Perceptions of barriers and opportunities for conservation in Central Coast California rangelands by landowners, managers, and range academics.

AUTHOR

Lina Aoyama
M.S. Range Management Candidate
CCRC Scholar
University of California, Berkeley

Draft: May 25, 2018

ABSTRACT

Conservation of biodiversity and ecosystem services on California rangelands hinges on partnerships among ranchers (many of whom are private landowners), agency and NGO managers, and academics. To inform efforts to make these partnerships as productive and mutually beneficial as possible, I used interviews and online surveys to evaluate the differences in conservation perspectives and perception of conservation priorities and barriers among these various rangeland stakeholders in the Central Coast region of California, USA. I found that a "sustainable use" perspective on conservation predominates among ranchers, while the perspective of NGO and agency managers is more preservation-oriented. Conservation priorities among ranchers and managers largely overlap, except that ranchers prioritize livestock production and ranch succession and managers prioritize habitat protection. Ranchers note a variety of barriers to conservation, including lack of public understanding of rangeland values, cumbersome paperwork for implementing conservation practices, and variable precipitation. Land use change is one of the threats to rangelands emphasized by all three groups. All interviewed ranchers who owned land showed interest in voluntary conservation easements, while others expressed concerns about access limitations and the inflexibility of lease contracts. Surveyed academics provided insights on opportunities for rangeland conservation as well as recent developments in scientific knowledge that are often not fully applied in range management.

KEYWORDS

Range; conservation priorities; development; conservation easements; land ethic

I. INTRODUCTION

California's Mediterranean grasslands are among the world's "hotspots" of native species rarity and richness (Noss and Peters 1995; Myers et al. 2000; Stein et al. 2000). Globally, temperate grassland and savanna biomes are endangered, and California's Mediterranean grasslands are recognized as a "critically endangered eco-region" (Hoekstra et al. 2005).

Most of the grasslands in California are managed as grazing lands (Huntsinger and Bartolome 2014). Consistent with this fact, 80% of California's rangelands in the Mediterranean climate zone are privately owned (Huntsinger et al. 2007). On private and public lands, livestock grazing is an important conservation tool. Grazing is used to manipulate plant community structure, decrease fuel loads, control invasive plant species, maintain and create wildlife habitat, and enhance species diversity (Marty 2005;

Pyke and Marty 2005). For these reasons, ranchers—particularly those grazing cattle on their private land—are key partners in efforts to conserve California rangelands and their biodiversity.

However, intense economic and social pressure for private ranchers to sell their land has resulted in the loss of tens of thousands of rangeland acres per year over the past decade in California (CDFFP 2010). Land conversion is of particular concern in the Central Coast region of California, where population is increasing (U.S. Census Bureau 2017). Despite tapping into niche markets such as grass-fed beef, ranching businesses in California typically suffer from low profitability, high management costs, and high opportunity costs associated with competing uses that contribute to conversion of these lands to other uses (Sulak and Huntsinger 2007, Cheatum et al. 2011).

Public acquisition is one way to protect grasslands from conversions, but it is costly and controversial (Merenlender et al. 2004). Keeping existing ranches intact to safeguard biodiversity and social values has been a key conservation strategy for decades (Knight et al. 1994, 2002; Huntsinger and Hopkinson 1996; Rosnan 1997; Resnik et al. 2006; Brunson and Huntsinger 2008; Farley et al. 2017). The passage of the California Land Conservation Act (CLCA; also known as the Williamson Act) in 1965, means that ranchers in some counties can voluntarily participate in a program that allows them to pay property taxes at a rate based on the land's agricultural value as long as they agree to keep their land in agricultural production (CDOC 2010). In recent years, additional efforts have been made by the conservation community to offer incentives to private ranchers to keep "working landscapes" working. For example, ranchers can participate in cost-share programs such as the Environmental Quality Incentive Program (EQIP). A growing phenomenon is establishment of conservation easements, which are voluntary legal agreements between landowners and land trusts or government agencies to permanently limit certain uses on all or a portion of a property for conservation purposes (Huntsinger et al. 2007).

Even putting aside the issue of rangeland conversion, the conservation of California grasslands used for livestock grazing is a complex undertaking. Understanding the effects of grazing on California grassland is complicated by a large climactic gradient, pronounced year-to-year variation in weather, strong variation in topography and land-use history, and regional variation in the species pool (Huntsinger et al. 2007). Range management relies on information from ecosystem sciences as well as the traditional knowledge and personal experience of ranchers (Huntsinger et al. 2007). This means that NGO land and public agency managers (from this point on referred to simply as "managers") must work closely with ranchers, recognize the value of their site-specific knowledge, and integrate that knowledge with the knowledge gained from scientific investigation.

Ranchers and managers come to the rangeland conservation management "table" with widely varying perspectives, values, and priorities. Even if ranchers and managers share the broad goal of conservation, these differences can become barriers to building trust, communicating effectively, and reaching agreement on conservation strategies. It is critically important for all rangeland management stakeholders to understand "where each is coming from." While there are studies on rancher perceptions of conservation (Henderson et al. 2014; Farley et al. 2017), there are none that compare perceptions of conservation among ranchers, managers, and academics.

The purpose of this study is to fill that gap. Designed and carried out in partnership with the Central Coast Rangeland Coalition, which brings together ranchers, land managers, and academics to coordinate conservation efforts on a patchwork of public and private lands in the Central Coast region, the study is grounded in a set of five inter-related research questions: (1) How do different stakeholders define the

term "conservation"?; (2) What are their conservation priorities?; (3) What conservation practices do stakeholders employ, and what do they perceive as barriers standing in the way of adopting them?; (4) What do stakeholders perceive as threats to rangeland conservation?; and (5) What are perceived opportunities to improve conservation? To answer these questions, I conducted interviews and online surveys of ranchers, managers, and academics, as detailed below.

The findings of the study will be used to support and inform rangeland conservation among ranchers, managers, and academics in the Central Coast Rangeland Coalition. Given that grazing is the dominant land use globally (Phelps and Kaplan 2017), insights from this region may be useful for other regions of the world where multiple stakeholders are involved in rangeland conservation.

II. METHODS

2.1 Study Area

Interviewees were selected from an area characterized by annual grass and hardwood rangelands in the Central Coast region of California. This included participants in 13 counties, from Marin County in the north to San Luis Obispo County in the south, and from Stanislaus County in the east to the counties along the coast (Figure 1).

