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RANCHER PERCEPTIONS OF ECOSYSTEM SERVICES FROM RANGELANDS OF THE INTERMOUNTAIN WEST

by

Elisabeth C. York

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

of

MASTER OF SCIENCE

in

Environment and Society

Approved:

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UTAH STATE UNIVERSITY
Logan, Utah

2017

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ABSTRACT

Rancher Perceptions of Ecosystem Services from Rangelands of the Intermountain West

by

Elisabeth C. York, Master of Science

Utah State University, 2017

Major Professor: Dr. Mark Brunson, Ph.D.
Department: Environment and Society

Ecosystem services are benefits that humans obtain as a result of ecosystem processes and conditions. Rangelands in the Intermountain West are increasingly expected to provide ecosystem services to the general public as well as ranchers. Land management agencies in cooperation with ranchers have created management strategies to fulfill this need. Successful strategies allow for the management of a suite of ecosystem services including those necessary for livestock production as well as ecosystem function and human appreciation. There is a need to understand the values placed on certain ecosystem services by those charged with implementing range management strategies. During the summer and fall of 2016, I conducted a mixed-method sociological approach to broadly understand the values ranchers place on ecosystem services. This research began with semi-structured interviews utilizing grounded theory to develop a management motivation hypothesis. Interview participants were ranchers in the tri-state corner of Utah, Idaho and Wyoming. A variety of services were highlighted as part of management schema and could be placed into three management motivation

categories, including (1) livestock production, (2) heritage and legacy preservation, and (3) destiny control. These common themes seem to determine how the majority of decisions are made on livestock operations. Themes and highlighted ecosystem services were utilized to develop a survey administered to a larger sample of ranchers across the Great Basin. A 44% response rate was achieved and corroborated the management motivation hypothesis developed during phase one of the study. I also uncovered several operational characteristics such as management activity level, trusted sources, and size of operation that determine the amount as well as the type of ecosystem services managed for on operations throughout the Great Basin region. This research will aid agencies such as the Bureau of Land Management, United States Forest Service and Natural Resources Conservation Service in understanding rancher motivations for management. By understanding what resources are highly valued by ranchers, as well as what operational characteristics either inhibit or promote management, strategies promoting the social and ecological resilience can be developed for more widespread manager adoption.

(121 pages)

PUBLIC ABSTRACT

Rancher Perceptions of Ecosystem Services from Rangelands of the Intermountain West

Elisabeth C. York

Rangelands within the Great Basin are responsible for the provision of multiple resources that humans depend on for a variety of reasons. Ranchers in this region are dependent on public lands to remain economically viable in their cattle operations. As a majority of land in this region is publically owned, there are varying interests at play in what should and could be the focus of management. Ranchers are charged with implementing strategies aimed at conserving these landscapes and their motivations for what to manage may significantly influence resource provision from Intermountain West ecosystem.

In this study, I sought to understand what resources ranchers manage and why ranchers manage for certain resources. I also sought to understand operational characteristics which allow or inhibit them from managing for a suite of resources. My study population was ranchers throughout the Intermountain West who depend on public lands to graze their cattle. I utilized interviews as well as mail-in surveys to broadly understand what ranchers value about rangelands. From both qualitative and quantitative data, I found that ranchers make management decisions to encourage productivity, maintain a ranching legacy and remain autonomous in their operation. Managing to encourage these three ideals could ensure that their operations remain viable for their family in the future. I also found that based on size of operation, how active ranchers are

on their operation, and how income dependent they are on their operation contribute to managing for more and a certain type of resource.

Overall, this research was designed to encourage management for a suite of resources on rangeland landscapes. Ranchers seem to manage most highly for resources directly beneficial to their operation. By educating and incentivizing ranchers to manage more broadly for resources that benefit a broader public on public lands which we all hold claim to, resilience of both human communities as well as the ecosystem itself will be enhanced.

ACKNOWLEDGMENTS

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I would first like to thank the ranchers who took the time to either meet with me and be interviewed or fill out the mailed survey. Without your insight, this work would not have been possible. I would especially like to thank the 11 ranchers who invited me into their homes. I learned so much from our interactions and I will never forget your friendliness and hospitality to a city girl from the Midwest.

I would like to thank my co-advisors Mark Brunson and Kris Hulvey. Your ongoing support throughout the process was instrumental to the success of this thesis. I developed into a more confident writer, speaker and researcher thanks to your feedback, support and encouragement. Also thank you to my committee member Ros who gave extremely insightful feedback and always made me a little jealous I couldn't be in Moab more often. Finally, thank you to my lab mates Taya, Gwendwr and Adam who helped me through the research process and kept me sane. As always, I would be nowhere without my family and I thank them so much for always encouraging, loving, and supporting me.

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CHAPTER 1

INTRODUCTION

Rangelands are working landscapes characterized by the variety of natural resource outputs they are relied on to produce. Within the Intermountain West, they cover a significant amount of land, producing a suite of sources benefitting humans. In addition to agricultural outputs, such as forage for livestock, they are also relied upon for ecosystem regulation, such as water quantity and quality, as well as more intangible resources such as cultural identity (Lund 2007; Brunson et al. 2016). The expectations about which resources should be the focus of management can vary significantly between segments of society. For example, ranchers of the American West are likely to value resources differently than those who have recently moved to the area or are tourists to the region (Gosnell and Travis 2005; Gosnell et al. 2007). Understanding ranchers' perceptions of natural resources produced by the rangelands they manage is important to developing management plans for multiple resources. Including this information during formation of landscape management plans can contribute to the widespread fulfillment of resource provision for multiple segments of society.

Ecosystem services are the benefits that humans obtain as a result of ecosystem processes and conditions (Daily 1997). Rangelands are an ideal study unit for understanding the benefits humans receive from a landscape, as there is a constant presence of human management and the landscape and stakeholders are intrinsically linked (Brunson and Huntsinger 2008; Plieninger et al. 2012; Huntsinger and Oviedo 2014). In the past, western rangelands have been expected to provide material outputs for

human benefit including but not limited to forage for livestock grazing, sites for mining, and habitat that supports game animals. Currently, rangelands are expected to produce these services as well as many more that benefit a broader public (Brunson and Huntsinger 2008; USU Extension 2016). The natural landscape has the ability to also produce many other resources extremely important to a broader segment of society such as recreation opportunities, habitat for biological diversity, and clean water (Havstad et al. 2007). Due to varying interests of society, professional natural resource managers must understand how to satisfy diverse resource goals, as these ecosystem services increase human well-being in different ways (Daily 1997). With more diverse populations moving to the Great Basin, perceptions and expectations of ecosystem services are shifting (Gosnell and Travis 2005; Gosnell et al. 2007; Brunson and Huntsinger 2008). By creating multi-resource focused management plans, the differing needs and desires for ecosystem service provision on rangelands can be addressed.

Multi-resource management plans may strive to bridge the gaps that exist between rancher goals and a broader segment of society's goals for the landscape (Dosskey et al. 2012). By managing for multiple resources, an increase in both ecosystem provision of resources and overall functionality of the ecosystem can be achieved (Nelson et al. 2009; Cardinale et al. 2012). Ranchers participate in the management of public lands and their activities are more likely to focus on resources, either tangible or intangible, that are of most value to them and within their capacity for management (Andersson et al. 2007). Understanding rancher management motivations for specific ecosystem services is a key element in fully understanding management regimes on public lands. Perceived importance is an indicator of management focus (Rowan et al. 1994). Studies have

identified the ecosystem services ranchers are most likely to manage for (Kachergis et al. 2013; Roche et al. 2015), but not which are most valuable to them and why. The research described in this thesis addresses this missing aspect of rangeland ecosystem service management. By understanding what is most important to ranchers, management plans can be communicated that highlight ranchers' most valued resources, as well as a host of others desired by the public.

Rangelands in the Great Basin are consistently changing both ecologically and socially, and these changes are accelerating as climate change and diverse populations apply pressure to the region (Lund 2007; McCollum et al. 2017). The resilience of this ecosystem in the face of change is dependent on a full understanding of the rangeland system, including, most notably, the humans and the well-being they derive from the landscape (Chapin III et al. 2010; Briske 2017). The future of clean water, wildlife habitat, recreational opportunities and heritage preservation in the Great Basin depends on the value placed on services by those charged with managing these western landscapes (Brunson and Huntsinger 2008; Maczko et al. 2011). Throughout this region, this task falls to individual ranchers. Because of this, it is imperative to understand how ranchers perceive the ecosystem services produced on the landscapes they manage. By characterizing these perceptions, multi-resource management plans can incorporate ecosystem services valued by both ranchers and the public.

Purpose of Study

The GrazES ("Using livestock grazing systems to manage ecosystem services on Utah rangelands") project at Utah State University strives to understand ecosystem

service provision on rangelands and how to integrate multiple resources contributing to human and ecosystem well-being into management. In order to address this, the objective of the GrazES project is to study both the ecology and social psychology of western rangelands. This thesis research undertook the social-psychological characterization of ranchers grazing livestock on public lands within the Great Basin. Using social science methods, I illustrate, both qualitatively and quantitatively, the resources valued and managed for as well as the reasoning behind this management. Chapter 2 offers a review of relevant literature related to both ecosystem service provision on rangelands as well as rangeland resource decision-making. Chapter 3 describes the social science methods utilized in this study, and how they were applied to create research results specific to Great Basin ranchers whose livestock graze public land forage. Chapter 4 describes the ecosystem services managed for on Great Basin rangelands and why these may be of value. The conclusion of this thesis discusses, first, ranch characteristics contributing to ecosystem service provision and what a changing population may mean for provision of ecosystem services on rangelands. Second, three reasons are presented for why ranchers may be choosing to manage for certain ecosystem services, as well as how the understanding of rancher goals can be utilized in management plan educational materials both now and in the future.

CHAPTER 2

BACKGROUND

Ecosystem Service Provision on Rangelands

Social-Ecological Systems

In this research, rangelands in the Intermountain West were studied as a social-ecological system (SES). The SES framework proposes that human communities and individuals must be understood as interacting with services provided by ecosystems (Bennett et al. 2009; Brunson 2014; Huntsinger and Oviedo 2014; Hruska et al. 2017). This exploratory piece of the GrazES study focuses on understanding the human side of this complex system. Previous studies have considered landscapes in this way and have seen the importance of including humans in ecosystem understanding, as there are no natural areas which are not impacted by, or currently interacting with, humans (Hooper et al. 2005; Brunson 2012; Huntsinger and Oviedo 2014). For example, by studying resources as part of a social-ecological system, managers in South East Queensland, Australia, have been able to translate research products into policy-relevant changes for management in a coastal ecosystem (Maynard et al. 2010). Social-ecological systems are extremely complex in the diverse information that must be comprehended and included, but are integral in understanding ecosystem service provision on landscapes (Endter-Wada et al. 1998). This type of complex system understanding is also beneficial when we must look to social, cultural or economic reasons for why certain decisions are made when it may not seem logical ecologically (Bestelmeyer and Briske 2012). According to Hruska et. al. (2017), by characterizing the social side of social-ecological systems, the

effects of either a social or ecological change on the community can be better understood. By understanding these trade-offs, resilience of both the society and the ecosystem is more likely to be maintained.

Ecosystem Services

The identification and characterization of ecosystem services have been undertaken in many capacities to inform management (Balmford et al. 2002; Kareiva et al. 2011). Ecosystem service provision is quickly becoming a preferred conceptual framework in discipline-specific research as well as a desired format in federally funded research (Kareiva et al. 2011; Guswa et al. 2014; Donovan et al. 2015). Ecosystem services are the resources a landscape can produce which contribute to human well-being (Daily 1997; MEA 2005; Hodgson et al. 2007;). Human well-being is characterized by how well a resource satisfies one of four categories: security, basic material for a good life, health, or strong social relations. These in turn contribute to the freedom of choice and action of an individual (MEA 2005). All of these resources which contribute to human well-being can be categorized by how they do so. The Millennium Ecosystem Assessment designated four categories of ecosystem services: provisioning, regulating, supporting and cultural. Provisioning services contribute to material ecosystem outputs; regulating services allow an ecosystem to function normally; supporting services allow all other services to provide benefit; and cultural services contribute to intangible benefits received by an ecosystem (Daily 1997; MEA 2005).

Ecosystem services fit well within the SES framework, as they represent a direct intersection of the ecosystem and the community residing within that ecosystem.

Ecosystem services can be a useful tool to bridge the gap between the natural world and the human world (Braat and de Groot 2012; Frank et al. 2014). Ecosystem services on landscapes in Germany were studied to preserve both ecological as well as societal benefits (Plieninger et al. 2013). This study found that by understanding how areas on their study landscape contribute to human well-being, multifunctionality of resource provision could be achieved to satisfy diverse stakeholder needs. In the context of North American rangelands, both the resources produced on the landscape as well as the cultural narrative depicted on the landscape are important for preservation (Brunson and Huntsinger 2008). Ecosystem services give the field a focus and help to pare down the complexity of the system into specific units of study (Salzman et al. 2001). This allows researchers to understand the importance of each service to human well-being.

Management of Ecosystem Services

Multiple ecosystem services need to be incorporated into management objectives to achieve healthy landscapes. Schindler et al. (2014) proposed that by focusing on ecosystem services and striving to restore and manage for multiple services, one could achieve a highly functional ecosystem. In recent years, multi-disciplinary teams have increasingly been called upon to better understand how ecosystem services can be successfully managed by studying both the ecological aspects of an ecosystem as well as the humans directly interacting with the ecosystem (Daily et al. 2009; Curtin and Prellezo 2010; de Groot et al. 2010; Delgado et al. 2013 Brunson 2014). While this trend is gaining popularity, it is still common for ecosystem service studies to focus only on

ecology of ecosystems and not the social aspects driving management (Zavaleta et al. 2010; Isbell et al. 2011) .

Using an ecosystem services lens helps provide a local focus because management concentrates on the resources available for a community to utilize (Chan et al. 2006; Nahlik et al. 2012). An example from the restoration literature shows that focusing on restoring those services which the community most cares about increases success (Benayas et al. 2009; Palmer 2009). The community will provide more effort to ensure success when it believes the resource is important (Raymond et al. 2009; Bryan et al. 2010). By assessing the local community through a social science lens, an understanding of what is important can be highlighted (Cowling et al. 2008; Bryan et al. 2010). An example of wild food collecting in Europe shows how focusing on specific services highlighted by those directly associated and relying upon the landscape can be an integral piece in developing management plans that are successful (Schulp et al. 2014). In order to target management objectives in the degraded Murray-Darling region of Australia, locals were asked to divulge highly valued services. This study strived to go beyond ecological and economic valuation and better understand how humans benefit from specific management regimes (Bryan et al. 2010). Finally, within the Intermountain West, management regimes of forest service land in Wyoming and Colorado have used social surveys to target ecosystem services voiced by the community of users (Sherrouse et al. 2014). If services are selected which are perceived to benefit the local community, there is more engagement and success in sustainable management (Paetzold et al. 2010).

Managing Ecosystem Services to Increase Resilience

As stated, it is important to identify specific resources produced on the study landscape that benefit community well-being. If an individual or organization manages for a service without mandate, it generally means they believe it is valuable and contributes to well-being. This step in the research process needs to be included early in order to ensure plans are valuable to the community charged with implementing them (Menzel and Teng 2010). To increase resilience of both the ecosystem and the social system in the Intermountain West, we need to understand what services are important to the continued livelihood of ranchers. (Folke et al. 2002; Braat & de Groot 2012; Brunson 2012; Burkhard et al. 2012; Dosskey et al. 2012). This resilience can be fostered by successful implementation of policy for protection of locally desired resources (Salzman et al. 2001; Carpenter et al. 2009; Seppelt et al. 2011). Another way is by communities organizing themselves to deal with problems threatening their resilience. Berkes and Folke (1992) described this as a "bucket brigade" mentality, working together to adapt management and ensure community survival. Rangelands are continually changing both ecologically and socially and a focus on community resilience-based management is believed to be the most successful management model going forward (Bestelmeyer and Briske 2012). In order to achieve this, we must understand rancher perceptions of ecosystem services and the relationship between ranchers and the land they manage.

