



# Developing a social science research agenda to guide managers in sagebrush ecosystems

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SEPTEMBER 2019

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# Introduction

Sagebrush dominates much of the western United States, but invasive plants, altered fire regimes, exurban development, and other disturbances threaten the health of sagebrush ecosystems and the species that depend on them. Resource managers and other stakeholders face significant challenges in balancing healthy, functioning ecosystems while supporting human uses and addressing environmental changes.

Over the last several decades, scientists have significantly advanced our understanding of ecological processes and biophysical components within sagebrush ecosystems. These advances provide a strong scientific basis for informing management and conservation efforts. Much of these advances have been made in response to concerns about population declines of Greater sage-grouse (*Centrocercus urophasianus*) and its potential listing under the U.S. Endangered Species Act (ESA). The strong ecological and biophysical focus of these previous research efforts, however, have left significant gaps in other topics relevant to managing and conserving sagebrush landscapes. There is now a growing appreciation that people play a fundamental role in the health of sagebrush ecosystems through the decisions they make. The social sciences can inform conservation efforts in multiple ways (Table 1), yet the human dimensions of sagebrush management and conservation are not well understood.

These insights motivated the Western Association of Fish and Wildlife Agencies' (WAFWA) Sagebrush Science Initiative to release a request for proposals (RFP) to “facilitate the integration of social science and associated data into sagebrush conservation” (WAFWA 2017). Subsequently, WAFWA funded the Ruckelshaus Institute at the University of Wyoming to conduct research on the social science research needs and priorities to help natural resource managers integrate social and ecological perspectives into more comprehensive sagebrush management strategies.

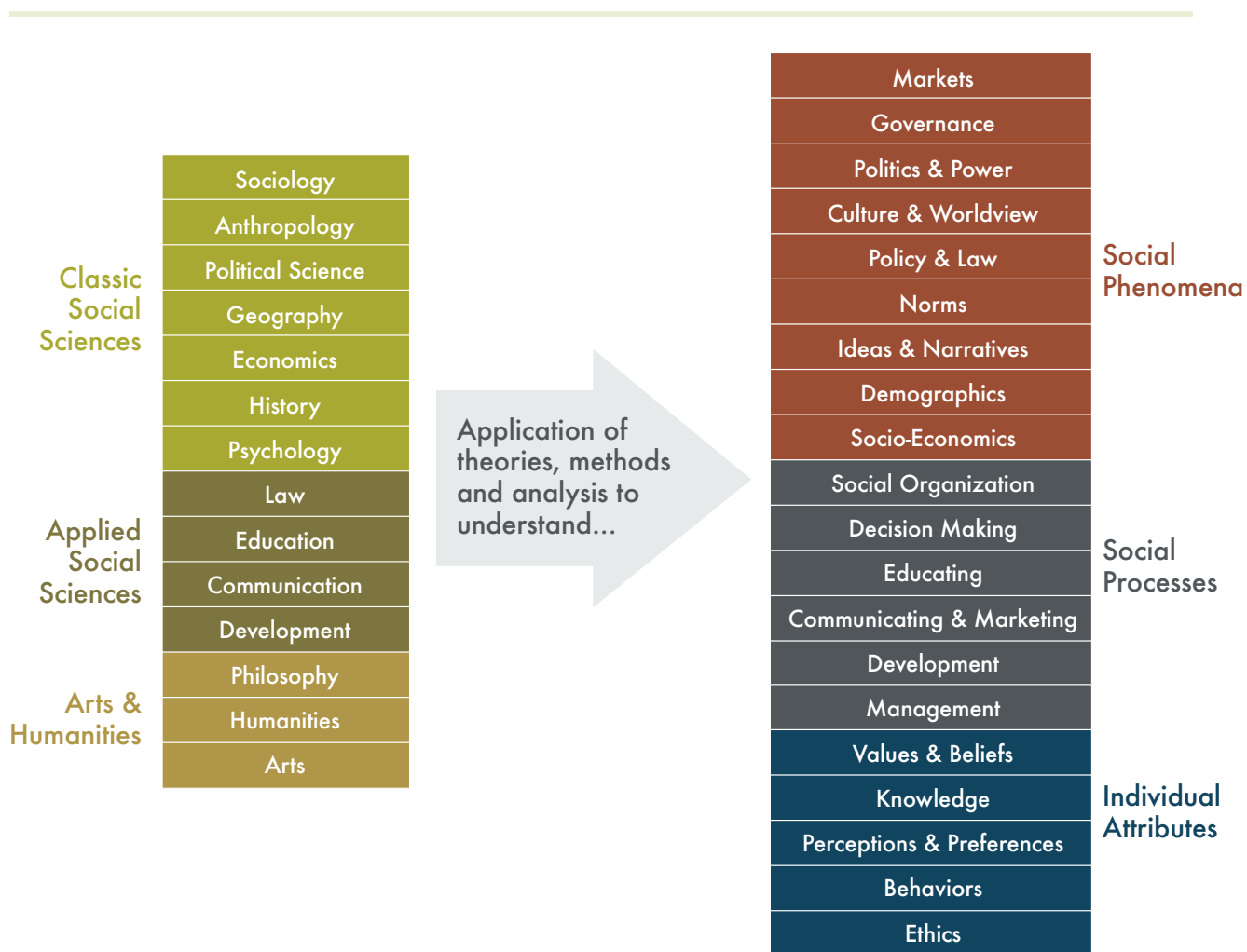
“The social sciences can inform conservation efforts in multiple ways, yet the human dimensions of sagebrush management and conservation are not well understood.”

**Table 1.** How social science can contribute to management and conservation.\*

1.	Documenting and increasing understanding of the diversity of ways in which conservation occurs in different contexts.
2.	Facilitating learning about and knowledge of conservation challenges, practices and processes as well as successes or failures.
3.	Improving conservation management practices and governance processes, including understanding how to better engage different stakeholders.
4.	Enabling planning and design of conservation initiatives that match different social, economic, cultural and governance contexts and that are socially acceptable.
5.	Facilitating more socially equitable and just conservation processes and outcomes.

\*From Bennett et al. 2017b, DOI: <https://doi.org/10.1016/j.biocon.2016.10.006>, used under Creative Commons CC-BY-NC-ND license.

Throughout the project we defined “social science” broadly to include disciplines such as political science, sociology, economics, governance, social psychology and anthropology – or the myriad of disciplines that study human society, behavior, and relationships. Bennett et al. (2017b) identify 18 classic and applied disciplines that comprise social science relevant to conservation issues (Figure 1). Each of these disciplines has its own traditions and theoretical perspectives while many methods (e.g., interviews, surveys, participant observation) are shared across the social sciences. Although a full description of each of the disciplines is beyond the scope of this report, Bennett et al. (2017b), Decker et al. (2012), Manfredro et al. (2014), Newing et al. (2011), and Vaccaro et al. (2010) provide in-depth discussion of the methods, theories, and approaches in the conservation social sciences.



**Figure 1.** The social sciences, humanities and related topics of study.  
 \*From Bennett et al. 2017b, DOI: <https://doi.org/10.1016/j.biocon.2016.10.006>, used under Creative Commons CC-BY-NC-ND license.



“We hope this project promotes the delivery of information necessary for managers to better integrate social science insights into their work”

This report focuses on a mixed-method social science study that engaged stakeholders closely involved with management and conservation efforts across the sagebrush range in order to address the following research objectives:

1. Assess the current state of knowledge in peer-reviewed literature regarding the human dimensions of sagebrush management and conservation.
2. Understand and prioritize on-the-ground social science needs to inform management decisions and conservation actions.
3. Compare our research findings with the realities stakeholders face in their work and discuss the integration of research priorities into decision-making contexts and processes through focus groups with resource managers and other practitioners working in sagebrush ecosystems.

In the following report, we summarize the collective findings from the research project while the data and results for individual components of the project are presented in Appendices A-D. We begin by providing an overview of the research methods. We then discuss the implications of the findings by describing:

- Perceptions of the social sciences among research participants
- Identified priority research topics
- Barriers and opportunities in applying insights from social science.

We conclude with seven recommendations for advancing the application of social science to inform sagebrush management and conservation. We hope this project promotes the delivery of information necessary for managers to better integrate social science insights into their work through the design of applied social science research projects, development of RFPs, better communication of research to stakeholders, and other activities.



# Overview of the Project

We conducted this research from April 2018 to September 2019. As an initial step, we completed a Q-study to understand the current discourse around sagebrush issues and how social science can contribute to management and conservation. For the Q-study, we examined a wide variety of secondary sources (e.g., newspaper articles, grey literature) to understand how resource issues and conservation challenges are discussed among stakeholders. We extracted statements relating to social science research needs from these secondary sources. Thirty-eight research participants in Colorado, Idaho, Oregon, and Wyoming then ranked these statements according to the priority they would assign to the research topics. We then interviewed the participants to understand their rationale behind their rankings. We selected participants to represent a range of stakeholder perspectives in each state (e.g., state and federal agency staff, landowners, conservation organizations). We recruited participants through known contacts and based on suggestions from individuals working closely on sagebrush management issues in each of the four states. This process helped us understand how groups of stakeholders perceive the research needs and the specific topics that motivate their interests. We further describe the methods, results, and key findings for the Q-study in Appendix A.

Following the Q-study, we developed a survey to assess how a broader population of stakeholders perceived research needs and how social science research can inform decision making. We sourced a list of 700 people working on sagebrush issues identified through the SageWest Communications Network and a network analysis from another WAFWA funded research project. The sample included a wide range of individuals involved with management, research, and conservation across the sagebrush range. A total of 222 participants responded to the survey for a roughly 32 percent response rate and included participants in all states within the sagebrush range and beyond. We further describe the methods, results, and key findings for the survey in Appendix B.