The coast range of central California is in the Mediterranean climate zone, with hot, dry summers and cool, wet winters that support a fall-winter-spring growing season (Huntsinger and Bartolome 2014). It is drier and warmer in the south, and wetter and cooler in the north. The summer marine layer along the Pacific coast creates a persistent pattern on the landscape in dry season soil moisture availability each year and a narrow annual temperature range; this maritime climate influences the vegetation composition and diversity in the Central Coast region (Vasey et al. 2014).

According to the National Vegetation Classification (NVC) system, vegetation types found in the Central Coast California region include Mediterranean grassland and forb meadows, Mediterranean scrub, and oak woodlands (Dolanc et al. 2016). Grasslands of California's Mediterranean climate zone are further classified into two subtypes: coastal prairie and valley grassland (Bartolome et al. 2007). Valley grassland is dominated by non-native grasses and forbs (Keeler-Wolf et al. 2007), but forb species richness is four times greater than grass richness (Sims and Risser 2000). Native perennial bunchgrasses are more prevalent in coastal prairie than in valley grasslands (Spiegal et al. 2016b). Overall, native cover is higher in coastal prairie than in valley grasslands (Eviner 2016).

Most of the rangelands in the Central Coast region are privately owned (CDFFP 2003). The remainder are owned by the federal government (United States Forest Service, Bureau of Land Management, National Park Service, and the Department of Defense), watershed and utility districts, open space districts, state and local governments, and land trusts (Huntsinger et al. 2007).

Figure 1. Counties of the study area in the Central Coast. Interviews were conducted with individuals who manage rangelands in the counties shaded in green.

2.2 Data Collection and Analysis

In-depth, structured interviews with ranchers and managers in the Central Coast Region of California were conducted in accordance with IRB Protocol #2017-11-10460. The questions focused on themes of relationship with the land, conservation priorities, barriers to implementing conservation practices, threats to rangeland conservation, and opportunities for improvement in conservation efforts.

Interviewees included owners of private rangeland engaged in livestock production, referred to here as "ranchers." Some of these ranchers had additional operations on leased public or private land. Interviewees were identified and contacted by sending requests for participation to members of the Central Coast Rangeland Coalition, as well as by sending letters of introduction to individual ranchers and NGO and agency managers identified by regional rangeland consultants, referred to here as "managers." Additional respondents were then identified via snowball sampling, in which interviewees referred us to other ranchers or managers (Berg 2004; Stewart and Shamdasani 2015). Interviews with ten ranchers and six managers were conducted from February through March of 2018; interviews were done by phone and lasted approximately one hour each. Interviews were transcribed and spreadsheet analysis was used to identify key themes.

A five-question online survey was conducted to complement the interviews described above. The survey was completed by rangeland science researchers and educators (referred to here as "academics") in the same region of California. The survey was sent out to 40 academics via email along with letters of introduction. A Google Forms platform was used to keep the responses anonymous. The survey questions are provided in Appendix A.

This is qualitative study using purposive sampling, so inferential statistics are not applicable. Qualitative studies provide depth and detail and encourage respondents to expand on topics and bring in their own experiences and ideas, rather than limiting them to the researcher's anticipated responses and pre-judgements (Neuman 2003). This approach is particularly useful for new research areas (Gutwein and Goldstein 2013). In-depth qualitative research is a much needed complement to the existing survey research on rangeland management and use (Sayre 2004).

III. RESULTS

3.1 Participants and perceptions of conservation

The ten ranchers interviewed for the study had varying lengths of ranching experience (from 10 years to 63 years). Of the ten, two operated only on their own private lands and eight on both private and public land. The ranchers operating on public lands are leasing the land from county and regional parks and a municipal water district. The six managers interviewed were employed by county and regional parks, land trusts, the National Park Service, and a municipal water district. The ten academics who participated in the online survey were from the University of California, the University of California Cooperative Extension, and the California State University.

Nine out of ten ranchers said they are satisfied overall with the condition of their ranches, whereas five out of six managers were somewhat satisfied and stated that some things could be improved.

When asked to define the term "conservation," ranchers, managers, and academics had similar but distinctly different answers. Ranchers commonly used verbs like "take care," "manage," and "steward," while managers commonly used verbs like, "preserve," "protect," and "keep." Five out of ten academics used the verbs "maintain" and "use." The word "natural" was the most commonly used adjective by all three groups. Ranchers listed land, wildlife, and natural resources as objects to be conserved; managers listed habitat, land, and population; and academics listed land, species, environment, ecosystems, and functions.

3.2. Conservation priorities

Ranchers and managers were asked to list their top three conservation priorities for the land they manage or use. Some of the conservation priorities of ranchers were congruent with those of managers (Table 1). Five out of ten ranchers and two out of six managers listed water and wildlife as conservation priorities. In addition, nine out of ten ranchers and three out of six managers said they prioritize some form of plant management (to protect native or special status plants, to control invasive plant species, or to provide adequate amount and quality of feed).

Ranchers operating on both private and public lease lands prioritize first and foremost the economic viability of their operations; conservation of water, plants, and wildlife may also be priorities for them, but these never trump economic viability. They said their conservation priorities are not that different on public lands except that they may give more emphasis to meeting the specific residual dry matter (RDM) level and to protecting habitat for special-status species. Two ranchers operating only on private lands said their conservation priorities are the following: amount and quality of feed, stock water, soil, transfer of operation to next generation, and wildlife. Conservation priorities mentioned by ranchers but not by managers are management of soil, maintenance of livestock body condition, and succession of their operations.

One manager included the economic sustainability of ranching as a priority. Four out of six managers listed a specific type of habitat (e.g., steelhead habitat, riparian area, wetland, or grassland) as a conservation priority. A conservation priority mentioned by managers but not by ranchers is management of wetland and riparian areas.

Table 1. Conservation priorities on the land they manage, as mentioned by ranchers and manager respondents. Priorities are not listed in a particular order.

