emphasizes that cooperation involves some sort of exchange between individuals. In some cases this may be symbolic (e.g., favors) or arrive in a more tangible form that involves an exchange of quantifiable goods (e.g., equipment, money, goods, etc.) (Cropanzano & Mitchell, 2005). This study focusses on information exchange to build shared understanding, power, and responsibility that fosters cooperative behavior. In this context, a "transactional mismatch" may occur when perceptions of willingness to cooperate are not equal between actors. Perceptions towards the equity of such exchange can influence the ability to build trusting relationships (Meadows et al., 2013, Rickenbach and Reed, 2002, Wagner et al., 2007).

While difficult to measure, trust is a critical component of social connectivity and ultimately cross-boundary cooperation (Bergmann & Bliss, 2012). As a concept, trust is a complex psychological phenomena that comes with a range of definitions. One of the most widely cited definitions of trust comes from Rousseau et al. (1998):

> *"Trust is a psychological state comprising the intention to accept vulnerability based upon positive expectations of the intentions or behavior of another."*

This definition highlights three key components of trust. First, "the intention to accept" represents a willingness to trust individuals or groups. Furthermore, according to this widely accepted definition, trust is fostered through psychological intent (James et al., 2005). The second important component of trust is vulnerability. Vulnerability is realized if a given actor in a trusting relationship misplaces the trust willingly provided by another. This highlights the third key component of trust: expectations. Trusting others assumes a reciprocal dynamic between two or more parties in which the trusted party is expected to attend to the interests of others involved and have the competence to do so (Hardin, 2004). Trust may provide a key prerequisite to cooperative behavior, but actors must also identify a reason or need to cooperate and believe they have the ability to do so.

Perceived risk is argued to be a key driver of natural resource management efforts (Grothmann and Patt 2005; Amacher et al., 2005; Niemeyer et al., 2005; Jarrett et al., 2009; McCaffrey 2004; Fischer 2011; Winter & Fried 2000). Risk perceptions are not formed solely by factual information, but also through past experiences, interactions with others, and personal ideologies, norms, and worldviews (Douglas & Wildavsky, 1982;

Berger & Luckmann, 1967; Tierney, 1999; Hertwig et al., 2004). Mileti (1999) defines risk perception as, "subjective probability of experiencing a damaging environmental extreme." To interpret this definition, it is important to consider what specifically is at risk of experiencing damage? In some cases this may be risk to the safety and health of individuals and their family, risk to a natural resource that generates income, risk to biodiversity, etc. Therefore, to generate a more comprehensive understanding of cooperative behavior, this research aims to measure levels of perceived risk, as well as the personal and environmental drivers of those perceptions.

However, risk perception may not always result in risk mitigation efforts (Fischer & Charnley, 2012). *Cooperative* risk management requires a sense of responsibility for the welfare of the people or landscape facing threat, and the belief that cooperative risk management will increase the likelihood of a desired outcome (Andras et al., 2003). Furthermore, private landowners are more likely to participate in cooperative activity if they believe they have the capacity to address a given issue (Paton, 2003). In summary, cooperative resource management may occur in a range of scenarios, but the individuals involved must perceive a reason for working with others, a belief that doing so will result in desired outcomes, and a perceived capacity to address a given issue.

In summary, protected areas have been established across the globe to achieve long-term conservation goals associated with ecosystem services and cultural values. In the United States many of these protected areas have been designated as national parks and are managed by the National Park Service. The boundaries of a park rarely cover an entire ecosystem. Therefore, it is important to recognize activities that take place across the larger Protected Area-Centered Ecosystem (PACE). A PACE encompasses a

management mosaic of various federal and state agencies, non-governmental organizations, and private landowners with different management objectives. Administrative boundaries within the mosaic can affect social dynamics, livelihoods, information flow and ecological characteristics across a landscape. Differing land use objectives and mandates can create barriers that influence PACE connectivity. A lack of ecological and social flows within a PACE may lead to fragmentation. Ultimately, this type of fragmentation can cause social and ecological divergence. Therefore this research aims to further our understanding of cross-boundary stewardship by exploring aspects of cooperative conservation among and between public land management officials and private landowners. Towards this goal, data collection will include qualitative interviews with land managers, surveys of private landowners, and strategic use of census and county level data. Ultimately this research aims to inform the management of PACEs across the United States.

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CHAPTER II

CROSS-BOUNDARY NATURAL RESOURCE MANAGEMENT IN PROTECTED AREA-CENTERED ECOSYSTEMS: PERCEPTIONS OF SUCCESS AMONG LAND MANAGEMENT OFFICIALS

Abstract

A protected area-centered ecosystem (PACE) encompasses a management mosaic of various federal and state agencies, non-governmental organizations, and private landowners with different management objectives. Administrative boundaries within the mosaic can affect social dynamics, livelihoods, information flow and ecological characteristics across a landscape. Differing land use objectives and mandates can create barriers to ecological processes and cooperative management activities that cross jurisdictional boundaries. This research explores cross-jurisdictional cooperation between public land management to understand how management officials define success in cooperative conservation efforts. Semi-structured interviews were conducted with land managers working within PACEs centered on five national parks: Rocky Mountain NP, Grand Canyon NP, Great Smoky Mountains NP, Lassen Volcanic NP and Sequoia-Kings Canyon NP. When defining successful cross-boundary stewardship, managers discussed aspects of two overarching themes: outcome and process. In other words, managers discussed procedural components and strategies for achieving success (process), and indicators, or evidence of a successful cooperative effort (outcome). Themes related to process include: *shared power and responsibility, fostering trusting relationships, sharing information, and managing a system rather than a jurisdiction.* Additionally, themes related to outcome include: *project completion, learning, landscape changes, and*

conflict/risk reduction. While several of these themes are established within the collaborative natural resource management literature, this study provides empirical examples that help bridge the gap between theory and real-world application.

Introduction

Protected areas (PAs) such as national parks are managed to serve an increasingly diverse range of social, ecological and economic objectives (Keiter, 2010). However, PAs rarely encompass the geographical extent of the larger ecosystem (Davis & Hansen, 2011). Rather, the larger natural system is subject to administrative partitioning, which involves the division large expanses of land by establishing socially constructed, artificial boundaries. The result is a landscape comprised of an increasing number of land tracts owned and managed by a diverse population of stakeholders with differing values, objectives and land management practices. Given that all boundaries are ultimately human constructs (Brunson, 1998), differing land uses on either side of an administrative boundary can fragment the natural system and create new ecological zones within the larger natural system (Epanchin-Niell et al. 2017).

Recognizing the inherent social and ecological feedbacks between PAs and the surrounding landscape, Hansen et al. (2011) developed a framework to delineate the geographic extent of Protected Area Centered Ecosystems (PACEs) across the U.S. PACEs represent an approach to conceptualize the geographic scope of ecological processes that extend beyond the jurisdictional boundaries of a single PA. While the PACE concept delineates ecological flows at the landscape scale, it does not address the inherent challenges of managing large landscapes that are subject to administrative partitioning. The overarching challenge is to find ways for multiple jurisdictions to

participate in cross-boundary stewardship that promotes ecosystem connectivity and function, while also considering the multitude of management goals and objectives held by a diverse population of stakeholders.

The largest expanses of lands within a PACE are publicly owned and managed by federal agencies. The hierarchical structure of large federal land management agencies influences the way in which responsibility is distributed for managing various aspects of a PACE. For example, a national forest will be divided into multiple districts, each of which is led by a district ranger who supervises staff members responsible for key components of the SES that encompasses that district (wildlife, fire, timber, recreation, etc.). In addition to the districts, staff experts in those same SES components are housed in the national forest's headquarters, where they provide support for and coordinate efforts among the district-level staff members. All of these report to a forest supervisor. Each of these individuals has discrete but related goals and responsibilities that can influence how they perceive and act toward stewardship of their jurisdictions. PACEs typically include more than one district, and often more than one national forest.

It is important to recognize that not all natural resource management organizations are land-owning. Rather, many public and non-governmental organizations exist to manage a specific resource across a number of land management jurisdictions. For example, The Northern Colorado Water Conservancy District provides water management infrastructure and monitoring across multiple jurisdictions within the Rocky Mountain National Park PACE. Other organizations may focus on a range of natural resources that extend beyond a single jurisdiction (e.g., air quality, wildlife, wildfire, invasive species, etc.). While all of these agencies are focused on sustaining the resources

which are their primary responsibilities, some do so primarily through coordination with landholding jurisdictions, as in the case of state wildlife agencies that manage the animals that range through a PACE while the landholding jurisdiction manages the habitat on which the wildlife depend.

In summary, the structure and organization of federal land management agencies influence the inter-dependent, yet distinct roles they play in PACE management. At the level of individual managers, this can affect how they approach cooperative cross-boundary stewardship activities and what they consider as successful outcomes of those activities. Therefore, the focus of this study is to understand aspects of cross-boundary stewardship among resource management agencies and organizations within five PACEs, all of which are centered on U.S. national parks. Specifically, this research seeks to identify definitions of *successful* cross-boundary stewardship that are derived from the perspectives of managers working in the system.

Background

Broadly, cooperation involves shared rights and responsibilities among actors seeking mutually beneficial outcomes (Ostrom, 1990; Plummer & FitzGibbon, 2004). As a general concept, cooperation can take many forms and involves a range of behaviors depending on the needs and interests of the cooperators. In terms of cross-boundary resource management, much of the attention is given to collaboration, i.e., active partnerships that share resources and responsibilities, especially for studies focused on large, land-owning agencies involved in landscape-scale management activities (López-Hoffman et al. 2010). Many studies have highlighted the advantageous facets of

collaborative conservation efforts (Mattsson et al., 2019; Rodrigues & Gaston, 2002; Bladt et al., 2009). The idea is that collaboration can foster mutually beneficial outcomes that would otherwise not be possible (Cumming et al., 2012). Collaborative efforts are of particular importance when managing natural resources that cross jurisdictional boundaries to avoid a spatial mismatch between the ecological system and the management jurisdictions (Guerrero et al., 2013). For example, large watersheds often have headwaters in a given jurisdiction, but the larger natural system may cross several jurisdictional boundaries. Therefore, sufficient cooperation among management jurisdictions is vital for maintaining ecological integrity and achieving agency and organizational objectives.

In practice, managing natural resources at the PACE scale presents a significant governance challenge. It requires management efforts at varying spatial and temporal scales (Folke et al., 2007) which commonly lack the regulatory power and institutional mechanisms required to manage at the geographical scope of ecological processes (Mason, 2008). The existing literature emphasizes inclusive planning and decision making, institutional flexibility that allows for specific management approaches at the local scale while still achieving the broad goals held by the agency, and the role of non-governmental organizations in leveraging additional resources to increase management capacities (Ansell and Gash, 2008; Craig et al., 2017; DeCaro et al., 2017). The hope is that these facets of cooperative stewardship will foster social learning, a shared sense of ownership and responsibility, and establish a process that can create mutual understanding (Ansell and Gash, 2008; Cumming et al., 2012).

However, moving from theory to practice has proven to be a challenge especially when attempting to manage resources at the landscape scale. For example, researchers typically argue for an inclusive, collective management process, but the inclusion of multiple actors increases the likelihood of conflict among stakeholders (Bryson et al., 2006; DeCaro et al., 2017). This highlights the role of bridging originations, which are groups that provide a platform for diverse stakeholders to coordinate and share information with potential cooperators (Berkes, 2009). While these well-documented challenges have inspired theoretical approaches for solving them, less attention has been given to understanding when participants agree the challenges have been met. Previous studies commonly outline key aspects to achieving success to establish frameworks and definitions that can serve as a guide to achieving successful collaboration. For example, a frequently cited study conducted by Schuett et al. (2001) identified development, information exchange, organizational support, personal communication, relationship/team building, and accomplishments as keys to successful collaboration. Additional studies have narrowed the scope to explore the role of trust (Stern & Coleman, 2014), or knowledge transfer (Mattsson et al., 2019) in addressing challenges and achieving success.

Studies that define and provide theoretical frameworks for achieving and evaluating successful natural resources management are crucial for furthering our understanding of complex phenomenon. However, in addition to these research-defined conceptualizations of "success," it's important to understand how success is defined by managers, and how these definitions influence the ways in which collaborative stewardship happens. Therefore, this study attempts to contribute to our understanding of

cross-boundary natural resource management by providing empirical examples from managers working in PACEs. Specifically, it aims to address two research questions: (1) how do natural resource managers working within a PACE define successful cross-boundary stewardship efforts? And (2) how are these definitions operationalized to achieve successful cross-boundary stewardship?

Methods

Study area

The study sites include five PACEs centered on the following national parks: Rocky Mountain (RMNP), Grand Canyon (GCNP), Great Smoky Mountains (GSMNP), Sequoia and Kings Canyon (SKCNP) (jointly administered), and Lassen Volcanic (LVNP). The five PACEs span portions of 7 states: Colorado, Arizona, Utah, Nevada, Tennessee, North Carolina, and California.

When RMNP became a protected area 1915, the tracts of private lands around the boundaries of the park were primarily devoted to ranching, resource extraction, and tourism (Musselman, 1971). RMNP is located about 70 miles NW of Denver Colorado, making it an attractive location for further tourism development and second-home ownership. GCNP was first established as a protected area in 1893, but it wasn't until 1919 that it became a national park. Today, it receives nearly 6 million annual visitors from all over the world. The surrounding areas are sparsely settled, mainly consisting of large expanses of public, tribal and ranching land. GSMNP is located in the southern Appalachian Mountains along the border between North Carolina and Tennessee and has high levels of land use and home density when compares to the other PACEs. Sequoia National Park was established in 1890, and it wasn't until 50 years later that Kings

Canyon became a national park, and the two have since been jointly administered as Sequoia & Kings Canyon National Parks (SKCNP). LVNP became a national park in 1916 due to its remarkable volcanic features (Krahe & Catton, 2010). LVNP, in north-central California, is located in a rural landscape with less access to densely populated areas, which has resulted in less development of surrounding lands than more accessible parks.

These protected areas were selected for several reasons. First, they vary in size and visitation and therefore patterns common among them may yield information that is applicable beyond a given region. Also, they are nested in a management mosaic comprised of public and private lands and therefore are well-suited to serve the research objectives of this study.

Data Collection

Data collection for this chapter involved semi-structured key informant interviews with natural resource professionals across all five PACEs. Semi-structured interviews foster understanding from the participants' perspective and enable researchers to uncover meaning by integrating rich descriptions of people's experiences from multiple points of view (Creswell 2013; Montello and Sutton 2013). Key informants were identified at each PACE to include managers serving federal, state, and local governmental agencies, as well as managers working for non-governmental organizations (NGOs). The process began with outreach to the chief of natural resources officer at each national park identify collaborations with other individuals and agencies. Upon interviewing key informants identified by each natural resources officer, snowball sampling allowed interviewees to identify additional participants with specific knowledge or experience that related to the

topic of this study (Biernacki & Waldorf, 1981).The interviews took place between October 2017 and December 2019. The interview guide (see Appendix A) includes questions that fall into one of three broad categories: 1) personal experience & background, 2) cross-boundary collaborations, and 3) social and institutional contexts of collaborative management.

The first section (background) included questions about tenure with the current agency and working in the current geographic region, the manger's role and focus within their organization, and their perspectives on the role of the organization they work for. The second section (jurisdictional boundaries) included the bulk of the questions and covered topics such as: cross-jurisdictional management challenges, historic and current partnerships, collaborative management activities, and perceptions of cross-boundary collaboration dynamics (information and resource sharing, challenges and opportunities, and definitions of success). The final section of the interview built upon the previous section by asking about perspectives regarding the interviewee's experience with collaborative partnerships, willingness to cooperate, balance of effort, alignment of management objectives, and regional changes that influence cross-boundary stewardship. All interviews were recorded and then transcribed prior to qualitative data analysis.

Analysis

Interview analysis was conducted using qualitative data analysis software (ATLAS.ti,) to conduct a systematic, iterative coding process designed to organize and understand complex qualitative data (Creswell, 2013; Miles, et al., 2019; Saldana, 2009). This is an inductive process to generate codes, categories, and themes across a set of semi-structured interview transcripts. This approach consists of three broad steps:

exploration, coding, and interpretation. The first step entails a review of the transcripts to identify common concepts and ideas that arise in the qualitative dataset. Next, these key concepts and ideas inform development of a codebook to enable an increasingly systematic review of the interview transcripts.

Coding included several iterative "cycles." First, codes and sub-codes were used to flag words, statements or phrases that hold relevance to the research questions (Decuir-Gunby, et al., 2011). Codes were then organized into various categories that align with the pertinent research question. This categorization is helpful for generating a taxonomy of codes for comparative assessment in the second cycle of analysis. This cycle identified and grouped patterns arising from the first coding cycle to generate categories, and ultimately themes that provide greater explanatory power for complex social phenomena (Decuir-Gunby, et al., 2011).

Results and Discussion

Managers were asked to define successful cross-boundary stewardship efforts given their personal experience and perceptions. The responses to this interview question fell under two broad categories: process and outcomes. In other words, this line of questioning elicited answers that had to do with the procedural components for working across jurisdictional boundaries, and the outcomes, or indicators of success, associated with these collaborative efforts. Put simply, land managers discussed key components and strategies for achieving success and outcomes from those approaches that serve as evidence of success. While theoretical frameworks are helpful for understanding the complexities of collaborative resource management, this study sought to extend our understanding by allowing the practitioners working within the system to define

successful cross-boundary stewardship. The first to follow highlights successful outcomes, or evidence of a successful process. This helps frame the second section that discusses strategies for achieving desired outcomes. In other words, the first section explores what successful cross-boundary management looks like according to public land managers, and the second section highlights some of the ways in which successful cross-boundary management is achieved.