We used results from the survey to frame the discussions in a series of focus groups consisting of 9 to 10 participants in four western states. The two-hour focus groups took place in Cheyenne, WY (June 25), Fort Collins, CO (June 27), Boise, ID (July 12) and Prineville, OR (July 15). Potential participants were identified through known contacts, suggestions from other professionals and previously contacted individuals. The focus group protocol was based on the survey results with an emphasis on discussing the rationale for prioritizing certain research topics that came out of the survey and to gain a better understanding of how these topics might inform management and conservation decisions. In particular, the participants were asked to rank research topics 1 through 10 (1 being highest priority) and give a weighted value in which they distributed 10 points among the research topics how they saw fit. Finally, participants were given the opportunity to re-weigh the 10 points, if their feelings changed after the group discussion. The focus groups also allowed us to identify additional social science topics and research needs not identified in the survey instrument. We further describe the methods, results, and key findings for the focus groups in Appendix C.

We note that some participants were involved in more than one of the research activities. For instance, a majority of participants in the Q-study and focus groups also had the opportunity

“[Research participants] included a wide range of individuals involved with management, research, and conservation across the sagebrush range.”

to complete the survey. A couple of focus group participants also participated in the Q-study. Our goal throughout the research process was to incorporate perspectives from a range of stakeholders closely involved with sagebrush management and conservation.

As a complement to the other research tasks, we conducted a literature synthesis following principles similar to a systematic review to understand the scope and focus of existing social science literature relating to sagebrush ecosystems. This allowed us to understand the research that has already been done and how it compares to identified needs and priorities among stakeholders. We provide a full description of the methods, results, and key findings for the literature synthesis in Appendix D.

## Perceptions on Why Social Science Matters

There is an increasing awareness of the need to consider the human dimensions of many natural resource management issues (Mascia et al. 2003, Baruch-Mordo et al. 2009, Lowe et al. 2009). For instance, Bennett et al. (2017a) describe the transition within the Society for Conservation Biology that saw its social science working group grow into the second largest group of the society by 2011 after its creation in 2003. Other professional associations like The Wildlife Society and the Society for Range Management have also created human dimensions groups and social science courses have become required components of natural resources curricula at a number of universities in the United States (Bennett et al. 2017a).

While there is growing awareness of the need for human dimensions research in resource management, social science remains an abstract concept for many stakeholders working in sagebrush landscapes. Although we identified 95 articles addressing social issues relevant to sagebrush ecosystems through the literature synthesis, few participants in this project were familiar with concrete examples of how social science can be used to inform decision making and conservation of sagebrush ecosystems. These findings are likely due to the background and of the population we studied – namely practitioners trained in the physical sciences or applied natural resource management. Yet this abstract nature led some participants to assume that social science was “soft,” “less rigorous,” or “simply people’s opinion,” and that physical science (e.g., ecology) should be the basis for management decisions – challenges that plague the social sciences more broadly (Viseu 2015). Because these perceptions can hinder meaningful engagement on the topic for many stakeholders, social scientists are likely starting at a disadvantage when trying to integrate their research or inform management decisions relative to natural sciences. At a foundational level, there is a general lack of understanding regarding what social science is, and what it is not. For this reason, increasing the social science literacy of stakeholders and making the case as to why social science matters is necessary to increase its use in sagebrush management and conservation. This is elaborated on in the “Applying Social Science” section below.

Yet as we had the chance to dive deeper into conversation through interviews and focus groups, many participants came around to recognize that people are critical to management.

“Increasing the social science literacy of stakeholders and making the case as to why social science matters is necessary to increase its use in sagebrush management and conservation.”



In concept, these participants could see value in different social science perspectives and prioritized different research topics. However, identifying tangible ways to integrate insights borne from these research priorities into management and decision making remained a challenge. What eventually emerged from the stakeholder discussions is that the relevance of social science can be distilled down to two primary motivations: 1) understanding how to change other's behavior, and 2) changing one's own behavior. By focusing on the concept of behavioral change, while recognizing it does not encompass the breadth of the social sciences and emphasizes instrumental uses, it may be easier to gain initial support and buy-in for social science research. As this research proceeds, it can help identify additional ways social science research can inform management decisions and the conservation of sagebrush ecosystems beyond the initial emphasis on instrumental uses.

“One of the main perceived values of social science was in determining ways to design interventions to influence behaviors.”

## An emphasis on behavioral change

Much of the discussion during the focus groups regarding the perceived value of social science in natural resources decision making centered around motivating or influencing the decisions and behaviors of others. We often heard comments like, “if we could just get the public to care,” or, “if we could just get [stakeholder group] to [do some action].” At the heart of these comments, we found a desire to understand what motivates individuals, organizations, agencies, corporations, and other entities, to act in particular ways. Once these motivations are understood, they could then be used to influence management decisions among the range of stakeholders in sagebrush systems. Examples highlighted included:

- Understanding influences that play a role in a landowner's decision to adopt conservation practices (e.g., financial incentives or technical assistance);
- Raising public awareness of invasive species to increase support efforts to address the issue (e.g., voting for a mill levy to support their local weed and pest district);
- Documenting the economic benefits of sagebrush conservation to influence state and federal policies.

Ultimately, one of the main perceived values of social science was in determining ways to design interventions to influence the behaviors of others.

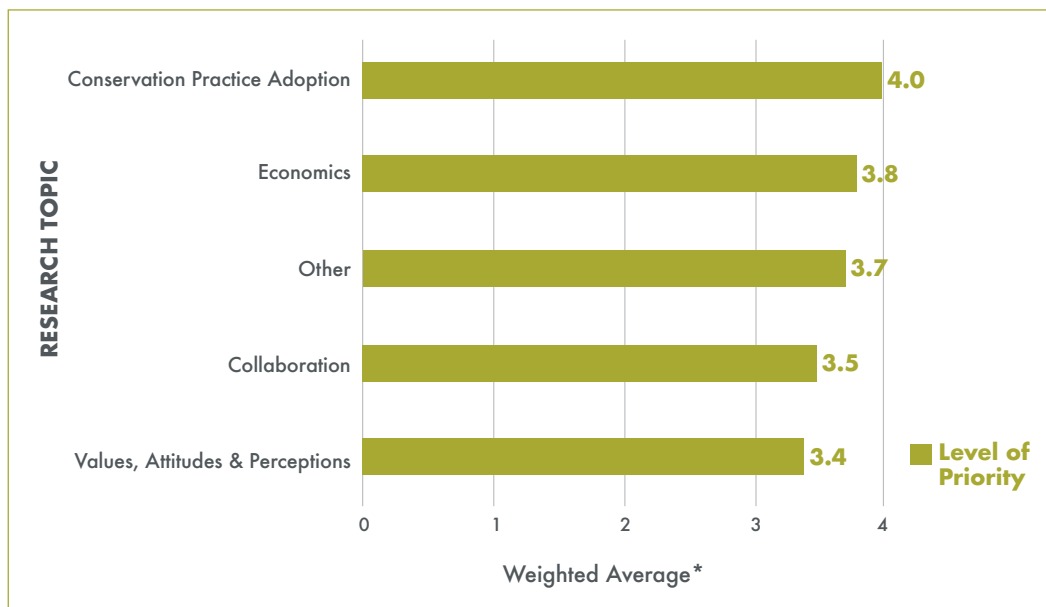
Further discussion regarding the value of social science was more reflective and considered how individuals and agencies could adapt their own actions based on research findings and inform how they accomplish their work. For example, one participant reported, “opinion polls of affected stakeholders...can demonstrate levels of awareness and support for selected actions and solutions.” Understanding the values and attitudes of various segments



of the population or stakeholder groups was highlighted as one research area needed to inform how organizations and agencies communicate their work, conduct outreach, and justify management decisions. Although some participants in our Q-study and focus groups balked at the idea that decisions or management actions should be altered based on public perceptions, others recognized the importance of considering these insights. Those participants that aligned with the latter sentiment appear to be sensitive to the broader social landscape dynamics that impact how they conduct their work. Considering these behavioral change motivations for additional social science research can help explain how research participants prioritized specific research topics.

## Priority Research Topics

Our process considered a wide range of research topics related to the human dimensions of sagebrush management and conservation. We included topics from a broad array of social science disciplines or approaches (e.g., economics, social psychology, collaborative processes) and their application to specific resource issues facing sagebrush ecosystems (e.g., wildfire, invasive species, wild horses and burros). Our goal in this process was to identify how specific social science research perspectives could be applied to better understand how to address resource management challenges. Throughout this process, several social science research themes emerged as top priorities perceived by participants as having the greatest potential to inform sagebrush management and conservation. Figure 2 shows the overall prioritization of research topics. In Appendix C, Figure C1 shows the prioritization of the top ten specific research questions included in the survey while Table C3 reports how focus group participants ranked the research questions before and after the focus group discussion.



\* Weighted average of a 5-point scale from No Priority (1) to Highest Priority (5).

**Figure 2.** Comparison of priority social science research topics.

In the section that follows, we describe each of these thematic areas in detail. It is worth noting, however, that participant perceptions regarding the prioritization of these topics were not static. Although we asked participants in the in the Q-sort, survey, and focus groups to rank topics in terms priority, results were not consistent across the board, and differed by context (geographic location) and audience/participant type (resource manager, NGO, etc.). What's more, we also found that some participants' prioritization of research topics changed following in-depth discussion. Therefore, we emphasize that perceptions around the potential contributions of social science perspectives to particular management needs be considered in context. Additionally, four of the five of the priority research topics (economics, stakeholder values, attitudes, and perceptions, conservation practice adoption, and collaboration) overlap with topics addressed in the literature as identified through the literature synthesis. This suggests a gap in the communication of existing research to practitioners or that existing research is insufficient to inform decisions.