RANCHERS	MANAGERS
Plants • Protect special status species • Manage amount and quality of feed • Reduce fuel loads • Protect native plants • Meet the residual dry matter levels • Reduce yellow star thistle (*Centaurea solstitialis*) • Enhance or promote biodiversity	Plants • Maintain special status species populations • Preserve native plants • Control invasive plant species
Water • Manage amount and quality of water	Water • Manage amount and quality of water
Wildlife • Protect special status species • Create wildlife habitat	Wildlife • Maintain populations of listed species • Protect wildlife corridor • Protect steelhead and their habitat
Manage healthy range	Improve range

Manage soil	No priority mentioned about soil
Ensure ranch succession	No priority mentioned about ranch succession
Provide for the family	Economic sustainability of ranching
Maintain body condition of livestock	No priority mentioned about animal performance
No priority mentioned about specific habitats	Habitats • Improve riparian areas • Manage wetlands • Maintain annual and mixed grassland habitat

3.3 Conservation practices and barriers

Ranchers were asked what conservation practices they had implemented on their ranches in the last 10 years. They listed a total of ten practices, of which seven are NRCS approved (Table 2). Improvement or development of water infrastructure was the most common conservation practice: all ranchers interviewed had done it to provide adequate amounts of water for their livestock and to improve livestock distribution on the landscape. Invasive plant species management was the second most common conservation practice; eight out of ten ranchers had either mowed, prescribed grazed or burned, and/or treated an invasive plant with herbicides. Several ranchers talked about the effectiveness of prescribed grazing on yellow starthistle (*Centauria solstitialis*) and medusahead (*Taeniatherum caput-medusea*) using specific classes of cattle at specific times. Rotational grazing was the third most common conservation practice; seven out of ten ranchers had done it, though the definition of the practice varied from simply moving cattle from one large pasture to another when the forage was consumed to the proper level, to more intensive grazing systems. Only one rancher listed RDM monitoring in the fall as a practice. Other practices listed were the following: intensive grazing for special status species, extensive periods of deferment, acorn planting, riparian planting of willows and coyote brush, stock pond restoration, putting in wildlife-friendly fences, and range planting.

Five out of 10 ranchers mentioned the lengthy permitting process with the local NRCS office as a major obstacle to implementing conservation practices – especially water development projects and stock pond rehabilitation. In terms of controlling invasive plant species, two out of ten ranchers attributed climate and availability of water as limiting factors in their ability to use prescribed grazing. In addition, ranchers operating on public lands noted that they face the challenge of maintaining aging infrastructure and public access when implementing rotational grazing. Public recreation visitors sometimes leave ranch gates open, hindering ranchers' control of cattle access to certain pastures. One rancher expressed difficulty in meeting the other stakeholders' goals.

Ranchers were asked what other conservation practices they would like to implement if they had more time and money. Four out of ten ranchers said they would want to implement more fencing and water projects. One rancher said he would rehabilitate creeks.

Table 2. Practices implemented for conservation in the last 10 years according to respondents.

PRACTICES	IMPLEMENTED BY RANCHERS	IMPLEMENTED BY NGO and AGENCY MANGERS
Rotational grazing	Most respondents	Most respondents
Intensive grazing for special status species	Few respondents	Few respondents
Invasive plant species management * (e.g., prescribed grazing, mowing, spray of herbicides, prescribed burning, had removal)	Most respondents	Most respondents
Extensive period of deferment	Few respondents	No respondents
Water development * (e.g., trough, storage tank, pipeline, spring)	Most respondents	Most respondents
Water quality and stream survey	No respondents	Few respondents
Acorn planting	Few respondents	None
No grazing in oak woodland in summer months	No respondents	Few respondents
Riparian planting of trees and shrubs for wildlife *	Few respondents	Few respondents
Stock pond clean-up and restoration *	Few respondents	Few respondents
Wetland restoration*	None	Few respondents
Wildlife-friendly fences *	Few respondents	None
Fencing riparian areas	None	Few respondents
Range planting (e.g., seeding rose clover and subclover *)	Few respondents	None
Mapping vegetation	None	Few respondents
Road rehabilitation and commissioning	None	Few respondents
Specific calving season and strict animal health standards	None	Few respondents
Place supplements on higher elevation sites	None	Few respondents

*NRCS-approved conservation practices.

Managers were asked the same questions as ranchers. They listed a total of 13 conservation practices, of which four are NRCS-approved (Table 2). Five out of six managers responded that they have helped ranchers with their water development projects for livestock distribution. The same proportion of managers said they have overseen treatments of invasive plant species (i.e., barbed goatgrass,

medusahead, yellow and purple starthistle, and poison hemlock). Four out of six land managers said they have facilitated rotational grazing.

Challenges that managers face when they implement conservation practices – especially water development projects and invasive plant species management – were limited staff time and funding. For example, coordinating with seven to nine agencies to complete the initial permitting process for water development projects can be time-consuming and lead to delays. Another issue is that agencies are not able to match funds with the federal grant on every project. Furthermore, staff turnover at agencies prevented some water and vegetation monitoring efforts to continue.

When managers were asked what other conservation practices they would want to implement if they had more resources, two out of six managers said they want to investigate impacts of grazing on certain plant species. Two others said they would want to better distribute the livestock by taking salt and protein supplements to higher ground. Other practices mentioned were water quality monitoring in grazed and non-grazed areas, oak woodland and grassland restoration, and vegetation sampling on forbs.