Outcomes: indicators of success

Managers discussed several outcomes that serve as evidence, or indicators of a successful collaboration. Specifically, the major themes related to outcomes include: project completion, learning, landscape changes, and conflict/risk reduction. Project completion arrives as a clear, literal measure of success. Many of the managers interviewed within this study cited this aspect of success towards the beginning of their response before providing detail upon how they have been able to achieve agreed upon goals and provide project deliverables. For example, one manger began by answering from an agency perspective:

> *Well, when you're talking about the agency success or failure, that's usually mission-oriented. Success or failure is making sure that you get your mission completed successfully. (GSMNP, Interview 29)*

Completing a project also allows managers to reflect and assess the advantages of completing a project collaboratively. For example, one manager cited improved efficiencies as a measure of success," *I think collaboration done correctly really builds efficiencies" (GSMNP, Interview 28).* Other managers discussed beliefs that related to increased capacity as an outcome of successful cross-boundary cooperation:

> *...the amount of work that you can get done together and the quality of work that you can get done together that you wouldn't have been able to get done in isolation. (GSMNP, Interview 23)*

These examples show how completing a project can foster reflection that encourages and informs future collaboration. Reflection upon past efforts commonly falls outside the written objectives of the project, however, given the findings of this study it may be a worthwhile component to include within official agreements between agencies and organizations.

Several managers also discussed the importance of collaborative learning as an outcome of successful collaboration. One manager explained how sometimes the practices occurring on the other side of a jurisdictional boundary are poorly understood:

> *One way that I define success is shared understanding. I think that a lot of times-- You find this all the time where everyone's doing their own thing, working on the same projects with no idea of what the other people right next door are doing. (SKCNP, Interview 33)*

Additionally, collaborative learning creates a space for managers to share missions and objectives to identify cooperative activities that address common problems:

> *A successful outcome is when everybody's engaged and everybody has input into decision making and then everybody constructs as equally as possible, win, win solutions to common problems. (GCNP, interview 10)*

Identifying mutually beneficial outcomes from successful collaboration can also help managers inspire data-driven decisions in subsequent management efforts. A good example of this comes from a manager working in the GSMNP PACE:

> *.... elements of success are things like, "Did we successfully complete a research project collaboratively and then use the results to change management?" That's really challenging actually it turns out because I*

> *mean, as we all know, ecological research can take several years to address variability and that the results may be, we actually need more research as opposed to here's the direction of what you need to go…. that could be another metric of success of whether or not you're able to break that science management gap effectively….. To have folks be excited about the results, I think that is an important metric for success. (GSMNP, Interview 23)*

The mutual understanding built through successful cooperation can also facilitate a sense of support and confidence for working through issues that may otherwise be controversial. The following example demonstrates how this can serve as an outcome, or indicator of success:

> *One of the benefits that comes out of partnerships, there's a whole lot of it, intangible. We end up with a lot greater support for our employees and agency after we've worked side by side with folks to figure out issues together, after we understand one another. (GCNP, Interview 20)*

Another manager echoed this perspective by saying:

> *"Other metrics of success are, what are the projects that you've been able to work on together that might otherwise be controversial? I think there are a couple of different criteria to look at. One, is I think there's a huge importance and establishing a functional relationship and a functional process, like a working process that despite everybody's political leanings or affiliations, that there's a work in process or enough trust or relationship goals that folks can still meet regularly to come together and to talk about." (LVNP, Interview 42)*

Additionally, risk reduction can entail situations where managers are able to avoid legal action that hinders their ability to address a given issue:

> *There are a number of criteria. The first one that came to mind is litigation. Can we avoid litigation? My intent in the work I do is to do everything I can to avoid us filing a lawsuit. (GCNP, Interview 24)*

The final thematic aspect that can be viewed as an indicator of success relates to changes within the landscape being managed. This may include changes such as reduced fire risk, improved habitat, or any other physical evidence of an intact ecosystem across jurisdictional boundaries:

> *For me really the bottom line success is a sustainable, intact ecosystem. (GCNP, Interview 18)*

Other managers discussed changes on the land that relate to a given resource or the primary focus within the position they hold. For example, fire management proved to be a common topic of discussion when working across jurisdictional boundaries. One manager that placed the focus on fire while defining success:

> *To me, defining success in that is we don't have a landscape-scale fire like we had in the Redding Fire in 2012 in that area, so we don't lose that function. (LVNP, Interview 48)*

Finally, to recognize successful outcomes on the landscape, it is important to define what that is early on so it is easier to recognize and agree on a successful effort when it comes to fruition:

> *I guess the greatest degree of success is, does management change for the better in terms of what we consider better, which is a less intensive, more wildlife and ecosystem-based manner of management, versus a more intensive commodity-based paradigm (GCNP, Interview 24)*

Indicators of success may take a range of forms and hold differing weights of importance depending on the given objectives of the collaborative group. The major themes that surfaced during the analysis include: collaborative learning that builds shared understanding to identify common goals and strategies for achieving those goals

efficiently through a collective effort. Additionally, avoiding conflict and seeing actual change on the landscape served as metrics of a successful process. These themes also highlighted the value of reflecting on the outcomes and process of a completed project to make results-driven management decisions that improve subsequent efforts.

Process: fostering successful cross-boundary management

Now that we've outlined the major themes that serve as indicators of success, the next step is to explore perceptions related to how managers go about achieving these desired outcomes of success. Several themes relating to the procedural aspects of cross-boundary collaboration surfaced while analyzing the transcripts. The primary themes related to process include: shared power and responsibility, fostering trusting relationships, sharing information, and managing a system rather than a jurisdiction.

Many managers brought up the importance of shared power and responsibility among cooperators, and how a shared sense of responsibility can increase capacity when facing unforeseen challenges. One manager highlighted how this can contribute to project completion with a given group of collaborators:

> *Then just getting projects done. Developing projects collaboratively, where we agree upon them sticking to your schedule, and getting it done in a team-oriented fashion where everybody's working towards the same goal. Sharing responsibility when we run into hurdles, with either staffing or money. (LVNP, Interview 48)*

This example emphasizes how establishing shared responsibility in the joint planning process can facilitate project completion. Shared power and responsibility are built through joint planning among managers from differing organizations and agencies.

Planning efforts that are genuinely collaborative provide a space for generating innovative ideas that may increase procedural efficiencies that would not be possible through independent management efforts.

Several managers conveyed the benefits of getting out in the field together during the planning process. This enables members of the collaborative to realize the various goals and objectives held by others through seeing and understanding them on the ground. In other words, several managers interviewed in this study believe getting into the field together is an effective strategy for building shared understanding that fosters shared power and responsibility. One of the managers that supported this strategy said:

> *What I see as a true partnership is when you go out in the land and talk together about, "Well, what do we think is needed here? What [do] you think? What do I think?" Then we come up with the proposal collaboratively and then we figure out where the expertise is, where the resources are, where the capacity is, and we go from there. I think what's really key is early collaboration. (GCNP, Interview 20)*

The joint planning process also allows members of the group to identify common goals that may encapsulate a range of individual management objectives. This example also shows how joint planning can be instrumental for pooling resources to increase capacity. Another manager also highlighted how effective joint planning may generate additional resources through collaborative proposals that can result in additional funding for a given project:

> *That's something that I think as we really start to collaborate more and get a better understanding for the strengths of each group and what the questions are, our questions and research proposals and whatnot just become more compelling. I think the more times we get money to do things together, that's definitely one way I would define success. (SKCNP, Interview 33)*

In that sense, a successful joint planning process may enable insightful discovery that would otherwise not be possible. However, the clear benefits of a joint planning process require consistent willingness from members of the collaborative. In other words, this process may require specific intent that falls outside of the duties and objectives of a given manager.

> *Collaboration requires utmost openness, transparency, honesty, and a willingness to look at the ultimate goal and if necessary, perhaps set aside or modify individual stakeholder goals in order to resolve the bigger issues, the bigger problem. (GCNP, Interview 22)*

This perspective demonstrates how attitudes among the members of the group can help reduce potential conflict and provide the foundation for arguably the most important element of successful cross-boundary stewardship: relationships. Trusting relationships proved to be the most prevalent theme when managers were asked to define successful cross-boundary resource management. This is far from a novel argument in the broad field of cooperative behavior, yet understanding how to build and sustain trust in a cooperative conservation context requires empirical examples like those provided by this study. In a cross-boundary management context, trusting relationships are central to successful stewardship that crosses jurisdictional boundaries.

> *Another important indicator would be personal relationships. If, at the culmination of a planning process, I can still be in good relations with people in the agency who I may have had intellectual combat with, then I think there's degree of success there. (GCNP, Interview 24)*

One challenge with sustaining this sort of working relationship given the issue of turnover within land management agencies and organizations. The current literature highlights turnover as a significant barrier to building trusting relationships with potential cooperators (Stern & Coleman, 2015; Stern & Baid, 2015). One of the mangers interviewed in this study offered a strategy for mitigating this challenge:

> *A success to me would be that it is institutionalized to the point that I would have faith that it would continue without me coordinating it or even on a turnover, that it is now has enough value that the members-- Well, like I said, it becomes institutionalized, that this is something that is embedded into their individual work plan and priorities. Maybe that's true for all collaborations, that ultimately, the theoretical value becomes apparent, that however they define success or however they feel success, comes out in a way that it incentivizes investing resources in that continued collaboration. (SKCNP, Interview 38)*

Embedding the collaborative process requires managers to reflect on past success to inform future process. While relationships and trust aren't transferable at the level of individuals, embedding a successful process may garner trust in an approach with proven success. For example, this may include getting into the field together to identify common goals and build trusting relationships. Further, developing funding proposals with members outside of your agency or organization may result in more compelling research questions with higher potential to secure additional funding. Finally, this sort of embedded process can alleviate potential litigation that can hinder the efficiency for project completion. This aspect was identified as another benefit, of indicator of working collaboratively across jurisdictional boundaries,

> *Other metrics of success are, what are the projects that you've been able to work on together that might otherwise be controversial? I think there are a couple of different criteria to look at. One, is I think there's a huge*

> *importance and establishing a functional relationship and a functional process, like a working process that despite everybody's political leanings or affiliations, that there's a work in process or enough trust or relationship goals that folks can still meet regularly to come together and to talk about. (GCNP, Interview 23)*

Building trust (individual or institutional) can influence the flow of information between organizations and agencies in the form of more frequent communication and sharing data. Information flow can be thought of as the social currency within PACE management. As the flow of information increases, so does the level of trust and the ease of addressing unforeseen challenges:

> *The other thing I see from a success standpoint is efficiencies because once people believe you and you're sharing stuff, I think it elevates trust, to be honest with you. (GSMNP, Interview 28)*

Again, if we recognize that jurisdictional boundaries are ultimately human constructs, data sharing can help shift managers from a jurisdictional focus to a systems focus. Even when management practices stop at a jurisdictional boundary, data sharing still provides crucial benefits to neighboring managers and the ecosystem as a whole. A useful example of this comes from a SCKNP manager:

> *I can't say in the whole Southern Sierra, it's most important that we treat these things on the Forest Service property. Really, I can partner, I can provide data. We can be the control for experiments that happen, but I can't get out of my lane that much, and neither can the forest service…. Between the land management staff, sometimes we look at it as a benefit in terms of, well, if they're going to plant, do reforestation and we're not, then we get to be the control for their treatments. (SCKNP, Interview 36)*

This example emphasizes a strategy for working across jurisdictional boundaries in situations where co-management may not be possible.

> *I find it successful just sharing information and sharing ideas. Very often we come up with joint solutions on management problems that span boundaries. A lot of it's just in developing the relationship and strengthening that for future issues that might come up that could be more challenging and harder to deal with. (SCKNP, Interview 25)*

The final example from the interviews pulls together many of the themes identified by this study as it applies to fire management:

> *Ultimately, if I keep my eye on the ball, I would say success would be working across boundaries, biggest current threat is these gnarly wildfires. Standing back and going, "Let's pretend there are no boundaries, and let's just figure out where the best strategic placement of forest treatments would be to reduce the effects of these kinds of wildfires.[P SEP]If the best treatments happen to span a boundary, let's do it anyway. If they don't span a boundary, we work together to figure that out and we put the treatments where they'll be best used. (SCKNP, Interview 36)*

Conclusion

Managing natural resources that cross jurisdictional boundaries is clearly a complex challenge that can't be addressed using a single framework or approach. However, the empirical examples provided by this study help bridge the gap between informative theory (Basco-Carrera et al., 2017; Crona & Parker, 2012) and real-world application. We found that managers working in PACEs define and achieve successful cross-boundary stewardship in a range of ways, and we identified key aspects for understanding the metrics and mechanisms of success.

First, a joint planning process that identifies common goals and challenges can foster shared understanding, power, and responsibility within a collaborative working group. This type of collaborative learning can build trust among mangers that lowers the potential for conflict and litigation, and increases the flow of information via frequency

of communication and sharing of data. When information is readily shared, managers are able to identify innovative strategies for working across boundaries and approaching management from a systems perspective, rather than a jurisdictional one. Additionally, when efforts are made to engage with others there is a potential to pool, or even generate additional resources that would not be available if they decided to manage an issue individually. Finally, this study highlights the importance of reflecting on past success in a way that informs better management and approaches moving forward. Additionally, embedding aspects of successful process at an institutional level is a potential strategy for addressing turnover and fostering trust among cooperators. The hope is that these findings can contribute to our understanding of cross-boundary stewardship within coupled natural and human systems and inspire further research designed that contributes empirical evidence that can continue to bridge the gap between theoretical frameworks and real-world application.

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CHAPTER III

COOPERATIVE RESOURCE MANAGEMENT AMONG PRIVATE LANDOWNERS IN PROTECTED-AREA CENTERED ECOSYSTEMS

Abstract

This study is part of a larger research project that examines the ecological connectivity and characteristics of public land management across protected area-centered ecosystems (PACEs). Specifically, this study includes three PACEs in the western USA, each of which is centered around a national park: Rocky Mountain, Lassen Volcanic, and Sequoia-Kings Canyon. Federally owned and managed lands make up a significant portion of these large ecosystems, but as one moves further from the core of the system, the landscape becomes increasingly partitioned. As administrative partitioning increases, so does the range of ownership types, land uses, land management approaches, and overall complexity of the management mosaic. This study aims to further our understanding of PACE management by exploring the role of private land owners in PACE land stewardship. To address this key component, a survey was delivered to a sample of private landowners across all three PACEs. The survey was designed to measure characteristics of cooperative stewardship among private landowners living in a PACE. Specifically, the findings identify landowner characteristics associated with various forms of cooperation (i.e., communication, coordination, and collaboration).

Introduction

Protected areas are managed to serve an increasingly diverse range of social, ecological and economic objectives. The International Union for Conservation of Nature (IUCN) defines a protected area as, "…a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values." (IUCN, 2013). However, the jurisdictional boundaries of protected areas rarely encompass the larger ecosystem they are part of (Hansen et al., 2007). Rather, the larger landscape includes a diverse range of ownership types, some governmental and some private, whose management objectives and practices influence the social and ecological dynamics within that larger landscape.

Recognizing the inherent social and ecological feedbacks between protected areas and the surrounding landscape, Hansen et al. (2011) developed an approach to delineate the geographic extent of Protected Area-Centered Ecosystems (PACEs) across the U.S. A significant portion of these PACEs are comprised of federally owned and managed lands. However, as one moves outward from the boundaries of protected areas, the landscape becomes divided into an increasing number of land tracts owned and managed by a diverse population of stakeholders with differing values, objectives and land management practices (Holcomb et al., 2011). The administrative partitioning of undeveloped lands has created management mosaics (Epanchin-Niell et al., 2010). Over time, differing land-uses on either side of an administrative boundary can fragment the natural system and create new ecological zones within the larger ecosystem (Epanchin-Niell et al. 2017). The establishment of jurisdictional boundaries is ultimately a human construct that influences the ecological connectivity of large landscapes (Brunson, 1998). In other

words, there is a likely positive relationship between administrative partitioning and ecological fragmentation (Aslan et al., 2021).

In practice, landscape-scale management requires more resources and logistical coordination across jurisdictional boundaries rather than independent management efforts (Westing, 1998). In terms of cross-boundary resource management, much attention is given to the concept of collaboration, especially for studies focused on large, land-owning agencies involved in landscape-scale management activities (López-Hoffman et al. 2010). Many studies have highlighted the advantageous facets of collaborative conservation efforts (e.g., Mattsson et al., 2019; Rodrigues & Gaston, 2002; Bladt et al., 2009). Collaboration has the potential to foster mutually beneficial outcomes that would otherwise not be possible. Collaborative efforts are of particular importance when managing natural resources that cross jurisdictional boundaries in order to avoid a spatial mismatch between the ecological system and the management jurisdictions (Guerrero et al., 2013). For example, large watersheds often have headwaters in a given jurisdiction, but the larger natural system may cross several jurisdictional boundaries. Addressing these challenges requires information-sharing and cooperative decision-making among agencies, NGOs and private landowners.

Many of the studies aimed at understanding landscape-scale resource management focus on cooperative management among government agencies and nonprofit organizations (e.g., Singleton, 2000; Rahman et al., 2017; Reed et al., 2018). Studies that consider the role of private landowners in cooperative conservation often focus on a specific "type" of owner (e.g. farmers, ranchers) (Westerink et al., 2017) or a single resource management issue (Ma et al., 2018; Coon et al., 2020). Furthermore,

measures of cooperation commonly include reported willingness to work with resource management organizations, or the success of an outreach program (Ferranto et al., 2013), as opposed to reported cooperative action. We build on these studies, which advance understanding of cooperative conservation at the public-private interface, by examining cooperation across private land populations that vary in their land use objectives and management activities. Several researchers have encouraged this line of research as an important component for understanding cooperative conservation at the landscape scale (Floress et al., 2019; Ma et al., 2018; Fischer et al., 2017). Specifically, this study explores contextual and land manager characteristics associated with active resource management on private lands and cooperative engagement among private land managers living in protected area-centered ecosystems. Furthering our understanding of cooperative engagement from the perspective of private landowners has the potential to inform management practices that serve a wider range of stakeholders living and working with in a PACE.