## Economics

Among the topics, economic questions were consistently rated as a high priority to inform the management and conservation of sagebrush ecosystems. Although there were some subtle nuances with regard to the specific economic questions prioritized by participants in each location, this finding holds true for all focus groups, pre- and post-discussion. To be sure, topics like *“Measuring the economic costs and benefits of conserving sagebrush ecosystems,”* and *“Quantifying the economic implications of restoring sagebrush ecosystems affected by fire,”* were routinely ranked by focus group participants as being the highest priority and were two of the three highest prioritized questions in the survey (Appendix C, Figure C1 and Table C3). Participants in several of the focus groups identified economic research as a top priority because they said economic findings are relatively easy to communicate to the general public, particularly to populations living outside of sagebrush areas; management decisions are tied to funding; and, quantifiable data are easy to understand. To a large extent, reasons for prioritizing economic questions appear to be rooted in the assumption that these analyses will influence policy decisions by providing evidence that sagebrush conservation benefits society as a whole. Participants also expressed that additional economic research could inform their own decisions. For example, conservation and restoration efforts are resource-limited, and optimizing budgets through return on investment analyses or similar types of economic studies could help agencies and conservation organizations invest resources efficiently and effectively.

Although economic topics were consistently rated as the highest priority for social science, this finding should be interpreted thoughtfully. Notably, while several participants in the focus groups tended to focus initially on economic topics, throughout the course of the discussion, several focus group participants shifted their perspectives and expressed interest in prioritizing research topics other than economics. For example, at the beginning of the focus group discussions, many participants felt that more and better economic data were key to shifting behaviors and influencing decisions. As one participant noted, “[economic] numbers speak to people,” and economic data were perceived as a “common language” for the public and policy makers. However, as participants examined their logic in more detail, they seemed to recognize the limitations of purely economic analyses in promoting the

“Money drives everything we do. It’s easier to convince people to do something [with economic data].”

– Cheyenne, WY, focus group participant

“Conservation is not simply a dollar and cents conversation, it’s way more complex than that.”

– Fort Collins, CO, focus group participant

conservation of sagebrush ecosystems. For example, several groups raised the issue of whether society should still conserve sagebrush landscapes even if it poses an overall economic cost. These conversations shed light on the benefit of other social science perspectives, like understanding the values and attitudes of diverse stakeholders towards conservation efforts. This shift in mindset was reflected in the focus groups as participants initially ranked economic questions more highly than other topics. At the end of the focus groups, we asked participants to re-rank priorities and while economics remained a high priority, it was evident that other social science questions increased in perceived importance throughout the discussion, and the emphasis on economic questions declined. Additional economic research is still an identified need and should be considered a research priority; however, researchers and stakeholders should consider how specific research efforts will inform management and conservation decisions.



## Stakeholder values, attitudes, and perceptions

In addition to the research topics focused around economics, participants also noted the importance of pursuing research topics that provide a better understanding of community and landowner values regarding sagebrush conservation and management. Additional research to understand the values, attitudes, and perceptions of stakeholders involved with sagebrush management and conservation ranked below economic and conservation practice adoption questions in the survey results and in initial focus group rankings. Yet as conversations in the focus groups progressed, participants increasingly saw the benefit of better understanding the values, attitudes, and perceptions of a diverse set of stakeholders, as well as of broader segments of society (e.g., registered voters). In the initial conversations, few participants chose to rank these types of analyses highly and did not perceive these topics as relevant to informing decisions or behavioral change. However, as focus group conversations progressed, some participants began to acknowledge the ways in which values and related concepts are at the heart of how individuals relate to the natural environment, resource management agencies, and other stakeholders. This realization increased the perceived priority of research on these topics, and some participants expressed the sentiment that in-depth analysis of values, attitudes, and perceptions should form a foundation for additional research. Others felt that better information on these concepts could improve their communication and engagement with stakeholders, and better connect their work to what stakeholders care about. Similarly, open-ended questions from the survey yielded comments such as, “Human dimensions studies about... attitudes, public perception, etc., are valuable,” and “[We] need to understand issues and conflicts that people face and how they want them resolved.”



## Conservation practice adoption

Somewhat related to the topic of stakeholder values, attitudes, and perceptions, is gaining a better understanding of why stakeholders choose to adopt conservation practices. Research topics in this theme primarily focused on understanding the motivations and barriers of landowners or other resource users, such as ranchers, in adopting conservation practices (e.g., grazing plans compatible with sensitive wildlife species) or choosing to participate in conservation programs (e.g., conservation easements, Farm Bill programs). Specific research needs like, “Understanding the compatibility of different conservation practices with landowner goals in sagebrush areas,” were highly prioritized in the Q-study, survey, and focus groups. These types of research questions were particularly emphasized by participants operating in conservation delivery roles, such as private lands biologists and land protection staff with land trusts and other conservation organizations. Prioritizing this type of research could contribute to improved outreach to landowners and resource users about conservation opportunities, as well as inform the development of new conservation programs.

## Collaboration

Over the last decade, extensive collaborative efforts have become widespread throughout sagebrush range areas, particularly with the heightened focus on sage-grouse conservation. Yet collaborative processes and models vary significantly among states and are often driven by local, landscape-scale working groups. This variation creates opportunities to examine different approaches to collaboration, outcomes, and the durability of collaborative agreements overtime. Research topics related to collaboration were prioritized across the Q-study, the survey, and focus groups, just not as highly as economic and conservation practice adoption questions. There was a general consensus among participants that existing collaborative approaches were beneficial, but that there is a need to better understand the strengths, limitations, and applications of these approaches.

## Communication, messaging, marketing

Although communication, messaging, and marketing research topics were not a major focus of the Q-study or survey, these themes did emerge as priorities in the focus group discussions and in open ended comments in the survey (Appendix B, Table B4). Participants consistently emphasized a need for better communication about sagebrush conservation efforts and methods to “get others to care.” Several focus group participants highlighted invasive plant species as one specific resource issue which many sectors of society (e.g., urban populations) do not understand or perceive as a threat, but upon which participants placed a high priority. Communication and marketing strategies could build upon research related to the values, attitudes, and perceptions of stakeholders with a more applied emphasis. While marketing is often not identified within the social sciences, it is an applied social science field that uses similar methods (e.g., surveys, focus groups) to develop campaigns or strategies targeted to specific audiences with the goal of influencing behavior (McKenzie-Mohr et al. 2011, Verissimo et al. 2011). Conservation marketing is increasingly recognized as important to conservation efforts and the Society for Conservation Biology recently established a specific working group and hosted a conference to advance this applied subfield (see Additional

“We can’t be successful at conserving sagebrush unless the people living [in those areas] are behind it.”

– Fort Collins, CO, focus group participant

“It seems fundamental to understand where people are coming from”

– Cheyenne, CO, focus group participant

Resources section below). As more foundational research progresses, there will likely be additional needs and opportunities to incorporate communication, messaging, and marketing strategies to achieve sagebrush management and conservation goals.

## Applying Social Science

### Barriers to using social science

Social science will only be useful to management and conservation of sagebrush ecosystems if it is ultimately used to inform decisions. Ensuring social science is relevant to decision making is key to integrating insights from research (Fox et al. 2006, Cook et al. 2013). Yet there are significant barriers to applying social science. Data from the survey and focus groups showed that decision makers are often not be aware of existing research or do not recognize the relevance of social science to their own work even though the literature synthesis identified 95 articles addressing social science questions relevant to sagebrush ecosystems (Appendix D, Figure D1). Due to the lack of interaction between researchers and stakeholders, social science research has not become broadly recognized as relevant to management decisions. Research is also typically published in peer-reviewed, disciplinary journals that exist behind publisher paywalls and inaccessible to managers and other stakeholders.

An additional challenge is the lack of clear pathways for integrating social science into existing management and decision-making frameworks. For instance, there is no regulatory guidance to indicate that the requirement to include socio-economic data in National Environmental Policy Act (NEPA) documents should include human dimensions variables beyond demographics and economic information, such as values, attitudes, and preferences. Federal agencies currently conduct the minimum amount of social investigation to meet NEPA requirements, and are failing to substantially understand social contexts in natural resource decision-making. The ambiguity around how social science can be integrated into existing decision-making frameworks hinders its use, and does not stimulate demand for additional research.

Multiple participants in the survey and focus groups noted that social science is often difficult to understand and suffers from excessive jargon. The unfamiliar academic language prevents decision makers from understanding the implications and application of research in their work (Cook et al. 2013). Other participants described how social science researchers often pursue theoretical questions that may be relevant to broader academic debates, but are not practical to management decisions or other “on-the-ground” needs.

### Closing the application gap

Making social science more applicable to the management and conservation of sagebrush ecosystems will require a concerted effort on the part of researchers, managers, and other stakeholders to overcome barriers. A consistent theme that was emphasized throughout all of our research steps was the necessity for social scientists to work closely and collaboratively with stakeholders so that research is





tailored to stakeholder needs and communicated effectively. As one survey participant stated, “[We] need to actively engage stakeholders in all aspects of management from data collection through decisions.” Participants highlighted multiple examples of place-based, collaborative social science projects as exemplary models for future research efforts. For example, several social scientists participated in local sage-grouse conservation working groups. Being embedded in these local processes allowed them to understand the context for how their research could inform stakeholder-driven efforts. Building upon these initial examples in a concerted and deliberate manner could help streamline integration of social science insights.