The goal of this study was to identify resources important to ranchers of the Intermountain West. Incorporating these identified resources into multi-resource management plans on rangelands will conserve both the landscape ecology as well as the

livelihood of ranchers and the ranching community dependent on rangelands for their well-being. The GrazES project, by employing an emphasis on the social ecological system of rangelands, will be a revolutionary study on public lands within the Intermountain West.

Ecosystem Service Provision on Rangelands

Specifically within a rangeland ecosystem, provision of ecosystem services has been studied in both California and the western Great Plains (Roche et al. 2015). The authors used an ecosystem services framework to better understand why ranchers make certain livestock management decisions. In particular, they found that when ranchers focus on provision of multiple services, this affects which grazing system they choose. This thesis expands upon Roche et al. (2015) in two ways. First, the Intermountain West depends on federally managed public lands in order to graze livestock. Understanding the perceived barriers to ecosystem service management based on this differing landscape use is essential to understanding ecosystem service provision on public lands. Second, this study sought to understand all management decisions and all ecosystem services provided rather than simply those related to livestock management. Ranchers think about many things related to their operation that factor into resource provision, and by understanding these factors, range professionals can better understand current and future management decisions.

Rancher Motivations for Decision-Making on Rangelands

Overview

Rangelands are a model social-ecological system as there is continued human presence within these landscapes. As described previously, social-ecological systems benefit from identifying services that are important to the humans within the system. The importance of identifying these ecological indicators on rangelands can aid outreach agencies (NRCS, Extension services, etc.) in understanding future decision making on rangelands as operational goals and perceived importance of ecosystem services influence management decisions on the range (Rowan et al. 1994; Rissman and Sayre 2012). The goal of this study is to identify the value placed by ranchers on ecosystem services of rangelands in the Intermountain West, so that outreach materials in this region may be effective.

Decision-Making Systems

Smith and Martin (1972) first introduced the concept of a ranch being a production and consumption unit. Their study showed that ranch prices in Arizona were set for reasons other than production outputs of the land. The way of life as well as connection to the land were significant in the price as well (Smith and Martin 1972). Looking at a ranching operation in these terms implies ranchers see their operation as a means to an end. They enjoy the production side of raising livestock as those values have passed to them through generations of ranching, but their end motivation is simply the lifestyle and love of the land. As explained by Smith and Martin (1972), ranches are not only a business, but a home and way of life as well.

The theory of decision making systems explains the multi-faceted cognitive process that ranchers employ (Farmar-Bowers and Lane 2009). Looking at an operation as both a production and consumption unit brings different systems forward (Smith and Martin 1972). A 2009 study of producers in Australia used this concept to show that decisions on a family farm can be placed into different decision-making systems. This study in particular identified three systems: family decision system, business decision system, and land decision system (Farmar-Bowers and Lane 2009). These systems focus on maintaining familial legacy, economic livelihood related to the operation, and stewardship and landscape health respectively. When adaptations to management are required, the decision to adapt will fall into one or more systems. The family decision system is very strong and all decisions may filter through this system in agriculture-based family businesses (Farmar-Bowers and Lane 2009; Kirner 2015). This relates back to the production and consumption duality on ranches in the American West (Smith and Martin 1972). Some decisions will filter through as a production focus and others will filter through as a consumption focus. Ranchers within the Intermountain West will most likely follow this dichotomy of having a focus on both production and family.

The value placed on ecosystem services, and thus management decisions made by ranchers, will likely fall into a production and consumption dichotomy and fit into one of these two decision making systems. Ranchers are likely to place value based on the system of family, love of the land and the consumptive uses they derive from ownership, or they will place value based on the system of animal production. As described by Daly (1996) these are the "ultimate ends" that ranchers strive for. The "ultimate means," such as management and resource production, will work to satisfy the ultimate ends (Daly

1996). If we can understand why certain resources are valued based off of these decision making systems, outreach agencies can be better equipped to understand decisions made and create adaptable educational and outreach materials (Brain et al. 2014; Briske et al. 2015).

Change and Adaptive Management Response

Rangelands in this region are highly variable and extremely susceptible to alterations based on both ecological and social changes (Havstad et al. 2007; Svejcar 2015). The ecology of the region is responding to climate change, including fluctuating conditions of water quantity and forage quality (Briske et al. 2015). Management strategies must adapt to acknowledge these ecological changes (McCollum et al. 2017). The social structure of the region is changing due to shifting demographics of ownership as well as rolling enactment of federal policies which create tension between agencies and ranchers (Rowe et al. 2001; Gosnell and Travis 2005; Gosnell et al. 2007; Donovan et al. 2015). In response to these ever changing conditions both physically and socially, adaptive management is an important topic within the range science literature. It is paramount in understanding current and future management objectives of ranchers and the public (Lubell et al. 2013; Roche 2016). This complex and dynamic system must be studied in new and creative ways in order to conserve resources to benefit people (Armitage et al. 2010).

Adaptive management describes the flexible response of ranchers to conditions encountered on their landscape (Folke et al. 2005; Lubell et al. 2013). Rangeland management has transitioned from exploitation, to preservation, to single service

management (Briske 2017). Finally, we have reached the point of focusing on landscape level ecosystem service suite management. This increases the resilience of both the ecosystem and importantly the community depending on that ecosystem. Rangeland conservation must focus on adaptive and resilience-based management in the future. This management approach allows the operation to achieve resilience in the face of changing ecological and social conditions. In order to make decisions in this way, there must be an end goal based off of values and the means to achieving that goal change through a rancher's life (Farmar-Bowers and Lane 2009). Each individual has their own background and future that they want to satisfy and attain respectively (Roche et al. 2015; Roche 2016;). Adaptive management allows the ranchers to take pieces of their history, learn new techniques and apply that to their future so that they can continue to achieve future goals (Rowan et al. 1994; Farmar-Bowers and Lane 2009; Lubell et al. 2013; Roche 2016).

Ecosystem Service Valuation

Many previous studies have identified significant variables that can separate ranchers into categories which determine their valuation and decision making (Bartlett et al. 1989; Coppock and Birkenfeld 1999; Rowe et al. 2001; Kachergis et al. 2013; Roche et al. 2015). In a study of Colorado ranchers and their willingness to sell their operation, way of life—a cultural service—was the highest motivator for staying in the business (Bartlett et al. 1989). Studies on oak pasture landscapes in Sweden have also found way of life to be highly significant to stakeholders (Garrido et al. 2017). However, in order to retain this way of life, profit margins must be high which means resources that benefit the

production of livestock must be valued highly as well (Coppock and Birkenfeld 1999; Kreuter et al. 2004). So although consumptive value is higher, production means must be met to achieve consumptive goals (Farmar-Bowers and Lane 2009). A study conducted in Wyoming looked at the resources produced on rangelands and how ranchers place value. They found that forage production was most important followed by services that support forage production (Kachergis et al. 2013). This demonstrates focus on the production side of livestock operations. Conversely, a recurring theme is that many ranchers choose to stay on the land simply for the lifestyle and sense of stewardship (Smith and Martin 1972; Brain et al. 2014). The critical next piece is understanding how the production side of an operation interacts with the consumption side and how that blurs the lines of resource importance.

Management strategies, values and thus decision making frameworks on ranches in the American West are passed down through generations, instilling a sense of heritage and legacy associated with the land (Plieninger et al. 2012, 2013, 2015; Lubell et al. 2013). Farm structure and lifestyle, which are part of a familial norm, play into valuation and goals for the operation. Because of these norms, there are certain expectations imposed on management (Lubell et al. 2013). Land stewardship also plays a critical role in decision making on rangelands. Many ranchers in the Intermountain West realize that wildlife habitat is decreasing and see themselves as the protectors of this land. They realize they are providing resources for both themselves and the public and incorporate this into their decision making systems as well (Miller et al. 2010). Incorporating cultural ecosystem services into management can be the critical piece in drawing ranchers into conservation strategies. Cultural ecosystem services put a focus on the multifunctionality

of a landscape. In order for cultural ecosystem services to thrive, provisioning, regulating and supporting services must all be present and effective on the landscape. If ranchers want to retain open space, create a legacy of stewardship and other cultural services, they must take care of the multifunctionality of their landscape (Plieninger et al. 2015). In this way, incentive programs either monetary or non-monetary can be developed in order to encourage management of resources that satisfy rancher valuation and public valuation.

In conclusion, studies have looked at the importance of various demographic and operational characteristics in decision making (Bartlett et al. 1989; Coppock and Birkenfeld 1999; Kachergis et al. 2013; Roche et al. 2015). What still needs to be understood is how those factors relate to importance placed on resources on the landscape. This study will specifically strive to understand the value placed on ecosystem services of public grazing lands in the Great Basin and how that value can translate to making adaptive management decisions. By looking at specific ecosystem service provision, we can make current management plans much more specific to the stakeholders benefiting from landscape resources. Also, by understanding how ranchers make decisions, we can be better prepared for the future in changing social and ecological climates.

CHAPTER THREE

METHODOLOGY

Research Objectives

1. *Which ecosystem services do ranchers most value and why?*

The grazES project seeks to understand which resources ranchers manage for and the importance ranchers place on individual resources. These could be resources that contribute to economic gain, ecosystem health, sense of place, cultural or familial identity, or overall psychological well-being.

a. Do ranchers actively manage for identified resources?

This research sought to learn what steps ranchers take to manage for the resources identified above, especially those that are not easily converted to income. Can they manage for these identified resources while also managing for livestock, or does managing for identified resources conflict with their basic livestock operation?

b. What barriers (if any) prevent ranchers from managing for identified values?

What factors are hindering ranchers from managing for the landscape attributes that they most value? Are there any incentives that would allow them to overcome these barriers?

Research Design

This study applied a mixed-method approach to understand beliefs and values of ranchers in the Intermountain West. This approach included semi-structured interviews with qualitative data collection and mail-in surveys with quantitative data collection.

Participants were ranchers managing lands in the Intermountain West. A variety of agency personnel and agency databases were employed to recruit participants. The research protocol was reviewed and approved by the Utah State University Institutional Review Board (Protocol #6956).

Study Area

The Intermountain West describes a geographically unique area of land between the front range of the Rocky Mountains and the eastern slope of the Cascade and Sierra Mountains. This thesis study occurred within this area. Interviews conducted in this study occurred in the tri state region of Utah, Idaho and Wyoming. In order to obtain a larger generalization of study results, I then sent surveys to ranchers throughout the Great Basin, as well as parts of Wyoming and Idaho, which are geologically outside of the Great Basin. It was assumed that ecological conditions throughout the survey region were similar. The Great Basin is made up of a large area of land between the Wasatch mountain range to the east and the Sierra Nevada and Cascade mountain ranges to the west. This ecosystem is characterized by highly variable precipitation and a semi-arid climate (Havstad et al. 2007). It is sparsely populated, especially outside of Las Vegas, Reno, Boise and Salt Lake City (West 1983; Knapp 1996). The Bureau of Land Management (BLM) has historically administered the majority of the land in the Intermountain West (West 1983). In 14 western states, public lands such as those managed by the BLM cover 50% of total land area and livestock grazing is common across this landscape (Havstad et al. 2007). Due to its previously mentioned historical past uses and ecosystem characteristics, this region is very sensitive to disturbance

meaning that management is a crucial piece in protection of this landscape from disturbances such as overgrazing or recreational pressures (Knapp 1996). Given these considerations, this study focused especially on ranchers that hold permits to graze livestock at least part of the year on BLM land in the Intermountain West.

Semi-Structured Interviews

Interviews are a qualitative research method often used as an exploratory step in research. They allow participants to talk about topics they are passionate about while also allowing researchers to learn more about the topic of study. This research employed interviews to discuss with ranchers which resources produced on their grazing land are most valuable to them. I used a semi-structured interview format, allowing me to guide the conversation on topics of importance to the research, but not restricting what the participants wanted to discuss (Kennedy and Brunson 2007; Atwell et al. 2009). This allows participants to expand on topics they are passionate about (Clifford et al. 2016). Interviews were conducted in a setting familiar to participants, such as at their homes, on their property, or at a selected location of their choice. It has been shown that researchers can understand more about participants by their surroundings and how they act in environments in which they are comfortable (Creswell 2003).

This research followed a grounded theory approach, in which data were collected to develop theory rather than to test established theory (Glaser and Strauss 1999; Charmaz 2014). Grounded theory allows researchers to broadly question participants and produce knowledge with the subject rather than approaching the process with hypotheses and biases (Creswell 1998; Charmaz 2014). This method has been used in rangeland

social science research in order to interview and then analyze qualitative data for patterns (Didier and Brunson 2004; Wilmer and Fernández-Giménez 2015). When using grounded theory, the theory developed is considered very strong because it is directly linked to data collected (Glaser and Strauss 1999). This approach is especially useful in applied research, as data outcomes are descriptive of the study population; those that the research will directly affect. This is important, as the data collected will directly affect Intermountain West public lands ranchers by creating management plans which they can incorporate on their grazing land.

Interview participants were selected from suggestions made by collaborating outreach professionals such as Extension personnel or state agencies such as the Utah Grazing Improvement Program. Suggested participants were contacted first with a letter of invitation to participate. If they did not respond, they were called and invited to participate. Those who agreed to participate were asked the questions set forth in the interview guide (see Appendix A). Questions began broadly with an inquiry about the description of the ranch. I then asked questions regarding operation management characteristics. These questions covered changes that ranchers have made in their operation as well as how flexible they feel their management strategies are year to year. Finally, I asked questions to understand what ecosystem services are important to the rancher. Initial questions asked of each rancher were followed by more focused probes. Probes asked for more descriptive and clarified answers from the interviewee (Charmaz 2014). Interviews generally lasted about one hour.

Before interviews began, the participant was asked if they would allow the interview to be recorded. If they agreed, the interview was recorded in its entirety to be

transcribed later. Notes were also written in case of technical malfunction with the recording device. At the end of each interview, respondents were asked to provide names of other ranchers who might be willing to participate in the interview process and had ideas different than their own. This is termed snowballing (Biernacki and Waldorf 1981). By employing this technique, I expanded the interview population and had a more diverse sample of ranchers. I acknowledge that there is the potential for some non-response bias in the 3-5 ranchers who did not respond to invitations to participate (Filion 1975). The rationale for this was that I hoped to engage with those who interact with outreach agencies. Those more likely to respond to an invitation will be more apt to respond to outreach programs in the future as well. This means that the data this research collected is descriptive of the population that will most likely utilize the research outcomes.

In order to determine when enough interviews had been completed, I employed saturation. This technique is typically used in grounded theory research as it helps the researcher decide when to cease interviews (Suddaby 2006). Saturation refers to when most respondent's answers seem to fall into similar patterns and the researcher can explain relationships in the data collected (Charmaz 2014). Once this point was reached, I concluded interviews and began to analyze transcriptions inductively for common themes. According to Charmaz, sample size of the interviewed population is less important than being able to "illuminate properties of a category and relations between categories" for the population of study (2014).

In order to uncover why ranchers manage ecosystem services the way that they do, I analyzed interview transcripts for common themes. Taking transcripts and subdividing data into a prepared Excel spreadsheet accomplished the analysis. Each

question posed was highlighted and answers recorded. Each participant received their own column and researchers compared answers column to column looking for commonalities. Two different researchers analyzed this data spreadsheet, which also included key quotes related to the overarching research questions. Grounded theory was employed to highlight themes, which could then create a theory of why certain ecosystem services are managed for and why others are not.

Privacy of interview participants was protected under the guidelines of the Utah State University's Institutional Review Board, and the research approach approved by the IRB as protocol #6956.

Mail-In Surveys

Similar studies looking at rangelands as social-ecological systems have created surveys to reach a larger sample size than interviewing alone allows (Kennedy and Brunson 2007; Kachergis et al. 2013; Lubell et al. 2013; Roche et al. 2015). Survey questions in these studies were often based on established theories and hypotheses derived from previous work. This research differed in that patterns ascertained from interviews established a grounded theory that guided the creation of survey items. This allowed understanding if the qualitative themes could describe a vast population of ranchers across the Great Basin. In order to accomplish this, the study area utilized for the interviews was expanded to include BLM permittees within the Great Basin as well as parts of southern Idaho and western Wyoming. This permits results from the survey to be generalized to a wider region of North American rangelands.