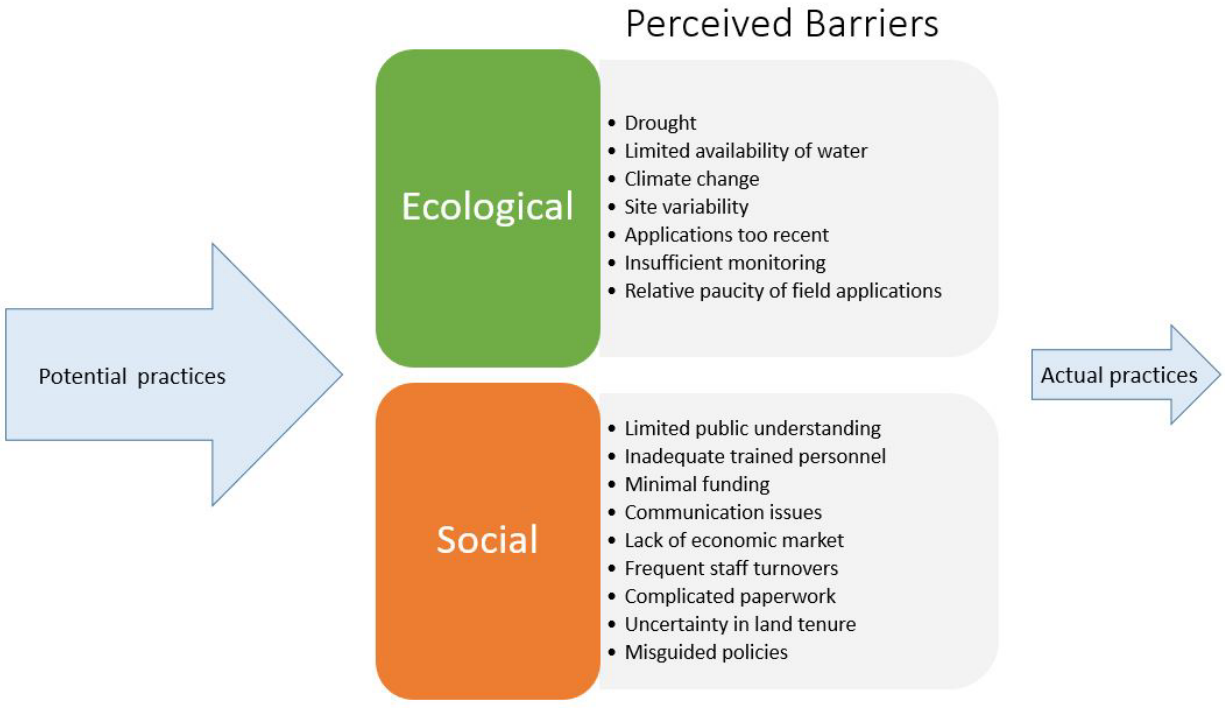

Figure 2. Ecological and social barriers that ranchers and managers said limited implementation of conservation practices.

3.4 Threats to conservation on California rangelands

The threats to conservation listed by ranchers included urban development, lack of understanding of range management among some managers and scientists, and lack of public appreciation of ecosystem services provided by grazers on rangelands. Ranchers noted that urban development increases property

values of the land nearby. Some argued that as a result, they have to use money to pay property taxes that they could otherwise use for conservation practices. On public grazing lands, ranchers perceive that some managers are inexperienced in range management and see it as problem that a fraction of the public has negative sentiments toward grazing animals because they see them as threats to conservation. Furthermore, ranchers mentioned that corporation or investment groups leasing their conservation easement property to ranchers for grazing could be a threat to conservation if they are not interested in implementing practices to enhance biodiversity or the habitat quality of their land.

Five out of six managers suggested that land use change is a major threat to conservation of Californian rangelands. Other concerns mentioned were climate change and multi-year drought, wildfires, market pressure and fluctuation, and disconnect between urban dwellers and ranchers.

Seven out of ten academics also claimed that land use change is one of the threats to conservation on Californian rangelands. One of the academics explained the mechanism of conversion: "there is high opportunity cost to keep land as rangeland due to high revenue from other things, low returns for rangeland production and almost no returns for other ecosystem services." Four out of ten academics also mentioned lack of public understanding of rangeland values as a concern. Other threats they mentioned included climate change, in particular lack of information on climate change effects on species distribution; invasive plant species; limited funding for rangeland research and extension; loss of use of prescribed fire as rangeland management tool; and misguided regulations and policies with unintended consequences.

3.5 Opportunities for conservation

According to the surveyed academics, a number of research advancements related to range science are not translating to range management. These are in the following areas of research and practice:

- Ecosystem services provided by native plants and animals
- Soil carbon
- Prevention of introduction and spread of invasive plant species
- Ecological Site Description and State-and-Transition models
- Adaptive management
- Social-ecological system
- Management in a non-equilibrium system

Academics identified the following opportunities for conservation:

- Educate the public to increase interest in rangeland ecosystems and the services they provide.
- Tax the public for the services provided by rangelands.
- Create incentives such as payment for ecosystem services.
- Extend the Ecological Site Description and State-and-Transition platform statewide.
- Engage in outreach to decision makers for better policies.
- Promote estate-planning support and conservation easements.
- Create space where ranchers, NGO and agency managers, and academics can share information.

All nine ranchers who own a private property said they would consider participating in conservation easement. Some ranchers said it depends on the contract; if the contract is too inflexible or limiting they do not want to participate.

Ranchers stated that they obtain information about regional conservation issues from the California Cattlemen's Association, California Rangeland Conservation Coalition (CRCC), Central Coast Rangeland Coalition (CCRC), University of California Cooperative Extension (UCCE), local NRCS and resource conservation district (RCD) offices, and other ranchers. Managers obtain information from the California Invasive Plant Council, California Native Grassland Association, local conservation leagues, as well as those outlets mentioned above.

IV. DISCUSSION

The perception of conservation among ranchers compared to that among managers can be seen as similar to the dichotomy between Aldo Leopold's ideas about conservation and sustainable use and John Muir's ideas about preserving nature without evident human use. Most ranchers' definitions of "conservation" and the role of the landowner resonates with Aldo Leopold's land ethic, in which humans have the moral responsibility to care for the natural world. Leopold stated that "It is inconceivable to me that an ethical relation to the land can exist without love, respect, and admiration for land, and a high regard for its value" (Leopold, 1949, pg. 223). As one interviewed rancher said, "[conservation is] to respect and to take care of the land, enhancing various plant life and natural systems on the land you are working on." Leopold recognized that economics is a factor in landowner decisions, saying that understanding economic land use as well as the land was critical to conservation (Leopold, 1949, pg.225). Further, another interviewed rancher defined "[conservation as] a wise and thoughtful use of natural resources." In line with the idea of sustainable use, Leopold wrote that "Land health is the capacity for self-renewal in the soils, waters, plants, and animals that collectively comprise the land" Overall, Leopold's focus was on an individual's ethical relationship to the land, not the duty of governments to dictate the limits and parameters of use. Reflective of rancher interest in cost share and easement programs, Leopold believed that "conservation will ultimately boil down to rewarding the private landowner who conserves the public interest" (quoted in Flader and Callicot, 1991).

On the other hand, manager definitions of "conservation" seem more related to John Muir's philosophy of "consecrating a small part of nature" (Worster 2008), although the interviewed managers have accepted some grazing use as necessary to meet conservation goals. According to the interviewed managers, conservation is "[to] preserve a natural state" and "[to] protect native species and habitats in decline." The word choices of "preserve" and "protect" imply that humans do not play a part in natural processes or the production of ecosystem services (Huntsinger and Oviedo 2014). In other words, the main difference between the two groups is that ranchers see humans taking an active role in managing (even enhancing) the land or natural resources, while managers more often see nature (usually biologically meaningful taxa or communities) as needing to be set aside or protected from too much human use. For example, one interviewed manager said her role is to "make sure livestock do not infringe on wildlife." Academics working in the field of rangeland management tend to be somewhere in between. One academic defined conservation as "maintaining all species and the processes that support them." This reflects John Muir's statement that "When we try to pick out anything by itself, we find it hitched to everything else in the Universe," and Leopold's statement that "A thing is right when it

tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise" (Leopold 1949 pg. 225).