Background

Cooperative resource management is a multifaceted phenomenon that involves shared rights and responsibilities among actors seeking mutually beneficial outcomes (Ostrom, 1990; Plummer & FitzGibbon, 2004). As a general concept, cooperation can take many forms and involves a range of behaviors depending on the needs and interests of the cooperators. More specifically, cross-boundary cooperation refers to, “a voluntary behavior in which landowners account for the plans and practices of adjacent or nearby properties when making management decisions about their land” (Ferranto et al., 2013). Given the various forms of cooperation, this study considers a taxonomy of cooperative

behavior (Yaffee 1998) that provides definitions for various forms of cooperation (Table 2). The conceptual definitions offered by Yaffee (1998) inform the approach and interpretation of cooperative engagement within this study. [Note, within this research the term "cooperative engagement" refers to any type, or level, of cooperative behavior between two or more actors, but it is important to recognize the various forms (communication, coordination, collaboration) in which cooperation may occur.]

Table 2

A taxonomy of cooperative behavior. (Yaffee, 1998).

Behavior Type	Definition
Awareness	Being cognizant of others' 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

There is now a large body of literature aimed at understanding and modeling cooperative conservation as a behavioral outcome. Cooperation is considered vital for solving complex natural resource management challenges that occur at a range of scales and cross a variety of jurisdictional boundaries. Collective action theory (CAT) posits that Individuals will engage in cooperative behavior when: (1) cooperative engagement can potentially lower risk posed to a valued resource; (2) individuals have the capacity to engage in cooperative behavior; (3) there is a mutual understanding that uncoordinated efforts will sustain or increase the risk posed to the valued resource; (4) individuals believe that their change in behavior will encourage others to adopt a similar behavior; and (5) there is a belief that cooperation will yield benefits that outweigh the costs

(Ostrom, 1994). Additional social and psychological factors believed to influence cooperative behavior include alignment of perceived risk and management objectives, and common values and beliefs (Douglas & Wildavsky, 1982; Berger, 1967; Tierney, 1999; Hertwig et al., 2004.); and mutual trust among individuals (Pretty, 2003 Ferranto et al., 2013, Fischer and Charnley, 2012,). Shared perceptions of risk and mutual trust in others are central themes to CAT that commonly appear in cooperative conservation research.

Perceived risk is argued to be a key driver of natural resource management efforts (Grothmann and Patt 2005; Amacher et al., 2005; Niemeyer et al., 2005; Jarrett et al., 2009; Fischer, 2011;). Risk perceptions are not formed solely by factual information, but also through past experiences, interactions with others, and personal ideologies, norms, and worldviews (Douglas & Wildavsky, 1982; Berger & Luckmann, 1967; Tierney, 1999; Hertwig et al., 2004). Additionally, trust is believed to be a critical component of cross-boundary cooperation aimed at addressing a shared perception of risk (Bergmann & Bliss, 2012). As a concept, trust is a complex psychological phenomenon that comes with a range of definitions. One of the most widely cited definitions of trust comes from Rousseau et al. (1998): “Trust is a psychological state comprising the intention to accept vulnerability based upon positive expectations of the intentions or behavior of another.” According to this widely accepted definition, trust is fostered through psychological intent (James et al., 2005) and assumes a reciprocal dynamic between two or more parties in which the trusted party is expected to attend to the interests of others involved and have the competence to do so (Hardin, 2004). Contextual variables such as ownership

tenure, parcel size and location, residency, and benefits derived from owning land may also influence cooperative engagement (Butler, 2008).

Despite the extensive body of research on cooperative conservation, the factors that drive or limit cooperation directly between private landowners are still poorly understood (Fischer et al., 2013). This study aims to address this knowledge gap through empirical research designed to further our understanding of the role played by private landowners in cooperative resource management efforts. Towards this goal, this study includes two primary objectives:

(1) Assess the amount of reported management occurring on private lands and identify the characteristics associated with differing levels of reported management activity

(2) Identify characteristics of private lands and landowners associated with different forms of cooperative engagement that extends beyond the boundaries of the property they own.

Methods

To gain a more comprehensive understanding of PACE land management, we explored the role of private landowners in PACE stewardship. To address this key component, a survey was delivered to a sample of private landowners across three PACEs centered on three national parks in the western USA. The survey was designed to measure and identify the characteristics of cooperative land management activities that cross property or jurisdictional boundaries. Participants were selected through an integration of county tax-assessor property records and GIS parcel data. This approach

enabled a spatially-explicit sampling design that linked survey responses to specific parcel-level locations.

Data collection took place across all three Protected Area-Centered Ecosystems (PACEs). Participants were selected through an integration of county tax-assessor property records and GIS parcel data. This approach enabled a spatially explicit sampling design that linked survey responses to specific parcel-level locations. As there is no centralized ownership database, data acquisition occurred at the county level by contacting several departments within each county government office. In some cases, this information was publicly available in a geospatial format on county government websites. In the majority of cases, acquisition of ownership data involved outreach to county tax-assessor offices and county GIS departments. Next, the ownership information was linked to each respective county parcel map and assigned a unique, password protected ID to ensure confidentiality for survey participants. To the extent possible, sampling was restricted to individuals that own 2 or more acres of private land within one of the three PACEs (Figure 1).

Study Area

This study includes three PACEs centered on Rocky Mountain National Park (RMNP), Lassen Volcanic National Park (LVNP), and Sequoia & Kings Canyon National Parks (SKCNP). The extent of the PACEs includes portions of 12 counties across two states: Boulder, Clear Creek, Gilpin, Grand, Larimer and Jackson, Colorado; and Plumas, Shasta, Tehama, Lassen, Fresno, Inyo and Tulare, California. When RMNP

became a protected area 1915, the tracts of private lands around the boundaries of the park were primarily devoted to ranching, resource extraction, and tourism (Musselman, 1971). RMNP is located about 70 miles NW of Denver Colorado, making it an attractive location for further tourism development and second-home ownership. LVNP became a national park in 1916 due to its remarkable volcanic features (Krahe & Catton, 2010). LVNP, in north-central California, is located in a rural landscape with less access to densely populated areas, which has resulted in less development of surrounding lands than more accessible parks. Sequoia National Park was established in 1890, and it wasn't until 50 years later that Kings Canyon became a national park, and the two have since been jointly administered as Sequoia & Kings Canyon National Parks (SKCNP). These protected areas were selected for several reasons. First, they vary in size and visitation and therefore patterns common among them may yield information that is applicable beyond a given region. Also, they are nested in a management mosaic comprised of public and private lands and therefore are well-suited to serve the research objectives of this study.

Data Collection

The first step of this approach is determining the counties and parcels within the boundaries of the three PACEs. To do this, the three PACE shapefiles (determined and provided by members of the NSF research team), and statewide county maps (ESRI open source data) were uploaded and analyzed in ArcGIS Pro to identify which counties fell within, or intersected the boundaries of each PACE. This process identified 12 counties across the three PACEs. With no centralized ownership database, data acquisition occurred at the county level by contacting several departments within each county

government office. In some cases, this information was publicly available in a geospatial format on county government websites. Unfortunately, this was not a common occurrence. In the majority of cases, acquisition of ownership data involved outreach to county tax-assessor offices and county GIS departments. For two of the counties, payment was required to obtain specific ownership information. Also, it was important that these ownership datasets include some sort of ID number that could be linked or joined to geospatial data. In most cases the linkable ID was the assessor parcel number (APN). Most county GIS websites included downloadable parcel-maps but lacked specific ownership information.

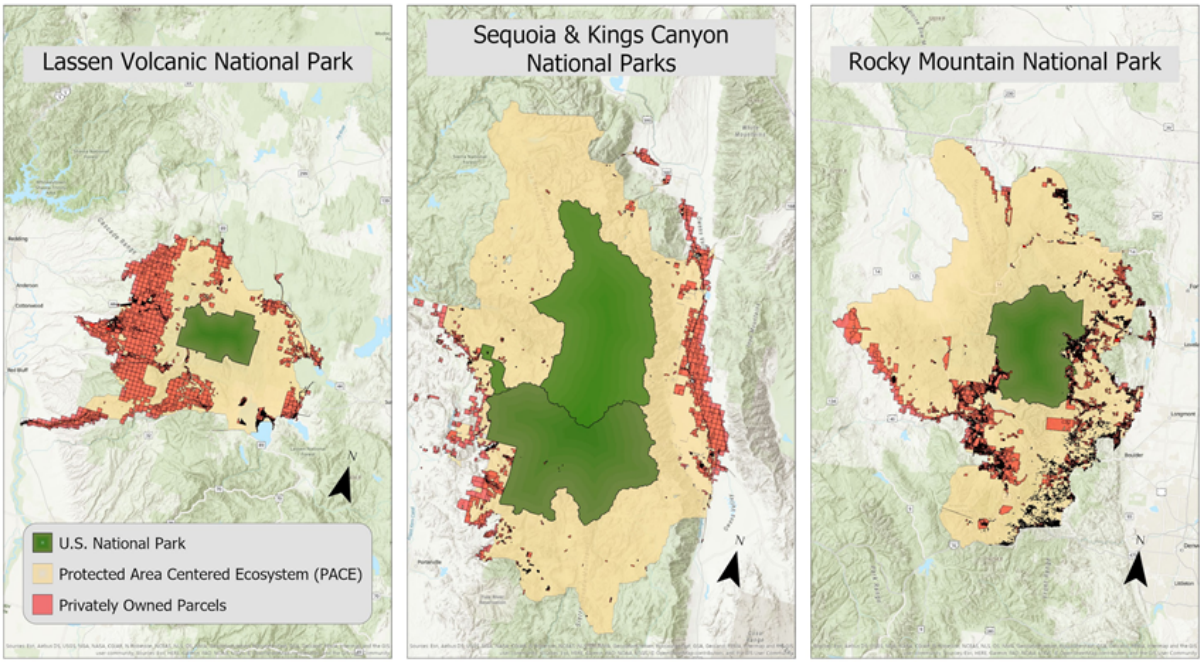
After obtaining the necessary ownership information, the next step next step entailed organizing and cleaning the data. To get the data in the proper format the tax assessor ownership data (spreadsheet format) were integrated with the GIS data (shapefiles and geodatabases) using the "Add Join" tool within ArcGIS Pro. For ecologically defined study areas, it is unlikely that a socially constructed boundaries, in this case county lines, will align with the boundaries of the study area. Therefore, the next step was to delineate the parcels that fall within (or intersect) the study area, in this case a PACE. An inherent challenge with using data from multiple sources is managing the considerably different ways in which they are organized. It is likely that the field names differ from source to source and require reformatting if attempting to generate a master dataset across the entire study area(s). If possible, it is good practice to request field code name definitions so that you can better interpret the datasets provided by each county.

Upon generating a master dataset, it was now possible to identify and select the sample population, Again, the selection criteria included privately owned lands that were

2 acres or larger. For this research, the sample population was calculated using a 5% margin of error and 50% population variance level. The sample was randomly selected using a random number generator in the spreadsheet program Excel.

Figure 2

Study areas showing extent of PACE, location of national parks, and location of privately owned parcels.



Survey distribution utilized an adapted outreach protocol from the Total Design Method (TDM) established by Dillman (2002). Invitations to participate in the private landowner survey were mailed to selected participants' legal addresses. The invitation included a letter of information with instructions for accessing an online version of the survey. Upon accessing the survey, participants were asked to provide their unique survey ID provided in the invitation letter. After two weeks, a reminder postcard was sent

to any potential participants that had yet to complete the online survey. The postcard once again provided instructions on how to access the survey and enter their unique survey I.D. to provide consent and begin the survey. A third and final recruitment letter was sent one month after the first recruitment letter. The final letter included a paper copy of the survey, an informed consent document, and a pre-paid return envelope.

Survey Content

The survey sought to identify and quantify characteristics of collaborative land management activities that cross property or jurisdictional boundaries. Specifically, the survey aims to measure psychological and contextual factors as potential explanatory variables for management activity and cooperative engagement. The psychological measures include: benefits of owning land; perceptions of the land as part of larger natural, economic and social systems; trust in others when working together to make land management decisions; perceived drivers and barriers to managing the land; perceived risk posed by specific natural resource issues; the influence of neighboring land and landowners; and private landowner value orientation measures. Additionally, the survey and sampling design enabled the inclusion of parcel characteristics as potential explanatory variables for land management activity and cooperative engagement, including parcel size and location, proximity to public land, and the number and type of adjacent parcels. The spatial variables were generated in ArcGIS Pro using the PACE parcel maps discussed in the previous section. Other contextual factors derived from the survey include residency status, length of ownership, and sociodemographic variables. For further detail regarding the specific items and measures within the survey, see Appendix B.

The outcome variables for this study include a) the level of management occurring on privately owned parcels of land and b) cooperative engagement taking place between private landowners living in a PACE. Respondents were asked to rate the amount of management on their own property to address each of four potential issues: wildfire; invasive weeds, shrubs or trees; pests (insects, plant disease, etc.); wildlife; and "other." The rating scale included four response options ranging from (1) no management to (4) intensive management. Participants were also asked to rate their level of agreement with statements related to cooperative engagement with other private landowners, using a 7-point scale ranging from 1 (strongly disagree) to 7 (strongly agree). Four statements were designed to measure different forms of reported cooperation behaviors adapted from Yaffe (1998) (communication, coordination, general collaboration, and cross-boundary collaboration) (Table 3).

Table 3.

Measures of cooperative engagement with other private landowners.

Statement	**Cooperation type**
I inform my neighbors of the land management practices on my own land.	Communication
I work with my neighbors when making land management decisions.	Coordination
I work with my neighbors on land management activities.	General Collaboration
I work with my neighbors on land management activities that cross the boundary between our properties.	Cross-boundary Collaboration

Analysis

Survey analysis was conducted using SPSS, and ArcGIS PRO. SPSS is a statistical analysis software platform (IBM Corp., 2020), and ArcGIS Pro is a software package for exploring, visualizing and analyzing geospatial data (ESRI Inc., 2020).

1. Data Reduction

Given the relatively large number of items within the survey, a data reduction process was employed to reduce the number of individual items for subsequent analysis. Data reduction is helpful for simplifying the complexity in high-dimensional data (Lever et al., 2017). A principal component analysis (PCA) with varimax rotation was used to identify survey items that grouped together and loaded on a single component with 0.5 as the threshold for loading scores. The assumptions behind PCA include: linearity exists among components, components with large variances are generally the most interesting ones, and reducing the dimensionality of the original data does not result in the loss of important information (Batina et al., 2012). Next, Cronbach's alpha scores were calculated across all survey items that loaded on a single component to assess the reliability and provide additional justification for the use of composite scores. All survey item groupings identified by the PCA had acceptable Cronbach alpha scores (>0.7) (Christmann & Van Aelst, 2006) and were therefore used to calculate mean scores across survey items that loaded on a single component for subsequent analysis. Variables included in the final regression models are described in the next section.

2. Reported Management

Participants were asked to rate the level of management they conducted on their own property to address potential natural resource issues that may pose risk to the property they own. The potential issues, informed by interviews with natural resource management officials working in one of the three PACES, include: wildfire; invasive weeds, shrubs or trees; pests; and wildlife. The survey also included an "other" category so participants could report management that did not fall under one of the four specific management issues. Participants used a 4-point scale ranging from 1 (no management) – 4 (intensive management) to report the level of management they conducted on their own land to address each given issue. The survey sought to assess management levels rather than specific management practices; therefore the reported management may include a range of specific activities (e.g. reducing vegetative fuels to manage wildfire risk, or building structures to prevent wildlife from consuming crops, etc.).

Responses to this survey question were organized into four categories to better summarize and compare differing levels of reported management (Table 4). The "Infrequent manager" category included participants that reported "no" or "some" management to address no more than one of the potential management issues. "Episodic managers" are defined as individuals that reported "no" or "some" management for two or more issues. "Focused managers" include participants that reported "regular" or "intensive" management on a single issue. The final category, "Active managers," represents the individuals that reported regular or intensive management to address two or more issues on the property they own.

Table 4

Categorization of reported management activity.

		No. of management issues addressed	
		0-1 issues	2-5 issues
Level of management	Regular/intensive	Focused manager	Active manager
	None/Some	Infrequent manager	Episodic manager

The next step of analysis sought to explore the influence of various management barriers and drivers on reported management levels. Respondents were asked to rate a number of potential drivers of and barriers to managing the property they own. Participants used a five-point rating scale (1: not at all important – 5: extremely important) to assess the importance of potential factors in encouraging (drivers) and limiting (barriers) their reported management activity on the land they own. The survey included 10 potential drivers of management and 11 potential barriers to management. The principal component analysis used in the data reduction process distilled the individual survey items into three distinct categories of drivers, and an additional three categories of barriers. The three categories of drivers include individual factors related to: (1) the influence of others; (2) the property they own and people that live there; and (3) economic considerations. Additionally, the three categories of barriers to managing land include: (1) limited access to information; (2) limited capacity to carry out management activates; and (3) a perception that the cost of management options outweighed the benefits. Further detail regarding the individual survey items within each category can be found in Appendix B.

To summarize factors that influence management activity, mean response scores and standard deviations were calculated for each driver and barrier category across the entire sample population. Next, a one-way analysis of variance (ANOVA) was used to compare the effect of the potential drivers and barriers on reported levels of management. Additionally, a Tukey post-hoc test was used to generate multiple comparisons between management groups. The post-hoc test was only conducted for barriers and drivers that exhibited statistically significant *p*-values in the ANOVA.

3. Cooperative Engagement

This study considered four types of cooperative behavior (Table 3) that may occur between private landowners living in a PACE. Binary dependent variables were computed for each of the reported cooperation behaviors where "1" represents a landowner that reported engagement with a given behavior (communication, coordination, general collaboration, and cross-boundary collaboration). Specifically, a binary variable was calculated for each statement so that "1" represented any responses that ranged from (5) somewhat agree to (7) strongly agree, and "0" represented all other potential responses (i.e. strongly disagree, disagree, somewhat disagree, neutral).). This enabled the construction of empirical regression models to identify predictors for each form of cooperation. Further, this allowed for a comparison across the models to assess commonalities and potential differences among the predictors for each type of cooperative behavior.

The regression models included a relatively large number of independent variables hypothesized to influence cooperative behavior (Table 6). The contextual

independent variables included residency type, ownership tenure, amount of reported management, parcel size, and the number of adjacent parcels or the number of neighbors. Additionally, the psychosocial independent variables include perceptions of: the conditions on neighboring lands, alignment of land management objectives with neighboring landowners, trust in other private landowners, and natural resource issues that pose potential risk to the land owned by the respondent. Finally, the models included independent variables aimed at assessing the benefits of owning land, perceptions of the relationship of their land to larger social, economic, and natural systems, environmental value orientations, and a range of potential drivers and barriers for managing the land they own.