In order to better understand the derived qualitative themes, the survey asked questions about specific resources and how important they are to the respondent's grazing management. The mail survey began with two simple questions to ensure participation. Following these questions (which were what type of cattle they raise as well as what land types they graze), I present a long list of ecosystem services. Every service listed had been mentioned over the course of interviews as being considered in management decisions. The survey asked participants to mark which resources they manage for and rank how important each is to them. As these participants manage on both federal and private land, I did not highlight this before asking about certain resources. I instead asked the question of how each resource exists in their "general approach to grazing management". Because I was curious if they feel they are not able to manage for certain resources on leased land, I also asked if they manage their leased land differently than their deeded land. The survey also highlighted key resources and tried to understand rancher motivations for managing for these as well as influential information sources. The survey concluded with demographic information (Appendix B). I administered surveys via a mailing list of ranchers located in the Great Basin. This mailing list was obtained from a national list of BLM permittees. Every field office within the Great Basin was included (Fig.1).

From the list of over 3,500 permittees, a sample of 1,000 was randomly selected to receive the survey. Grazing associations, tribal groups, and energy companies were removed from the sample in order to focus on individual ranchers and their thoughts on grazing management. The random sample was selected through a random number generator in *Microsoft Excel*. By randomly selecting a portion of the BLM permittees

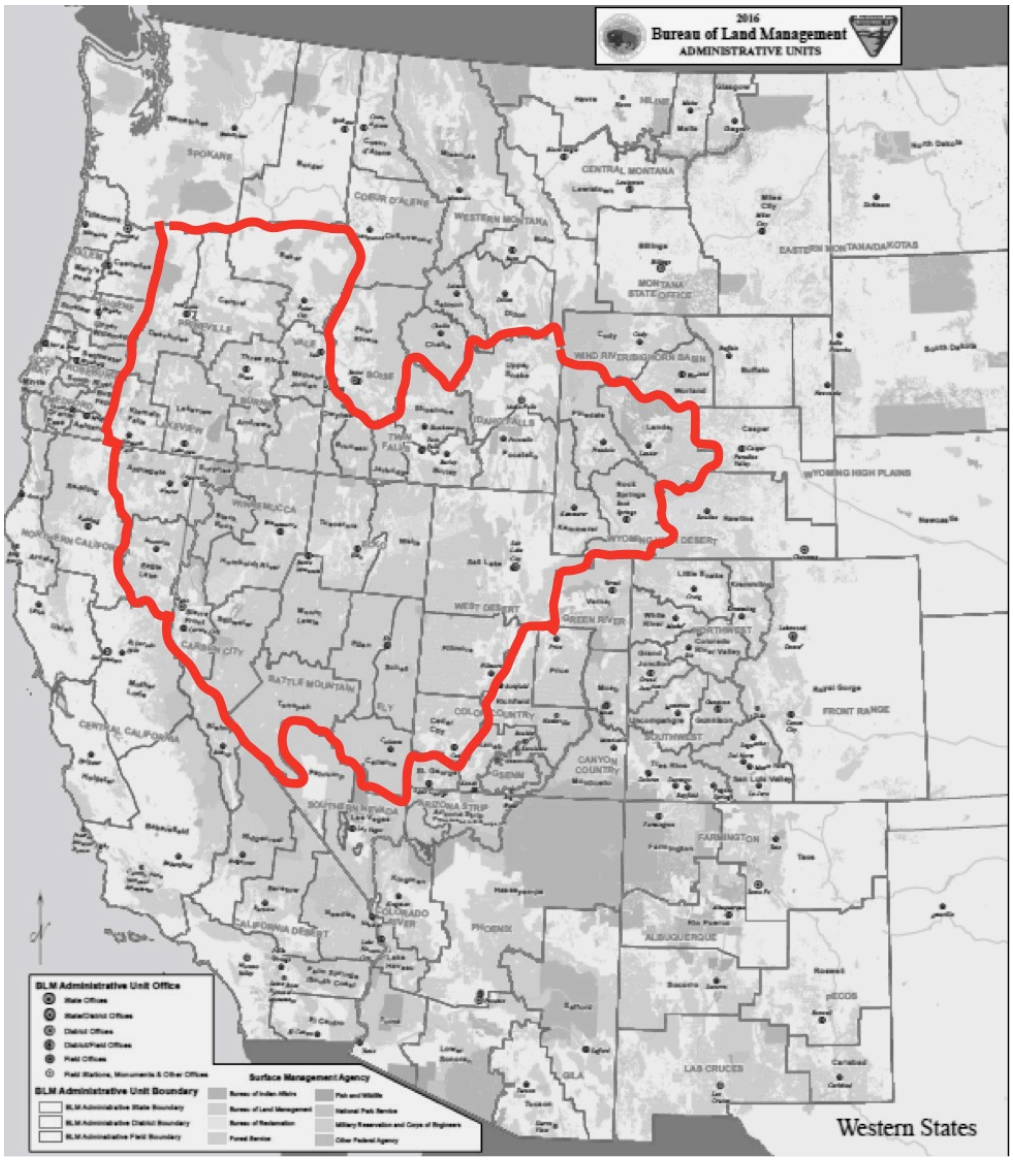

Figure 1. Map displaying Bureau of Land Management field offices of the Western United States. Field offices selected for mailings are included within the red border.

listed in the address directory, this allows stronger inference and the ability to apply research results to the entire population of BLM permittees in the Great Basin.

The survey design followed the Tailored Design Method of Sample Surveys, including four different mailings (Dillman et al. 2014). This method is used frequently in sociological research in order to receive the greatest response rate. The method begins

with a postcard, which informs the recipient that they will receive a survey soon from the research team and the purpose of the study. A couple days to a week later, they receive a copy of the survey. This mailing also contains a cover letter explaining the purpose of the survey and their rights as a participant as defined by the Utah State University Institutional Review Board. Also included in this study was a prepaid envelope to return the survey. Finally, as a way to encourage participation, a coupon for 10% off any purchase at C-A-L Ranch stores, was included in this mailing. Reciprocity or compensation in behavioral surveys generally increases participation (Babbie 2015; Boyce and Geller 2001). A couple days to a week after this initial mailing is sent, a reminder postcard was mailed. This both thanks those who took the time to fill out the survey as well as reminds those who have not to return the survey. After these reminder postcards were sent, I monitored who had returned a survey and who had not. A final mailing was sent between 2-4 weeks later to those who have not responded. This included a cover letter explaining the importance of every randomly selected participant responding. It also included a second copy of the survey in case the first copy had been lost or recycled. Waiting this long cuts down on mailing costs in giving participants time to have mailed their original survey in (Dillman et al. 2014).

Once surveys were received, each response was entered into a *Microsoft Excel* document. After all surveys were entered, they were double checked for entry errors. Once all data was configured for analysis, R Statistical programming was employed. Data were imported into R Studio, and descriptive statistics as well as comparative statistics were used to uncover patterns within the data. With the amount of data that the surveys provided, the main research questions guided the analysis. This meant that the focus of

the survey was on ecosystem service management, ecosystem service valuation, management motivations and management information sources.

This study utilized a mixed-method approach. By taking this route of analysis, it was possible to obtain results very specific to the population of study particularly by beginning with grounded theory. Data was first analyzed after qualitative interviews and then once again analyzed after quantitative surveys. This allowed seamless incorporation between phase one of the study with phase two of the study. Because of this, results showcase qualitative outcomes, quantitative outcomes and quantitative testing of qualitative outcomes. This gives a wide breadth of evidence for the results and implications of this study.

CHAPTER FOUR

RESULTS

Qualitative Analysis of Semi-Structured Interviews

Between May 2016 and August 2016, I conducted 11 interviews in Western Wyoming (2), Southeast Idaho (4), and Northeast Utah (5). Interviews lasted from 45 minutes to three hours. I conducted all interviews in person. All but one occurred at the residence of the participant. Of the 11 participants, 10 were male. All were primary decision makers on the operation. Ten of the 11 operations were primarily cow-calf cattle operations. One operation runs sheep in four counties across Utah and Wyoming. All had private deed land while also depending on state and federal permits for grazing.

Overarching Themes of Interviews

Analysis of interview transcripts revealed three common themes appearing repeatedly throughout the region relating to ecosystem service valuation and, in turn, why ecosystem service management decisions are made. These three themes were livestock production, heritage and legacy preservation, and control of one's own destiny. Each of these is described in detail below:

Livestock Production. Livestock production is the primary means by which ranching operations maintain their economic livelihood and thus ranch families' way of life (Smith and Martin 1972). Throughout the interviews conducted it was apparent that this was a main focus of all thought related to interviewees' operations, whether this was maintaining forage so cattle had a way to survive or maintaining water so cattle had a

drinking source. Cattle profit was always at the forefront of their minds. Several ranchers highlighted the need to focus on cattle forage in order to maintain large calves to sell for a large profit.

> *"We're a grass farm is what we are…and so, actually, if you wanna put it in another sense, most valuable part of the ranch is the grass itself…"*
>
> *"…by increasing forage production [ranchers] increase the number of days we're able to graze and increase profitability. And that's why we manage the grasses."*
>
> *"...we don't like to hit them hard, any pasture hard because its our livelihood and we like to keep the grass in good shape because if the grass is in good shape the calves come back in good shape so its just a management thing you just kinda, you have to be there and watch it to know what to do and be involved."*

These statements demonstrate that ranchers view forage as an ecosystem service that requires careful management to ensure a long-term sustainable supply. Particularly highlighted in the second quotation, many ranchers do think about the future, as they have to continually depend on the same land to be productive. Some ranchers also referred to the idea that they are simply making money off of the grass. As the first quotation states, ranchers view their operation as a grass farm rather than a livestock factory. Another aspect that was mentioned was the amount of production relating to the health of the land. These ranchers believed that if their land was producing, that was a good sign and meant that they were doing something right. They see themselves as feeding the country with their forage management practices.

> *"And I guess to me the most important thing about my ground is that it's healthy; that it's able to produce food for my livestock and for me and for others."*

> "Interviewer*: So the things you said were most important to you...the grass and the water rights. So you feel able to manage for those pretty well based on the land you have?*
>
> Interviewee*: That's all we do!"*

Livestock production on a ranch is paramount to anything else. In order to maintain their way of life, operations have to remain economically viable. The way that they accomplish this is by making sure production comes into every decision.

> *"I would think to be able to sustain livestock [is the most important aspect of my land]. To sustain life basically, because if the ground is not able to sustain life for my livestock, or provide, or sustain me, we're all gonna go, we're all gonna leave."*
>
> *"I don't know anybody that wakes up in the morning and says: 'Hm what can I destroy today,' right? Cause it's how we make our living…"*

In order for other rangeland ecosystem services to fully benefit ranchers, they must be able to remain on the rangeland. For most family operations in the Intermountain West, this requires that they can produce enough forage, and sell enough animals raised on that forage, to maintain economic viability.

Heritage and Legacy Preservation. Preserving a ranching heritage and family legacy was a second idea touched on repeatedly throughout the interviews. When asked what they are most passionate about in ranching, the family way of life that it affords was key. Emotional ties were evident when discussing the past and future of their operations. Each rancher immediately could describe the exact heritage of their operation including who had owned it and how long it had been in their family. It was obvious that this is an important piece of their identity and instills a sense of pride in what they are doing. There

were also mental attachments to both the idea of a future for their operations as well as tangible management decisions made to ensure a future.

> *"I'm the third generation; my son will be fourth."*
>
> *"[I manage for my] grandkids I guess. Trying to make sure there is something to hand on down."*

All interview participants were at least 3rd generation ranchers. They had all grown up on an operation and were either operating on that same property or had purchased their own operation after an older sibling had taken over the family operation. Due to this, each shared memories of times with their parents and grandparents on the range. Several also shared memories that they had already made with their own children and plans for their children to take it over.

> *"...as I take my boys and go do stuff, I have memories of [dad] taking me to do the same things and that's really neat to me to be able to pass the knowledge I learned from him down to them."*

Along with being able to maintain a family legacy and their ranching identity, it is also important to ranchers to pass down an ideology of land stewardship. In order to do this, they want to instill in their children a work ethic and the idea that they are the stewards of this landscape. One rancher tied this together in that raising a family on the land is a great way to teach hard work, and is a noble way to live.

> *"...it's a good place to raise a family. You don't get rich but your kids learn how to work. They learn that they don't like sprinkler pipe or fixing fence but they learn how to work and it's just a good clean way of life, it's a good heritage."*

Finally, it was very apparent how crucial they view the idea of taking care of the land. Their stewardship provided a sense of pride and a familial legacy that they want handed down. If they believe that their family has been known as great stewards of the

same land for years, this is very important to maintain in the tradition of their operation. They see a feedback between themselves and the land, as stated in the first quotation below. Ranchers discuss the landscape with such emotion, the land could be seen as intrinsically linked or even an intangible family member.

> *"I think if I don't take care of it, it's not gonna be here for my boys. And I want them also to make sure that it's here for their boys or their daughters or whoever. I think that it was instilled in me through my grandfather on both sides. My mom's dad is a farmer in eastern Oregon…if you take care of it, it will take care of you."*

> *"We look at this place as not an inheritance and not an ownership but it's a legacy that we have to take care of. I just happen to be the guy that's here right now taking care of this. It's not really mine, only by the government records….and being driven by that force, the reason I'm in ranching is for my family…it's the greatest occupation in the world to raise a family."*

The way in which the ranchers talked about the family life and the land steward connection that ranching allows them easily demonstrates why maintaining this way of life is so important. For this reason, they make decisions about what ecosystem services to manage for in order to maintain these ideals both now and in the future.

Destiny Control. The third and final theme for why ranchers manage the way that they do was also the least expected theme illuminated by the interviews. Ranchers in the Intermountain West are part of a very individualistic community comparatively to the rest of the United States (Vandello and Cohen 1999). Due to this, it is felt very strongly they should be able to have the final say regarding management decisions on their personal operations. It was surprising to see that some ecosystem services were not managed for out of their direct value to the rancher or the operation, but because respondents believe that managing for some services would allow them to stay in charge of their operation. In

other words, if they stay ahead of the management, then regulations will not be imposed on them that could take control away from them.

> *"You know most of [a threatened fish species] spawn here down here in this creek down further in the meadow and then up on the neighbor's [private land] so it kind of made them back off. You know, saying, 'whatever you're doing, you know, it's good. Don't change.' But like I said, it's one of those things out there that gives you nightmares."*

Out of the three themes, the most abstract was the idea that ecosystem service management decisions may be made to maintain autonomy for the future. All participants discussed the importance of being in charge of decisions on their operation. Contempt was often expressed when discussing environmental groups or agencies that demand certain actions of the operation against the will of the rancher.

> *"I mean they have to go out there and look for whether or not you're gonna hurt an artifact and they have to go out there and look and see whether or not you're gonna disturb existing plants if a plant gets listed you can't do anything if there's an animal in there that gets listed you can't do anything and so it's regulations [that keep me from managing for what I want to]."*

> *"It's a sad day when I go out here [on the landscape] and go 'oh shit there's a sage grouse, I wish he was on the next allotment' and [federal agencies imposing regulations have] done that!"*

Many of the ranchers talked about how much they love seeing wildlife on their property, so it was somewhat incongruous to hear them say that there are certain species that, when present on their land, scare them. If they are not able to manage their operation the way they would like to, they feel out of control. And when a rancher has so much invested in an operation, both emotionally and fiscally, being unable to make decisions can be a very unsettling feeling.

> *"…there are so many regulations and mandates that are being handed down to landowners. It's scary. They're always scared they are gonna lose something. And it means a lot to them, they work hard for this stuff."*
>
> Interviewee: *"There's actually a fish that a group out of Colorado is trying to list as endangered. The Bonneville Cutthroat [trout]. And yeah they're here."*
>
> Interviewer: *"Is that affecting or would it affect your operation at all [if it were to get listed as endangered]?"*
>
> Interviewee: *"It would, if they were successful in listing it as endangered, it would affect us in a negative way. Yeah that's one of those things that's out there that kinda keeps us up at night."*

Ranchers want to be a part of the management conversation on *all* lands they depend on for grazing (both private and public). Having maintained this legacy on the same landscape for generations, they feel ownership over the area – including lands that are legally owned by government entities. For this reason, when referring to "their" land they are most likely referring to both private holdings and any land under permit holdings. Having made management decisions and maintained their operation for so long, they feel they know the best plan of action to take.