Recognizing the nuances in perceptions of conservation and conservation practices may improve communication among various groups. Basically, for ranchers, the "who" is critical: for them, the landowner is the person who should take responsibility for the land. For managers, it is the government agency who is ultimately responsible. Academics in range management work with both groups, and the mechanism and outcome of conservation is more of their focus than the "who" takes responsibility.

The interviews indicate that there are many overlaps in the top conservation priorities of ranchers and land managers. Both groups prioritize economic viability, maintenance of biodiversity, invasive plant species control, protection of water quality, and good range conditions. Though various land ownerships have different management goals, grassland "sustainability" is a general theme (Huntsinger et al. 2007). Many conservation priorities that ranchers listed—stewardship of feed, water, and soil—are essential to their operations. Despite the recent enthusiasm for soil conservation on rangelands, none of the managers interviewed listed soil conservation as one of their top three conservation priorities. Instead, managers are focusing their conservation efforts on protecting habitats such as grasslands, wetlands and riparian areas.

There are some priorities that may conflict. For example, when controlling for invasive plant species with prescribed grazing, or maintaining wildlife habitat, managers want to graze livestock in an area long enough or at a high enough stocking rate to reduce undesirable plants or litter, but ranchers may find it difficult to attain the desired livestock body condition under such a grazing regime (Germano et al. 2011; Shapero et al. 2018). Depending on the season, weather, and available resources, some practices are not feasible. Therefore, frequent communication between ranchers and managers about their priorities is important.

For the most part, conservation practices that ranchers and managers implement correspond with their conservation priorities and available resources. Common conservation practices implemented by both groups were improvement of water infrastructure, invasive plant species control, and various forms of rotational grazing. These are practices that ranchers and managers work on together at the pasture scale. Not surprisingly, only a few ranchers and managers prioritize landscape-scale practices, such as watershed health or habitat connectivity for large mammals, yet as rangelands become more fragmented and land uses become intermixed, it is increasingly necessary to coordinate management for wildlife, water, and fire hazard reduction across property boundaries (Goldman et al. 2007, Plieninger et al. 2012, Ferranto et al. 2013).

4.1 Conservation barriers and threats

Two of the most common barriers to implementing conservation practices are limited time and financial resources. This study revealed other barriers that ranchers and managers are facing that prohibit them from implementing more conservation practices (Fig 2). As shown by Huntsinger et al. (2007), ranchers described how obtaining permits to implement water projects or rehabilitate stock ponds is an arduous process. Ranchers highlighted the following issues associated with the permitting process: cumbersome paperwork, long turnaround time, scheduling with biologists, and frequent agency staff turnover. One rancher expressed his frustration: "Work is the easy part; the hard part is getting the green light for doing so." Some obstacles to implementation are not controllable, such as rainfall and availability of

water. For example, one rancher described a situation when prescribed grazing was ineffective because late spring rain resulted in a vigorous growth of yellow starthistle. Another rancher described a situation when there was not enough water supply for cattle to do targeted grazing or to reduce fuel load. Shapero et al (2018) found in a study of invasive plant control by ranchers and managers that one factor that limited willingness to invest in practices was the high risk of failure due to unpredictable rainfall and weather conditions. Interestingly, even though California had just coped with the state's most severe drought in the last 500 years (Macon et al. 2016), only managers, not ranchers, mentioned multiyear droughts as barriers to conservation.

Threats looming over California rangelands are not easy to solve. In this study, fragmentation of rangelands from land use change is the most common shared concern among ranchers, managers, and academics in the Central Coast California. Over 100,000 acres of California grazing lands were lost to conversion between 1999 and 2004, and it is estimated that 750,000 additional acres will be lost by 2040 (Kroeger et al. 2009). With the high opportunity cost to continue ranching and no heirs to take over the operation, some ranchers are either selling their land to developers or converting their property to vineyards or orchards (Cameron et al. 2014). If many more livestock production businesses were to close down in the Central Coast California region, the "critical mass" of ranches that can support ranching and marketing infrastructure would be jeopardized (Liffmann et al. 2000). One of the opportunities to prevent further conversions is to focus on currently unprotected lands. About 37 % of California rangelands are protected, at least for a decade, from residential and associated commercial development by the Williamson Act and 24 % more (of which 4 % are easements) permanently by private conservation organizations or public agencies, while the remaining 39 % of rangelands have no protection status at all (Cameron et al. 2014). Engaging with landowners on lands with no protection status to discuss the possibility of conservation easements is an underutilized strategy for rangeland conservation.

Other threats to conservation perceived by managers and academics are climate change and drought. In response to 4 degrees Celsius of warming with increased rainfall, many scattered shrubland vegetation communities in the Central Coast Californian rangelands are expected to shift to predominantly shrubland (Chornesky et al. 2015). This has implications for increased wildfire risks. Furthermore, the future scenarios for climate change and land use change interact with each other to reduce water supply and priority habitat for wildlife (Byrd et al. 2015). Coordinated efforts across jurisdictions to share grassbanks and other resources in time of severe drought (Macon et al. 2016), reconsidering regulations to allow prescribed fire and grazing where it has been reduced or removed on wildlands to control shrub invasion, and prioritizing conservation efforts on areas with water deficits are some opportunities to alleviate future climate change impacts.

Two other rancher perceived threats to conservation are social. One area of concern is managers' lack of range management experience or knowledge. Ranchers are concerned that "people in resource management positions either do not know or do not care about the cost of implementation [of conservation practices]." This finding is consistent with research from other regions that highlights the importance of the stakeholder's level of trust in organizations or agencies to manage rangelands (Marshall et al. 2000; Garbach et al. 2012; Brain et al. 2014; and Henderson et al. 2014). According to a representative of the CRCC, one of the main components of this lack of trust is the belief that non-ranchers don't appreciate ranchers' need to maintain a positive financial bottom line (Sweet, pers. com.). A second area of concern is public misconceptions of ranching, which was echoed by ranchers,

managers, and academics in the interviews. On public grazing lands, recreationists may startle livestock because they are fearful of the animals, perhaps due to past experiences, but more often due to lack of familiarity (Barry 2014; Huntsinger et al. 2007; Resnik et al. 2006; Ringgold 2009; and Sulak et al. 2008). On rare occasions, ranchers receive threats from those who oppose livestock grazing on public lands (Tempest 2004). As illustrated by Wolf et al. (2017), there are plenty of opportunities to educate the public about the values and benefits of grazing on public lands.