Balancing the need to advance theory and contribute to academic debates with delivering relevant, on-the-ground social science is a challenge that social scientists need to address. While social scientists must publish in social science journals to advance the state of knowledge within their disciplines, such publication outlets are insufficient for stakeholder needs. Addressing this challenge may require a coordinated effort to translate research into broadly accessible formats and engage directly with target audiences through in-person presentations, webinars, extension publications, and other outreach strategies. It may also entail changing how research is conducted by researching questions that are more relevant to decision makers. Conducting research in iterative steps with intermittent feedback from decision makers or other stakeholders may also help facilitate joint learning and ensure research products meet applied needs. As one survey respondent stated, “Relax on the academic rigor of the research because that often creates research products that have little applicability to decision-makers [...] and land managers.” While social scientists should still maintain quality standards in their research, they should report practical significance of their findings in addition to the statistical significance and consider the decision-making needs of end-users. Navigating demands for rigor and professional expectations of social scientists with on-the-ground needs will continue to be a challenge but one worth acknowledging and developing strategies to overcome.

“Social scientists need to work closely and collaboratively with stakeholders so that research is tailored to needs and communicated effectively.”

## Recommendations

Based on the extensive stakeholder engagement process conducted in this research project, we provide the recommendations below to enhance the role of social science in informing management and conservation of sagebrush ecosystems. These suggestions are relevant to the development and implementation of funding programs (e.g., WAFWA’s Sagebrush Science Initiative) and researchers developing research programs to fill the needs of a diverse range of stakeholders.

1.

### **Prioritize decision-making needs, rather than research topics**

A range of specific research topics emerged as research priorities, yet there was no clear understanding about how this research would directly contribute to management and conservation decisions. Instead of prioritizing specific social science research topics, we suggest that funders prioritize research that has clearly defined applications for end users.

2.

## **Develop templates for integrating social science into agency and organizational plans**

To support decision-relevant research, we suggest supporting efforts to pair social scientists with specific land or resource management agencies to develop templates to integrate social science insights into agency documents and plans, for example US Forest Service Forest Management Plans and Bureau of Land Management's Resource Management Plans. These collaborations can help improve the usefulness of social science research as agency staff can help researchers understand the spatial and temporal scales, data formats, and other considerations that are relevant to management decisions. Once initial success is achieved, similar processes can be replicated in other locations to integrate these approaches in other management documents by sharing lessons and providing guidance. For example, the North American Bird Conservation Initiative (NABCI) developed a guide on how to incorporate human dimensions into joint venture implementation plans (see Additional Resources section below).

3.

## **Support collaboration among social scientists and practitioners**

Collaborative research that pairs researchers and practitioners will likely result in significant co-learning outcomes and increase the capacity of researchers and practitioners to integrate social science insights into management and conservation decisions overtime. These funding strategies will help address the identified challenges to applying social science and bridge the gap between academic and theoretically-oriented research with on-the-ground needs of resource managers and other stakeholders. Co-production of research will also enable two-way communication and help practitioners recognize the value of social science theories in understanding issues facing sagebrush ecosystems and inspire new approaches that may be transformative to management and conservation efforts. We recognize that co-developing and co-producing research takes significantly longer to implement, yet the rewards can be substantial. Funding organizations should be sensitive to this challenge in project timelines.

4.

## **Raise the profile of social science by illustrating impact**

Throughout the focus group discussions and in open-ended survey questions, we found evidence that the social sciences were perceived negatively or as irrelevant to some individuals and stakeholder groups. This perception limits opportunities to integrate the social sciences into management and decision making as their value and usefulness are not broadly recognized. Although several federal and state agencies have added social science staff, we recommend funders and researchers develop a deliberate strategy to continue

to raise the profile of the social sciences through targeted communications and trainings. While this strategy could highlight specific social science methods and theories, we feel it is most important to demonstrate the tangible impact social science research has had on real world decision-making and improved management and conservation outcomes. For example, NABCI launched their “Human Dimensions Success Stories” in 2018 to highlight how social science insights have advanced bird conservation efforts. To date, the initiative has highlighted 13 stories to show a diversity of social science applications and could provide a model that could be replicated in sagebrush ecosystems (see the Additional Resources section below). Social scientists are integral to implementing this strategy, but it is also essential for practitioners to tell their story and describe how social science has improved their ability to manage and address resource challenges. This strategy could focus on identifying specific case studies across a range of resource issues facing sagebrush ecosystems and describing how research was used in concrete and accessible language. Participants in this research project mentioned several examples of social scientists participating in collaborations focused on sage-grouse conservation. These examples could form initial case studies. Collectively, efforts to highlight the impact and value of social sciences could prove to be a low cost – high return investment to increase interest in and application of social science research.

“Efforts to highlight the impact and value of social sciences could prove to be a low cost – high return investment.”

## 5.

### **Invest in social science communication strategy**

Few research participants were familiar with current or ongoing social science research related to the management and conservation of sagebrush landscapes. Many participants expressed interest in learning more but were not certain of the best ways to find information. We suggest researchers and funders invest in a communication strategy to share social science insights and assist with recommendation 4. Our survey results indicated that there is no one preferred avenue for communicating social science research findings, so an effective strategy will likely need to include multiple engagement formats, ranging from in-person communication, briefing papers, newsletters, and webinars. One communication model highlighted by multiple participants is the Sage Grouse Initiative’s (SGI) Science to Solutions program, which multiple participants felt was an effective strategy for reaching a diverse array of stakeholders. Research participants also emphasized the SageWest

Communications Network as a useful tool to share information through its listserv and newsletter. We suggest developing a social science communication strategy that is integrated within the SGI or

SageWest infrastructure, or similar frameworks, to reach key constituencies and increase awareness of social science research. Building on these existing efforts is likely to be a more efficient and effective approach than creating a separate communication program from scratch.

6.

## **Develop integrated social-ecological systems or coupled human and natural systems approaches**

Social science research is likely to be more relevant and useful when it is integrated with ecological and other natural sciences. Conceptual frameworks that integrate natural and social sciences, such as social-ecological systems or coupled human and natural systems approaches (Liu et al. 2007, Ostrom 2009, Liu et al. 2015), can be especially helpful in understanding the links between otherwise disparate and independently pursued research. These approaches can help to map social-ecological systems, organize existing knowledge, identify gaps, and diagnose drivers of change within the system and their related feedbacks, such as explicitly recognizing how existing governance structures and power relationships present barriers to conservation action. A body of social science research that does not include a systems approach is likely to be incomplete. We suggest additional research that integrates social and natural sciences through a systems perspective, and this work is likely best done by focusing on a specific landscape within the sagebrush biome and co-produced with local management and conservation practitioners.

7.

## **Build social science capacity within agencies and organizations**

Federal agencies (e.g., USGS, BLM, USFS, USFWS), state wildlife management agencies, and conservation organizations have made significant progress in expanding social science capacity in recent years. Yet this capacity is still insufficient to meet the need and integrate social science perspectives in sagebrush management and conservation. Additionally, while many agencies and organizations support a diverse range of natural science expertise (e.g., wildlife ecologists, fire ecologists, fisheries scientists, hydrologists), the spectrum of social scientists (e.g., sociologists, economists, human geographers, social psychologists) is rarely represented within these institutions. More typically, social scientists need to fill multiple social science needs within their agency or organization, regardless of their specialization within a given field. We recommend management agencies and all types of organizations continue to build social science capacity by hiring additional social scientists and considering the breadth of social science disciplines and how these different perspectives can contribute to addressing resource management challenges.

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# References

- Baruch-Mordo, S., Breck, S. W., Wilson, K., and Broderick, J. 2009. A tool box half full: How social science can help solve human-wildlife conflict. *Human Dimensions of Wildlife* 14: 219-223.
- Bennett, N., Roth, R., Klain, S., Chan, K., Clark, D., Cullman, G., Epstein, G., Nelson, P., Stedman, R., Teel, T., Thomas, R., Wyborn, C., Currans, D., Greenberg, A., Sandlos, J., and Verissimo, D. 2017a. Mainstreaming the social sciences in conservation. *Conservation Biology* 31(1): 56-66.
- Bennett, N., Roth, R., Klain, S., Chan, K., Christie, P., Clark, D., Cullman, G., Curran, D., Durbin, T., Epstein, G., Greenberg, A., Nelson, P., Sandlos, J., Stedman, R., Teel, T., Thomas, R., Verissimo, D. and Wyborn, C. 2017b. Conservation social science: Understanding and integrating human dimensions to improve conservation. *Biological Conservation* 205: 93–108. <https://doi.org/10.1016/j.biocon.2016.10.006>
- Cook, C., Mascia, M., Schwartz, M., Possingham, H., and Fuller, R. 2013. Achieving conservation science that bridges the knowledge-action boundary. *Conservation Biology* 27(4): 669-678.
- Decker D. J., Riley, S.J., Siemer, W. F. 2012. *Human dimensions of wildlife management*. JHU Press, Baltimore, Maryland.
- Fox, H., Christian, C., Nordby, C., Pergams, O., Peterson, G., and Pyke, C. 2006. Perceived barriers to integrating social science and conservation. *Conservation Biology* 20(6): 1817-1820.
- Liu, J., Dietz, T. Carpenter, S., Alberti, M., Folke, C., Moran, E., Pell, A., Deadman, P., Kratz, T., Lubchenco, J., Ostrom, E., Ouyang, Z., Provencher, W., Redman, C., Schneider, S. H., and Taylor, W. H. 2007. Complexity of coupled human and natural systems. *Science* 317(5844): 1513-1516.
- Liu, J., Mooney, H., Hull, V., Davis, S. J., Gaskell, J., Hertel, T., Lubchenco, J., Seto, K. C., Gleick, P., Kremen, C., and Li, S. 2015. Systems integration for global sustainability. *Science* 347(6225): 1258832-1 - 1258832-9.
- Lowe, P., Whitman, G., and Phillipson, J. 2009. Ecology and the social sciences. *Journal of Applied Ecology* 46: 297–305.
- Mascia, M. B., Brosius, J. P., Dobson, T. A., Forbes, B. C., Horowitz, L., McKean, M. A., and Turner, N. J. 2003. Conservation and the social sciences. *Conservation Biology* 17(3): 649-650.
- Manfredo, M.J., Vaske, J.J., Rechkemmer, A., and Duke, E.A., editors. 2014. *Understanding society and natural resources*. Springer, Dordrecht, the Netherlands.
- McKenzie-Mohr, D., Lee, N. R., and Kotler, P. 2011. *Social Marketing to Protect the Environment: What Works*. SAGE Publications, London, UK.
- Newing, H., Eagle, C.M., Puri, R., and Watson, C.W. 2011. *Conducting research in conservation: social science methods and practice*. Routledge, London, UK.
- Ostrom, E. 2009. A general framework for analyzing the sustainability of social-ecological systems. *Science* 325(5930): 419-422.
- Vaccaro, I., Smith, E. A., Aswani, S., editors. 2010. *Environmental social sciences: methods and research design*. Cambridge University Press, Cambridge, UK.
- Verissimo, D., MacMillan, D. C., Smith, R. J. 2011. *Toward a systematic approach for identifying conservation flagships*. *Conservation Letters* 4: 1-8.
- Viseu, A. 2015. Integration of social science into research is crucial. *Nature* 525: 291–291.