> *"We been here for longer than Wyoming's been a state and you think we'd still be operating in a positive manner if we were such terrible operators? So I think that alone is pretty unique even out here in the west, to find a place that's been homesteaded and is still in the same family from beginning until now. I think that's pretty unique you're not gonna find that very many places."*

Overall, they know that there is a need for multiple services to be managed for, and they try to maintain some or all of these ecosystem services, first and foremost to maintain a viable operation. They are not averse to satisfying a broader segment of the

public as a by product, and often take pride in doing so. But, in order to do this, they feel that they need to be in charge.

> Interviewer*: "So with those other things that you said you manage for, like the wildlife, do you feel like that ever interferes with managing for livestock?"*
> Interviewee*: "No as long as were in control of it, it doesn't."*
>
> *"Nobody likes being told what you have to do. Even if you're not a landowner you don't like being told what you have to do. But if you can make it their idea…they'll do it!"*

The second quotation refers to how ranchers do not like being told what they have to do because they want to remain autonomous. This interviewee also talked about how, as a part-time consultant, he uses a technique to allow the ranchers to feel in control. He discussed how by providing detailed information to ranchers of what needs to be managed for and what will happen if it is not, they are forced to come up with management ideas on their own. When this happens, they are still managing for the resource, but made the decision themselves in order to retain control of their own destiny. He argued that this would create a much more harmonious landscape. Ecosystem services of high priority would be managed for, but there would be less turmoil felt by the rancher.

These three themes led to the resultant hypothesis: **Ecosystem services will be of management priority when they contribute to the goals of the rancher. The most-desired goals for ranchers in the study area are forage production, legacy preservation, and destiny control. If an ecosystem service contributes to the ability of fostering these ideals within their operation it will be highly managed for.** Grounded theory allowed development of a hypothesis for management motivation specific to those interviewed. The next step was to test if this hypothesis could be

applicable to a geographically diverse population of ranchers. The survey, mailed to ranchers across the Great Basin, utilized this hypothesis to develop survey items to determine the extent of its functionality.

Identification of Ecosystem Services

A second goal of the qualitative interview phase was to characterize the breadth of ecosystem services that interviewees identified as management objectives. Ecosystem services typically were identified in the context of changes that ranchers had made in their grazing management. Several of the more intangible ecosystem services were mentioned when ranchers answered a question about why they remain in the livestock industry and what they enjoy about being a rancher. Throughout interviews, the term "ecosystem services" was not used in order to avoid academic jargon. The idea of ecosystem services was accessed through understanding resources managed for and why. Although the ranchers did not explicitly say they were managing ecosystem services, a long list of resources was highlighted in interview transcriptions that could be separated into four categories based on how they may benefit the ranchers' well-being (Fig. 2).

This research used a survey in order to understand tangible benefits produced on rangelands. For this reason, another element of the analysis of ecosystem services was determining which categories of ecosystem services were mentioned. Categorization used the well-accepted framework used by the Millennium Ecosystem Assessment (2005). Ecosystem services focused on by previous studies were provisioning, regulating, and supporting. These services produce tangible benefits by way of material outputs,

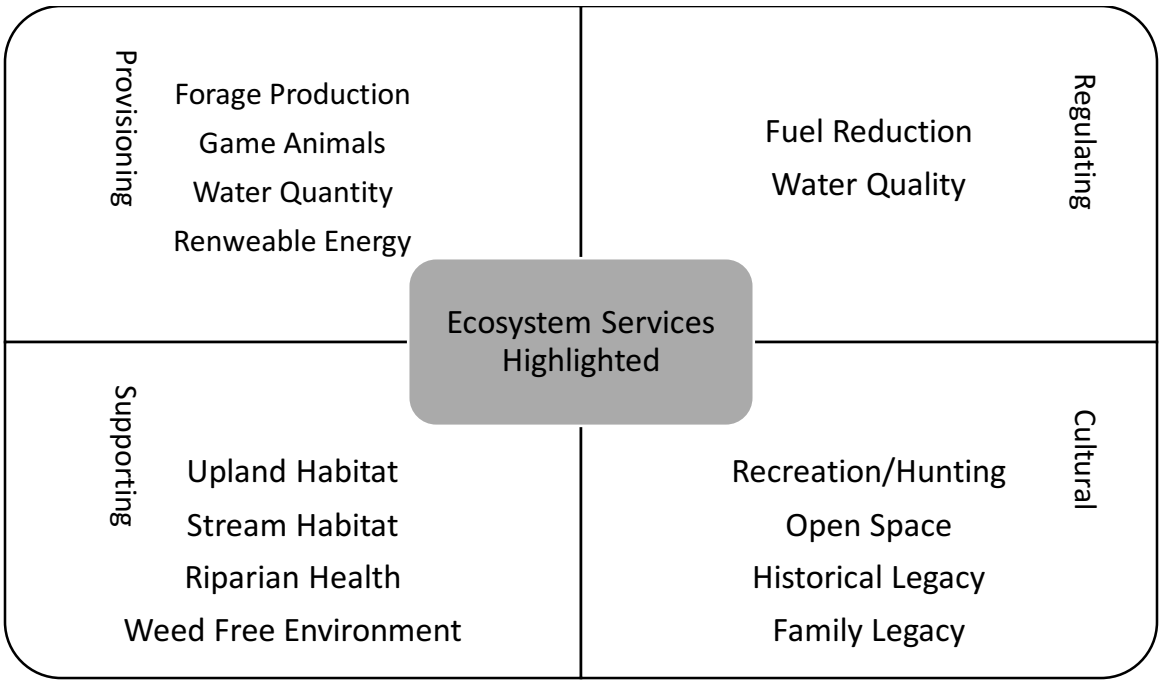

Figure 2. Ecosystem services mentioned during rancher interviews.

ecosystem functioning, and habitat, respectively. Cultural services, which are nonmaterial benefits produced by a landscape, were highlighted extensively in this study.

As stated, previous research found that provisioning services were viewed as much more important than other resources benefiting human well-being. Interviewees emphasized forage and livestock production in their overarching management goals for their operation, but also mentioned a full breadth of services.

> *"If you don't do the noxious weed control, if you don't do wildlife management, you think it would be any fun to most of us to not have wild critters on our land? I mean it's the highlight of everybody's life when the ridiculous moose tears your fence down and takes its baby down to get a drink. We might be ranchers but we love them too! Goll!"*

> *"Do I manage for things other than livestock? Oh yeah definitely. All of our water projects have bird ladders in them so we're definitely managing for the birds. On our private land in Utah, the farm we have down there, we actually work with fish and game*

> *and planted elk forage in our grasses down there because for the elk that's a great winter range and so we're managing for the elk and the deer."*
>
> *"You know what a water gap looks like after 100 cattle come to it every day, day after day? Yeah, terrible. And so you're better off, we feel, that you're better off making time to leave your riparian areas alone to put some upland water resources available to them on your uplands."*

Finally, intangible benefits of rangelands would contribute to ranchers managing for less tangible ecosystem services that fall under the cultural ecosystem services category.

> *"I think keeping open spaces open and being wildlife friendly and not locked up so to speak [is why my land is important]"*
>
> *"I like spending time with my family, but I also like to go spend time alone, just riding my horse out through the mountains. I love the solitude of it, it's very peaceful."*

An interviewee summarized the idea that multiple resources and, thus, multiple categories of services are important for management very well.

> *"Well I think [using my land] as a multiple use facility, that's what is most important to me. You know, so we can't push anything else out and they can't push us out, and it can be run so it works for everybody."*

Quantitative Analysis of Mail-In Survey

The goal of the mail surveys was to test the applicability of themes derived from the qualitative interviews. The interviews had analyzed the opinions of 11 ranchers in southeast Idaho, northeast Utah and southwest Wyoming. The survey was sent to 1,000 ranchers throughout the Great Basin. Interview participants were excluded from this list. These ranchers maintained Bureau of Land Management grazing permits in field offices

in Idaho, Utah, Wyoming, Nevada, California, and Oregon. Of the 1,000 mailings, 12 were sent back by respondents claiming to no longer be livestock producers. Of the remaining 988 potential respondents, 435 ranchers returned the survey that was mailed to them giving a 44.0% response rate. For data analysis, some surveys were unusable as they did not answer questions correctly or information was incomplete. This occurred most often if they had not answered both parts of a two-part question as seen in questions 3 – 21 (Appendix B). These responses were removed to ensure that statistical results were accurate.

The livestock raised by respondents was predominantly cattle (95%), with some who raised sheep (7%). From the demographic questions that were asked of survey respondents, the average age, age range, and gender ratio is displayed in Table 1. When it came to decisions made on the operation, 69.7% of respondents indicated they were not solo decision makers but had others they consulted about operation decisions. Of those that said they did have a fellow decision maker, 85.8% described this fellow decision maker as some kind of family member (father, sibling, wife, cousin, etc.). When asked about the future of their operation, 66.2% were sure that another family member would be taking it over. Also in relation to investment in the operation, 62.6% rely on the ranch for over half their income.

Overall, the population was primarily large family operations with a male head of house but with family input considered. These operations are generally raising cattle and have been in the family for some time and plan to continue to remain in the family. They are also relatively active on the rangeland and rely on their livestock to produce a significant amount of their yearly income.

Table 1
Relevant demographic information to quantitative analysis

AGE		
	Average	63.4 years
	Range	25-98
GENDER		
	Male	87.1%
	Female	12.9%
AGE OF FAMILY OPERATION		
	<1 year	0
	1-10 years	4.9%
	11-25 years	8.6%
	26-50 years	21.5%
	51-100 years	35.5%
	>100 years	29.4%
SIZE OF OPERATION		
	<50 head	7.5%
	50-100 head	15.3%
	101-300 head	26.8%
	301-500 head	20.5%
	>500 head	29.9%
INCOME FROM RANCHING		
	0	7.6%
	<10%	10.9%
	10-49%	18.9%
	50-99%	32.9%
	100%	29.8%
ACTIVITY ON RANGE		
	Average	4.1 days per week

Ecosystem Services Included in Management

A key objective of this research was to determine which ecosystem services ranchers are managing for and if there are certain barriers holding them back from management. In order to answer this question, it was important to understand which services are most highly managed for by ranchers on BLM holdings of the Great Basin and which were most highly valued. I also wanted to understand what operation characteristics contribute to ecosystem service provision as well as information network correlation.

I asked survey respondents if they do or do not manage for 19 different services that had been mentioned during semi-structured interviews. Table 2 shows the entire list of ecosystem services and percentage of respondents that reported managing for each. The three most frequently selected services were provisioning or cultural services: forage for livestock (98.4%), demonstrating good stewardship to the public or other ranchers (95.9%), and maintaining a family legacy for future generations (93.8%). The least frequently managed services were also provisioning services, but ones which tend to benefit a broader segment of society while having less utility to ranchers themselves, typically because they or their families could not benefit monetarily: oil and gas production (11.4%); renewable energy production (21.9%); and income from tourism, recreation experiences and/or hunting leases (22.3%).

The next several most managed for services included: water quality (91.4%), weed-free environment (86.8%), healthy riparian areas (86.1%), and maintaining a historical legacy of ranching for the community (85.9%) are services that are not solely

Table 2
Percentage of respondents claiming to manage for each of 19 services listed on mail survey

Service	Percent Respondents Managing	Type of Ecosystem Service
Forage for livestock	98.4%	Provisioning
Demonstrating good stewardship to public or other ranchers	95.9%	Cultural
Family legacy for future generations	93.8%	Cultural
Water Quality	91.4%	Supporting
Natural environment free of weeds	86.8%	Regulating
Healthy riparian areas	86.1%	Supporting
Maintaining a historical legacy of ranching for the community	85.9%	Cultural
Sustainable flows of water	84.7%	Regulating
Reducing fuels for wildfire prevention	81.4%	Regulating
Solitude and privacy	79.8%	Cultural
Upland habitat for wildlife (game or non-game)	76.9%	Supporting
Open space free from development	76.7%	Cultural
Game animals for hunting by yourself, family or friends	70.7%	Provisioning
Recreation opportunities for family and friends	64.1%	Cultural
Stream habitat for fish	48.2%	Supporting
Plants for pollinating insects	47.3%	Supporting
Income from tourism, recreation experiences and/or hunting leases	22.3%	Cultural
Renewable energy production (wind, geothermal, etc.)	21.9%	Provisioning
Oil and gas production	11.4%	Provisioning

operation-focused. A weed-free environment, healthy riparian areas and water quality have both ranch-level utility and the potential to benefit a much larger stakeholder population as well as ranchers themselves.

Importance Ratings for Ecosystem Services

As well as uncovering the total amount of services managed and which specific services are managed for, I was also curious to know how important certain services are to ranchers in the study area. If ranchers said they managed for a service, the survey then asked them to indicate how important it is to their operation on a 1-to-4 Likert scale with 1 being "not important" and 4 being "very important." This data is shown in Table 3. In comparing Tables 2 and 3, there are differences in the relative rankings of services. Generally, those at the top in Table 2 remain near the top in Table 3, but there are some that vary significantly.

For example, sustainable flows of water are not ranked as highly managed for, but are ranked as highly valued. Alternatively, demonstrating good stewardship to public or other ranchers is managed for highly, but not ranked as highly valued. These discrepancies may have implications into understanding barriers that are present to management for highly valued ecosystem services as well as shed light on perceived obligations for management that could reduce feelings of destiny control.

There is disagreement within the social science research community as to whether Likert-type data should be analyzed as continuous variables or categorical variables (Sullivan and Artino 2013). Due to this, the analysis was undertaken in both ways to ensure any significance found was accurate. As seen in Table 3, the average importance

Table 3
Mean importance rating and type of ecosystem service for each of 19 services listed on mail survey

Service	Average Likert Response	Standard Deviation	Type of Ecosystem Service
Forage for livestock	3.94	0.25	Provisioning
Family legacy for future generations	3.78	0.48	Cultural
Sustainable flows of water	3.74	0.49	Regulating
Water Quality	3.70	0.53	Supporting
Demonstrating good stewardship to public or other ranchers	3.63	0.61	Cultural
Open space free from development	3.56	0.68	Cultural
Reducing fuels for wildfire prevention	3.51	0.65	Regulating
Solitude and privacy	3.51	0.66	Cultural
Healthy riparian areas	3.45	0.67	Supporting
Maintaining a historical legacy of ranching for the community	3.44	0.72	Cultural
Natural environment free of weeds	3.43	0.67	Regulating
Upland habitat for wildlife (game or non-game)	3.22	0.72	Supporting
Stream habitat for fish	3.18	0.75	Supporting
Game animals for hunting by yourself, family or friends	3.10	0.77	Provisioning
Oil and gas production	3.10	0.97	Provisioning
Income from tourism, recreation experiences and/or hunting leases	3.00	0.86	Cultural
Plants for pollinating insects	2.97	0.79	Supporting
Renewable energy production (wind, geothermal, etc.)	2.94	0.78	Provisioning
Recreation opportunities for family and friends	2.90	0.80	Cultural

rankings of ecosystem service categories were relatively similar to each other. When looking at this data as continuous variables, the grand means for services within each category were: provisioning (3.564), regulating (3.609), supporting (3.292) and cultural (3.474). The *provisioning* category contained four resources, *supporting* contained five resources, *regulating* contained three resources and *cultural* contained seven resources.

A one-way analysis of variance (ANOVA) was conducted to compare the means between each of these populations. Although assumptions of equal variance and normality were not met, previous studies have stated that with a large sample size, parametric tests such as an ANOVA can and should be utilized due to their robustness compared to non-parametric tests (Sullivan and Artino 2013). The overall p-value of the analysis was found to be significant ($p < 0.001$, $df = 3$, mean square = 20.28, sum of square = 60.8). The ANOVA rejected the null hypothesis of equal means, thus a Tukey post-hoc test was utilized to determine which populations were significantly different. Regulating ecosystem services and provisioning ecosystem services are the only populations not found to be significantly different from one another. According to population means, supporting services are valued significantly lower than other categories of services.

When looking at this data categorically, a measure of tendency is the median rather than the mean of the population. This shows a similar trend in that "very important (4)" was most often selected for provisioning, regulating, and cultural services. Supporting services were most often selected as "moderately important (3)." A chi-square test was performed in order to determine if the spread of selection would be evenly

distributed in the population. The analysis showed that the collected data is significantly different than expected ($p < 0.001$).