Binary logistic regression was used to explore the influence of potential predictors on reported cooperation behavior. Estimates for the potential predictor variables were generated through a maximum likelihood (ML) estimation approach. A forward stepwise logistic regression was used to identify the most influential predictors for each type of reported cooperation. Starting with 23 candidate variables as potential predictors of cooperative behavior, a forward selection process based on p-values was used to reduce the number of predictors for the final models. At each step, the variable that had the strongest correlation with the dependent cooperation variable was entered into the model as long as it met the selection criterion of ($p<0.05$). The selection procedure was complete when none of the unselected variables satisfy the selection criterion ($p<0.05$). This process was carried out to produce four separate models that represent different forms of cooperative behavior. Each model included a dichotomous dependent variable

where 1 represented reported engagement with the given form of cooperation, and "0" represented all other potential responses.

Coefficients (B) and odds ratio (OR) are key outputs used to interpret the results of the regression analysis. A positive coefficient (B) score means that the likelihood of engaging in reported cooperative behavior increases as the value of the independent variables also increases. Alternatively, a negative coefficient (B) value means that the likelihood of engaging in reported cooperative behavior decreases as the value of the independent also increases. The odds ratio (OR) is calculated using the coefficient (B) values and is helpful for interpreting the model results. OR values greater than 1 signify a positive relationship between the likelihood of reported cooperative behavior and the given predictor variable. On the other hand, an OR value less than 1 represents a negative relationship between the predictor and outcome variable (i.e. decrease in likelihood).

The various models were comparatively assessed for accuracy and model fit using Hosmer and Lemeshow test statistics, Omnibus Tests of Model Coefficients, R-squared values, and classification tables before fitting the final models (Table 9). The Hosmer-Lemeshow test is used to assess goodness of fit for a logistic regression model with binary dependent variable. The key output is a level of significance score (p-value) and should be greater than .05 for determining that the data appropriately fit the model. Omnibus Tests of Model Coefficients are used to determine if the model is an improvement over the null model (i.e., $p < 0.05$). Additionally, the SPSS model summary output provides pseudo R2 values that are used to assess the amount of variance explained by the regression model. Finally, the classification table provides calculations for the percentage of cases that were accurately predicted by the model.

Results

Sample Characteristics

In total, 590 respondents met the sampling criteria and returned a survey (response rate = 22%). The average age was 66 years old (SD = 11.8) and the majority (65%) of the respondents were male. More than half (57%) reported a household income greater than $100,000 in the previous year, with "retired" (46%) as the most common employment status. The majority (70%) of the respondents held at least a bachelor's degree, and 38% reported a graduate or professional degree. The average private landowner parcel size was 16 acres and median size was 5.4 acres, when excluding extreme outliers (top 5%, N= 29). Participants were asked if they live on the parcel they owned within the PACE. The response options included: yes, this is my primary residence; yes, but only for part of the year (<6 months per year); no, I lease or rent the property to someone else; no, other. The latter two categories were combined to represent the "absentee" residency type. Table 5 provides a breakdown of respondent's residency type for each PACE.

Table 5

Residency type by PACE

Residency Type	**PACE**		
	LVNP (N= 154)	RMNP (N= 270)	SKCNP (N= 163)
Primary (N=239)	65	11	61
Seasonal (N=160)	39	81	40
Absentee (N=188)	50	76	62

In addition to these demographic and contextual characteristics, participants provided responses to a number of psychosocial measures that are believed to influence cooperative resource management behavior. Table 6 provides variable descriptions and mean response scores for the sample population. The variables listed in Table 6 served as potential predictors within the regression models aimed at understanding the various forms cooperative behavior considered by this study. When considering mean response values for the entire sample population, there were several noteworthy results. First, non-use benefits were rated as the most important category of benefits derived from owning land within the boundary of a PACE. Next, when asked about the larger system to which their land belonged, participants had higher average levels of agreement with the perception that their land was part of a larger social and natural system rather than part of a larger economic system. Additionally, the average levels of agreement for statements aligned with existence value orientations (i.e. Nature has value, whether people are present or not) were higher than statements aimed at measuring use value orientations (i.e. Nature's primary value is to provide products useful to people). Finally, the average length of ownership was almost three decades (28.6 years) and the median number of adjacent parcels was 6.

Table 6

Independent variable codes, descriptions and summary statistics.

Variable	Description	Mean (s.d.)
Neighboring land conditions	The conditions on neighboring lands influence my land management decisions. 1 = strongly disagree to 7 = strongly agree	4.77 (1.58) n = 553
Alignment of objectives	My land management objectives align with my neighbor's objectives. 1 = strongly disagree to 7 = strongly agree	4.39 (1.43) n = 550
Non-use benefits	Non-use benefits of owning land 1 = not at all important to 5 = extremely important	4.23 (.74) n = 566
Income benefits	Income benefits of owning land 1 = not at all important to 5 = extremely important	1.57 (1.11) n = 566
Access benefits	Access benefits of owning land (i.e. hunt/fish) 1 = not at all important to 5 = extremely important	2.13 (1.39) n = 571
Social system perspective	Owned property viewed as part of larger social system 1 = strongly disagree to 7 = strongly agree	5.87 (.92) n = 558
Economic system perspective	Owned property viewed as part of larger economic system 1 = strongly disagree to 7 = strongly agree	3.76 (1.91) n = 558
Natural system perspective	Owned property viewed as part of larger natural system 1 = strongly disagree to 7 = strongly agree	5.99 (1.33) n = 559
Existence value orientation	Value orientation: existence 1 = strongly disagree to 7 = strongly agree	5.76 (1.08) n = 506
Use value orientation	Value orientation: use 1 = strongly disagree to 7 = strongly agree	2.87 (1.51) n = 520
Trust	Trust in neighboring private landowners 1 = no trust to 5 = complete trust	3.06 (.82) n = 544
Perceived risk	Concern about risk to property posed by natural processes 1 = not at all a concern to 5 = extreme concern	4.56 (.72) n = 539
Ownership tenure	Length of ownership in years Range: <1 – 160 years	28.6 (26.9) n = 565
***Parcel size**	*parcel size (acres) Range: 2 - 1319	5.4 (median)
***Number of neighbors**	*number of adjacent parcels Range: 1 - 203	6 (median)

*variables that were log transformed to address non-normality across variable.

Reported Management

To address the first objective of this study, respondents were categorized by reported management activities on their own land (Figure 3). Figure 3 gives a breakdown of residency type for each management level category. The majority of respondents (58.9%) reported "regular" or "intensive" management on more than one issue (Active Manager). Additionally, another 20.4% (n=109) of respondents reported "regular" or "intensive" management on one of the potential management issues (Focused Managers). Alternatively, 20.6% of participants (n=110) reported conducting "some" or "no" management on their property (Episodic & Infrequent Managers). Within the Episodic and Infrequent manager groups, the majority of respondents (67.2%) reported being an absentee owner.

Figure 3

Frequency distribution of residency by management style (n=533).

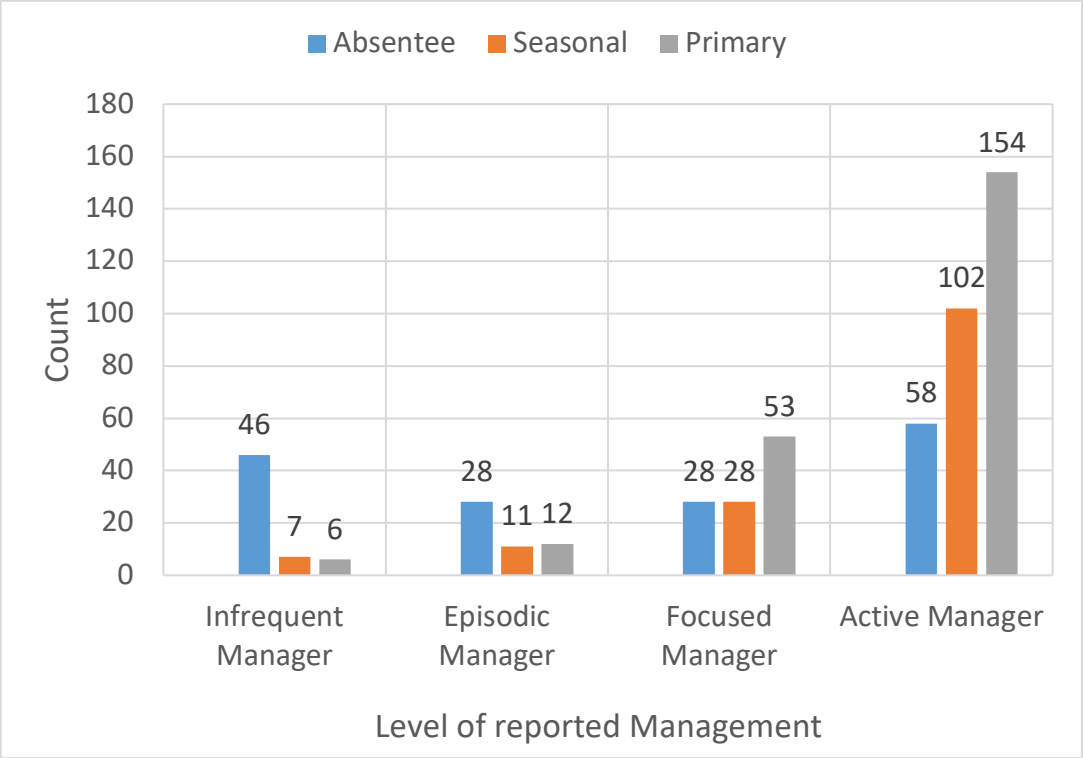


Table 7 provides mean response scores and standard deviations for each management driver and barrier category. On average, the "influence of others" category was rated as the most important driver of management activity on the land they own. This management driver category included four individual survey items: It's what my neighbors are doing; Neighbors have asked me to do it; Required by law or regulation; and to avoid governmental intervention. Alternatively, when considering potential barriers to management, the "Costs > benefits" category had the highest average score on the 5-point "level of importance" scale. The individual items within this category of

management barrier includes: Benefits are not worth the costs; Conflict with other management goals; It wouldn't make a difference; Governmental regulations.

Table 7

Summary statistics for management barriers and drivers.

Drivers of management	**Mean**	**S.D.**	**N**
Influence of others	2.92	(.85)	501
Personal benefits	1.81	(.87)	515
Economic considerations	2.55	(1.24)	516
Barriers to management			
Lack of information	2.93	(1.06)	472
Limited capacity	2.77	(.86)	474
Costs > benefits	3.48	(1.01)	446

Note. Rated on scale ranging from 1 = not at all important to 5 = extremely important

Next, a one-way analysis of variance (ANOVA) was used to compare the influence of the potential drivers and barriers on reported levels of management between each level of management (Table 8). There was a statistically significant difference between groups for the personal benefits and economic considerations management

drivers ($p<0.05$). Specifically, a Tukey post-hoc test showed that these two categories of management drivers were rated as less important by the active management group. In total, these two categories of management drivers include 5 individual survey items: To maintain the ecological integrity of my land; It's the right thing to do; To maintain aesthetic quality of my land; The safety of me and/or my family; To maintain economic value of my land.

Table 8.

Mean scores for management drivers and barriers across all reported management levels. Within rows, means with different superscript letters are significantly different (by Tukey's post hoc tests).

	Level of Management			
	Infrequent Managers	Episodic Managers	Focused Managers	Active Managers
Drivers				
Influence on others	2.86	3.09	2.98	2.89
Personal benefits	2.12[a]	2.25[a]	1.92[a]	1.64[b]
Economic considerations	2.96[a]	2.94[a]	2.83[a]	2.33[b]
Barriers				
Limited Information	2.55	2.99	2.97	2.96
Capacity limitations	2.67	2.77	2.90	2.74
Cost > benefit	3.30	3.28	3.61	3.49

Note that rating scale ranges from 1(not important at all) to 5(extremely important).

Cooperative Engagement

The following section provides details for each model of cooperative behavior (Table 9). For example, the variable "non-use benefit" has an OR of 1.629, meaning as a respondent's non-use benefit increases by one unit, they are about 1.6 times more likely to inform their neighboring landowners about the land management practices on their own land (Table 9). Across all four cooperative behaviors, alignment of objectives and

conditions on neighboring lands were positive, significant predictors of cooperation. In the results descriptions below, specific attention is given to the predictors that differed across the four models.

Table 9

Logistic regression statistics for four independent models to identify predictive factors associated with various forms of cooperative behavior.

	Communication		**Coordination**		**Collaboration**		**Cross-boundary Collaboration**	
	O.R.	Sig.	O.R.	Sig.	O.R.	Sig.	O.R.	Sig.
Neighboring land conditions	1.608	.000	2.963	.000	1.493	.000	1.887	.000
Alignment of objectives	1.761	.000	1.844	.000	3.263	.000	1.774	.000
Ownership benefit: non-use	1.629	.007						
Management driver: Personal	1.468	.028						
Management barrier: Capacity					.650	.016		
Management barrier: cost > benefit			.647	.003				
Existence value orientation							.773	.035
Trust					1.545	.033		
% Correctly classified	70		77.6		78.2		72.4	
% Variance explained	33		52		51		37	

Each of the final models was found to be statistically significant at a 99% confidence interval (p-value <0.01) and correctly classified at least 70% of cases. The R-square values indicate that the models explained 33-52% of the variance for the various forms of cooperative behavior. Finally, the Hosmer and Lemeshow Test provided

evidence for acceptable model fit with a chi-square significance scores greater than 0.05 across all of the models.

Communication: I inform my neighbors of the land management practices on my own land.

The forward selection process retained four independent variables in the final model as potential predictors of reported communication with neighboring landowners (Table 9). The significant predictors include alignment of objectives, conditions on neighboring lands, non-use benefits of owning property, and personal drivers of management. The Non-use Benefits variable is a mean score derived from the data reduction process and includes four individual items from a scale aimed at measuring the benefits of owning land. The four items include: privacy, maintaining way of life, scenic value, and conservation of local nature. The personal drivers variable includes four items from a scale aimed at measuring drivers of management on the land they own, which includes: "To maintain the ecological integrity of my land," "It's the right thing to do," "To maintain aesthetic quality of my land," and "The safety of me and/or my family."

Coordination: I work with my neighbors when making land management decisions.

The forward selection model for reported coordination with neighboring landowners retained alignment of objectives, conditions on neighboring lands, and the cost > benefit management barrier as significant predictors of reported coordination. The independent variable unique to this model (cost >ben) has an OR value of 0.647, which indicates a negative relationship between perceived management conflict and reported coordination with neighbors. In other words, as perceptions of this management barrier

increase, the likelihood of reporting coordination with neighbors decreases. The individual items within this management barrier include: “Governmental regulations,” “It wouldn’t make a difference,” “Conflict with other management goals,” and “Benefits are not worth the costs.”

General collaboration: I work with my neighbors on land management activities.

The forward selection model for general collaboration with neighboring landowners retained alignment of objectives, conditions on neighboring lands, trust, and the management barrier related to capacity as predictors of general collaboration. The trust variable was derived from a survey question that asked participants to indicate their level of trust in others to “work with you to make land management decisions.” The two items used to compute the trust variable include trust ratings for “My private land-owning neighbors” and “Private citizens within my community.” The management barrier related to perceptions of limited capacity variable has an OR value of 0.65, indicating a negative relationship between general collaboration with neighbors and reporting a lack of capacity as a barrier to managing their own land. Note, the individual items for this management barrier include: “Time constraints,” “Financial constraints,” “Effectiveness of management options,” and “Lack of management on neighboring lands” as potential barriers to managing the land they own.

Cross-boundary collaboration: I work with my neighbors on land management activities that cross the boundary between our properties.

The final cooperation model aimed at predicting collaborative land management activities that cross property boundaries. The cross-boundary collaboration model

retained alignment of objectives, conditions on neighboring lands and existence value orientations as predictor variables. The latter variable (existence value orientations), which represents value orientations related to the preservation of the natural landscape, showed a negative relationship with reported cross-boundary cooperation behavior. This indicates that the likelihood of reporting cross-boundary cooperation behavior decreased as existence value orientations increased. For further information on the specific statements used to measure value orientations, see Appendix B.

Discussion

Natural resource management at the landscape scale requires cooperative conservation activities that address the challenge of jurisdictional partitioning. There is a growing body of literature aimed at understanding the feedbacks between social and ecological systems. However, the role of private lands and landowners in cooperative conservation efforts at the landscape scale remains unclear. To address this research gap, we developed and delivered a survey to assess the level of management activity occurring on private lands and the characteristics of cooperation between private landowners living within a PACE.

The sample characteristics of the population of respondents included in this study suggest that private lands within a PACE are owned by a non-typical population that on average are older, more educated, earn higher incomes, and is less racially diverse than the general U.S. population, according to the 2020 US Census (US Census Bureau, 2020). The majority of the respondents were male retirees. The sample demographics for this study align with the findings from the 2013 USDA Forest Service's National

Woodland Owner Survey that sought to assess the characteristics, attitudes, and behaviors of private family forest owners across the U.S. (Butler et al., 2016).

Beyond the demographics, it is also important to understand the attitudes and values associated with private ownership to determine the roles they play in landscape-scale resource management (Davis et al. 2010, Andrejczyk et al., 2016). This study suggests that private landowners derive a range of benefits from the land they own, but the benefits that are most likely to be rated as important or very important fall under the non-use benefit category. On average, participants ranked non-use benefits of owning land higher than economic or access benefits from owning land. Namely, these non-use benefits include privacy, scenic value, conservation of local nature, and maintaining a way of life. Also, when considering the larger system that their land was part of, the most common perceptions related to being part of a larger social and natural system when compared to an economic system. In the context of landscape scale land management, understanding the characteristics, attitudes and values associated with private ownership may inform improved policies, programs and services for this less understood population of landowners within PACEs. For example, this study suggests that private landowners living in close proximity to protected lands are well-educated and likely to be aware of ecological processes that affect their properties, but some may be old enough that active participation in some kinds of cross-boundary management is difficult. The survey did not allow us to distinguish between active managers who personally provide all of their own labor and those who may hire outside assistance.