# Additional Resources

The following resources maybe helpful for those interested in learning more about the social sciences and their application to natural resource management:

## HDgov – Human Dimensions

HDgov is a multi-agency website that provides a wide range of resources on human dimensions relevant to natural resource management. <https://my.usgs.gov/hd/>

## National Oceanic and Atmospheric Administration’s (NOAA) Social Science Basics

NOAA provides an online training on social science basics relevant to resource managers interested in learning more about social sciences and working with researchers. [https://training.weather.gov/nwstc/socialscience/presentation\\_html5.html](https://training.weather.gov/nwstc/socialscience/presentation_html5.html)

## The North American Bird Conservation Initiative (NABCI)

NABCI is a forum of government agencies, private organizations, and bird conservation initiatives helping partners across the continent accomplish common bird conservation objectives. The Human Dimensions Subcommittee of NABCI (<http://nabci-us.org/how-we-work/human-dimensions/>) has been working to integrate insights from the social sciences into bird conservation efforts. Their website provides numerous resources that could inform efforts in sagebrush ecosystems including Human Dimensions Success Stories (<http://nabci-us.org/success-stories/>), a guide to incorporating human dimensions into joint venture implementation plans (<http://nabci-us.org/wp-content/uploads/2019/05/Incorporating-Human-Dimensions-into-Joint-Venture-Implementation-Plans.pdf>), and brief introductions to the value of human dimensions work to conservation (<http://nabci-us.org/wp-content/uploads/2016/04/NABCI-HD-Fact-Sheet-8-18-17.pdf>).

## Partnering to Conserve Sagebrush Rangeland

The Partnering to Conserve Sagebrush Rangeland is a collaborative effort to conserve sagebrush rangeland across public and private lands. Their website, <https://www.partnersinthesage.com/>, includes diverse resources including communication efforts on social science resource.

## Society for Conservation Biology (SCB)

SCB’s Social Science Working Group and its associated listserv supports conservation practitioners in exchanging resources and building social science capacity (<https://conbio.org/groups/working-groups/social-science>). SCB’s Conservation Marketing & Engagement Working Group (<https://www.consmark.org/>) promotes “awareness, acceptance, and use of scientifically-supported marketing techniques and strategies” in support of conservation efforts. The working group hosted a conservation marketing conference in 2018 with trainings for conservation practitioners and research talks on the application of marketing techniques in conservation. The group plans to host its second conference in 2020.

## The Wildlife Society (TWS)

TWS’s Human Dimensions Working Group promotes the study and transfer of information related to social aspects of wildlife management by providing a forum for sharing findings and collaborating on research. <https://wildlife.org/HDWG/>

# Appendices

## Appendix A - Q-study

### Key findings

We explored peer-reviewed and grey literature for social science needs in relation to sagebrush ecosystems. The 36 statements (Table A1) that resulted were sorted by 40 sagebrush professionally involved individuals in Colorado, Idaho, Oregon and Wyoming, after which each participant was interviewed. Five themes of social science subjects important to professionals for whom sagebrush ecosystems are a key focus resulted from the Q-study part of our research. We identified the five themes as Conservation, Sagebrush Users, Values and Perceptions, Economics and Landowners. The highest-ranking priority subjects were then used in our survey to explore the extent to which sagebrush related stakeholders agreed with those subjects and those rankings in their conservation and management efforts.

### Methods

We went through a variety of secondary sources (grey literature, newspaper articles, meeting minutes, etc.) to establish the variety of social science needs that have emerged from the discourse regarding sagebrush ecosystems. From these secondary literature sources, we compiled a list of 36 statements that each represent a different social science need in relation to sagebrush ecosystems. We identified professionals in the four states who are daily active in sagebrush management and invited them via email to participate in this online Q-study. We use the online software program QsorTouch.com to administer the q-sort exercise (Figure A1). By ranking the statements from Highest Priority to Lowest Priority, followed by a short interview (Table A2) to explore participants' rationale for their rankings, we were able to identify the research needs that emerged for these professionals, and the relative priority of those research needs. Data analysis tools used in the Q-study included Microsoft Excel and R-software (statistical analysis).

### Results

The five factors that resulted from data analysis were:

#### **Factor 1:** Social Science related to Sagebrush Conservation

This theme is more concerned with sagebrush ecosystems generally and not with any specific interest. Subjects such as non-native species, restoration of sagebrush and the economics related to both were ranked high as social science subjects to investigate further. The motive appears to be conservation of sagebrush ecosystems and within that context participants are interested in tools such as collaboration, government assistance against cheatgrass, credit markets and economic incentives. Subjects such as oil and gas, ranching specifically, social drivers, and any one particular interest are not ranked high.

#### **Factor 2:** Social Science related to Extractive Uses

In this theme the interests of oil and gas companies and ranchers are ranked highly. It is a very applied theme in the sense that the tools that are immediately usable to people on the ground are ranked highest. Statements regarding information needs related to grazing, oil and gas, how to enable collaboration, restoration and the economics related to all of this feature highly. Statements related to the military, exploring public perceptions, whether land is converted to cropland or ex-urban environments are not.

#### **Factor 3:** Values and Perceptions

This is the one theme that puts a heavy emphasis on social perceptions and interactions. While most other themes rank collaboration statements positively, this one ranks the social science behind collaboration relatively high, i.e. an understanding of social perceptions, values, opinions and preferences. In this theme. On the ground aspects such as oil and gas, military, grazing impacts and credit markets are ranked lowest.

#### **Factor 4:** Economics

The first three statements are directly related to the economic value of sagebrush, sagebrush uses and sagebrush restoration treatments. In this theme the value of making sagebrush ecosystems economically viable is ranked highly. There is also a strong agricultural flavor to this theme since statements related to cheatgrass, ranching and grazing also are ranked relatively high. Lower ranked statements concern oil and gas, military, conservation easements, and generally social science needs such as public and landowner perceptions.

**Factor 5: Landowners**

The participants who loaded on this theme are big picture people, who work on sagebrush ecosystems issues across the region or a state. The statements ranking highly concern collaboration, cheatgrass, livestock and economics. The perspective is not one of a rancher, but of participants wishing to enable sagebrush conservation while meeting the needs of landowners. Hence, incentives feature higher such as credit markets and conservation easements. Lower ranking statements include oil and gas, military, economics and exploration of economic trade-offs.

**Supplemental**

Table A1. Statements derived from literature review and used in Q-study.

1. We need to explore ways for collaborative agreements to stay in place across governmental administrations at the federal and state levels for successful management.
2. We need to know how to enable sincere collaborative efforts among non-governmental, private, state and federal entities that is supported across administrations.
3. We need to have social science data we can integrate with ecological data to identify conservation opportunities.
4. We need to find out what incentives exist that persuade private landowners to undertake conservation practices.
5. We need to understand the motivations of land managers to adopt conservation practices and behaviors.
6. It is essential to evaluate the effectiveness of conservation easements to ensure the public trust is well served.
7. We need to know in what ways a healthy sagebrush ecosystem is an economic driver for Western economies.
8. We need to know how the protection and conservation of sagebrush ecosystems will affect economies.
9. It is important to adaptive management to identify the environmental drivers of restoration success and their financial ramifications.
10. We need more information on how to develop and implement regional credit markets in relation to sage grouse habitat.
11. We need to quantify the economic consequences of the continued expansion of exotic annual grasses and other invasive plants on sagebrush ecosystems.
12. We need more information regarding the ways the government can prevent the spread of invasive plants such as fire-prone cheatgrass.
13. We need more knowledge on the impact of indirect human activities.
14. What are landowners' perceptions on the effectiveness or appropriateness of various sagebrush treatments?
15. We need more information on the social drivers and social-ecological effects of converting ecosystems from sagebrush to cropland.
16. We think the sage-grouse are staying with the cows. We need scientific evidence that cattle grazing provides protection to sage grouse.
17. We need more information on grazing impacts and benefits to sagebrush conservation.
18. We need to know how sagebrush protection will affect military programs.
19. We need more knowledge about oil and gas development to know if more exploration and production will disturb sagebrush ecosystems.
20. We need more social science to know how to balance human land-use needs such as ranching with the needs of species that depend on sagebrush.
21. We need more understanding of the unique challenges and opportunities related to ranching on sagebrush lands.
22. We need to know more about the social drivers and social-ecological effects of converting ecosystems from sagebrush to ex-urban developments.
23. In light of historically negative perceptions regarding sagebrush, it is important to measure current human values related to these ecosystems.
24. We need more data regarding citizens' opinions and perceptions about rangeland management in sagebrush ecosystems.
25. We need data regarding trust in resource managers and how citizens judge the nature of their interactions with resource agencies.
26. It is important to identify and characterize any differences between rural and urban residents who may have different expectations regarding sagebrush management.
27. We need to study public acceptance of sagebrush ecosystem management practices.
28. It is important to study public perspectives regarding rangeland management on sagebrush state by state.
29. We need to be able to understand and compare conservation norms between different stakeholder groups.
30. Social science data can be a tool to initiate collaborative, place-based discussions by creating an accurate picture of community values.
31. It is important to find ecologically and economically effective ways to establish indigenous plant species to allow for restoration success.
32. We need social science information to help us understand the uses that stakeholders perceive as damaging to restored sagebrush.
33. We need to know the extent to which stakeholder groups perceive uses of sagebrush ecosystems to be damaging?
34. We need to keep learning about what's working in this landscape and we need to incorporate social science into our decisions in the future.
35. We need valid and reliable social science based on empirical evidence.
36. We need more social science to inform effective science delivery to landowners.