Ecosystem Services Management Based on Information Networks

A characteristic significant to ecosystem service provision was how many sources of information a rancher trusts to receive information on range management. As seen in Figure 3, the survey offered seven options of information sources and respondents could mark as many as they trust. The most frequently selected was other ranchers, with the lowest being NRCS and Natural Resources Conservation District. The data displayed shows the percent of total respondents ($n = 443$) who marked that they trusted an item.

Previous research has shown that individuals with larger information networks are more likely to make management changes and may follow more complex management strategies (Didier and Brunson 2004). Therefore, I explored whether the number of ecosystem services ranchers manage for was associated with the size of their trusted

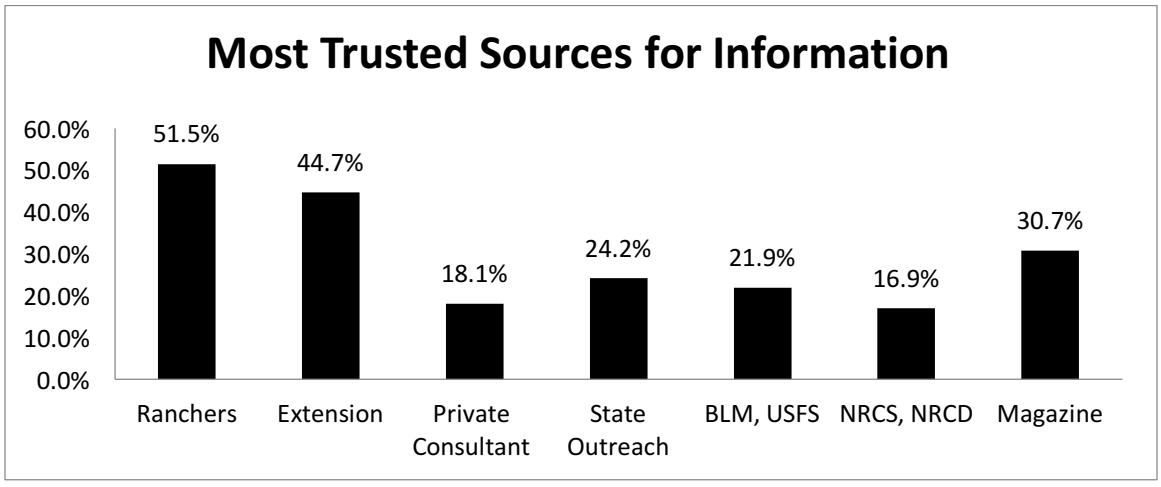

Figure 3. Percent of how many respondents trusted each of 7 sources for rangeland resource management information.

information networks. In order to accomplish this, I subdivided the respondent population into those that trust 0 – 2 sources and those that trust 5 – 7 sources. This assumes that if ranchers trust more than two sources, they are most likely going beyond local information sources such as other ranchers and local conservation agencies to gain a more diverse knowledge base. When comparing how many ecosystem services these two populations manage for, the low network population managed for an average of 12.53 ecosystem services while the high network population managed for an average of 14.12 ecosystem services (Fig. 4).

When comparing which ecosystem services are managed for differently, those with a larger network were more likely to manage for recreation opportunities for family and friends ($p = 0.02$) and stream habitat for fish ($p = 0.002$).

Ecosystem Services of Public Concern

A section of the survey asked about respondents' confidence in their ability to manage their land, both generally and with respect to key ecosystem services that have been of recent focus for federal or state land management agencies. The questions (Appendix B) covered respondents' public land allotments, sage grouse habitat, riparian health, soil health, and carbon sequestration.

First, it is important to understand the management differences between deeded land and leased land. Ranchers may feel constrained by federal regulations or feel they do not have control on public lands. In order to study if this feeling was present, I inquired whether ranchers feel able to manage these parcels the same.

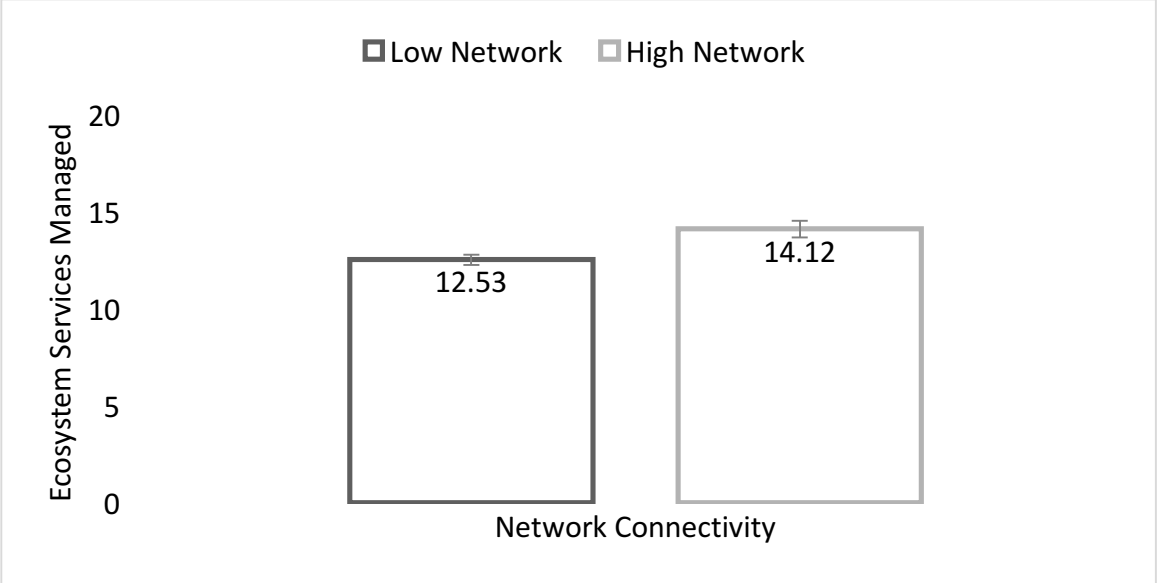

Figure 4. Amount of services managed for by those with low network connectivity and those with high network connectivity.

Results show that 54% of the respondent population manages their deeded land and leased land to the same standard. Similarly, 10% of respondents do not feel constraints on their management but focus more on their deeded land. Finally, 33% do not feel able to manage their leased land to the extent that they manage their deeded land whether they desire to or not. An analysis of differences in ecosystem service management in these populations was insignificant. This means that those who feel able to manage their leased land to the same extent as their deeded land do not manage for more or fewer ecosystem services than those that do not feel able to manage their deeded and leased land the same.

Next, the survey asked about certain ecosystem services of high management priority to land management agencies. First, I asked about sage grouse habitat management. This was a very contentious question with many respondents asserting their

dislike of this question. Several respondents who wrote comments in the margins next to this survey item:

> *"The sage grouse was put on BLM - not native!"*
>
> *"The dishonesty and stupidity of this item shows how feds sway opinions and management."*
>
> *"Sage grouse are very compatible to livestock grazing and the lack of grazing will cause them to disappear completely."*
>
> *"Sage grouse management fits nicely into what we are already trying to do."*

There were strong opinions pertaining to sage grouse, but in terms of habitat provision, 34% stated that they would manage for sage grouse even if the species were not considered at risk; 2% manage for habitat but only so that sage grouse can be hunted; and 30% manage for habitat only so that listing of the species does not impact their operation. This final option once again can reinforce the management motivation theory of phase one of this study. These results show that 30% of ranchers in the Intermountain West manage for sage grouse habitat, a supporting ecosystem service, in order to maintain control of their destiny. Overall, two-thirds of the survey population reported actively providing this supporting service. The final choice for this survey item, that the respondent does not consider sage grouse in their management, was selected by 34% of respondents. It was not clear whether this was because they simply don't think about sage grouse or care to manage them, or if their ranch is outside the range of sage grouse.

Another ecosystem service of interest was soil health, a supporting service. With the rate of erosion in ecosystems degraded by wildfire and invasive grasses in the Great Basin, soil health has increasingly been a focus of management for land management

agencies (Pellant et al. 2004). I wanted to know how practices to improve soil health were incorporated on their operation. As seen in Figure 5, 74% of respondents claim to understand management practices and employ them while 16% know soil health is important but are unsure what to do to manage for it on their operation. Similarly, data collected on riparian health shows people understand practices and use them. As seen in Figure 6, 6% indicated they did not understand how to employ practices on their operation. I was not able to measure whether that number included ranchers who do not have natural water sources on the land they graze. That could be an explanation for the larger than expected amount of people stating riparian health is not important to their operation.

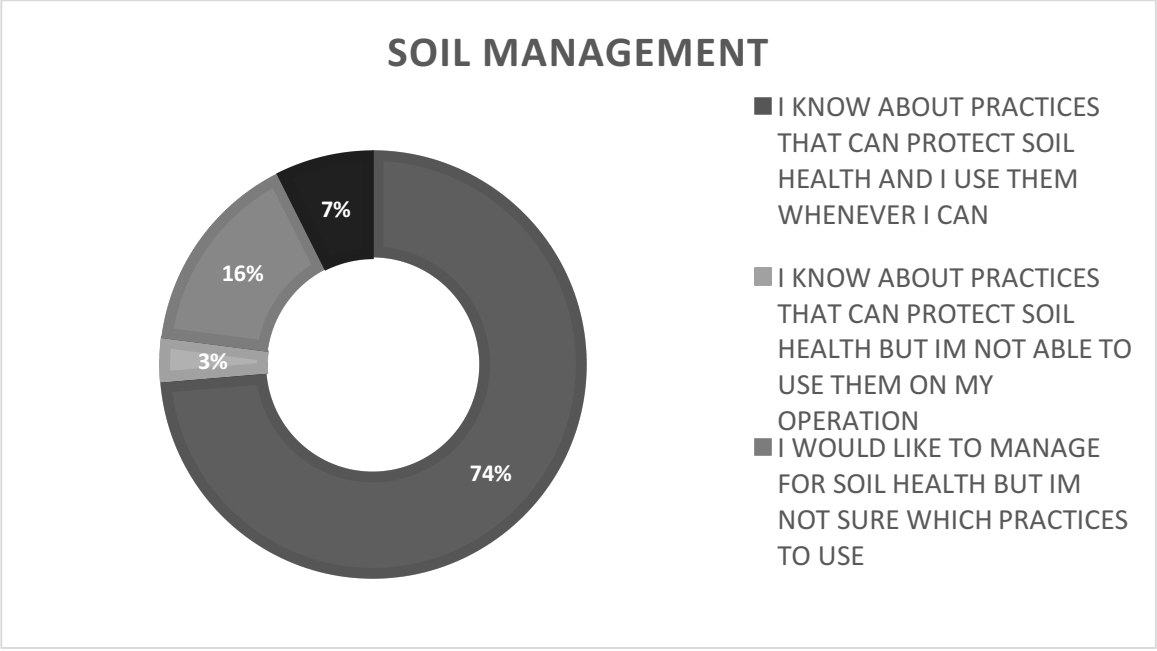

Figure 5. Respondents' response to their knowledge and application of soil health techniques on their operation.

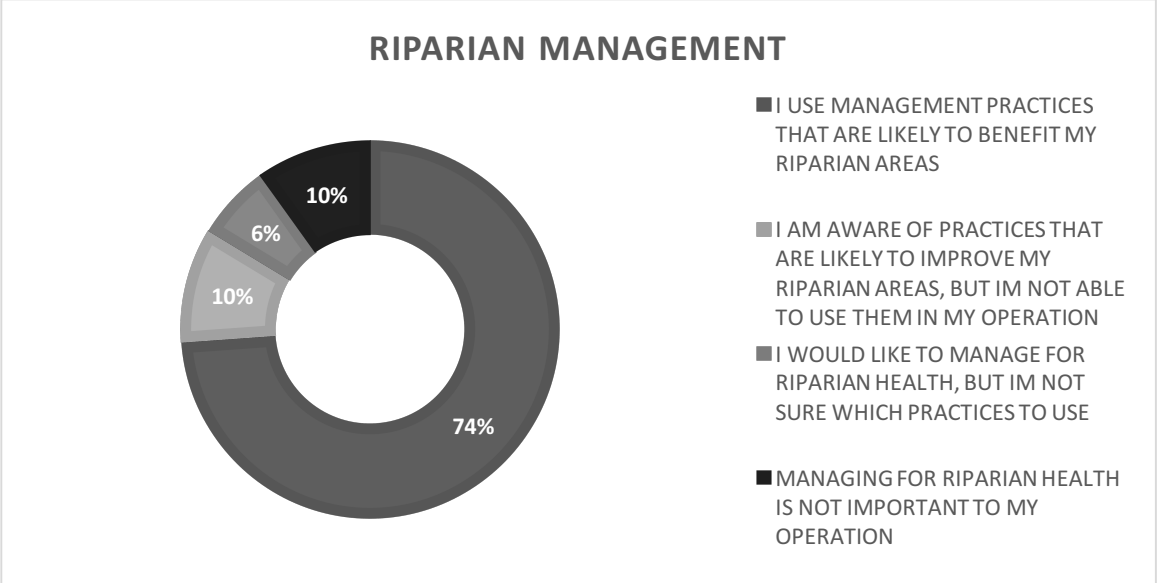

Figure 6. Respondents' response to their knowledge and application of riparian health techniques on their operation.

Finally, I wanted to know how managing to sequester carbon is perceived on rangelands. This important regulating service was rated as significantly less important than the previous three ecosystem services. Almost half of respondents said that managing to sequester carbon is not important to their operation. The second most populous category did not understand which practices to use in order to sequester more carbon (Fig. 7).

The number of respondents for each of soil health (n = 418), management ability (n = 417), sage grouse habitat management (n = 408) and riparian health (n = 417) remained relatively stable. However, the number of responses was lower for the question about carbon sequestration (n = 366). Several ranchers who left this response blank drew a question mark next to or over the question. This question also inspired

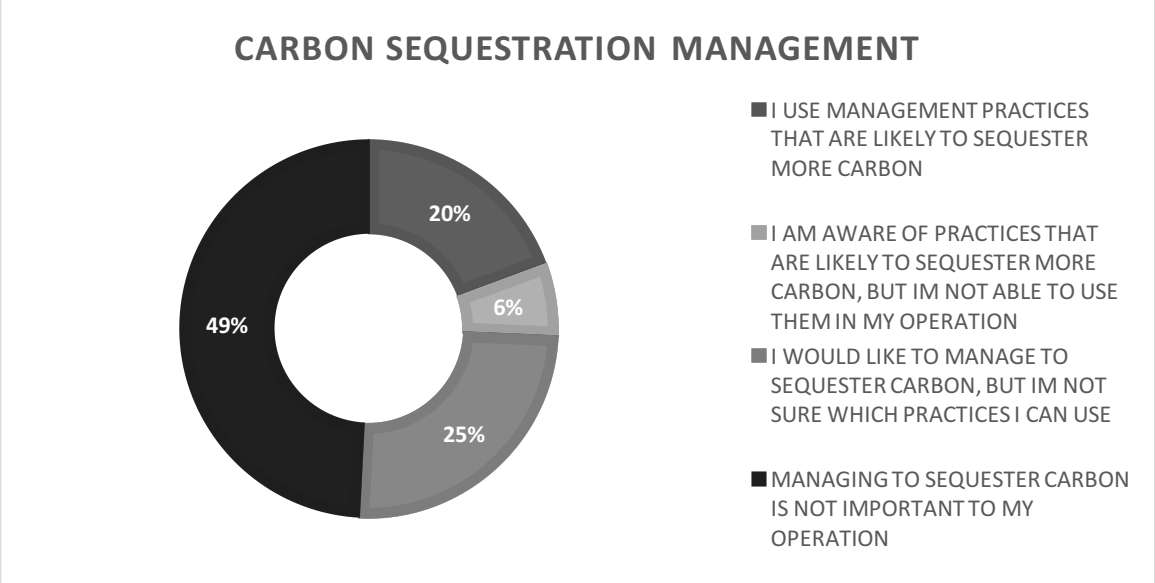

Figure 7. Respondents' response to their knowledge and application of carbon sequestration techniques on their operation.

several comments written in the margins indicating disfavor for the idea of carbon sequestration on rangelands.