V. IMPLICATIONS

Keeping "working landscapes" working is vital to rangeland conservation, because economically sustainable ranches, and landowners who are benefiting from their properties, have more resources and incentive to invest time and money in better management (Huntsinger and Oviedo 2014). There are a number of strategies that can be used to keep ranching viable: 1) promote conservation easements, in addition to tax relief and incentive programs, to avoid conversion; 2) educate the public about rangeland ecosystem services and values; 3) tax the public for the ecosystem services they are receiving from rangelands; 4) train the next generation of range managers; and 5) provide more opportunities for ranchers, managers, and academics to share information, as occurs at meetings of the Central Coast Rangeland Coalition and the California Rangeland Conservation Coalition. Most importantly, communication among ranchers, managers, and academics could be improved if they tried to understand each other's perception of conservation.

In the interviews, academics identified numerous research advancements that are not widely applied to range management in California. Those advancements include theoretical concepts such as social-ecological systems and equilibrium verses non-equilibrium system dynamics. Details about these concepts are outside the scope of this paper. But briefly, the social-ecological system is a conceptual framework that illustrates both the social and ecological components of a system that influence each other (Hruska et al. 2017). Identifying feedbacks between social and ecological drivers on ecosystem services at multiple scales is helpful in achieving rangeland sustainability (Huntsinger and Oviedo 2014). For example, bureaucratic red-tape and uncertain land tenure on public land could ultimately create a feedback loop that leads ranchers to sell their private land. Draconian environmental regulations, aimed at conserving habitat on private land, could feed back to the ranch operation by reducing profitability and leading to the failure and sale of the ranch.

An example of inadequate application of newer scientific findings is in the area of non-equilibrium vegetation dynamics. The equilibrium model stresses the role of biotic factors such competition among plants as a driver of ecosystem change, while non-equilibrium models highlight stochastic abiotic factors such as variable rainfall as major drivers of system change (Vetter 2005). Using this framework, Jackson and Bartolome (2007) show that the influence of the abiotic environment, including the soil type, elevation, precipitation, and temperature, is particularly important in the California Mediterranean environment. Understanding where the site they are managing resides in the equilibrium verses non-equilibrium continuum would help range managers develop management strategies to cope with drought and site variability that are the best fit to the system, and avoid pursuing methods based on manipulation of processes that have weak or non-existent influence on the system.

Other research advancements mentioned by academics that are more directly linked to management are NRCS Ecological Site Descriptions and State and Transition models, and soil carbon dynamics on rangelands. The Ecological Site Description and State-and-Transition models are underutilized tools to

manage heterogeneous landscapes with limited financial resources (Spiegal et al. 2016a). They are designed to identify landscape divisions with the highest chances of responding favorably to specific management activities (Spiegal et al. 2016a). They could be used to prioritize where and when to implement conservation practices and restoration projects. As for soil carbon, Silver et al. (2010) have shown that, although variable by site, California grasslands are sequestering carbon in the soil now without assistance. In 2016, the California Department Food and Agriculture established the Healthy Soils Program, a payment for ecosystem service program that promotes healthy soils – defined as increased soil organic matter - on Californian farms and rangelands (CDFA 2016). However, one academic warned in the survey, "There is more excitement about carbon sequestration potential, and obsession with the loosely defined term, 'soil health,' than is reasonable given the underlying condition and potential of most of California lands." If an application is too recent and understood too simplistically it also may be a barrier. These "knowledge-blocks," in other words, scientific knowledge that is not translated into practical management solutions, need to be addressed by Universities and Cooperative Extension to lower barriers to conservation on Californian rangelands. These should also be topics adopted for future Central Coast Rangeland Coalition workshops. This fits well with a growing interest in "usable science" for rangelands (Brunson et al. 2016).

ACKNOWLEDGEMENTS

The study was funded by the East Bay Regional Parks and The Nature Conservancy through a grant to the Central Coast Rangeland Coalition (CCRC), a local group of ranchers, managers, non-profit scientists, and students. The CCRC conceived this project as part of their Rancher, Manager, and Scientist Forum on Rangeland Conservation (http://www.elkhornsloughctp.org/training/show_train_detail.php?TRAIN_ID=RaV1HLP). This work was supported in part by project no. CA-B-ECO-0117-MS of the USDA National Institute of Food and Agriculture and the University of California, Berkeley. I would like to thank Lynn Huntsinger for her guidance throughout the project. Thanks to Lynn Huntinger, Larry Ford, and Eric Engle for editing this manuscript. Larry Ford, Sheila Barry, and Veronica Yovovich helped tremendously with devising interview questions and connections. I also would like to thank the many ranchers, managers, and academics who offered their time to discuss pertinent issues related to this topic.

LITERATURE CITED

Barry, S. 2014. Using social media to discover public values, interests, and perceptions about cattle grazing on park lands. *Environmental Management* 53:454-464.

Bartolome, J. W., Barry, J., Griggs, T., and Hopkinson, P. 2007. Valley grassland. In: M. G. Barbour, T. Keeler-Wolf, and A. A., Schoenherr (eds.). Terrestrial vegetation of California. Third edition. University of California Press, Berkeley, California.

Berg, S. 2004. "Snowball sampling" In *Encyclopedia of Statistical Sciences*. John Wiley & Sons. doi:10.1002/0471667196.ess2478.pub2.

Brain, R. G., Hostetler, M. E., and Irani, T. A. 2014. Why do cattle ranchers participate in conservation easements? Key motivators in decision making. *Agroecology and Sustainable Food Systems* 38(3):299-316.

Brunson, M. W. and L. Huntsinger. 2008. Ranching as a Conservation Strategy: Can Old Ranchers Save the New West? *Rangeland Ecology Management* 61:137-147.

Brunson, M.W., Huntsinger, L., Kreuter, U., Ritten, J. 2016. Usable socio-economic science for rangelands. 2016. *Rangelands* 38(2): 85-89.

Byrd, K., Flint, L. E., Alvarez, P., Casey, C. F., Sleeter, B. M., Soulard, C. E., Flint, A. L., and Sohl, T. L. 2015. Integrated climate and land use change scenarios for California rangeland ecosystem services: wildlife habitat, soil carbon, and water supply. *Landscape Ecology* 30:729-750.