Towards the first objective of this study aimed at exploring the level of management activity occurring on privately owned lands, we found that the majority of

respondents reported “regular” or “intensive” management on one or more on the land they own. The majority of respondents that made up the *infrequent managers* group were absentee owners. However, when considering all of the absentee owners that returned surveys, a little over half reported regular or intensive management on at least one issue. These findings suggest that residency status has more explanatory power when trying to understand a lack of management activity on private lands than it does in explaining the management styles of those who do actively manage their land.

To better understand reported management occurring on private lands, participants were asked to rate a number of factors that may encourage or limit management activity. The analysis identified personal and economic drivers of management as being statistically significantly different when comparing mean ratings of importance across management levels. Specifically, active managers rated these categories of drivers as being less important when compared to other groups. This finding suggests that as levels of reported management increase, the drivers of management become more related to factors that involve the influence it has on the surrounding community and/or landscape.

The second objective was to explore the characteristics of cooperative engagement between private landowners living in a PACE. Broadly, cooperation involves shared rights and responsibilities among actors seeking mutually beneficial outcomes (Ostrom, 1990; Plummer & FitzGibbon, 2004). This study utilized logistic regression models to identify factors associated with various forms of cooperative behavior. The outputs of these models identified a range of potential predictors of cooperative behavior with some being common to all forms of cooperation and others that were unique to a

given behavior. The predictors that were consistent across all models include: 1) a belief that the conditions on neighboring lands influence the land management decisions for the land owned by the respondent; and 2) the perception that their land management objectives aligned with the objectives of neighboring land owners. This finding did not arrive as a surprise, though it is worth noting that each of the cooperation behaviors are predicted by an awareness of surrounding lands and landowners.

The first level of cooperation (communication) showed a positive relationship with non-use benefits derived from owning land and personal drivers of management. The individual items included in these components relate to the natural, social and intrinsic benefits that stem from the location of the land they own. This suggests that communication is, in part, a byproduct of community. A sense of community is believed to influence personal values and social norms (Smith et al., 2021). In a management context, this may increase the likelihood of cooperation through aspects of trust and a shared value for a given way of life made possible by the community they are part of. Additionally, a sense of community may also slow the rate of administrative partitioning when groups of individual private landowners value their way of life and are therefore less likely to sell their property for residential or commercial development (Marshall, 2005).

The next form of cooperation (coordination) showed a negative relationship with the "cost>benefit" barrier to managing land. This variable included the individual barriers: governmental regulations, conflict with other management goals, the perception that "it wouldn't make a difference," and the belief that the benefits of management are not worth the cost. In other words, reported coordination was more common among

participants that did not experience conflicting goals with neighbors or feel restricted by governmental regulations, and who believed cooperation was worthwhile. This aligns with the belief that cooperative management, in this case coordination, requires a sense of responsibility for the welfare of the people or landscape facing threat, and that active coordination will increase the likelihood of a desired outcome (Andras et al., 2002).

The final two measures of cooperation relate to collaboration behavior, with one being specific to collaborative land management activities that cross property boundaries. General collaboration was predicted by perceived trust in others and the belief that they have the capacity to manage the land they own. Trust is argued to be a critical component of social connectivity and ultimately cross-boundary cooperation (Bergmann & Bliss, 2004). Trusting others assumes a reciprocal dynamic between two or more parties in which the trusted party is expected to attend to the interests of others involved and have the competence to do so (Hardin, 2004). Furthermore, private landowners are more likely to participate in cooperative activity if they believe they have the capacity to address a given issue (Paton, 2003). This study found these aspects of trust and capacity were significant predictors for collaborative behavior, suggesting that trust may provide a key prerequisite to cooperative behavior, but actors must also identify a reason or need to cooperate and believe they have the ability to do so.

Finally, cross boundary collaboration showed a negative correlation with existence value orientation, suggesting that this population of cooperators were not averse to manipulating the natural landscape to achieve desired conditions of their properties. Furthermore, several studies posit that perceived value congruence is a foundational

aspect of forming groups, community and social capital (Earle, 2010; Pirson & Malhorta, 2008; Ostrom, 1994).

Compared to active collaboration, coordination and communication likely require less effort and resources, which may include time, money or social capital. Overall, the results suggest that various forms of cooperation among neighbors are underpinned by beliefs about shared objectives and shared need for active management, but also have unique drivers dependent on the given type of cooperative behavior. Communication and coordination align more with a sense of community and a perception that the costs associated with managing the land they own are worth the benefits of doing so. On the other hand, more involved forms of cooperation (collaboration) are more strongly associated with trust, and a belief that they have the right and capacity to manipulate the land they own.

This study is explorative in nature and these findings should be viewed as signposts for further research into the private landowner population and their role in landscape scale resource management. Future studies should place more emphasis on the growing population of absentee owners to understand the role they play in landscape scale management. It's likely that this trend will influence the social connectivity of PACEs with more private landowners having their primary residence somewhere other than the PACE. Additionally, further research is needed to understand the mechanisms of cooperative behavior among private landowners in order to achieve a level of understanding that lends itself to more frequent and mutually beneficial cooperation between private landowners and public land managers. There is a growing body of research that focuses on the public-private interface, but the characteristics of informal

cooperation among private landowners need to be specifically addressed to build upon our understanding of landscape-scale management.

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CHAPTER IV

PROTECTED AREA-CENTERED ECOSYSTEM MANAGEMENT AT THE PUBLIC-PRIVATE INTERFACE: AN EXPLORATION OF WILLINGNESS AND ENGAGEMENT AMONG PRIVATE LANDOWNERS

Abstract

Federally owned and managed lands make up a significant portion of large protected area-centered ecosystems (PACEs), but as one moves further from the core of the system the landscape becomes increasingly partitioned and includes a greater frequency of privately owned parcels. Therefore, this study explores cooperative stewardship at the private-public interface within three PACEs in the western USA, each of which is centered on a national park: Rocky Mountain, Lassen Volcanic, and Sequoia-Kings Canyon. To address this key component, a survey was delivered to a sample of private landowners across all three PACEs. The survey was designed to measure the influence of proximity, trust and information flow from public agencies on perceptions of willingness and reported cooperation. The findings suggest that the majority of private landowners living in a PACE are willing to work with public land managers. Additionally, peer-to-peer communication was associated with cooperative engagement among the willing population of private landowners.

Introduction

Managing natural resources at the landscape-scale is widely recognized as an important approach for sustaining biodiversity and ecological processes across large expanses of undeveloped lands (Phillips, 1998; Hansen et al., 2011; Wu, 2012, Fischer et al., 2019). In practice, managing at such a scale faces a range of challenges that stem from administrative partitioning (Epanchin-Niell et al. 2010). While protected areas

(PAs) such as U.S. national parks, wilderness areas, and national forests are designated in part to conserve and maintain ecological health and function, the spatial extent of a single PA can only encompass a portion of the larger ecosystem (Hansen et al., 2011). The surrounding landscape is comprised of various land tracts that fall under public and private ownership (Epanchin-Niell & Wilen 2012), resulting in a patchwork of ownership across the larger protected-area centered ecosystem (PACE). While information about the missions and mandates of public land agencies and organizations are publicly available, the role of private landowners in PACE management is less understood (Fischer et al., 2013). Therefore, this aims to understand cooperative conservation at the public-private interface through the perspective of private landowners.

The notion that individual private landowners can impact the flow of ecological processes at varying spatial scales is not a recent proposition (Odom, 1982). Landowner surveys are common in forestry literature in the field of forest economics (e.g., Amacher et al., 2005; Ma et al., 2012; Butler et al., 2016), but such studies commonly focus on specific issues such as timber harvest (Silver et al., 2015), or the influence and effectiveness of voluntary incentive programs (VIPs) to encourage land management practices that align with the missions of public agencies (Rouleau et al., 2016). There is also a growing literature on absentee landowners (Petrzelka et al.; 2013; Snyder et al., 2020; Sorice et al. 2018). Typically, the focus of these studies is to encourage an increase in natural resource management activity by landowners, especially in ways that increase the flow of resources from their lands. Previous studies focused on VIP enrollment have argued that financial incentives are the most important driver for private landowner enrollment (Horne, 2006; Jack et al., 2008). However, more recent studies have argued

that public land managers should focus on "peer-to-peer" interaction with private landowners as a strategy for increasing voluntary action from this important population (Ma et al., 2012; Rouleau et al., 2016).

Therefore, this research builds upon previous studies by considering various forms of information flow from public agencies to private landowners. Additionally, the scope of this research differs from existing literature in several ways: first, it places focus on sustaining ecological processes and conditions, rather than marketable products and services. Also, the sample population is not confined to a particular land type (e.g. forests or farmland) as it considers any type of landscape and land use that can be part of a PACE. Finally, this research does not aim to develop strategies that encourage management activity, but rather to understand the drivers of cooperative activity among people who have already chosen to do so. Specifically, this study assesses the association between access to information, awareness of practices, and proximity to public land on the perceptions of willingness and reported behavior among private land owners. The hope is that this study can further our understanding of PACE management by exploring the perspectives of cooperative resource management among private landowners living in a PACE. Specifically, this study is designed to address the following research objectives:

(1) to assess and compare cooperation among private land owners, and between private land owners and public land managers within a PACE.

(2) To explore the relationship between reported willingness and actual cooperative engagement at the public-private interface.

(3) To assess how reported willingness and actual cooperative engagement at the public-private interface is related to indicators of information flow.

Methods

Towards these objectives, a survey was delivered to a sample of private landowners across three PACEs centered on three national parks in the western USA. The survey was designed to measure and identify the characteristics of cooperative land management activities that cross property or jurisdictional boundaries. Participants were selected through an integration of county tax-assessor property records and GIS parcel data. This approach enabled a spatially explicit sampling design that linked survey responses to specific parcel-level locations. We analyzed survey responses to identify the most relevant factors influencing reported cooperation with public land managers among private landowners living in a PACE. Chi-square tests were used to understand differences between reported willingness to cooperate and actual cooperative engagement. We then utilized logistic regression to test the feasibility of predicting reported cooperation from the various factors measured within the survey.

Study Area

This study includes three PACEs centered on Rocky Mountain National Park (RMNP), Lassen Volcanic National Park (LVNP), and Sequoia & Kings Canyon National Parks (SKCNP) (Figure 4). The extent of the PACEs includes portions of 12 counties across two states: Boulder, Clear Creek, Gilpin, Grand, Larimer and Jackson, Colorado; and Plumas, Shasta, Tehama, Lassen, Fresno, Inyo and Tulare, California. When RMNP became a protected area 1915, the tracts of private lands around the boundaries of the park were primarily devoted to ranching, resource extraction, and

tourism (Musselman, 1971). RMNP is located about 70 miles NW of Denver Colorado, making it an attractive location for further tourism development and second-home ownership. LVNP became a national park in 1916 due to its remarkable volcanic features (Krahe & Catton, 2010). LVNP, in north-central California, is located in a rural landscape with less access to densely populated areas, which has resulted in less development of surrounding lands than more accessible parks. Sequoia National Park was established in 1890. It wasn't until 50 years later that Kings Canyon became a national park, and the two have since been jointly administered as Sequoia & Kings Canyon National Parks (SKCNP).

These protected areas were selected for several reasons. First, they vary in size and visitation and therefore patterns common among them may yield information that is applicable beyond a given region. Also, they are nested in a management mosaic comprised of public and private lands and therefore are well-suited to serve the research objectives of this study.

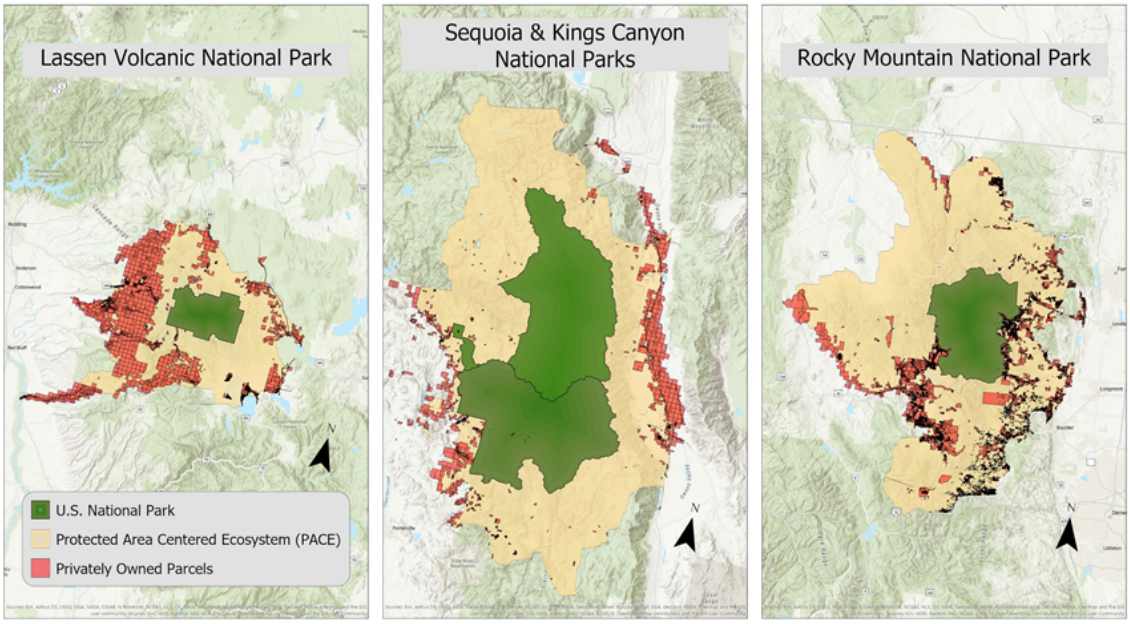
Sampling

Data collection took place across all three Protected Area-Centered Ecosystems (PACEs). Participants were selected through an integration of county tax-assessor property records and GIS parcel data. This approach enabled a spatially explicit sampling design that linked survey responses to specific parcel-level locations. As there is no centralized ownership database, data acquisition occurred at the county level by contacting several departments within each county government office. In some cases, this information was publicly available in a geospatial format on county government websites. In the majority of cases, acquisition of ownership data involved outreach to

county tax-assessor offices and county GIS departments. Next, the ownership information was linked to each respective county parcel map and assigned a unique, password protected ID to ensure confidentiality for survey participants. To the extent possible, sampling was restricted to individuals that own 2 or more acres of private land within one of the three PACEs (Figure 4).

Figure 4

Study areas showing extent of PACE, location of national parks, and location of privately owned parcels.



Survey distribution utilized an adapted outreach protocol from the Total Design Method (TDM) established by Dillman (2002). Invitations to participate in the private landowner survey were mailed to selected participants' legal addresses. The invitation included a letter of information with instructions for accessing an online version of the survey. Upon accessing the survey, participants were asked to enter a unique survey ID

provided in the invitation letter. After two weeks a reminder postcard was sent to any potential participants that had yet to complete the online survey. The postcard once again provided instructions on how to access the survey and enter their unique survey I.D. to provide consent and begin the survey. A third and final recruitment letter was sent one month after the first recruitment letter. The final letter included a paper copy of the survey, an informed consent document, and a pre-paid return envelope.

Survey Content

The survey sought to identify and quantify characteristics of collaborative land management activities that cross property or jurisdictional boundaries. Specifically, the survey aimed to measure psychological and contextual factors as potential explanatory variables for reported cooperation with public land management agencies and officials. This study considered factors related to the flow of information from public land managers and trust in public land agencies: specifically, trust in others when working together to make land management decisions; and access to information about the management practices occurring on public lands near the property they own. The cooperative willingness factor included reported willingness to work with public land managers and perceptions of public land managers' willingness to work with them (private land owners). Each factor was measured using a range of individual survey items (Table 10).

Table 10

Measures of cooperative engagement and cooperative willingness.

Statement
I know where to find information about land management practices on public lands.
Public land managers inform me of activities occurring on public lands.
I am aware of land management practices occurring on public lands.
I'm willing to work with public land agencies.
Public land agencies are willing to work with me.

Additionally, the survey and sampling design enabled the inclusion of contextual variables believed to influence cooperation between private land owners and public land managers. For this study, the contextual factors included parcel size, proximity to public land, and residency type. The residency classification was derived from individual survey responses and the spatial variables were generated in ArcGIS, which is a software package for exploring, visualizing and analyzing geospatial data (ESRI Inc., 2020). Finally, the outcome, or dependent, variable for this study is reported cooperation with other land-owning individuals and agencies. For further detail regarding the specific items and measures within the survey, see Appendix B.

Analysis

The first phase of analysis included any participant that reported cooperation with others when making land management decisions. This population was organized into two groups that include: (1) participants that only reported cooperation with other private landowners, and (2) those that reported cooperation with public land managers. Participants that reported cooperation with both public land managers and private land owners were placed in the second group.

The second phase of analysis focused on those individuals that reported a willingness to work with public land managers when making land management decisions. This population was also organized into two groups: (1) those who are willing to work with public land managers and reported actual cooperation in the past vs. (2) those who are willing to work with public land managers, but have not done so. Binary dependent variables were computed for each of the reported cooperation behaviors where "1" represents a landowner that reported engagement with a given behavior. Specifically, a binary variable was calculated for each statement so that "1" represented any responses that ranged from (5) somewhat agree to (7) strongly agree, and "0" represented all other potential responses (i.e. strongly disagree, disagree, somewhat disagree, neutral). This comparative analysis aimed to identify factors related to behavioral outcomes among a willing population of private land owners.

The analytical approach was consistent across phase 1 and phase 2 of analysis due to the dichotomous categorization of each sample population. Additionally, having a consistent analytical approach increases the ease of interpretation, comparison and synthesis, which lends itself to addressing the primary objective to better understand cross-boundary cooperation at the private-public interface. To test for differences between groups, we used Pearson Chi-square tests of independence for categorical variables, and an independent-samples T-test to for any continuous variables. To better understand and interpret the differences for each of the independent variables, adjusted standardized residuals were interpreted for chi-square test that were significant ($P<0.05$ level). In addition to the Chi-square statistics, Cramer's V values were calculated as a measure of effect size. Table 11 provides a guide for interpreting Cramer's V values and

is organized into small, medium, and large effect size categories (Cohen, 2013). This interpretation is determined by the smaller number of categories in either the row or column of the contingency table. Given that the cooperation groups were organized into two groups for each phase of analysis, the interpretation is consistent across all explanatory factors.