Figure A1. Participants sorted the 36 statements in an online diagram according to their prioritization of the social science subject.

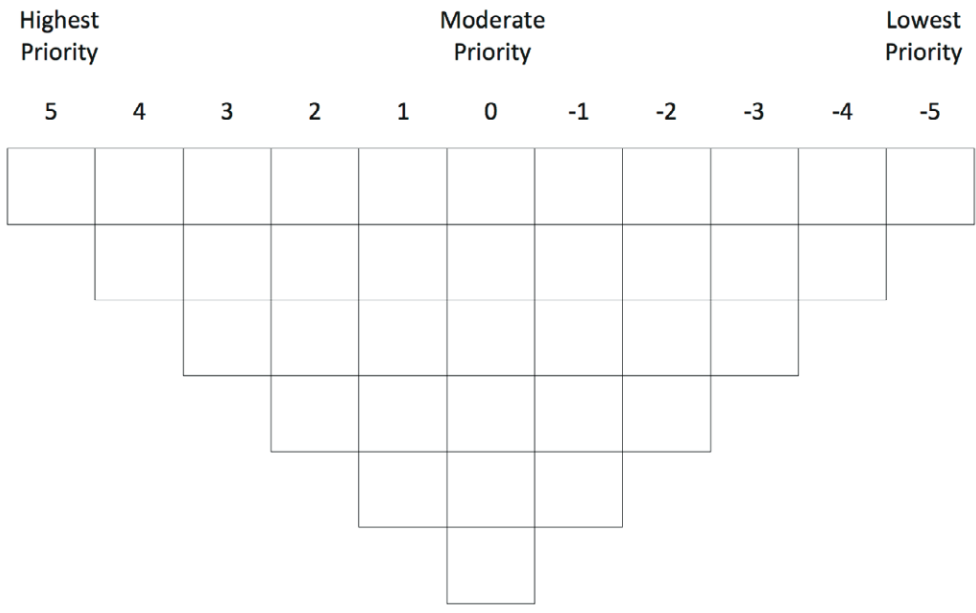


Table A2. Q-study interview protocol employed after the Q-sort was completed.

Q-study Interview Protocol
<b>About You:</b>
1. What is your title at ____ (said organization) ?
2. How would you define your stakeholder type?
3. How are you involved in sagebrush management?
4. How long have you been involved in working with sagebrush ecosystems?
<b>About the Q-sort</b>
1. What statements reflect your highest priorities for sagebrush social science? Why?
2. What statements reflect your lowest priorities for sagebrush social science? Why?
3. Why are statements in the moderate priority section of your Q-sort?
4. Were there any statements you had difficulty placing? Why?
5. Are there any social science research needs missing from the Q-sort?
<b>About Sagebrush Social Science Needs</b>
1. Is there any social science that you have been using, or know has been used, in sagebrush management?
2. In addition to the Q-sort above, and in your own words, please tell me what social science needs exist that would help in sagebrush management?
3. From what sources do you obtain your information about sagebrush ecosystem management?
4. In your opinion, what is the most effective way to share social science information regarding sagebrush ecosystems?
5. Is there anything else you would like to add that I haven't asked you about regarding sagebrush social science needs?
6. Do you have questions for me [the interviewer]?

## Appendix B - Survey

### Key findings

Some of the broad themes that emerged and were consistent among the survey questions included investigating community values/perspectives, engaging local stakeholders, conducting economic analysis, evaluating management practices/decisions, and understanding certain relationships/dynamics (at all levels; local, state, federal). These themes also reinforce the Q-study and were substantiated by the focus group results. Based on rating level of preference and rating level of priority of social science topics and needs questions, items related to conservation practice adoption and economics were marked high.

Similarly, the open-ended questions and additional comments mentioned economic related items, however, there was also a repeated pattern of comments describing the need for better communication and increased collaboration among agencies and organizations, as well as integrating social science information early on in management processes. Moreover, these agencies and organizations need to better communicate and engage local stakeholders and communities to gain insight on their values and perspectives. Local, state and federal agencies/governments could be better partners in improving sagebrush management and conservation by hiring skilled social scientists or having more training on social science approaches for personnel that interface with the public, landowners and/or local communities. In order to achieve this, respondents commented that collecting social data from people (i.e. survey, interviews, or in-person meetings), collaborating and relationship building could be effective methods. One constant remains clear: there is a continued need for additional social science research and to explore ways to utilize data in a practical way that benefits the overall health of sagebrush ecosystems.

### Methods

The survey consisted of 18 questions, which were developed based on the results of the Q-study analysis (see Appendix A, Supplemental, Table A1.). The survey was distributed via Survey Monkey to over 700 participants and was active for one month (late April to late May 2019). The list of invitees was primarily generated by a WAFWA funded project about network analysis in Sagebrush rangelands. Another invitee source was the SageWest ListServ. Data analysis tools included Survey Monkey, Excel and MaxQDA (Qualitative Data Analysis).

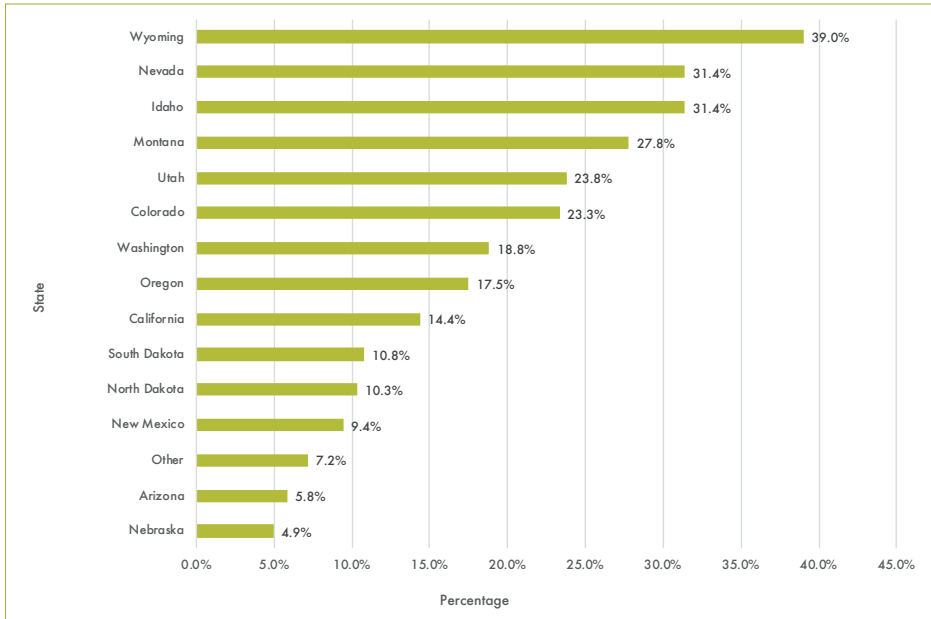
### Results

There were 222 responses making the response rate just a little over 30 percent. Among those responses, there was an 87 percent completion rate. There was a wide range of age of respondents and years of working with sagebrush related topics. Respondents came from various stakeholder groups and all sagebrush rangeland states were represented, as well as Canada and Washington DC. Over 90 percent of respondents had a college degree or higher.

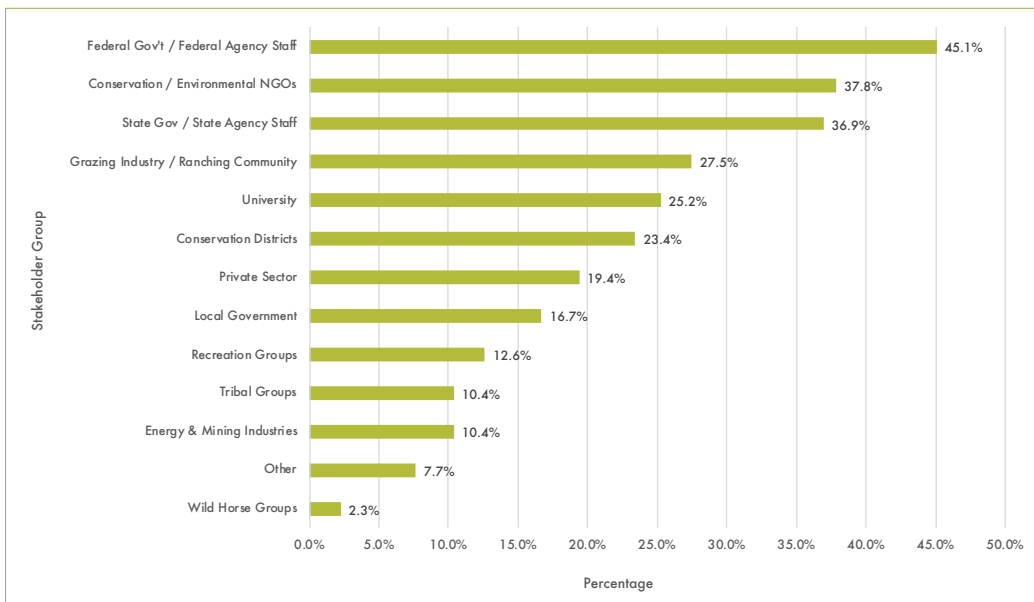
Table B1. Demographic information: age, years involved in sagebrush ecosystem matters, gender, highest level of education.