Cameron, D. R., Marty, J., and Holland, R. F. 2014. Whither the Rangeland?: Protection and Conversion in California's Rangeland Ecosystems. *PLoS ONE* 9(8):e103468. doi:10.1371/journal.pone.0103468

CDFA (California Department of Food & Agriculture). 2016. California Healthy Soils Initiative Action Plan. CDFA, Sacramento, CA, USA. Available at: https://www.cdfa.ca.gov/oefi/healthysoils/docs/CA-HealthySoilsActionPlan.pdf.

CDFFP (California Department of Forestry and Fire Protection). 2003. The changing California: Forest and range 2003 assessment. Sacramento, CA: State of California, The Resources Agency, Fire and Resource Assessment Program.

CDFFP. 2010. California's forests and rangelands: 2010 assessment. Sacramento, CA: State of California, The Resources Agency, Fire and Resource Assessment Program.

CDOC (California Department of Conservation). 2010. California Land Conservation (Williamson) Act Status Report. Sacramento. CA: CA Department of Conservation.

Cheatum, M., Casey, F., Alvarez, P. and Parkhurst, B. 2011. Payments for ecosystem services: a California rancher perspective. Conservation Economics White Paper. Defenders of Wildlife, Washington, D.C., USA. Available at: https://defenders.org/publications/payments_for_ecosystem_services_a_california_rancher_perspective.pdf.

Chornesky, E. A., Ackerly, D. D., Beier, P., Davis, F. W., Flint, L. E., Lawler, J. J., Moyle, P. B., Moritz, M. A., Scoonover, M., Byrd, K., Alvarez, P., Heller, N. E., Micheli, E. R., and Weiss, S. B. 2015. Adapting California's ecosystems to a changing climate. *BioScience* 65:247-262.

Dolanc, C. R., Keeler-wolf, T., Barbour, M. G. 2016. Chapter 12 Vegetation. In: Mooney, H. and E. Zavaleta (eds.). Ecosystems of California. University of California Press, Berkeley, California.

Eviner, V. T. 2016. Chapter 23 Grasslands. In: Mooney, H. and E. Zavaleta (eds.). Ecosystems of California. University of California Press, Berkeley, California.

Farley, K. A., Walsh, K. C., and Levine, A. S. 2017. Opportunities and obstacles for rangeland conservation in San Diego County, California, USA. *Ecology and Society* 22(1):38.

Ferranto, S., Huntsinger, L., Getz, C., Lahiff, M., Stewart, W., Nakamura, G., and Kelly, M. 2013. Management without borders? A survey of landowner practices and attitudes towards cross-boundary cooperation. *Society and Natural Resources* 26(9):1082-1100.

Flader, S. L. and J. B. Collicott. 1991. The River of the Mother God Essays by Aldo Leopold. University of Wisconsin Press, Madison, Wisconsin.

Garbach, K., Lubell, M., and DeClerck, F. A. J. 2012. Payment for ecosystem services: the roles of positive incentives and information sharing in stimulating adoption of silvopastoral conservation practices. *Agriculture, Ecosystems and Environment* 156:27-36.

Germano, D. J., G. B. Rathbun, and L. R. Saslaw. 2011. Effects of grazing and invasive grasses on desert vertebrates in California. *Journal of Wildlife Management* 76(4):670–682. http://dx.doi.org/10.1002/jwmg.316.

Goldman, R. L., Thompson, B. H., Daily, G. C. 2007. Institutional incentives for managing the landscape: Inducing cooperation for the production of ecosystem services. *Ecological Economics* 64(2): 333-343. http://dx.doi.org/10.1016/j.ecolecon.2007.01.012.

Gutwein, M. and J. H. Goldstein 2013. Integrating Conservation and Financial Objectives on Private Rangelands in Northern Colorado: Rancher and Practitioner Perceptions. *Rangeland Ecology & Management* 66: 330-338. doi: 10.2111/rem-d-11-00206.1

Henderson, A. E., M. Reed, and S. K. Davis. 2014. Voluntary stewardship and the Canadian Species at Risk Act: exploring rancher willingness to support species at risk in the Canadian prairies. *Human Dimensions of Wildlife* 19(1):17-32.

Hoekstra, J. M., Boucher, T. M., Ricketts, T. H., and Roberts, C. 2005. Confronting a biome crisis: global disparities of habitat loss and protection. *Ecology Letters* 8:23-29.

Hruska, T., Huntsinger, L., Brunson, M., Li, W., Marshall, N., Oviedo, J., and Whitcomb, H. 2017. Rangelands as Social-Ecological Systems. In: Briske, D. D. (Ed.). Rangeland Systems: Processes, Management and Challenges. Springer Series on Environmental Management, Cham, Swizerland.

Huntsinger, L. and J. W. Bartolome. 2014. Cows? In California? Rangelands and Livestock in the Golden State. *Rangelands* 36(5):4-10.

Huntsinger, L., Bartolome, J. W., and D'Antonio, C. M. 2007. Grazing Management on California's Mediterranean Grasslands. In: Stromberg, M. R., Corbin, J. D., and D'Antonio (eds.). California grasslands: Ecology and management. University of California Press, Berkeley, California.

Huntsinger, L. and P. Hopkinson. 1996. Viewpoint. Sustaining rangeland landscapes: a social and ecological process. *Journal of Range Management* 49:167-173.

Huntsinger, L. and J. Oviedo. 2014. Ecosystem services are social-ecological services in a traditional pastoral system: the case of California's Mediterranean rangelands. *Ecology and Society* 19(1):8.

Keeler-wolf, T., Evens, J. M., Solomeshch, A. I., Holland, V. I., and Barbour, M. G. 2007. Community classification and nomenclature. In: Stromberg, M. R., Corbin, J. D., and D'Antonio (eds.). California grasslands: Ecology and management. University of California Press, Berkeley, California.

Knight, R. L., Gilgert, W. C., and Marston, E. 2002. Ranching west of the 100th meridian: culture, ecology, and economics. Washington, DC, USA: Island Press. 196 p.

Knight, R. L., Wallace, G. N., and Riebsame, W. E. 1994. Ranching the view: subdivisions vs. agriculture. *Conservation Biology* 9:459-461.

Kroeger, T., Casey, F., Alvarez, P., Cheatum, M., and Tavassoli, L. 2009. An Economic Analysis of the Benefits of Habitat Conservation on California Rangelands. Conservation Economics White Paper. Conservation Economics Program. Washington, DC: Defenders of Wildlife. 91 p.