Table 11

Cramer's V interpretation guide for determining effect size. (Cohen, 2013)

Effect size	Cramer's V value
Small	0.10
Medium	0.30
Large	0.50

Next, binary logistic regression was used to explore feasibility of predicting the influence of explanatory variables on reported cooperation behavior. Estimates for the potential predictor variables were generated through a forward stepwise regression with a maximum likelihood (ML) estimation approach. Coefficients (B) and odds ratio (OR) are key outputs used to interpret the results of the regression analysis. A positive coefficient (B) score means that the likelihood of engaging in reported cooperative behavior increases as the value of the independent also increases. Alternatively, a negative coefficient (B) value means that the likelihood of engaging in reported cooperative behavior decreases as the value of the independent also increases. The odds ratio (OR) is calculated using the coefficient (B) values and is helpful for interpreting the model results. OR values greater than 1 signify a positive relationship between the likelihood of reported cooperation and a given predictor variable. On the other hand, an OR value less

than 1 represents a negative relationship between the predictor and outcome variable (i.e. decrease in likelihood). Each model considered all factors that were statistically significant in the chi-square test. A forward stepwise logistic regression was used to identify the most influential predictors for each model. At each step, the variable that had the strongest correlation with the dependent cooperation variable was entered into the model as long as it met the selection criterion of ($p<0.05$). In other words, the final models only includes factors that significantly improved the model at the $p<0.05$ level. Survey analysis was conducted using SPSS, which is a statistical analysis software platform (IBM Corp., 2020).

Results

Sample Characteristics

In total, 590 respondents met the sampling criteria and returned a survey (response rate = 22%). The average age was 66 years old (SD = 11.8) and the majority (65%) of the respondents were male. More than half (57%) reported a household income greater than $100,000 in the previous year, with “retired” (46%) as the most common employment status. The majority (70%) of the respondents held at least a bachelor’s degree, and 38% reported a graduate or professional degree. The average private landowner parcel size was 16 acres and median size was 5.4 acres, when excluding extreme outliers (top 5%, N= 29). Note, the sociodemographic variables were considered as explanatory variables for phase 1 and 2 of the analysis, however these variables did not prove to have statistical significance when exploring the differences between the

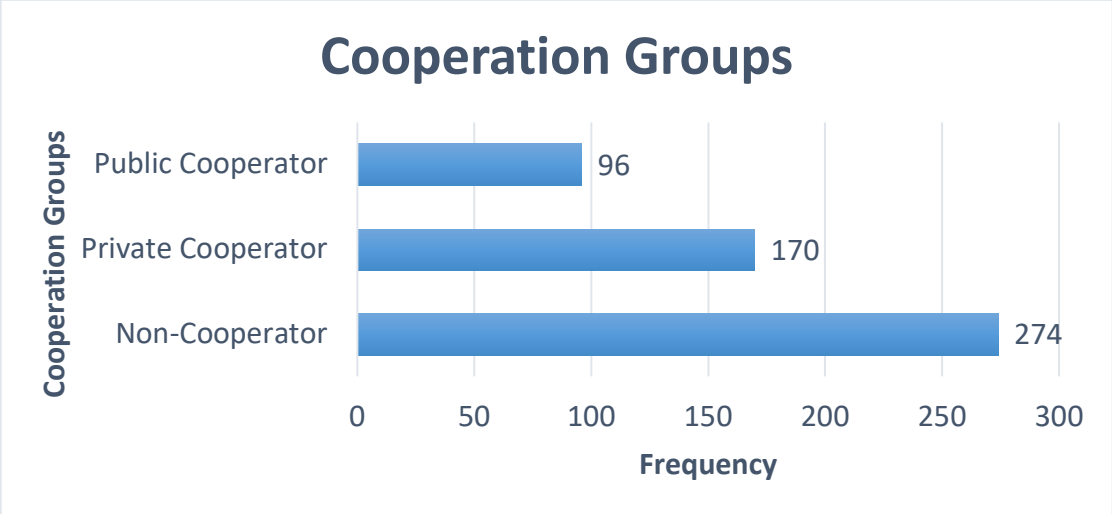
cooperation groups. Additionally, this study aims to identify aspects of cross-boundary cooperation that may inform management approaches and decisions. Therefore, more focus is given to explanatory variables that can be operationalized in a land management context.

Public vs. Private Cooperation

The first phase of analysis involved a comparative analysis for respondents that reported cooperation with public land managers vs. those who reported cooperation exclusively with other private land owners. Figure 5 provides a frequency distribution for the cooperation groups. In total, 266 respondents reported cooperation behavior when making management decisions. This represents nearly half of the total sample population, with the remaining 274 respondents reporting no cooperation with others when making land management decisions. Many of the individuals that did not report cooperation with others did express a willingness to work with public land managers and therefore are considered in the second phase of analysis. Within the cooperation groups, 64% (n=170) reported cooperation with neighboring private land owners, but not with public land managers. The remaining 36% (N=96) reported cooperative engagement with public land managers when making management decisions.

Figure 5

Frequency distribution for cooperative engagement with others when making land management decisions.



There were clear differences when looking at those who reported cooperation with public managers and those who only reported cooperation with other private landowners (Table 12). The variable most strongly associated with reported cooperation with public land managers was a perception that those managers were willing to work with private landowners. When comparing the two groups, we see that only 16% of the private-private cooperator group believed public land managers were willing to work with them when making land management decisions (Table 13). Comparatively, 65% of respondents that reported past cooperation with public land managers believed they were willing to involve them in the land management decision process. This means that within the group that had worked with public land managers, about one-third did not perceive that public land managers were willing to work with them.

Additional factors that showed a moderate effect on reported cooperation were related to information flow from public land managers and the proximity of the land they owned to public lands. Specifically, the factors related to information flow included: being aware or the management practices occurring on public lands; and whether or not public land managers informed respondents of the activities occurring on public lands. Because knowing where to find information about land management practices on public lands was right at the 0.200 cutoff between small and medium effect size, this variable also was considered in subsequent analysis. Tables 12 and 13 only includes explanatory variables that showed statistical significance in the Chi-Square test. For example, residency type did not show statistical significance between groups and therefore was not included in the following table.

Table 12

Chi-square test for differences between reported cooperation among private land owners and between private land owners and public land managers.

Factor	Private cooperator vs. Public cooperator	
	p-value (df, n)	Cramer's V
Adjacent to fed lands	<.001 (1, 266)	.231 (Medium)
I know where to find information about land management practices on public lands.	<.001 (1, 265)	.199 (Small)
Public land managers inform me of activities occurring on public lands.	<.001 (1, 264)	.323 (Medium)
I am aware of land management practices occurring on public lands.	<.001 (1, 265)	.321 (Medium)
I'm willing to work with public land agencies.	<.001 (6, 264)	.307 (Medium)
Public land agencies are willing to work with me.	<.001 (6, 265)	.521 (Large)

To better understand the results of the Chi-square analysis, table 13 provides a comparative summary between cooperation groups for the variables that showed statistical significance. For this analysis, the explanatory variables were transformed into dichotomous variables using the survey response scale. Each statement included a 7-point response scale ranging from 1(strongly disagree) – 7 (strongly agree) and responses ranging from 5(somewhat agree) - 7 (strongly agree) were coded with a 1 to represent agreement with the statement. All other responses were coded as "0" to represent responses that did not agree with the statement.

In general, the majority of respondents that reported cooperation with public land managers also reported having awareness and access to information regarding the

management practices and activities occurring on public lands (Table 13). Additionally, nearly all the respondents in this group (97.9%) reported a willingness to work with public land managers. Comparatively, 77.6% of individuals that have only cooperated with other private landowners reported that they would be willing to work with public land managers. (The relationship between willingness and actual cooperative engagement is explored in detail in the following section.) Finally, we see that 60.4% of the respondents that reported cooperation with public land managers owned property adjacent to public lands. Among the private cooperator group, 35.6% owned property adjacent to public land. However, the majority of respondents considered in this phase 1 of the analysis lived within 2 km of public land, with 67.6% and 74% for the private cooperator public cooperator group, respectively (Table 14).

Table 13

Proportions of private landowners that agree with survey statements related to willingness and flow of information in each cooperation group.

	Private – Private cooperators		Private – Public cooperators	
Statement	Agree	Do not agree	Agree	Do not agree
I know where to find information about land management practices on public lands.	63.3%	36.7%	82.3%	17.7%
Public land managers inform me of activities occurring on public lands.	30.4%	69.6%	63.5%	36.5%
I am aware of land management practices occurring on public lands.	43.5%	56.5%	76.8%	23.2%
I'm willing to work with public land agencies.	77.6%	22.4%	97.9%	2.1%
Public land agencies are willing to work with me.	16%	84%	64.6 %	35.4%

Table 14

Proximity of private parcels owned by respondents to public lands. The values represent cumulative percentages of group population for each distance category.

	Proximity to public lands (Cumulative %)			
	Adjacent	< 2km	< 5km	< 10 km
Private – Private cooperators	36.5%	67.6%	82.4%	87%
Private – Public cooperators	60.4%	74%	89.8%	92.7%

Finally, it is worth noting that trust in public land agencies was higher among those that reported cooperation with public land managers. Respondents were asked to rate their level of trust for a number of public agencies (Table 15) on a scale ranging from 1 (no trust) – 5(complete trust). When looking at the mean scores for each group we see that they all fall under the low (2) to moderate (3) trust categories. While the differences between the groups are small, all but one (NPS) differed significantly using an independent-samples T-test. The relationship between trust and cooperative behavior is discussed further in the discussion section.

Table 15

Comparison of mean trust levels for public land agencies between cooperation groups.

Agency	Private cooperators	Public cooperators	Total
National Park Service	3.33	3.53	3.40
U.S. Fish and Wildlife Service	3.22	3.58	3.35
Forest Service	3.12	3.44	3.23
Bureau of Land Management	2.86	3.10	2.95
State wildlife agencies	3.11	3.45	3.23
Local governmental organizations	2.71	2.98	2.81
Average across all agencies	3.13	3.42	3.23

Reported cooperation with public managers among willing population

Having a better sense of the factors associated with decisions by private landowners about whom they cooperate with, the second phase of analysis attempted to further our understanding of cooperation between private landowners and public land managers. Towards this goal, the following analysis includes all participants that reported a willingness to work with public land managers. Starting with this population, we compare two groups that include participants that reported cooperation with public land managers vs. those that did not. This approach hopes to inform management strategies to engage a willing population of private landowners in cooperative land management activities by focusing on the factors that may leverage willingness into actual behavior.

Again, this phase of analysis takes a similar approach to the previous phase for ease of interpretation and real-world application.

The first thing to note is the proportion of individuals that reported a willingness to cooperate with public land managers when making land management decisions. Of the 590 individuals that completed returned surveys, 70% of participants (N=413) reported that they would be willing to work with public land managers. Among the willing population, only 23% reported cooperative engagement with public land managers.

To understand the differences between cooperators and potential cooperators we once again used a Chi-square test across the set of explanatory factors along with a Cramer's V statistic to understand the relative effect size for each statistically significant factor. In line with the first phase of analysis, perceptions of public land manager's willingness to work with respondents was closely associated with cooperative engagement among the willing population (Table 16). Additionally, having a public land manager inform a given participant of activities occurring on public land was strongly associated with cooperative engagement between private landowners and public land managers. Knowing where to find information about, and being aware of, management practices and activates occurring on private lands had a moderate association with cooperative engagement. Finally, there were small, but significant differences in reported cooperation between properties that were adjacent to public lands, vs. those that were not.

Table 16

Chi-square test for differences between past cooperators and willing cooperators across factors related to proximity and the follow of information.

Factor	Cooperate vs. Don't Cooperate (Willing population)	
	p-value (df, n)	Cramer's V
Adjacent to fed lands	.010 (409, 1)	.127 (Small)
I know where to find information about land management practices on public lands.	<.001 (407,6)	.256 (Medium)
Public land managers inform me of activities occurring on public lands.	<.001 (406,6)	.347 (Large)
I am aware of land management practices occurring on public lands.	<.001 (408,6)	.297 (Medium)
Public land agencies are willing to work with me.	<.001 (405,6)	.487 (Large)

Table 17 provides proportion of agreement within each group for the statements that proved to have statistical significance in the Chi-square analysis. The percentages were calculated using the transformed, dichotomous variables for each statement (see phase 1 of analysis). Within the willing population, the majority of individuals that reported cooperative engagement with public land managers agreed with statements designed to measure the flow of information from public land agencies and perceptions of public land manager's willingness to work with them when making land management decisions. Alternatively, the majority of individuals that reported willingness to work

with public land managers did not agree with the various statements. While owning land adjacent to public lands was more common among those that reported previous cooperation with public land managers, there were actually a greater number of adjacent landowners (n = 137) in the potential cooperator group than the past cooperator group (n = 55) (Table 18).

Table 17

Comparison of population proportions between past cooperators and potential cooperators according to their agreement with survey statements related to the flow of information.

Statement	Reported cooperation with Public Managers?			
	Potential Cooperators		Past Cooperators	
	Agree	Do not agree	Agree	Do not agree
I know where to find information about land management practices on public lands.	39.9%	60.1%	81.9%	18.1%
Public land managers inform me of activities occurring on public lands.	29.8%	71.2%	64.9%	35.1%
I am aware of land management practices occurring on public lands.	47.3%	52.7%	78.5%	21.5%
Public land agencies are willing to work with me.	17.4%	82.6%	67%	33%

Table 18

Proximity of private parcels owned by respondents to public lands. The values represent cumulative percentages of group population for each distance category.

	Proximity to public lands (Cumulative %)			
	Adjacent	< 2km	< 5km	< 10 km
Past cooperators	58.5%	72.3	88.3	93.6
Potential cooperators	43.5%	67	82.5	90.2

Predictive Models of Cooperative Engagement and Cooperative Willingness

We constructed binary logistic regression models to test the feasibility of predicting reported cooperation with public land managers. Two separate models were generated to explore group membership for phase 1 and 2 of analysis. In other words, the first model sought to predict reported cooperation with public land managers among the population that reported cooperation with others (private land owners or public land owners). The second model focuses on the population that reported a willingness to work with public land managers to identify variables that could predict whether willingness to cooperate led to actual cooperative engagement. Additionally, a third model was constructed to explore perceptions of willingness. Perceptions related to the willingness of public land managers to work with respondents had the largest effect on group membership in both phases of analysis, therefore the third model is an attempt to explore factors that may influence perceptions of willingness.

The three models correctly classified 76.9 – 80.8 percent of cases (Table 19) and proved to be significant improvement when compared to the null model ($p<.001$). The R-square values indicate that the models explained 28%-41.6% of the variance for reported cooperation and perceptions of willingness. The first model, to predict cooperation with public land managers, retained four explanatory variables (Table 20). The most influential factors included a reported willingness to work with public land managers and the perception that land managers were willing to work with them. Additionally, owning

property adjacent to public lands and having an awareness of the practices occurring on public land showed a positive and significant relationship with cooperative engagement among respondents and public land managers.

Table 19

Classification table for the accuracy, variance explained and significance across logistic regression models.

	Percent correct	Nagelkerke	Sig.
Private vs. public	76.9	.416	<.001
Coop among willing	79.5	.280	<.001
Perception of willingness	80.8	.355	<.001

Table 20

Logistic regression to identify predictive factors associated with Public Cooperation among participants that reported cooperation with others.

Factor	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B) Lower	Upper
Adjacent to fed lands	.939	.334	7.914	1	.005	2.558	1.330	4.922
I am aware of land management practices occurring on public lands.	1.118	.354	9.997	1	.002	3.060	1.530	6.120
I'm willing to work with public land agencies.	2.438	1.044	5.458	1	.019	11.450	1.481	88.534
Public land agencies are willing to work with me.	1.713	.338	25.737	1	.000	5.543	2.860	10.742
Constant	4.631	1.066	18.863	1	.000	.010		

The second model, to identify factors that predicted actual engagement with public land managers among a willing population of private landowners, retained two explanatory variables (Table 21): the perception that public land managers are willing to work with the respondent, and being aware of the land management practices occurring on public lands.

Table 21

Logistic regression to identify predictive factors associated with reported cooperation among willing population.

Factor	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B) Lower	Upper
I am aware of land management practices occurring on public lands.	.814	.307	7.027	1	.008	2.256	1.236	4.117
Public land agencies are willing to work with me.	1.970	.282	48.643	1	.000	7.172	4.123	12.475
Constant	2.522	.267	89.545	1	.000	.080		

Given the considerable influence that perceived willingness had throughout each phase of analysis, the third and final model sought to identify predictor variables associated with respondents that believed land managers were willing to work with them when making land management decisions. This model retained four explanatory variables related to trust, proximity, and access to information and communication (Table 22). The two most influential factors related to the flow of information from public land agencies and managers. This finding suggests that perceptions of cooperative willingness are more common for private landowners that live adjacent to public lands, have received outreach from public land managers and report higher levels of trust in land management agencies.

Table 22

Logistic regression to identify predictive factors associated with perceptions of willingness.

Factor	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B) Lower	Upper
Adjacent to fed lands	.721	.249	8.394	1	.004	2.056	1.263	3.348
I know where to find information about land management practices on public lands.	1.303	.339	14.728	1	.000	3.679	1.892	7.157
Public land managers inform me of activities occurring on public lands.	1.622	.256	40.080	1	.000	5.064	3.065	8.368
Trust in public agencies	.591	.145	16.607	1	.000	1.805	1.359	2.398
Constant	5.174	.604	73.344	1	.000	.006		

Discussion

The findings of this study provide insight into the role played by private landowners in cooperative stewardship across three PACEs. The first thing to note is the surprisingly high level of reported cooperation among this population. Nearly half of the participants said they engage with neighbors when making land management decisions, which is higher than one might expect given previous studies that found lower levels of cooperative management among the private landowner population (Gill et al., 2010; Kittredge, 2005). It's possible that actual levels are lower, simply because the people that chose to complete the survey are more interested in the topic than participants that did not elect to complete and return a survey. However, given the assumption that cross-

boundary stewardship is an important aspect of ecosystem management (Brunckhorst, 2011, Forman, 1995), this is an encouraging finding.