Age	Years
Mean	46.7
Median	40.5
Range	31 to 79
Years involved in sagebrush ecosystem matters	Years
Mean	15.18
Median	26
Range	1 to 46
Gender	Percentage
Female	39.8%
Male	56.6%
Prefer not to specify	3.6%

Highest level of education	Percentage
Master's	45.6%
Bachelor's	29.7%
Doctorate or JD	19.0%
Some College, or Associate, Technical or other education	6.7%



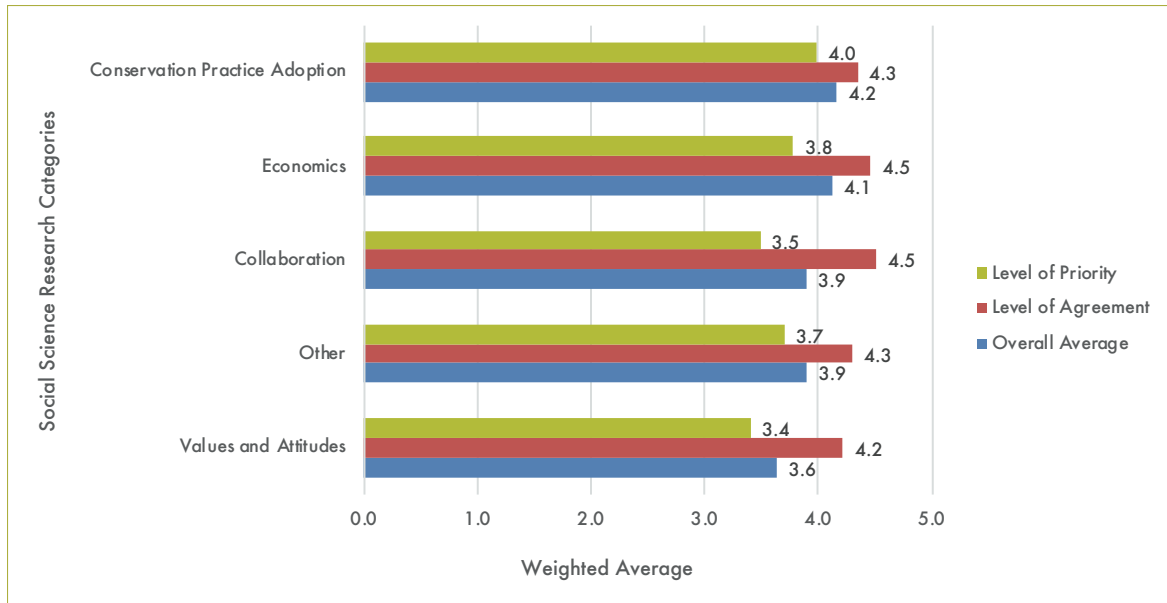
\*Total percentage exceeds 100% because respondents could choose more than one state/location.  
 Figure B1. State where respondents currently work or are involved with Sagebrush Issues.



\*Total percentage exceeds 100% because respondents could choose more than one group.  
 Figure B2. Stakeholder group respondents identify with.



Participants were asked to rate their level of agreement of 14 statements (determined as most prevalent from the Literature Review and Q-sort). These statements articulate topics on social science needs regarding sagebrush ecosystems. Participants were also asked to rate their level of priority for 20 social science research topics that emerged from previous research steps. The social science research topics and needs can be encompassed in the following categories: conservation practice adoption, economics, collaboration, values and attitudes and other. The following graph compares the average weighted value of the combined topics and needs compared to the level of agreement versus the level of priority, respectively.



\*Weighted average of a 5-point scale from Do Not Prefer (1) to Strongly Prefer (5).

Figure B2. Social Science Research Categories Comparison.

In addition, participants were asked about their preference and opinion about communication of social science research. Because a majority of respondents were professionals, much of the preferred method of learning about social science research centered on peer-reviewed publications, webinars and briefing papers. In comparison, when asked about the best way to share social science information regarding sagebrush ecosystems to the public, respondents thought the best methods were social media, in-person communication and newspapers.

Table B2. Respondents’ preferred method of learning about social science research.

Respondents’ Preferred Method of Learning About Social Science Research	
Method+	Weighted Average*
Peer reviewed publications	3.74
Webinars	3.65
Briefing papers	3.83
Social media	2.58
In person communication	4.08
Newspapers	2.65

Magazines	2.75
Agency website	3.01
Third party website	2.57
Email / Listservs	3.25
Radio	2.42
Podcast	2.7

+Other methods: video/tv, conferences, workshops, and newsletters

\*Weighted average of a 5-point scale from Do not Prefer (1) to Strongly Prefer (5)

Table B3. Best way to share social science information regarding sagebrush ecosystems with the general public.

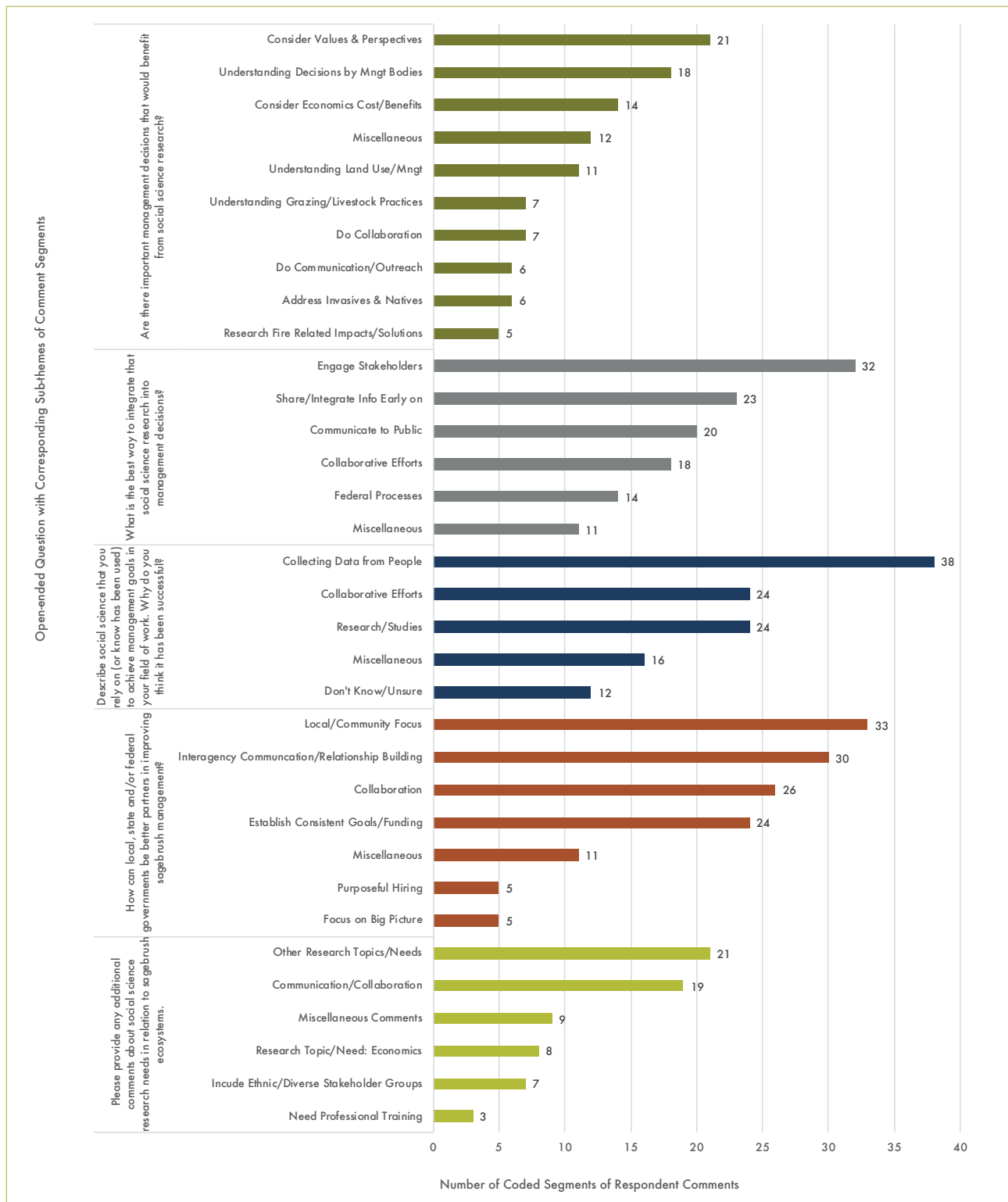
Best Way to Share Social Science Information Regarding Sagebrush Ecosystems with the General Public	
Method+	Weighted Average*
Social media	54.50%
In person communication	49.50%
Newspapers	40.00%
Radio	35.00%
Magazines	31.00%
Podcast	30.00%
Briefing papers	25.50%
Webinars	23.00%
Email / Listservs	22.50%
Third party website	19.50%
Agency website	19.00%
Peer reviewed publications	17.50%
Other	8.50%

+Other methods: visuals with images, such as videos through TV or internet broadcast, and workshops.

\*Total percentage exceeds 100% because respondents could choose more than one method

There were 5 open-ended questions that appeared throughout the survey. The comments were coded and categorized into the follow sub-themes for each question.

Table B4. Sub-themes of coded segments of respondent comments



\*Coded segments represent a portion of a respondent's comment. A comment could be segmented multiple times for appropriate sub-themes. Therefore, the number of segments is more than the total number of respondent comments.