> *"We don't manage to sequester carbon per se but proper management of range leads to some carbon sequestration."*
>
> *"I would like to know more."*
>
> *"Sequestering carbon is a corrupt political agenda. I manage to enhance organic matter in my soils."*
>
> *"God's job - he is doing a good job."*

Overall, this suggests that carbon sequestration is less known and less accepted as an ecosystem service provided by rangelands within the Intermountain West.

Ranch Characteristics and Ecosystem Service Provision

The last page of the mail survey included eight questions asking about characteristics of the rancher and the operation (see Appendix B). Because ecosystem service needs and preferences are likely to vary based on individual and socio-cultural contexts (Martín-López et al. 2012; Hicks et al. 2015), I tested for characteristics that could be associated with the number and type of services for which ranchers were managing. Ranch characteristics contributing significantly to provision of ecosystem services were: size of operation, income dependence on operation, how frequently respondents are physically present on their rangeland, and whether or not they manage for reasons related to ensuring autonomy of their operation. Responses to these variables were categorized, and total amount of services managed for was then compared between categories. If a significant difference was ascertained, each individual service was tested to determine which services are being managed for more or less by specified subsets of the population.

Over half of survey respondents depend on their operation for at least half of their income. This is meaningful in that decisions made on the ranch and what to manage for are contributing significantly to their economic livelihood. For this analysis, I subdivided the population into those that 0 – 49% of household income comes from ranching operations and 50 – 100% of household income comes from ranching operations. A standard t-test was used to compare the average amount of ecosystem services managed for between these two populations as seen in Figure 8. There was a statistically significant difference between these two populations in the amount of services managed

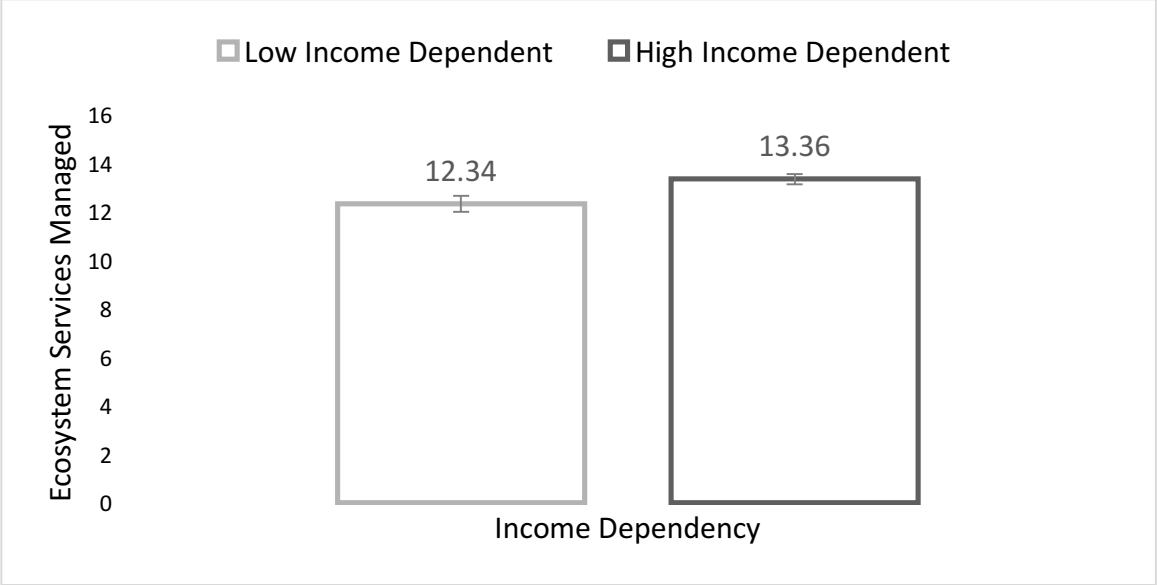

Figure 8. Amount of services managed for by those with low-income dependence and those with high-income dependence.

and what they manage for ($p = 0.012$). The average amount of services managed for if ranching constitutes 50 – 100% of income was 13.3. Those for whom less than half of income is from ranching reported managing on average for 12.3 ecosystem services.

To determine which services constitute this difference, a chi-square test was utilized. The number of people stating that they do or do not manage for each ecosystem service was compared between highly ranch-dependent populations and low-dependency operations. The chi square test determined which services differed significantly from what would be expected to be the proportion of those managing or not managing for a service. Those with greater income dependence were more likely to manage for stream habitat for fish ($p = 0.016$), forage for livestock ($p = 0.059$), reducing fuels for wildfire prevention ($p = 0.038$), healthy riparian areas ($p = 0.033$), game animals for hunting ($p < 0.001$), and sustainable flows of water ($p = 0.030$).

A second statistically significant ranch characteristic was the size of the respondents' operation. For this analysis, the respondent population was split into small, medium and large operations. These populations were defined as small: less than 50 head of cattle, medium: 50 – 300 cattle, and large: over 300 cattle. The term "head" when discussing ranch size generally refers to the mother cow only, but this was not defined on the survey so I made the assumption that this is what was meant in respondent's answers. ANOVA was utilized to compare the average amount of services managed for in each population. Small operations managed for on average 10.2 ecosystem services, medium-sized operations managed for on average 12.7 ecosystem services and large operations managed for on average 13.6 ecosystem services ($F = 13.2$; $df = 2$; $p < 0.001$; Fig. 9). In order to determine significant differences between populations of size classes, Fisher's least significant difference (LSD) and Games-Howell nonparametric post-hoc tests were performed in response to a significant ANOVA result. These were selected, as they do not assume a normal distribution of data. A statistically significant difference ($p < 0.05$) was found between all size classes. A chi-square test was utilized to examine differences in the ecosystem services managed for on ranches in different size classes. Stream habitat for fish ($p < 0.001$), forage for livestock ($p = 0.002$), reducing fuels for wildfire prevention ($p = 0.039$), water quality ($p = 0.002$), maintaining a historical legacy of ranching for the community ($p = 0.005$), sustainable flows of water ($p = 0.002$), and managing for income from tourism, recreation experiences and/or hunting leases ($p = 0.010$) were more likely to be a part of management on larger operations. Alternatively, managing for healthy riparian areas ($p < 0.001$) and upland habitat for wildlife (game or non-game) ($p = 0.011$) was more likely included in smaller operations.

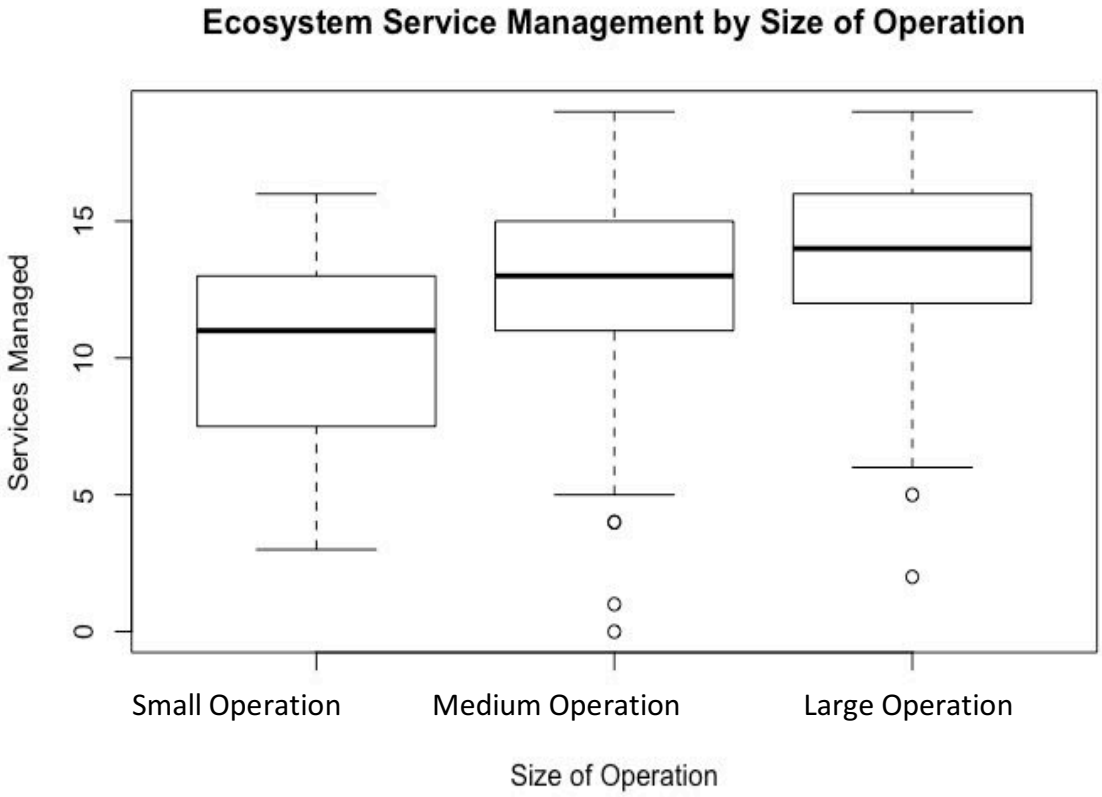

Figure 9. Boxplot displaying the number of services managed for by each of three ranching operation size classes.

A third ranch characteristic that was significantly associated with ecosystem service provision was the amount of time that the respondent spends on their operation. The survey asked how many days per week the respondent spends on the range during active management periods. The average amount of days for the entire population was 4.1 days. The subdivision for this analysis occurred for those considered low activity managers, who only spend from 0 – 2 days on the operation, and high activity managers, those that spend 5 – 7 days on the operation. The average amount of ecosystem services managed for by those exhibiting low activity was 12.1 and high activity was 13.8. A standard two-tailed t-test was run to determine a statistically significant difference

between these two means. Ranchers were more like to manage for more services when more active on their landscape ($p < 0.001$). Chi-square tests revealed that the ecosystem services that ranchers are more likely to manage for if they are more present on their operation are stream habitat for fish ($p = 0.005$), reducing fuels for wildfire prevention ($p < 0.001$), water quality ($p = 0.032$), open space free from development ($p = 0.032$), maintaining a historical legacy of ranching for the community ($p = <0.001$), plants for pollinating insects ($p = 0.01$) and sustainable flows of water ($p = 0.008$).

A fourth and final characteristic that was associated with ecosystem service provision can be linked to the decision-making themes outlined previously. One theme that emerged from the interview phase of this research was that ranchers make management decisions in part to maintain a sense of autonomy. In the Intermountain West, sage grouse conservation is an issue that is often described in terms of autonomy and loss of control; research has found that ranchers are more likely to successfully implement sage grouse conservation efforts if they perceive that it helps them maintain local authority and autonomy (Belton and Jackson-Smith 2010). Therefore, I compared ecosystem service provision between ranchers who would manage for sage grouse even if it were not a rare species, and those that only manage for sage grouse due to the impacts on their operation if it were to become listed (i.e., act to maintain autonomy rather than to provide an ecosystem service). The mean number of services managed for by those who would manage for sage grouse no matter what was 14.1. Comparatively, those that only manage for sage grouse to avoid regulation manage for an average of 13.2 services. Those who would manage for sage grouse no matter what tend to manage for more

services than those that are simply managing for sage grouse because they want to retain control of their own operational decisions ($p = 0.02$; 2-tailed t-test).

Ranchers who manage for sage-grouse as an ecosystem service, rather than to maintain control of their destiny, also were significantly more likely to: manage stream habitat for fish ($p = 0.03$), foster a natural environment free of weeds ($p = 0.03$), manage to maintain water quality ($p = 0.03$), manage to provide open space free from development ($p = 0.007$), maintain upland habitat for wildlife (game or non-game) ($p = 0.02$), and value solitude and privacy ($p = 0.008$).

CHAPTER FIVE

DISCUSSION

This two-phase study collected data on two main questions. The first, informed through interview data, examined reasons why ranchers are choosing to manage for specific ecosystem services. The second, informed through survey data, identified which ecosystem services are managed for and how they are valued, as well as factors that may encourage ecosystem service management in some way. Overall these results suggest that ranchers throughout the Intermountain West who graze their livestock part of the year on public land leases will decide to manage for an ecosystem service if it fulfills one of three major values: production, legacy preservation, or maintaining autonomy and control of their destiny. It was also found that based on these three decision making themes, there are a variety of ecosystem service types that will be included in management. This includes both tangible and intangible benefits produced on the landscape. Finally, several factors such as size of operation, income dependence, and management activity level influence a rancher's capacity to focus on particular ecosystem services.

Role of Production, Legacy and Destiny Control in Decision-Making

The qualitative analysis shed light on what ecosystem services are managed for by ranchers in southeast Idaho, southwest Wyoming and northeast Utah. It also allowed a better understanding why they may be focusing on managing for those services. Overall, it helped develop a hypothesis of why ranchers manage for the ecosystem services that they do.

Understanding why ranchers value and manage for certain resources more than others is the key to ensuring conservation-minded management now and in the future. By uncovering perceived importance of ecosystem services, range professionals can better understand what influences management decisions on the range (Rowan et al. 1994; Rissman and Sayre 2012). Rissman and Sayre (2012) point out that it is critical to understand rancher motivations. They explain that both *contract theory* and *agency theory* emphasize the importance of shared or understood goals in order to create positive stakeholder-land holder relationships. This study identified the value placed by ranchers on ecosystem services from rangelands in the Great Basin, so that educational outreach materials in this region may be effective by hinging on how specific ecosystem services align with their values.

Ranchers are constantly bombarded with ecological and social pressures, and they must make decisions to mitigate or respond to these pressures. Throughout this mixed methods research, it became evident that three dominant decision-making systems exist within the population of study. Decision-making systems of Australian farmers have been explored previously (Farmar-Bowers and Lane 2009), but it was still unknown what types of decision-making systems would arise in the minds of ranchers on public lands in the American West. When a change is presented, the decision to adapt and what adaptation to make will no doubt filter through the production and consumption mindsets. This reinforces previous work in showing that production and legacy preservation are of central focus in families relying on agricultural businesses (Smith and Martin 1972; Farmar- Bowers and Lane 2009; Kirner 2015). My study found these more specifically to be the ability to produce forage for livestock and the ability to maintain a family legacy,

as well as to demonstrate positive stewardship to the ranching community and a broader portion of society (Table 2). These are both extremely important aspects of ranching operations and operate within a feedback loop. If ranchers ensure the success of one, they are undoubtedly ensuring the success of the other. Due to this, they believe that forage production and, in turn, livestock production, must inform most ecosystem service management decisions that arise. Although diversified ranches may be able to sustain a living from other production outputs on their landscape, livestock would continue to be a central focus of management. Livestock production is central to both economy and lifestyle of an operation and ranchers will maintain livestock in order to maintain way of life. This means that whether or not livestock are economically depended on, they tend to be of central value and focus for management decisions. For example, as mentioned by one interviewee, thinking about management actions or innovations to promote consistent forage production on a ranch creates a future in which one's legacy and operation can continue. Also, if one is creating a culture around an operation of pride and stewardship, it will influence management for sustainable forage and encourage creation of productive and healthy landscapes. Similarly, previous work has shown that nonindustrial private forest landowners understand this connection to the broader public (Rickenbach et al. 1998). Producers will see a future for the operation and this, by association, will encourage more informed, ecologically sound decisions (Didier and Brunson 2004). The third decision-making system found in this study, autonomy, also plays a role in management decisions of ranchers in the Intermountain West. By making decisions which benefit the landscape and certain species that are threatened, they believe they can stave off regulations. This autonomy is a hallmark of western rancher identity (Peterson

and Horton 1995). Ranchers have had to depend on local ecological knowledge and individual know-how to survive in the West. Because of this, an autonomous ideology has sprouted in this community. One could infer that because 33% of our respondent population does not feel able to manage their public land allotments in the same way as their deeded land, that rancher autonomy is being challenged. Given how dependent they are on their operations for both emotional and fiscal health, ranchers strongly want to remain in control of decision making for their operation. For this reason, ranchers will choose to manage for ecosystem services which keep regulations on their operation at bay and allow them to remain in control of their ranch.