This study found that cooperation occurs both among private landowners and between private landowners and public land agencies and managers. Additionally, the majority of participants (70%) reported that they are willing to work with public land managers when making land management decisions. This is an interesting result when considering the interviews with public land managers described in Chapter 2. It was not uncommon for public land managers to cite lack of interest among private landowners as a barrier to conducting cross-boundary management at the public-private land interface. Meanwhile, the survey suggests a majority of respondents believe public land managers aren't willing to work with them. It's also interesting to note that this perception was reported even among participants that also reported previous cooperation with public land managers. These results highlight a disconnect between the perceptions of private landowners and public land managers, in that both groups commonly believe the other group lacks the interest to work with them on cooperative management activities. It's possible that sharing this finding, by itself, could improve communication of interest. Additionally, this underlines the need for further research aimed at understanding the nature of interaction between private and public land managers. The survey used for this study did not have room for an exhaustive exploration of all possible ways in which these interactions can take place, but this would be a worthwhile focus of future research.

Our study also highlights the association between information flow and reported cooperation. In this case, information flow includes access to information, communication, and awareness of activities occurring on public lands, all of which

showed an association with reported cooperation. In general, agreement with statements designed to measure the flow of information was higher among participants that reported cooperation with public land managers. This finding suggests that outreach from public land agencies can influence engagement with private landowners. This aligns with previous studies that posits the importance of institutional programs and policy tools for increasing cooperative engagement with private landowners (Ferranto et al., 2013; Fischer & Charnley, 2012; Rickenbach et al., 2011). One approach would be to recruit external actors and organizations to serve as facilitators for increasing the flow of information between public and private land managers (Meadows et al., 2013, Rickenbach et al., 2011). Moreover, these external actors could provide a platform for information exchange rather than serving as a messenger between groups. This approach would help satisfy private landowners' preferences for learning about management practices by way of their interpersonal relationships with others (Ferranto et al., 2013, Fischer and Charnley, 2012). It's also worth noting the proximity aspect considered within this study. Unsurprisingly, participants that owned properties adjacent to public land reported higher levels of awareness for the activities taking place on public lands. However, non-adjacent private landowners expressed interest in working with public agencies as well. Engaging with this audience becomes increasingly important when addressing management issues that pose risk at larger geographic scales (i.e. wildfire or insect pests). Also, this finding suggests there is an opportunity to design strategies that engage communities rather than individual owners of adjacent property.

It's clear that people are more likely to engage collaboratively if they trust their neighbors, perceive that their neighbors share an interest in stewardship so that

cooperation would be mutually beneficial, and are willing to offer support whether that consists of labor or financial assistance (Ostrom, 1990, Pretty, 2003, Yaffee, 1998). Average trust levels were higher among participants that reported a cooperative activity with public land managers. This aligns with previous studies that found trust is built through previous experiences (i.e. communicating, working together) with others (Petty, 2003; Fischer et al., 2019). While this study only measures associations among the flow of information, trust and cooperation, the results of the regression analysis sheds light on the nature of these associations and emphasizes the importance of peer-to-peer conversation. Agreeing with the statement, "*public land managers inform me of activities occurring on public lands,*" was the most influential predictor of being a participant that believes public land managers are willing to work them. Further, the belief that public agencies are willing to work with them was the most influential predictor of actual cooperation among the willing population. These findings suggest that regular, systematic, peer-to-peer outreach from land managers can establish clear communication pathways that build trust, and ultimately increase cooperative engagement between private landowners and public managers living and working within a PACE.

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CHAPTER V
CONCLUSION

Research synopsis

The research presented in this dissertation furthers our understanding of how natural resources can be managed across jurisdictional boundaries within protected area-centered ecosystems (PACEs). In the first study (Chapter II), I focus on public land management by exploring perceptions, definitions, and measures of successful cross-jurisdictional management among managers working for public agencies and organizations. The second study (Chapter III), examines characteristics of cooperation among owners of private lands within one of three PACEs. The final study (Chapter VI), assesses cooperation at the public-private interface from the perspective of private landowners. All three of the studies focus on the social aspects of social-ecological systems (SES) and the influence of jurisdictional partitioning on cooperative conservation behavior.

The public land managers interviewed for this study considered two overarching aspects when defining successful cross-boundary stewardship: process and outcome. Outcomes can be thought of as the indicators or evidence of successful process. Field-level personnel tended to focus on outcomes while higher-level interviewees tended to focus more on process when defining cross-boundary success, however this was not always the case. Project completion arrived as the most tangible outcome mentioned by managers. An example of this would be conducting collaborative wildfire fuels treatment activities across a geographically defined area that includes NPS and USFS land. Other

metrics of success included risk reduction, avoiding conflict (i.e. litigation), collective learning, and changes on the land. However, the most important aspect was not the specific outcome, but rather that desired outcomes were agreed upon among members of the cooperative group. This brings us to the other overarching theme; process. Process included perspectives of *how* successful outcomes are achieved in cross-boundary stewardship efforts. Measures of successful process mentioned by land managers include: shared power and responsibility, fostering trusting relationships, sharing information, and managing natural systems rather than socially defined jurisdictions. The findings suggest that these themes are operationalized through joint planning that fosters shared power and responsibility; collaborative learning to build shared understanding that builds trust; and data sharing/integration to identify innovative ideas that inform management of the system rather than the jurisdiction.

The second study found that the majority of private landowners reported regularly managing the land they own. The primary objective of the study was to understand the various ways landowners cooperate, which is still a poorly understood aspect of PACE management (Fischer et al., 2013). Overall, the results suggest that various forms of cooperation among neighbors are underpinned by beliefs about shared objectives and shared need for active management, but also have unique drivers dependent on the given type of cooperative behavior. Communication and coordination align more with a sense of community, which is believed to influence personal values and social norms (Smith et al., 2021). These forms of cooperation also showed an association with perceptions that the costs associated with managing the land they own are worth the benefits of doing so. On the other hand, more involved forms of cooperation

(collaboration) are more strongly associated with trust, and a belief that they have the right and capacity to manipulate the land they own. This aligns with the belief that trusting others assumes a reciprocal dynamic between two or more parties in which the trusted party is expected to attend to the interests of others involved and have the competence to do so (Hardin, 2004).

The final study suggest that private landowners living in a PACE reported surprisingly high levels of cooperative engagement when compared to previous studies (Gill et al., 2010; Kittredge, 2005). Also, the majority of this population reported a willingness to work with public land agencies when making land management decisions. However, the majority also believe public land managers aren't willing to work with them. Aside from perceptions of willingness, the factors that had the strongest association with actual cooperation at the public-private interface related to the flow of information from public land agencies. Specifically, the findings emphasize the importance of peer-to-peer communication as a strategy for building trust that has the potential to increase levels of cooperation at the public-private interface.

Research contributions

Collectively, these three studies aim to inform strategies for addressing the challenges associated with managing natural resources that cross socially constructed boundaries. Chapter II provides an empirical exploration of successful cross-boundary cooperation from the perspectives of managers working within the system. This sort of information is important for bridging the gap between theory and real-world application. Specifically, the findings highlight strategies with potential for application without major

institutional overhauls. For example, one manager advocated for data sharing that allows managers to understand how useful a given management approach may be by viewing one side of a boundary as a "control" and the other as the "treatment." This example presents a useful strategy for informing better management even in situations that agencies lack the capacity to conduct co-management across a boundary. Another manager emphasized the importance of reflecting on past successes to understand the procedural components that made successful outcomes possible. Further, these insights should inform approaches that are embedded at the institutional level as a way of addressing issues of turnover, which influence trust between individuals. These sorts of examples are important for establishing practices that address the needs of the managers working within a PACE.

Chapter III and IV contribute to our understanding of the role played by private landowners in cooperative conservation, which is a facet of cooperative stewardship that is still somewhat poorly understood (Fischer et al., 2013). Previous studies that have considered the role of private land owners in cooperative conservation often focus on a specific "type" of owner (e.g. farmers, ranchers) (Westerink et al., 2017) or a single resource management issue (Ma et al., 2018; Coon et al., 2020). These studies explored characteristics of informal cooperation behavior across a population of private landowners that own and manage land for a range of reasons. In other words, the findings of these studies provide insights engaging a population of private landowners that historically is viewed as a difficult population to engage (Gill et al., 2010; Kittredge, 2005). The primary contributions are two-fold: first, Chapter IV provides insight for establishing clear avenues of communication with a willing population of private

landowners. Second, the findings of Chapter III shed light on *how* and *why* cooperation occurs among private landowners, which can help public managers frame outreach efforts in a way that recognizes the needs and objectives of private landowners. Together, these contributions can help agency officials identify effective strategies for sharing and framing information in future outreach efforts.

Finally, the survey design for chapters III and IV makes a methodological contribution for future studies aimed at understanding social aspects of social ecological systems. While the spatial component of the survey design only played a small role in the analysis of Chapter IV, the potential for further exploration is vast. For example, survey responses can be readily integrated with existing geospatial data to explore how the physical landscape influences the perceptions, attitudes and beliefs of individual landowners. To my knowledge, this is the first study to link survey responses to individual parcels at the PACE scale. This approach allows researchers to identify sample populations for study areas that are defined by geographic extent of ecological processes, instead of socially defined areas (e.g. counties, states, etc.). In fact, the dataset I was able to build as part of my dissertation research will contribute to future studies beyond the scope of the dissertation.

Research limitations

As with any data source, landowner information has its limitations. The sampling design was built using tax assessor and geospatial data from 13 counties, across 2 states. In one case (Jackson county, CO), spatial parcel data was yet to exist and therefore couldn't be included within two of the three studies. For the rest of the counties that had

parcels located within one of the three PACEs, the most recent tax accessor and spatial data was used to build the total population from which the sample was selected. It's possible that some of the parcels changed ownership between data acquisition and survey distribution, however the letters used to contact potential participants did include owner names. Another potential limitation is an underrepresentation of absentee and seasonal residents. It's possible that some owners were not present during the survey distribution window. In some cases, mailing addresses were provided for individuals that owned land within the PACE, but lived elsewhere.

The primary limitation for Chapter II was the inability to conduct interviews with Native Americans that managed tribal lands within the Grand Canyon National Park PACE. However, I was able to speak with NPS employee whose primary role entailed coordinating tribal affairs with members of Navajo nation. This limitation is certainly something that should be considered and addressed in future studied that explore PACE management.

Recommendations

The studies presented in this research identify several opportunities for furthering our understanding of PACE management. Future studies should aim to build upon the empirical findings described in Chapter II. Longitudinal studies would be especially insightful given successful outcomes of a cooperative cross-boundary effort may not be evident until long after the completion of a project. Additionally, comparative case studies looking at cross-boundary projects would be helpful for identifying context-specific aspects of success. Specific attention should be given to solution-based

approaches given the challenges of landscape-scale stewardship are clearly established within the current literature (see De Groot et al., 2010). Such efforts will continue to bridge the gap between theoretical frameworks and real-world application.

Chapter III identifies the need for future research that explores the role of absentee owners in PACE management. Absentee landowners own approximately 117 million acres of private forestland in the U.S. and is likely to increase in coming years (Snyder et al., 2020). While this aspect has received more attention in recent years (Snyder et al., 2020; Sorice et al. 2018), there are still several opportunities for further exploration. For instance, Chapter III found that the majority of absentee owners reported regular management of the land they own, which refutes the assumption that absentee owners lack motivation to be stewards of their land. Therefore, it would be worthwhile to explore how absentee ownership status influences various aspects of cross-boundary stewardship such as trust, reciprocity and sense of community. Also, this aspect needs consideration when developing outreach strategies designed to engage private landowners to achieve landscape-scale management.

Finally, the third study within this dissertation highlights the need for future research that explores the nature of interactions between private landowners and public land managers. Again, this study found that nearly a third of the participants that reported cooperation with public agencies also believe that public land managers aren't willing to work with them. This finding suggests that a portion of private landowners that voluntarily cooperated with public land managers were left feeling dissatisfied with their experience. Therefore, it's important to understand what led to these perceptions in order to sustain cooperation from willing landowners. While these suggestions for future

research are only a few of the many needed to achieve cross-boundary cooperation at the PACE-scale, they'll build upon the insights garnered by the three studies presented in this dissertation.

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APPENDICES

APPENDIX A

INTERVIEW PROTOCOL

Interview Protocol: Stewardship across National Park Boundaries Study

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

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

1. How would you describe your current role with regard to land stewardship activities in this region?
2. How long have you been engaged in land stewardship in this region?
3. How long have you been engaged in land stewardship in total (including other areas you may have worked prior to coming to this region)?
4. Did you move to this region to assume your current role in land stewardship, or were you here prior to your involvement in land management and conservation?
5. (*If applicable*) You've described your own role with regard to land stewardship; now could you please describe the role of the organization you serve? What are the organization's management objectives?

As you know, the purpose of our research is to document the effects of national park boundaries on 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 cross-boundary collaborations in this region. The next few questions focus on this topic:

6. Do conditions across a boundary from the land you manage ever influence your management objectives or activities on property under your jurisdiction? How?
7. What do you see as the significant cross-boundary challenges that you face in this region, and why do you think so?
8. How are you addressing these challenges (recognizing that you may not be able to address all of them)?
9. What sorts of data do you use to assess environmental conditions at or across your boundaries (e.g., GIS/remote sensing, plant or soil surveys, etc.)? Do you regularly monitor conditions at the boundary, or are these more likely to be data that were gathered occasionally and/or for other purposes?

10. Which other organizations or individuals, if any, are working with you to address these challenges? (NOTE: If you are involved in more than one collaboration, please list the partners who are involved in each separate collaborative effort.)
11. What activities are the partnerships engaged in to address the cross-boundary challenges you have described? (Again, treat each collaboration separately.)
12. 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.)
13. How often do the partners in these efforts communicate, either through formal meetings or informal contacts and conversations?
14. 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?
15. Are there any collaborative partnerships that you or your organization formerly were involved with, but are no longer active? Why have those activities ceased?
16. What do you see as the biggest barriers to achieving cross-boundary collaboration or management of cross-boundary resource challenges?

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

17. (*For landowners/managers only*) About what proportion of your land's boundaries are covered by cross-boundary partnerships like the ones we've been discussing?
18. 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?
19. 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?
20. How would you describe the general willingness of your neighbors to collaborate on cross-boundary issues?
21. Do your neighbors occasionally or regularly contact you for information about land management, either generally or specific to activities on adjacent land?
22. Do you regularly consult your neighbors regarding activities on your land that's adjacent to theirs?
23. 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?
24. Have you noticed changes in the region – either in terms of the people who own and manage land immediately adjacent to you, or more generally – that are likely to influence your ability to achieve stewardship goals across boundaries?

25. What sort of future changes do you anticipate that could influence your ability to achieve stewardship goals across boundaries?

APPENDIX B

PRIVATE LANDOWNER SURVEY

Private Landowner Survey

<<PACE>> Neighbor Survey

First, we'd like you to tell us a little about the land you own near Sequoia & Kings Canyon National Parks. If you own multiple properties in the area, please answer about the property closest to Sequoia & Kings Canyon National Parks.

1. Do you live on the property that you own?
    a. Yes, this is my primary residence
    b. Yes, but only for part of the year (<6 months per year)
    c. No, I lease or rent the property to someone else
    d. No, other (_____)
        i. If you do not live on this property, please provide the zip code for your primary residence: (_____)
2. This property is managed by:
    a. Myself
    b. Myself along with family members or business partners
    c. A person or persons other than myself
    d. There is no active management of this property
3. How long have you (or members of your family) owned this property?
    a. _____ years
    b. Less than 1-year
4. How long have you (or members of your family) been part of the local community or area?
    a. _____ years
    b. Less than one year
5. Is the property, or any portion of it, in a conservation easement or other government conservation program?
    a. Yes, all of it
    b. Yes, some of it
    c. No
6. Does the property have a fence along its boundary?
    a. Yes, on all sides.
    b. Yes, but only on some sections.
    c. No

7. Please rate the following ***benefits*** of the land you own, based on their ***importance*** to you, by circling the answers below on a scale of 1(*not at all important*) to 5(*Extremely important*).

Benefit	Not at all important	Slightly important	Moderately important	Very important	Extremely important
Source of income	1	2	3	4	5
Privacy	1	2	3	4	5
Maintaining a way of life	1	2	3	4	5
Scenic value	1	2	3	4	5
Personal hunting and/or fishing	1	2	3	4	5
Personal recreation opportunities	1	2	3	4	5
Conservation of local nature	1	2	3	4	5
Being a member of my community	1	2	3	4	5
Other (Please specify _____)	1	2	3	4	5

If you derive any sort of income from this property, please respond to questions 8 & 9. If you do not derive income from this property, please skip to question 10.

8. Approximately what proportion of your total household income is derived from activities on the property you own?
    a. More than 90%
    b. 50% - 89%
    c. 10% - 49%
    d. Less than 10%
9. Please rate the ***importance*** of the following activities in generating income or financial benefit from your property, by circling the answers below on a scale of 1(*not at all important*) to 5(*Extremely important*).

Activity	Not at all important	Slightly important	Moderately important	Very important	Extremely important
Timber production	1	2	3	4	5
Livestock grazing	1	2	3	4	5
Agricultural production	1	2	3	4	5
Hunting leases	1	2	3	4	5
Property rental	1	2	3	4	5
Conservation payment	1	2	3	4	5
Mineral/oil and gas extraction	1	2	3	4	5
Tax benefit	1	2	3	4	5

Other (please specify _____)	1	2	3	4	5

10. Looking into the future, how would you evaluate the likelihood of different options for your land over the next 5-10 years?