Leopold, A. 1949. A Sand County Almanac and Sketches Here and There. Oxford University Press, New York, New York. 223-225 p.

Liffmann, R. H., Huntsinger, L., and Forero, L. C. 2000. To ranch or not to ranch: home on the urban range? *Journal or Range Management* 53(4):362-370.

Macon, D. K., Barry, S., Becchetti, T., Davy, J. S., Doran, M. P., Finzel, J. A., George, H., Harper, J. M., Huntsinger, L., Ingram, R. S., Lancaster, D. E., Larsen, R. E., Lewis, D. J., Lile, D. F., McDougald, N. K., Mashiri, F. E., Nader, G., Oneto, S. R., Stackhouse, J. W., and Roche, L. M. 2016. Coping with drought on California rangelands. *Rangelands* 38(4):222-228.

Marshall, A., Hoag, D., and Seidl, A. 2000. Colorado landowner conservation easement survey. Technical Bulletin 02-3. Colorado Experiment Station, Colorado State University, Fort Collins, Colorado, USA.

Merenlender, A. M., Huntsinger, L., Guthey, G., and Fairfax, S. K. 2004. Land trusts and conservation easements: Who is conserving what for whom? *Conservation Biology* 18:65-75.

Myers, N., Mittermeier, R. A., Mittermeier, C. G., da Fonseca, G. A. B., and Kent, J. 2000. Biodiversity hotspots for conservation priorities. *Nature* 403:853-858.

Neuman, W. L. 2003. Social research methods: qualitative and quantitative approaches. 5th ed. Boston, MA, USA: Pearson Education, Inc. 584 p.

Noss, R. F., and R. L. Peters. 1995. Endangered ecosystems: a status report on America's vanishing habitat and wildlife. Washington, D. C., USA: Defenders of Wildlife. 151 p.

Phelps, L. N. and J. O. Kaplan. 2017. Land use for animal production in global change studies: defining and characterizing a framework. *Global Change Biology* 23:4457-4471.

Plieninger, T., Schleyer, C., Schaich, H., Ohnesorge, B., Gerdes, H., Hernandez-Morcillo, M., and Bieling, C. 2012. Mainstreaming ecosystem services through reformed European agricultural policies. *Conservation Letters* 5(4):281-288.

Resnik, J. Wallace, G., Brunson, M., and Mitchell, J. 2006. Open spaces, working places. *Rangelands* 28:4-9.

Ringgold, P. 2009. Free-range cattle on the Bay Area's rural fringe. Golden Gate University Environmental Law Journal 3:1-18.

Rosnan, L. 1997. Preserving working ranches in the West. Tucson, AZ, USA: Sonoran Institute. 53 p.

Sayre, N. F. 2004. Viewpoint: the need for qualitative research to understand ranch management. *Journal of Range Management* 57(6):668-674.

Shapero, M. W. K., Huntsinger, L., Becchetti, T. A., Mashiri, F. E., and James, J. J. 2018. In press. Land manager perceptions of the opportunities and constraints of using livestock to manage invasive plants. *Rangeland Ecology and Management*.

Silver, W. L., Ryals, R., and Eviner, V. 2010. Soil carbon pools in California's annual grassland ecosystems. *Rangeland Ecosystem Management* 63:128-136.

Spiegal, S., Bartolome, J. W., and White, M. D. 2016a. Applying ecological site concepts to adaptive conservation management on an iconic California landscape. *Rangelands* 38(6):365-370.

Spiegal, S., Huntsinger, L., Hopkinson, P., and Bartolome, J. W. 2016b. Chapter 37 Range Ecosystems. In: Mooney, H. and E. Zavaleta (eds.). Ecosystems of California. University of California Press, Berkeley, California.

Stewart, D. W., and P. N. Shamdasani. 2015. *Focus Groups: Theory and Practice*. Thousand Oaks, California: SAGE Publications.

Stein, B. A., L. S. Kutner, and J. S. Adams. 2000. Precious heritage: the status of biodiversity in the United States. New York, NY, USA: Oxford University Press. 399 p.

Sulak, A. and L. Huntsinger. 2007. Public Land Grazing in California: Untapped Conservation Potential for Private Lands? *Rangelands* 36(3):9-12.

Sulak, A., Huntsinger, L., Barry, S., and Forero, L. 2008. Public land grazing for private land conservation? In: Merenlander, A., McCreary, D., Purcell, K. L. (Eds.), Proceedings of the Sixth California Oak Symposium: Today's Challenges, Tomorrow's Opportunities, General Technical Report PSW-GTR-217. USDA, Forest Service, Pacific Southwest Research Station, Albany, CA, USA. 17 p.

Tempest, R. 2004. Hikers in East Bay Parks have a beef with cows. Los Angeles Times, Los Angeles, CA, USA. Available at: http://articles.latimes.com/2004/sep/06/local/me-cows6. Accessed on April 26, 2018.

U.S. Census Bureau. 2017. State and county quickfacts. Available at: https://www.census.gov/quickfacts/fact/table/CA,US/PST045217. Accessed on April 24, 2018.

USDOI (U.S. Department of Interior). 2017. Gifford Pinchot: A Legacy of Conservation. Available at: https://www.doi.gov/blog/gifford-pinchot-legacy-conservation. Accessed on April 25, 2018.

Vasey, M. C., Parker, V. T., Holl, K. D., Loik, M. E., and Hiatt, S. 2014. Maritime climate influence on chaparral composition and diversity in the coast range of central California. *Ecology and Evolution* 4(18):3662-3674.

Vetter, S. 2005. Rangelands at equilibrium and non-equilibrium: recent developments in the debate. *Journal of Arid Environments* 62:321-341.

Wolf, K. M., Baldwin, R. A., and Barry, S. 2017. Compatibility of Livestock Grazing and Recreational Use on Coastal California Public Lands: Importance, Interactions, and Management Solutions. *Rangeland Ecology & Management* 70:192-201.

Worster, D. A Passion for Nature: The Life of John Muir. New York, NY, USA: Oxford University Press. 535 p.

APPENDIX A

Survey questions:

1. In your own words, please define the term, "conservation."

2. In your opinion, what are the top 3 conservation priorities in CA rangelands at the state level?

3. What do you see as research progress related to range science that is not translating to range management progress?

4. What do you see as threats and barriers to conservation in CA rangelands?

5. Can you identify any opportunities to alleviate these barriers?