In order to address this autonomy, programs have been created to encourage sustainable management while also allowing ranchers to stave off further governmental regulation. One such type of program is Safe Harbor Agreements. This U.S. Fish and Wildlife Service program allows private landowners to enroll by agreeing to baseline ecosystem conditions. By managing their lands to maintain this baseline, they are assured no further government control will befall them (Zhang and Mehmood 2002; Wilcove and Lee 2004; Mehmood and Zhang 2005). These programs were created for private landowners in order to manage for, while also mitigating the effects of, endangered or threatened species on their land. Ranchers throughout the Great Basin have both private holdings of land as well as dependence on federal permits. My findings show that agreements similar to this may also find success in this region of the country for other ecosystem services on public lands. These types of agreement have already aided in recovery of red cockaded woodpecker habitat (Zhang and Mehmood 2002) and restoring ponds of the California red-legged frog (Symonds 2008) on private lands. If ranchers in

the Great Basin could enroll in a similar program to manage for key ecosystem services at a certain baseline, they could be incentivized by the assurance of maintaining autonomy. A Safe Harbor type program may be more difficult to implement on public lands than private lands as ranchers would not receive any direct benefits. Although, because maintaining control of their own destiny is extremely important to ranchers in this area, an incentive of management flexibility on public lands holdings may be enough of a motivating factor to encourage enrollment. A promise of management flexibility if locally relevant ecosystem services are managed for could be a way of implementing this framework on public lands. Another example of this occurring on public lands are conservation easements. This type of land use agreement requires landowners to give up development rights in order to protect certain landscape relevant ecosystem services while also allowing them to remain autonomous in management on their property. Conservation easements and why landowners choose to partake in them has been studied in the eastern United States (Brain et al. 2014), but it would be advantageous to understand why and if ranchers on public lands in the west would choose to enroll in this type of agreement.

Motivations for decision-making provide deep insight into factors of importance for management of rangelands. It is important to know which resources are managed for, but knowing *why* those are chosen is the key piece in understanding how future management will unfold. Adaptive management requires ranchers to make decisions in response to a changing social and environmental climate. For this reason, varying resources may be selected for management, but the reasons behind those selected will most likely remain constant. Due to this, land management agencies charged with

conservation of landscape resources can frame management education to create appealing plans that incentivize management for rancher's goals. A similar approach has been used to develop outreach materials for nonindustrial private forest landowners. University Extension services have identified that landowners in this ecosystem are a diverse group of people and thus outreach materials must be tailored to their management objectives (Kuipers et al. 2013). It stands to reason that ranchers are just as diverse of a population and there are definitive regional differences. This has been shown in previous educational outreach work when study populations of landowners have been subdivided into how they utilize and interact with the landscape (Salmon et al. 2006). If outreach agencies such as Utah's Grazing Improvement Program and other local entities such as NRCS offices understand that ranchers need to fulfill production goals, legacy preservation goals, and destiny control goals in the Great Basin, this can be a facet taken into account when developing multi resource management plans that can be communicated effectively in this area.

For example, broader segments of society may have goals of recreation, biodiversity preservation, and water quality. Although these may be on a rancher's mind, they are not what ultimately cause a rancher to decide to manage for a resource unless they are provided with incentives or cause land use restrictions. When agency personnel frame a management idea for a threatened species in terms of how beneficial this plan will be for biodiversity, this may go in one ear and out the other of a rancher in the Great Basin. However, if the management idea is framed in terms of the benefit to forage production or possibility of regulation imposed if the threatened species is not managed for, this may be more successfully adopted. By giving more information, agencies may be

able to sway rancher opinion as shown in terms of carbon sequestration management in Utah (Ma and Coppock 2012). Also, due to the desire of ranchers to maintain viability of their operations, financial incentives may also be utilized. In terms of carbon sequestration, success is achieved through incentivizing landowners with financial gain when they convert pieces of their land into forests and productive grasslands. This has taken place in China and Costa Rica to mitigate deforestation (DeFries and Nagendra 2017). Incentivizing management in this way on Great Basin rangelands could encourage conservation of some ecosystem processes. However, when it comes to carbon sequestration in particular, simply educating on environmental benefits may be most beneficial (Cook and Ma 2014).

To further expand on this point, destiny control can be a strong motivator for broad ecosystem service management. There can be both a positive and negative spin related to this. One side is where the government decides that if certain management actions are not adopted they will take away current grazing rights. On the other side, there could also be incentives for adoption uptake. If ranchers employ management strategies incorporating multiple resources, they may be able to create strategies that work for them rather than rigid plans managing for resources in a specific way. It is unclear which would be more influential, but both are an option based on the importance of maintaining autonomy on ranching operations within in the Intermountain West.

Through this research, I found key facets of rancher well-being: forage production, legacy preservation, and destiny control. If a threatened species requires sustainable forage stands, rather than framing this as great for biodiversity, it would be more appealing to the rancher framed as: management will increase forage. Also, one

may employ the fact that by making these management changes, they will be able to stave off regulations. By framing preferable management actions in ways that highlight the benefits to the rancher, enacting the preferable management is incentivized.

One final consideration is that production and legacy preservation can be incorporated into management plans by maintaining open space and forage supplies, but with destiny control this may not be the case. The destiny control theme suggests that ranchers make certain decisions in order to maintain autonomy and keep regulations away from their land. As evidenced in previous work (Roche et al. 2015), the most highly used word when describing threats to the future of ranching operations was "regulations." They are trying to stay ahead of the land management agencies by managing for certain services. Another way to accomplish this could be devising a way for them to continually and fully be in charge of their operation, such as implementing Safe Harbor type agreements in this area. For example, in managing for stream habitat, there could be an incentive scheme devised to encourage management. If a rancher attended a course on creating fish habitat and devised a management plan that works for their operation to achieve agency goals they would maintain autonomy. If they are then adhering to agency standards, they can continue management in this way. If a rancher does not attend a class or their plan is not achieving agency standards for fish habitat then they would be required to adopt agency management goals, which may not align with their operation. To accomplish this, open communication between agencies and ranchers is desirable. In so doing, many arguments that make the idea of destiny control contentious could be eliminated. Stakeholder groups are gaining popularity especially in certain areas of Utah. For example, the listing of Greater Sage Grouse encouraged communication between

multiple stakeholder groups in order to stave off the listing of the species (Messmer et al. 2015). There were over 40 working groups devising ways to effectively manage for the species to reach federal agency habitat and species goals (Stiver et al. 2006). The outcome of this work was that Greater Sage Grouse was not listed and allowed ranchers in the Intermountain West to continue with management practices they had helped develop (Messmer et al. 2015). With these now established working groups, this type of win-win situation is already being expanded to address other ecosystem services on rangelands.

In conclusion, the qualitative aspect of this study makes a significant contribution to understanding the factors influencing why ranchers grazing livestock on public lands in the Intermountain West may manage for certain ecosystem services but not others. It is widely known across ecosystems and land management regimes that production and family are a pivotal piece in family agricultural businesses (Farmar- Bowers and Lane 2009; Kirner 2015). The Intermountain West is a unique social ecological system in that there are many stakeholders that must be considered, including those who have a deep kinship to the land from ranching in the ecosystem for generations. Diverse management for ecosystem services is critical as ranchers as well as a broader public have equal access to and rights to resources produced on the landscape. Characterizing this aspect of rangeland social-ecological systems and why decisions are made within it constitutes a significant contribution to the field, as it may be applied to other regions with diverse stakeholder input. Also, by combining this study with others similar to it studying other stakeholder groups, a comprehensive theory of ecosystem service provision desires could

be created. Both the social ecological systems field and the rangelands management field can benefit from the creation of this thesis information.

Ecosystem Service Provision by BLM Livestock Grazing Permittees

Ecosystem services produced on rangelands of the Great Basin are greatly influenced by rancher goals, values, and characteristics. Throughout this region of the western United States, much of the responsibility for maintaining ecosystem services lies with ranchers seeking to sustain a family business and lifestyle through grazing cattle on both private deeded land and public permitted land. Through this research, I uncovered which resources are managed for most highly and the reasons that influence this reality. This information can be used to better understand how different ranchers manage the landscape differently. In this way, educational materials on multiple resource management plans as well as increased ecosystem service management overall can be employed to offset these disparities and influence greater implementation of management for a full suite of ecosystem services landscape-wide.

The Great Basin is a socially and ecologically unique area of the country. The majority of land in this area is federally owned and thus ranchers must lease land in order to graze their livestock (West 1983). There is a growing population of non-westerners moving to this area creating a cultural divide in the population (Gosnell and Travis 2005). The ecology of the region is unique in that it receives variable rainfall and all water either evaporates, drains into the soil or drains into saline lakes (Havstad et al. 2007). For this reason, results obtained in this study characterize a unique area both socially and

ecologically. This is a key point in that the applied results of this study can be directly applied to the unique population it is striving to assist.

One purpose of the mail survey was to quantify the proportion of respondents who are managing for each ecosystem service identified in the qualitative phase and listed on the survey. Based on interviews, I expected that production services as well as heritage/legacy services would be the most important determinants in ranch operation decision-making. The top three services were: forage for livestock (98.4%), demonstrating good stewardship to public or other ranchers (95.9%), and family legacy for future generations (93.8%). These results corroborate previous work accomplished on rangelands in the western United States. Previously, Kachergis et al. (2013) found that the most important goals for livestock management were forage production and livestock production.

Overall, services most frequently managed for are those that directly benefit the operation. These resources include: forage for livestock, maintaining a family legacy, water quality, etc. This finding reinforces the management motivation hypothesis from phase one of this study: It was found that ranchers manage for ecosystem services in order to increase production and maintain a legacy and family heritage. By most highly managing for forage for livestock, demonstrating stewardship, and maintaining a legacy they are satisfying their most highly valued ideals for being in the ranching profession. This relates to previous work done in western watersheds of Oregon. When asking landowners what motivations are most important to them in making land and water management decisions, maintaining and preserving for future generations was the most common answer (Rosenberg and Margerum 2008). Those that benefit a broader society

are less frequently emphasized in management. Such resources would include: oil and gas production, renewable energy production, stream habitat for fish, etc. This discrepancy can be problematic, as most of the grazing land in this region is publicly owned. If there are differing ideas of what is important to manage, there will be dissent between ranchers and the broader public. Identifying which ecosystem services are most highly managed for can also be helpful to outreach agencies by showing them which ecosystem services need to be a focus of future outreach efforts.

Contributing factors to perceived importance are the sources land managers trust for getting information on rangeland management. This study found that ranchers trust other ranchers more than any other source. Also, those with more sources included in their information network are more likely to manage for more ecosystem services. This is significant in that it shows that the more trust that can be built between ranchers and a broader public, the higher the multifunctionality of a landscape is likely to be as ranchers ensure the provision of a greater amount of ecosystem services. This has also been found in watersheds in western Oregon. Landowners in this area trust a variety of sources but overall most highly trust friends and other landowners in a similar situation (Rosenberg and Margerum 2008). It has also been shown that whether the operation size is large or small, ranchers trust friends. This is significant in that the future of rangelands is most likely subdividing and small-tract rangelands owners. The fact that ranchers most highly trust other ranchers is not likely to change with this transition (Brunson and Price 2009).

A basis for this finding can be found in the theory of social embeddedness first proposed by Karl Polanyi (Polanyi and McIver 1957) and then expanded by Granovetter (1985). In a summary of the theory, Breetz et al. (2005) explain decisions are made

within a "structure of personal relations and networks of interaction." This makes sense for the population of ranchers in the Great Basin, particularly due to the rural nature of their livelihoods. They may only interact socially on a frequent basis with other ranchers. Familiarity has been shown in previous studies on land managers to be a significant factor in trust building in water policy (Lubell 2007). If one is socially embedded in a community, trust is established and an information recipient believes the information provider will not act in self-interest at their expense. The government and other agencies have not embedded themselves in the community and thus are not trusted as information sources. This brings up the necessity of boundary-spanning organizations, or, more specifically, a trusted person in the society previously discussed by Lubell et al. (2013).

In terms of outreach, ranchers were asked about their management practices pertaining to four key ecosystem services, which also benefit a larger society. Sage grouse habitat management, soil health, riparian health and carbon sequestration have each been a focus of range management and public concern to varying degrees. The instrumental benefits to ranchers of riparian health and soil health may be easier to communicate effectively, although they also benefit society to an extent. Carbon sequestration and sage grouse habitat are less directly beneficial to an operation. This may be a possible explanation as to why these are less managed and less accepted for management. If a change in management requires inputs from the operation, it is unlikely that it will be implemented if there are no obvious beneficial outputs (Kreuter et al. 2004; Olenick et al. 2005; Cook and Ma 2014). Outreach materials may need to focus on the direct impacts that management for these two services may have on a ranching operation, rather than their benefit to either society or the health of the ecosystem. Finally, carbon

sequestration has become a larger focus in the last few years but land management agencies may have not made this as much of a focus as riparian health and soil health. New outreach materials may be necessary for higher rancher buy-in.

Outreach efforts that increase management of these key ecosystem services on rangelands can be instrumental in establishing and maintaining ecosystem health. A functioning ecosystem has a suite of fully functioning ecosystem services present (Balvanera et al. 2006). When we characterize the social-ecological system in this region, future efforts can be more focused on ecosystem services that are lacking. Also, if there is disconnect between the effective provisions of resources although they are managed for, it may be required to alter how information is presented of disseminated.

It was interesting to note the apparent disconnect between which services are most frequently managed for and which services are most highly valued. This may be due to a variety of reasons. Ecosystem services that were highly valued, but not highly managed for, were sustainable flows of water, open space, oil and gas production, stream habitat for fish, solitude and privacy, and reducing fuels for wildfire prevention. One reason for this may be that ranchers feel they do not know how to manage for some of these ecosystem services effectively. For example, in a 2014 study of Utah landowners, 63% had no knowledge of carbon sequestration (Cook and Ma 2014). In this case, outreach materials can focus on what carbon sequestration is and how to manage for these services and their ecosystem importance. Although incentive programs may be beneficial, if ranchers are unsure how to manage for a resource, it may not be effective. The Chicago Climate Exchange was an unsuccessful carbon sequestration plan for rangelands in that the incentives were not high enough to retain ranchers. If ranchers already place a high

value on these services, it is likely they would be willing to include techniques for management of these resources in their management plans no matter the incentive. Similarly, a Texas study of willingness to manage for an endangered species found that if landowners agree with land management objectives they were more likely to enroll in a management program (Sorice and Conner 2010). A second reason for high value but low management may be that they feel that provision of these services is largely out of their control (or that it actually is out of their control). In this case, it would be beneficial to think about whether this is truly the reality, or if the issue is lack of education or knowledge about the subject or the influence that ranchers truly have the ability to wield. For example, geologic conditions or policy implementation may put resource management out of an individual rancher's control while more abstract ecosystem services such as open space and solitude and privacy may be considered outside simple management practices but in reality can be a part of landscape management. In both cases, communicating effectively how management practices for other ecosystem services may elicit highly valued benefits could begin conversations on how to implement innovations to their ranching practice.

Ecosystem services that were highly managed for, but not highly valued were: demonstrating good stewardship to public or other ranchers, natural environments free of weeds, healthy riparian areas, maintaining a historical legacy of ranching for the community, and recreation opportunities for family and friends. A reason for this mismatch in management and value may be that some ranchers do not understand how these ecosystem services benefit their operations. None of these services carries obvious

economic benefit, and may be undervalued for this reason. Outreach materials may need to highlight how these ecosystem services would benefit their economic livelihood.

There were also many other factors leading to a significant decrease in ecosystem service management between populations of ranchers. The linkage between rancher characteristics and ecosystem service provision could be a useful tool in designing management plans which address these varying segments of society. The characteristics I found to be significant were income dependence, size, management ideology, and activity level. Ranchers who depend on the operation for a significant portion of their income, run more livestock, manage for services because they see the good in that service, and are present on the operation as a full time job are more likely to manage for a suite of ecosystem services. This addresses the research question about barriers in management.

As mentioned previously, the Millennium Ecosystem Assessment identified four categories of ecosystem services, which benefit society differently (provisioning, regulating, supporting and cultural). Previous rancher surveys had found that provisioning services were managed for most highly (Kachergis et al. 2013; Roche et al. 2015). As seen in Table 2, the services managed for by ranchers in the Great Basin show no discernible pattern of preference for one category of service over others. A possible explanation for this difference in types of services mentioned between this study and previous work could be methodological. Previous work utilized solely mail-in surveys. This type of interaction may be insufficient to fully understand rancher management. Through interviews it was much clearer that there is a cultural services aspect to rangeland management. This insight could be because there is a trust established through face-to-face interviews that is not established through mail-in surveys (Charmaz 2014).