Option	Not at all likely	Slightly Likely	Somewhat likely	Likely	Very likely
The land will remain in its current ownership.	1	2	3	4	5
The land will be donated for conservation or other charitable purposes.	1	2	3	4	5
Ownership will be transferred to a family member or business partner.	1	2	3	4	5
The land will be sold to any willing buyer.	1	2	3	4	5

This next section will ask about the influence of neighboring private lands on your land management practices. For this section the term "neighbors" means private landowning individuals living adjacent to your property.

11. Please rate your ***level of agreement*** to the following statements, based on your beliefs, by circling the answers below on a scale of 1(*strongly disagree*) to 7(*strongly agree*).

Statement	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree
The activities on my land contribute to a larger *economic* system.	1	2	3	4	5	6	7
What my neighbors do on their land is important to me.	1	2	3	4	5	6	7
My land is part of a larger *natural* system.	1	2	3	4	5	6	7
We humans have a responsibility to account for our own environmental impacts	1	2	3	4	5	6	7

because they can harm other people							
How I manage the land, both for nature and for future people, reflects my sense of responsibility to the land.	1	2	3	4	5	6	7
What I do on my land is important to my neighbors.	1	2	3	4	5	6	7
Conditions on my land are important to the *community*.	1	2	3	4	5	6	7

12. Please rate your ***level of agreement*** to the following statements, based on your beliefs, by circling the answers below on a scale of 1(*strongly disagree*) to 7(*strongly agree*).

Statement	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree
My neighbors *inform me* of the land management practices on their land.	1	2	3	4	5	6	7
I'm *willing* to work with my neighbors.	1	2	3	4	5	6	7
My neighbors are *willing* to work with me.	1	2	3	4	5	6	7
I *inform* my neighbors of the land management practices on my own land.	1	2	3	4	5	6	7
I *work with* my neighbors on land	1	2	3	4	5	6	7

management *activities* that *cross the boundary* between our properties.							
The *conditions* on neighboring lands influence my land management decisions.	1	2	3	4	5	6	7
I *work with* my neighbors when making land management *decisions*.	1	2	3	4	5	6	7
My land management *objectives* align with my *neighbor's objectives*.	1	2	3	4	5	6	7
I *work with* my neighbors on land management *activities*.	1	2	3	4	5	6	7

You were selected to participate in this study due to the proximity of your land to publicly owned lands. The next section will ask about the influence of public lands in your area. For this section, the term "public lands" refers to any government-owned lands (county, state, federal etc.).

13. Please rate your ***level of agreement*** with the following statements, based on your beliefs, by circling the answers below on a scale of 1(*strongly disagree*) to 7(*strongly agree*).

Statement	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree
I believe *economic production* should be the primary goal of public land management.	1	2	3	4	5	6	7
In general, *my community* benefits from	1	2	3	4	5	6	7

the presence of public lands.							
Public lands need to be protected for the enjoyment of *future* generations.	1	2	3	4	5	6	7
I believe *environmental preservation* should be the primary goal of public land management.	1	2	3	4	5	6	7
The presence of public lands *adds* value to my property.	1	2	3	4	5	6	7
I believe public lands are being managed appropriately.	1	2	3	4	5	6	7

14. Do you derive any income from presence of *public lands* near the property you own?
    a. Yes
    b. No

*If you answered **yes** to question **#14**, please respond to questions 15-16. If not, please skip to question 17.*

15. Approximately what proportion of your total household income is derived from activities on public lands near the property you own?
    a. More than 90%
    b. 50% - 89%
    c. 10% - 49%
    d. Less than 10%
16. Please rate the ***importance*** of the following activities in generating income for your household, business, or employer from *public lands* near the property you own, by circling the answers below on a scale of 1(*not at all important*) to 5 (*extremely important*).

Activity	**Not at all important**	**Slightly important**	**Moderately important**	**Very important**	**Extremely important**
Timber production	1	2	3	4	5
Livestock grazing	1	2	3	4	5
Agricultural production	1	2	3	4	5
Tourism	1	2	3	4	5
Recreation activity	1	2	3	4	5

Mineral/oil and gas extraction	1	2	3	4	5
Other (please specify _____)	1	2	3	4	5

*The following section will ask about the **influence of public lands** when managing your own land.*

17. Please rate your ***level of agreement*** to the following statements, based on your beliefs, by circling the answers below on a scale of 1(*strongly disagree*) to 7(*strongly agree*).

Statement	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree
I know where to find *information* about land management practices on public lands.	1	2	3	4	5	6	7
Public land managers *inform* me of activities occurring on public lands.	1	2	3	4	5	6	7
I am *aware* of land management practices occurring on public lands.	1	2	3	4	5	6	7
The *conditions* on public lands influence my land management decisions.	1	2	3	4	5	6	7
I regularly *work with* public land agencies on land management activities.	1	2	3	4	5	6	7
I'm *willing* to work with public land agencies.	1	2	3	4	5	6	7

I *work with* public land agencies *to make* land management decisions.	1	2	3	4	5	6	7
My land management *objectives* align with the *objectives* of public land agencies.	1	2	3	4	5	6	7
Public land agencies are *willing* to work with me.	1	2	3	4	5	6	7
Public land managers are *aware* of my land management goals and activities.	1	2	3	4	5	6	7

18. Please indicate your ***level of trust*** in the following organizations and/or individuals to *work with you* to make land management decisions, by circling the answers below on a scale of 1(*no trust*) to 5(*complete trust*).

Organization	No trust	Limited trust	Moderate trust	Trust	Complete trust
National Park Service	1	2	3	4	5
U.S. Fish and Wildlife Service	1	2	3	4	5
Forest Service	1	2	3	4	5
Bureau of Land Management	1	2	3	4	5
State wildlife agencies	1	2	3	4	5
Local governmental organizations	1	2	3	4	5
Local non-profit organizations	1	2	3	4	5
My private land-owning neighbors	1	2	3	4	5
Private citizens within my community	1	2	3	4	5

When managing your land, you may face challenges or risks. We're interested in learning more about how you think about and/or try to address these challenges.

19. Please rate the following potential *land management issues*, given your ***level of concern*** they pose to *the property you own,* by circling answers below on a scale of 1 (*not at all concern*) to 5 (*extreme concern*).

Issue	Not at all a concern	Slight concern	Moderate concern	Concern	Extreme concern
Wildfire	1	2	3	4	5
Invasive weeds, shrubs or trees	1	2	3	4	5
Pests (insects, plant disease, etc.)	1	2	3	4	5
Wildlife	1	2	3	4	5
Other (please specify: _____)	1	2	3	4	5

20. What do you believe is the ***likelihood*** *t*hat within the next 10 years, a wildfire will cause damage to:

Area	Not at all likely (<1%)	Somewhat likely (1-24%)	Likely (25-50%)	Very likely (>50%)
Your home or property	1	2	3	4
Neighboring homes or property	1	2	3	4
Public lands near your property	1	2	3	4
Other homes or property in your region	1	2	3	4

21. Please characterize the ***current infestation*** by invasive weeds, shrubs and/or trees by circling answers below on a scale of 1 (*none*) to 4 (*severe*).

Area	None	Low	Moderate	Severe
On your property	1	2	3	4
On neighboring *private* property	1	2	3	4
On neighboring *public* property	1	2	3	4
Along roads adjoining or leading to your property	1	2	3	4
In your region	1	2	3	4

22. Please rate the ***amount of management*** you've done on your own land to mitigate the risk of the following potential issues, by circling the answers below on a scale of 1(*no management*) to 5(*intensive management*).

Issue	No management	Some management	Regular management	Intensive management
Wildfire	1	2	3	4
Invasive weeds, shrubs or trees	1	2	3	4
Pests (insects, plant disease, etc.)	1	2	3	4
Wildlife	1	2	3	4
Other (please specify: _____)	1	2	3	4

23. How much do you believe that your management of the following potential issues has reduced the threat posed by them? Please rate the ***level of improvement***, based on your beliefs, by circling the answers below on a scale of 1(*no improvement*) to 4(*great improvement*).

Issue	No improvement	Slight improvement	Moderate improvement	Great improvement
Wildfire	1	2	3	4
Invasive weeds, shrubs or trees	1	2	3	4
Pests (insects, plant disease, etc.)	1	2	3	4
Wildlife	1	2	3	4
Other (please specify: _____)	1	2	3	4

*For questions 23 & 24 please use the following definitions when rating your **level of engagement** for each issue:*

(1) **No engagement**	(2) **Slight engagement**	(3) **Moderate engagement**	(4) **Engagement**	(5) **Active engagement**
I haven't discussed, planned, or worked with others on the issue.	We've discussed the issue.	We've discussed potential management options to address the issue	We've worked together to determine the best management options for addressing the issue	We've worked together to design and carry out management activities to address the issue.

24. Please rate your ***level of engagement*** with neighboring ***private landowners*** when managing for the following potential issues, by circling the answers below on a scale of 1(*no engagement*) to 5(*active engagement*).

Issue	No engagement	Slight engagement	Moderate engagement	Engagement	Active engagement
Wildfire	1	2	3	4	5
Invasive weeds, shrubs or trees	1	2	3	4	5
Pests (insects, plant disease, etc.)	1	2	3	4	5
Wildlife	1	2	3	4	5
Other (please specify: _____)	1	2	3	4	5

25. Please rate your ***level of engagement*** with ***public land management agencies*** when managing for the following potential issues, by circling the answers below on a scale of 1(*no engagement*) to 5(*active engagement*).

Issue	No engagement	Slight engagement	Moderate engagement	Engagement	Active engagement
Wildfire	1	2	3	4	5
Invasive weeds, shrubs or trees	1	2	3	4	5
Pests (insects, plant disease, etc.)	1	2	3	4	5
Wildlife	1	2	3	4	5
Other (please specify: _____)	1	2	3	4	5

26. How important are the following factors in ***encouraging*** you to manage for potential issues that may pose a risk on your property? Please rate your ***level of importance***, based on your beliefs, by circling the answers below on a scale of 1(*not at all important*) to 5(*extremely important*).

Factor	Not at all Important	Slightly Important	Moderately Important	Very Important	Extremely important
It's what my neighbors are doing.	1	2	3	4	5
Required by law or regulation.	1	2	3	4	5
To avoid governmental intervention.	1	2	3	4	5
Neighbors have asked me to do it.	1	2	3	4	5
To maintain economic value of my land.	1	2	3	4	5
To maintain the ecological integrity of my land.	1	2	3	4	5
It's the right thing to do.	1	2	3	4	5
To avoid posing risk to my neighbors.	1	2	3	4	5
To maintain aesthetic quality of my land.	1	2	3	4	5
The safety of me and/or my family.	1	2	3	4	5

27. How important are the following factors in ***limiting*** your management for potential issues that pose a risk on your property? Please rate your ***level of importance***, based on your beliefs, by circling the answers below on a scale of 1(*not at all important*) to 5(*extremely important*).

Factor	Not at all Important	Slightly Important	Moderately Important	Very Important	Extremely important
Sense of responsibility	1	2	3	4	5
Lack of knowledge	1	2	3	4	5
Limited access to information	1	2	3	4	5
Time constraints	1	2	3	4	5
Financial constraints	1	2	3	4	5
Effectiveness of management options	1	2	3	4	5
Lack of management on neighboring lands	1	2	3	4	5
Governmental regulations	1	2	3	4	5
It wouldn't make a difference	1	2	3	4	5
Conflict with other management goals.	1	2	3	4	5
Benefits are not worth the costs.	1	2	3	4	5

28. Please rate your ***level of agreement*** to the following statements, based on your beliefs, by circling the answers below on a scale of 1(*strongly disagree*) to 7(*strongly agree*).

Statement	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree
The primary value of nature is to provide timber, grazing land, and minerals for people who depend on them for their way of life.	1	2	3	4	5	6	7
The primary value of nature is to generate money and economic self-reliance for communities.	1	2	3	4	5	6	7
There are natural landscapes that say something	1	2	3	4	5	6	7

about who we are as a community.							
Nature's primary value is to provide products useful to people.	1	2	3	4	5	6	7

(*Continued from previous page*)

Statement	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree
Nature has as much right to exist as people.	1	2	3	4	5	6	7
Wildlife, plants, and people have equal rights to live and develop.	1	2	3	4	5	6	7
Nature is valuable only if it produces jobs and income for people.	1	2	3	4	5	6	7
Nature has value, whether people are present or not.	1	2	3	4	5	6	7
I have strong feelings about nature that are part of who I am and how I live my life.	1	2	3	4	5	6	7

Finally, we'd like to know about who you are. Please answer the following questions to the best of your ability.

29. What is your year of birth?

(_____)

30. What is the highest level of school you have completed or the highest degree you have received?
    a. Less than high school degree

b. High school graduate (high school diploma or equivalent including GED)
c. Some college but no degree
d. Associate degree in college (2-year)
e. Bachelor's degree in college (4-year)
f. Graduate or Professional degree

31. Choose one or more races that you consider yourself to be:
    a. White
    b. Black or African American
    c. American Indian or Alaska Native
    d. Asian
    e. Native Hawaiian or Pacific Islander
    f. Other _____
32. What is your sex?
    a. Male
    b. Female
33. Information about income is very important to understand. Would you please give your best guess? Please indicate the answer that includes your entire household income in (previous year) before taxes.
    a. Less than $10,000
    b. $10,000 to $24,999
    c. $25,000 to $49,999
    d. $50,000 to $74,999
    e. $75,000 to $99,999
    f. $100,000 to $124,999
    g. $125,000 to $149,999
    h. $150,000 to $174,999
    i. $175,000 to $199,999
    j. $200,000 to $249,999
    k. $250,000 to $299,999
    l. $300,000 or more
34. Which statement best describes your current employment status?
    a. Working (paid employee)
    b. Working (self-employed)
    c. Not working (temporary layoff from a job)
    d. Not working (looking for work)
    e. Not working (retired)
    f. Not working (disabled)
    g. Not working (other) _____
35. Please indicate your occupation:

CURRICULUM VITAE

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Education

Ph.D., Environment & Society **2017 – 2022**
Utah State University, Logan, UT
Dissertation Title: *Social connectivity & divergence of land management practices in protected area centered ecosystems*
Advisor: Dr. Mark Brunson

M.S., Cultural & Environmental Resource Management **2016**
Central Washington University, Ellensburg, WA
Thesis Title: *Sustainable safari practices: proximity to wildlife, educational intervention, and the quality of experience*
Advisor: Dr. Kenneth Cohen

B.S., Recreation & Tourism Management **2012**
Central Washington University, Ellensburg, WA
Minor: psychology

Professional Experience

Graduate Research Assistant **2017 – 2022**
Department of Environment & Society, Utah State University
Conducted interviews with land management officials and distributed a survey questionnaire to private land owners across five large ecosystems centered on U.S National Parks to explore collaborative land management activates that cross jurisdictional boundaries. NSF (Award #1617309)

Graduate Research & Teaching Assistant **2014 – 2016**
Central Washington University
Designed and delivered a social survey in Ngorongoro Conservation Area, Tanzania to explore the influence of educational intervention on conservation perspectives and the quality of experience among safari tourists.

Publications

Tarver, R., Cohen, K., Klyve, D., & Liseki, S. (2019). Sustainable safari practices: Proximity to wildlife, educational intervention, and the quality of experience. Journal of Outdoor Recreation and Tourism, 25, 76-83.

R. Patrick Bixler, Rebecca Epanchin-Niell, Mark Brunson, **Ryan Tarver**, Benjamin Sikes, Meredith McClure, Clare Aslan. (2022). How social and ecological characteristics shape transaction costs in polycentric wildfire governance: insights from the Sequoia-Kings Canyon Ecosystem, California, USA. Ecology and Society.

Under Review:

Brunson, M., Aslan, C., Dickson, B., Epanchin-Niell, R., Sikes, B., **Tarver, R.,** Theobald, D., Veloz, S. Addressing cross-boundary stressors to national parks and protected areas: the challenge of jurisdictional partitioning.

In Prep:

Tarver, R., Brunson M. Social vs. ecological partitioning: the characteristics of managing protected area centered ecosystems across jurisdictional boundaries.

Tarver, R., Brunson M. The role of private landowners in protected area centered ecosystem land management: connectivity, divergence, and engagement.

Tarver, R., Brunson. Managing beyond boundaries: protected area centered ecosystem land management and the challenge of jurisdictional partitioning.

Presentations and Posters

Tarver, R., Sustainable Safari Practices: proximity to wildlife, educational intervention and the quality of experience. The Symposium of University Research and Creative Expression (SOURCE), Central Washington University, Ellensburg, WA April, 2016.

Tarver, R., Sustainable safari practices: proximity to wildlife, educational intervention and the quality of experience. International Symposium on Society and Resource Management, Snowbird, UT, June, 2018.

Tarver, R., The social dynamics of protected area centered ecosystems. Department of Environment & Society Pre-Project Symposium, Utah State University, Logan, UT, April, 2019.

Tarver, R., The social dynamics of protected area centered ecosystems. Student Research Symposium 2019, Utah State University, Logan, UT, April, 2019.

Teaching Experience

ENVS 2340: Natural Resources and Society **Spring 2021**
Utah State University, Instructor of Record

GEOG 4210: Geography of Utah **Fall 2020**
Utah State University, Instructor of Record

RT 355- Sustainable Tourism - contemporary issues **Fall 2016**
Central Washington University, Lecturer

Service

Departmental Service:

Graduate Student Counsel, Dept. Representative **2018-2019**
College of Natural Resources, Utah State University

Faculty Search Committee, Selected Member **Spring 2020**
Department of Environment & Society, Utah State University

Graduate Curriculum Review Committee, Student Representative **Spring 2020**
Department of Environment & Society, Utah State University

University Service:

Grad-Undergrad Mentor Program, Mentor **2018 – 2020**
Science Writing Center, Utah State University

Student Research Symposium Committee, Judge **2019**
Utah State University

Special Olympics Unified Sports Program, Coach **2018 – 2019**
Utah State University

Professional Service:

Restoring the West Conference, Moderator **October 2019**
College of Natural Resources, Utah State University

Journal Peer-Reviewer:

Human Dimensions of Wildlife, Journal of Outdoor Recreation & Tourism, International Journal of Environmental and Public health, Land