The breadth of services that emerged throughout the interviews was surprising, as previous research had not highlighted as many services. For example, Kachergis et al. (2013) identified 10 services while Roche et al. (2015) identified 9 services. This could have been achieved through probes encouraging the ranchers to divulge more resources that they consider in management during interviews than perhaps there was space on surveys in previous studies. In this way, a mixed method approach may be highly beneficial to research on landowner perceptions (Sayre 2004).

The population of ranchers in the West is changing. Large ranches are increasingly being sold off and subdivided to create smaller ranches for absentee owners (Gosnell and Travis 2005). If ranches are becoming smaller and ranchers are less active on the range, then it is possible that fewer services will be managed for in the future. This is significant in that ecosystems require a suite of functional services in order to remain healthy (Cardinale et al. 2012). The importance of an operation's capacity to manage for certain ecosystem service goals is a key finding of this research. The average number of ecosystem services managed for between populations was statistically significant if there was a difference of one ecosystem service. As well as being statistically significant, this may also be practically significant depending on which ecosystem service is less managed. The specific service left out of management may be a key resource desired by the public or a key resource contributing to ecosystem health and functionality. Management barriers were illustrated by the operational and personal characteristics that contribute to managing fewer ecosystem services. Support from this is shown from the analysis of how size of operation influences the services ranchers manage for. Stream habitat for fish and water quality were two of the seven resources managed for more

frequently in larger herd operations. This may be due to the ability of ranchers to more effectively manage these landscape-scale resources. Riparian health and upland habitat were more likely to be managed for on smaller operations. These two resources may benefit from smaller, more specific changes on a landscape and thus be more manageable to accomplish on a smaller scale. It has been shown previously that operation size is associated with higher implementation of a variety of management practices encouraging higher ecosystem service provision in Utah (Coppock and Birkenfeld 1999). My research demonstrates that this finding can be expanded to ranchers throughout the Great Basin. Alternatively, it is possible that some factors, such as being amenity-focused or being a new owner from a different area with different connections may bring different foci to management. In this instance, management may be pushed in the direction of a fuller suite of ecosystem service provision.

For this reason, there needs to be increased awareness of what ranchers believe are important on the landscape. By satisfying their values and needs, they are more likely to remain on the range and remain in control of providing a suite of ecosystem services for human benefit. This study also found that ranchers who are less highly networked to sources of information manage for fewer services. This potentially means that those trusting only ranchers and other local entities are not receiving information on ecosystem service importance and management techniques.

By incorporating all of this information, I can conclude that as populations of ranchers change across the Intermountain West, resource provision will alter. Also, understanding which ecosystem services are currently managed for, as well as which are highly valued, can illuminate which ecosystem services need to be of higher focus in

future outreach materials. By looking at resources produced and managed for on Intermountain West rangelands and how they relate to people, range professionals are better equipped to help maintain the resilience of both ranchers as well as the ecosystem. Finally, by understanding and listening to the population that academics and field educators hope to work and communicate with, there will likely be more success in building trust and partnerships encouraging multi resource management plans for the benefit of all public lands stakeholders.

In conclusion, ranchers managed for ecosystem services spanning all four ecosystem service categories –provisioning, regulating, supporting and cultural. Particularly, previous studies had found that provisioning services were of highest management focus (Kachergis et al. 2013; Roche et al. 2015). This thesis shares evidence that ranchers grazing on public lands manage for a variety of ecosystem services providing a variety of benefits to humans both tangible and intangible.

CHAPTER SIX

CONCLUSION AND IMPLICATIONS

The analysis of the ecosystem services provided on landscapes by direct rancher management and the reasoning behind these management choices revealed that there are a significant number of ecosystem services managed for as well as a diverse suite of well-being provided for by management. It also revealed that ranchers, specifically in the Intermountain West, where public lands are required for sufficient space for grazing, manage for services in order to satisfy three goals. It was consistently found that ecosystem services addressing production as well as lifestyle were highly important. In relation to lifestyle, on top of managing to maintain familial legacy, ranchers perceive that it is critical to maintain control of the land they graze their livestock upon. By utilizing a two-phase approach, I was able to characterize a large population of ranchers not only in the tri state area of Utah, Idaho and Wyoming, but also a broad population of ranchers in the Intermountain West who depend on public lands for grazing permits.

Previous research has sought to understand ecosystem service provision of rangelands (Kachergis et.al. 2013; Roche et.al. 2015). This thesis advances the field as it demonstrates that ranchers are not a one-size-fits-all population when it comes to ecosystem services provision, and that the characteristics of their operations can strongly affect how many and which services are managed. This study focused specifically on ranchers who depend on public lands for a significant portion of their grazing operation. In comparison to past studies (Kachergis et al. 2013; Roche et al. 2015), this population appears to manage for ecosystem services that align to a broader segment of society's

goals for a landscape, as there are varying stakeholder groups vying for specific provision on publically owned land. Many results from this study may be applicable to a diverse range of ranchers, but those results obtained specific to sagebrush-dominated ecosystems that comprise publically owned landscapes are an essential and necessary research advance.

In addition, this research advances the field of ecosystem services research. This type of framework has become a popular way to best understand the varying interests of diverse stakeholder groups when it comes to resources produced on a landscape. Rangelands in the Intermountain West have an extremely broad network of stakeholders from ranchers to extraction companies to the general public who utilize this landscape for recreational pursuits. By characterizing how ranchers in this area perceive services produced, this social-ecological system can be further studied within this framework. Also, it reinforces there are resources that are managed for which contribute to a variety of human benefits. The four categories of ecosystem services proposed in the Millennium Ecosystem Assessment are definitively managed for on rangelands and are of definitive value on rangelands.

This research stands to be useful in several contexts for rangeland management in the Intermountain West. Understanding how ranchers' motivations and values may play into decisions about ecosystem services can aid in developing an understanding between ranchers and the public. The results of this thesis can aid outreach agencies in their focus and framing of management options and the possible objectives achieved within those options. Public lands ranchers in the Intermountain West engage in management activities in order to achieve three main goals: livestock production, familial

legacy/heritage preservation, and destiny control. These motivations can be used in order to make outreach and educational materials more focused for the ranching community they hope to interact with. If there are certain resources of high focus, educational materials can be developed which highlight how that specific resource will satisfy one of the three main goals of ranchers. Also, by understanding which resources ranchers recognize and manage for on a landscape, educational materials can be focused on those services that they do not recognize or manage for as of yet. In this study, I found that ranchers were slightly more likely to value the provisioning and regulating ecosystem services included in our survey than the supporting and cultural services included. In particular, they overall valued services directly related to the productivity and viability of their operation no matter the ecosystem service category. Educational materials aimed at increasing ecosystem service provision should place greater emphasis on both how supporting services and cultural services can be managed for, as well as why they may satisfy the ideals of the ranchers. Also, in general, those ecosystem services desired by the broader public but less obviously beneficial to ranchers need to be of focus and how they benefit the ecology of the landscape that ranchers depend on for their livelihood. When something is ecologically beneficial it is more likely to be taken into management (Cook and Ma 2014).

Future research should expand understanding of why ranchers manage for certain ecosystem services and not others. This thesis found that ranchers had specific goals as to why they manage for things, but it is also necessary to understand the barriers that exist in their management. Ranchers may desire to manage for something, but not be able to do so for some reason. More specific information on this aspect could be collected in the

future. If it were understood what specific barriers are present, it would be easier to identify and work to remove those barriers in order to increase ecosystem service provision landscape-wide. Related to this, it would also be beneficial to understand what trade-offs ranchers have to consider when managing for certain ecosystem services and not others. The factors driving those tradeoffs and what results from the tradeoffs chosen could be a valuable addition to this information. Another valuable future study would be to see if these results are applicable to geographically different populations who also depend on public land for their livelihood. I also found that there are certain ranchers who manage for broadly beneficial ecosystem services no matter what, as well as ranchers who simply manage for broadly beneficial ecosystem services solely to remain autonomous in their operation. Understanding what determines this split in population would be highly educational in working with the two different groups. Finally, if education and outreach materials are created that focus on the benefits of certain ecosystem services based on this study, it would be necessary to determine if those materials are successful in increasing management for suites of ecosystem services landscape-wide.

The social ecological system maintained by the Intermountain West rangeland ecosystem is in a constant state of change. Diverse stakeholders are visiting, as well as moving to, the area. Changing climatic conditions and invasive species also affect and alter the state of the ecosystem. This constant barrage of change means that this system will require constant monitoring including constant communication in order to address responses required to maintain the resilience of society and the environment. This thesis is a snapshot of time in this region and will hopefully spark further and continuous

research to understand this critical landscape and create resilience for both ranchers in the region as well as the broad American public that feels a deep connection to this area of our country.

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APPENDICES

APPENDIX A

INTERVIEW GUIDE FOR SEMI-STRUCTURED RANCHER INTERVIEWS

Ranch Background

First, I have a few general questions to ask:

- Tell me a little about your ranch…
- Are you a first-generation rancher, or has it been in your family for more than one generation?
- Are you the primary operator of this ranch? Who else is involved in decision-making?
- Is your operation entirely on land you own or manage, or do you also lease land from the state or federal government or another private landowner?
- What kind of livestock do you raise here? Cow-calf? Stockers? Purebred? Sheep? Horses? Other animals.

Ranch Management

Next I'd like to know a little more about how you manage your ranch:

- How flexible is your grazing management? Do you have a standard approach you use each year, or do you vary your management from year to year?
- Have you made a major change in your grazing management in the past few years? If so, what was it and why did you choose to make this change? What have been the benefits and drawbacks of this change?

Ecosystem Services

The focus of this interview is on the landscape you manage and how you value different aspects of it and other things it can produce besides livestock: why you manage for certain things, if there are things you would like to manage for but don't feel able to, what aspects of your land trigger your management decisions

- What aspects of your land are most important to you? Why?
    - What are you passionate about in ranching? Why are you a rancher?
    - How do you manage for these things?
    - Do you feel able to manage for these?
    - Do you feel able to manage for both livestock and these other things?
    - How do you make the decision when managing for livestock interferes with these other things you mentioned?
- What information would you need to be able to manage for both?
    - What source would you trust to get this information on managing for these other things?

Finally, do you have any questions for me?

APPENDIX B:

MAIL-IN SURVEY FOR INTERMOUNTAIN WEST PUBLIC LAND PERMITTEE RANCHERS

Thank you for taking the time to complete this survey. In the first few questions of this survey, we'd like to know a little about your livestock operation.

1. **What do you produce in your operation? Please check all that apply.**

   ___ Cattle and calves

   ___ Sheep and lambs

   ___ Goats

   ___ Bison

   ___Other (Please explain _____)

2. **In addition to your deeded land and BLM lease, do you also graze livestock on the following (please check all that apply)?**

   ____ Leased private land ____Leased state land

   ____ Other federal land (Forest Service, national wildlife refuge, etc.)

In the next few questions, we'd like to know a bit about your general approach to grazing management. For each of the following management objectives, please circle "Yes" if you manage for it and "No" if you do not. Then, for any of the objectives that you manage for, please circle the number that best describes how important it is to you in your operation.

		Not Important	Slightly important	Moderately important	Very important
3. Forage for livestock					
YES	**NO**	**1**	**2**	**3**	**4**
4. Recreation opportunities for family and friends					
YES	**NO**	**1**	**2**	**3**	**4**
5. Stream habitat for fish					
YES	**NO**	**1**	**2**	**3**	**4**
6. Reducing fuels for wildfire prevention					
YES	**NO**	**1**	**2**	**3**	**4**
7. Healthy riparian areas					
YES	**NO**	**1**	**2**	**3**	**4**

8. Demonstrating good stewardship to public or other ranchers

YES NO **1** **2** **3** **4**

9. Oil and gas production

YES NO **1** **2** **3** **4**

	Not Important	**Slightly important**	**Moderately important**	**Very important**

10. Natural environments free of weeds

YES NO **1** **2** **3** **4**

11. Water quality

YES NO **1** **2** **3** **4**

12. Open space free from development

YES NO **1** **2** **3** **4**

13. Game animals for hunting by yourself, family, or friends

YES NO **1** **2** **3** **4**

14. Family legacy for future generations

YES NO **1** **2** **3** **4**

15. Upland habitat for wildlife (game or non-game)

YES NO 1 2 3 4

16. Renewable energy production (wind, geothermal, etc.)

YES NO 1 2 3 4

17. Maintaining a historical legacy of ranching for the community

YES NO 1 2 3 4

18. Plants for pollinating insects

YES NO 1 2 3 4

19. Sustainable flows of water

YES NO 1 2 3 4

20. Income from tourism, recreation experiences and/or hunting leases

YES NO 1 2 3 4

21. Solitude and privacy

YES NO 1 2 3 4

22. Do you feel you manage your operation differently on any deeded land compared to leased land?

___I manage both to the same standard

___I am able to manage both to the same standard, but focus more on my deeded land

___I would like to manage both, but feel unable to manage on my leased land to the extent I manage my deeded land

___I do not feel able to manage how I would like on my leased land

23. Which of the following statements best describes your feelings about managing to maintain <u>sage-grouse habitat</u>?

___ I manage for sage grouse, and would continue to do so if it weren't a rare species

___ I manage for sage grouse and would do so if it weren't a rare species, but only to provide hunting opportunities for family, friends, or paying guests

___ I manage for sage grouse, but only because I'm concerned about the impacts on my operation if the species were listed as threatened or endangered

___ I do not consider sage grouse in the management of my operation

24. Which of the following statements best describes your feelings about protecting <u>soil health</u> in your operation?

___ I know about practices that can protect soil health and I use them wherever I can.

___ I know about practices that can protect soil health, but I'm not able to use them on my operation

___ I would like to manage for soil health, but I'm not sure which practices I can use

___ Managing for soil health is not important to my operation

25. Which of the following statements best describes your feelings about managing to <u>sequester carbon</u> in your operation?

___ I use management practices that are likely to sequester more carbon

___ I am aware of practices that are likely to sequester more carbon, but I'm not able to use them in my operation

___ I would like to manage to sequester more carbon, but I'm not sure which practices I can use

___ Managing to sequester more carbon is not important to my operation.

26. Which of the following statements best describes your feelings about managing for <u>riparian health</u> in your operation?

___ I use management practices that are likely to benefit my riparian areas

___ I am aware of practices that are likely to improve my riparian areas, but I'm not able to use them in my operation

___ I would like to manage for riparian health, but I'm not sure which practices I can use

___ Managing for riparian health is not important to my operation

For the next two questions, we would like to know how you prefer to receive information on ranch management and in what form.

27. What sources do you most <u>trust</u> in receiving information on range management?

___ Other ranchers ___ Land management agencies (BLM, USFS)

___ University Extension ___ Conservation agencies (NRCS, NRCDs)

___ Private ranching consultants ___ Magazines or similar publications

___State range outreach programs (Utah Grazing Improvement Program, Idaho Rangeland Resource Commission, etc.)

___ Other (Please explain: _____)

28. What kinds of information do you feel is most helpful to receive in managing your ranch?

Finally, we would like to know more about your background. This information will remain strictly confidential. Feel free to answer only those questions with which you feel comfortable.

29. **How old are you?** _____years old.

30. How long has your family been managing your operation?

___ Less than 1 year ___ 26-50 years

___ 1-10 years ___ 51-100 years

___ 11-25 years ___ Over 100 years

31. Are you ___ Male ___ Female

32. How large is your operation?

___ Less than 50 head

___ 50-100 head

___ More than 500 head

___ 101-300 head

___ 301-500 head

33. Is anyone besides yourself involved in day-to-day decision-making for your operation?

___ Yes (Please explain: _____)

___ No

34. If/when you cease ranching, what do you think will most likely happen to your operation?

___ I don't know

___ Another family member will take over

___ I or my family will stay on the operation but lease the land to others

___ The operation will be sold to a rancher outside of the family

___ The operation will be sold for non-agricultural uses

___ Other (Please explain:

_____)

35. What portion of your household income usually comes from your ranching activities?

___ None

___ <10%

___ 10-49%

___ 50-99%

___ 100%

36. **During active management periods of your operation, about how many days per week do you spend on the range?** _____ days