## Supplemental

### Survey Questions

1. What is your job title? [open field]
2. In what state(s) do you currently work on or are involved with sagebrush issues?
  - a)
  - b) AZ
  - c) CA
  - d) CO
  - e) ID
  - f) MT
  - g) NE
  - h) NV
  - i) NM
  - j) ND
  - k) OR
  - l) SD
  - m) UT
  - n) WA
  - o) WY
  - p) Other\_\_\_\_\_
3. What stakeholder group(s) do you identify with?
  - a) Conservation Districts
  - b) Conservation / Environmental NGOs
  - c) Energy & Mining Industries
  - d) Federal Gov / Federal Agency Staff
  - e) Grazing Industry / Ranching Community
  - f) Local Government
  - g) Private Sector
  - h) Recreation Groups
  - i) State Gov / State Agency Staff
  - j) Tribal Groups
  - k) University
  - l) Wild Horse Groups
  - m) Other\_\_\_\_\_
5. How many years have you been involved in sagebrush ecosystem management, conservation, and/or related matters?  
[open field]
6. Please indicate your level of agreement for the following statements.
  - 1 - strongly disagree
  - 2 - disagree
  - 3 - neutral (neither agree nor disagree)
  - 4 - agree
  - 5 - strongly agree
  - 6 - Unsure / Do not know

1) It is important to find ecologically and economically effective ways to establish indigenous plant species to allow for restoration success.
2) We need to quantify the economic consequences of the continued expansion of invasive plants on sagebrush ecosystems.
3) We need to know how to enable sincere collaborative efforts among non-governmental, private, state and federal entities that is supported across administrations.
4) We need to understand the motivations of land managers to adopt conservation practices and behaviors.
5) We need to have social science data we can integrate with ecological data to identify conservation opportunities.
6) We need more social science to know how to balance human land-use needs such as ranching with the needs of species that depend on sagebrush.
7) Social science data can be a tool to initiate collaborative, place-based discussions by creating an accurate picture of community values.
8) It is important to understand different expectations between rural and urban residents regarding sagebrush management.
9) We need to know in what ways a healthy sagebrush ecosystem is an economic driver for Western economies.
10) We need to know how the protection and conservation of sagebrush ecosystems will affect economies.
11) For adaptive management to work, it is important to identify the environmental drivers of restoration success and their financial ramifications.
12) We need more information regarding ways to prevent the spread of invasive plants such as fire-prone cheatgrass.
13) We need to explore ways for collaborative agreements to stay in place across governmental administrations at the federal and state levels for successful management.
14) We need to keep learning about what is working in this landscape and we need to incorporate social science into our decisions in the future.

7. Continued: Please indicate your level of agreement for the following statements.

8. Please rate your level of priority for the following social science research topics.

- 0 - Unsure / Don't know
- 1 - Not a priority
- 2 - Very Low priority
- 3 - Moderate priority
- 4 - High priority
- 6 - Top priority

1) Understanding the situations in which collaboration is an appropriate tool to reach agreement on sagebrush management.
2) Quantifying the economic impacts of invasive species.
3) Evaluating the durability of collaborative agreements to political changes.
4) Measuring the economic costs and benefits of conserving sagebrush ecosystems.
5) Studying how community values can be integrated into sagebrush management.

6) Documenting local knowledge of sagebrush ecosystems.
7) Evaluating different planning approaches to balance energy development in sagebrush environments.
8) Surveying public attitudes towards land management agencies.
9) Assessing the importance of outdoor recreation to local economies in sagebrush areas.
10) Understanding how different stakeholders interpret sagebrush issues.
11) Quantifying the economic implications of restoring sagebrush ecosystems affected by fire.
12) Evaluating the effectiveness of early detection and rapid response strategies in addressing the spread of invasive species.
13) Documenting the compatibility of different grazing practices with sagebrush conservation.
14) Measuring the economic impact of listing sagebrush dependent species under the Endangered Species Act.
15) Developing methods to incorporate local knowledge into sagebrush management.
16) Mapping community values of sagebrush ecosystems.
17) Understanding public perceptions of different sagebrush management practices.
18) Understanding the compatibility of different conservation practices with landowner goals in sagebrush areas.
19) Studying stakeholders' willingness to engage in collaborative processes
20) Understanding the energy industry's role and willingness to mitigate impacts to sagebrush ecosystems.

9. Continued: Please rate your level of priority for the following social science research topics.
10. Are there important management decisions that would benefit from social science research? [open ended]
11. What is the best way to integrate that social science research into management decisions? [open ended]
12. What is your preferred method of learning about social science research?
  - a) Peer-reviewed publications
  - b) Webinars
  - c) Briefing papers
  - d) Social Media
  - e) In person communication
  - f) Newspapers
  - g) Magazines
  - h) Agency website
  - i) Third party website
  - j) Email / Listservs
  - k) Radio
  - l) Podcast
  - m) Other\_\_\_\_\_
13. In your opinion, what is the best way(s) to share social science information regarding sagebrush ecosystems with the general public?
  - a) Peer-reviewed publications
  - b) Webinars
  - c) Briefing papers

- d) Social Media
- e) In person communication
- f) Newspapers
- g) Magazines
- h) Agency website
- i) Third party website
- j) Email / Listservs
- k) Radio
- l) Podcast
- m) Other\_\_\_\_\_

15. Describe social science that you rely on (or know has been used) to achieve management goals in your field of work. Why do you think it has been successful? [open ended]

16. How can local, state, and/or federal governments be better partners in improving sagebrush management? [open ended]

17. Please provide any additional comments about social science research needs in relation to sagebrush ecosystems. [open ended]

18. Age [open field]

19. Gender
- a) Female
  - b) Male
  - c) Non-binary
  - d) Prefer not to specify

18. Highest Level of Education?
- a) High school diploma / GED
  - b) Associate's
  - c) Technical Degree
  - d) Some college
  - e) Bachelor's
  - f) Master's
  - g) PhD

Other\_\_\_\_\_



## Appendix C - Focus Groups

### Key findings

Findings from the focus group discussions in four western states reveal a fair amount of consensus among the focus groups participants in terms of identifying top priority topics for social science research to contribute to the conservation and management of sagebrush ecosystems. Chief among them was a focus on gaining a better understanding of the costs and benefits associated with conserving sagebrush ecosystems. Participants in several of the focus groups identified economic research as a top priority because they said economic findings are relatively easy to communicate to the general public, particularly to populations living outside of sagebrush areas; management decisions are tied to funding; and, quantifiable data are easy to understand. However, throughout the course of the focus group discussions, participants expressed increased interest in research topics that move beyond simply economic values to more nuanced ideas of value, for example understanding community values and landowner goals and motivations for decision making. Interest in research focused on values other than economic values was especially apparent in the Fort Collins, CO focus group.

Some research priorities identified by focus group participants varied from location to location, and may be explained by each specific context. For example, while focus group participants in Wyoming and Colorado showed interest in research topics related to energy development, participants in Idaho and Oregon were substantially less interested in prioritizing these research topics. This is likely due to the fact that, while energy development plays a large role in the economies of both Wyoming and Colorado, it plays a far lesser role in the economies of Idaho and Oregon. Similarly, although wildfire is a threat to sagebrush ecosystems in all states where focus groups were held, an interest in prioritizing research topics focused on or related to understanding and quantifying the economic implications of restoring sagebrush ecosystems was far more pronounced in Oregon and Idaho (respectively), where devastating wildfires have occurred in recent years. It's worth noting, however, that an interest in prioritizing research topics related to fire also ranked highly in Wyoming as well.

When asked how social science could best be incorporated into management decisions, focus group participants tended to focus on communication strategies, going so far as to even suggest that social science research should focus on how best to market or advertise conservation or management messages to the general public and other stakeholders. Participants emphasized the importance of trust and relationship building on behalf of social scientists and decision makers, and identified the Sage Grouse Initiative as an example of a trusted source of information that has had some success in influencing sagebrush conservation and management decision making.

With regard to the perceived barriers to incorporating social science into resource management decisions, participants offered several ideas. First, participants perceived a general lack of funding for social science research and of social scientists working in sagebrush country. Participants also noted that social science research “takes a long time” to conduct, and that decision makers are more likely to rely on quantifiable data that is readily available as opposed to waiting for findings from social science research that is often laced with uncertainty. This also brings up a recognition on behalf of focus group participants about a general unease, and/or, lack of understanding about what social science is and how it could be used to inform conservation and management of sagebrush ecosystems on the ground. In addition, participants in at least two of the focus groups identified the rural—urban divide as a perceived barrier to incorporating social science research into sagebrush management. Finally, participants described a lack of coordination between resource agencies at the federal, state, and local level as precluding the integration of social science research into management decisions, and also noted high turnover of staff in agencies as problematic for integrating social science research into management.

### Methods

The focus groups took place in Cheyenne, WY (June 25), Fort Collins, CO (June 27), Boise, ID (July 12) and Prineville, OR (July 15). Potential participants were identified through known contacts, suggestions from other professionals and previously contacted individuals. The focus group protocol was based on the survey results with an emphasis on discussing the rationale for prioritizing certain research topics that came out of the survey. In particular, the participants were asked to rank research topics 1 through 10 (1 being highest priority) and give a weighted value in which they distributed 10 points among the research topics how they saw fit. Finally, participants were given the opportunity to re-weigh the 10 points, if their feelings changed after the group discussion. The opportunity to re-weigh was formalized after the first focus group in Cheyenne.

## Results

A total of 38 individuals participated in the focus group discussions across the four locations. Table C1, below, provides a general overview of the makeup of each focus group, including representation by different stakeholder groups.

Table C1. Description of focus group participants

Focus group location	Stakeholder/Organizational representation
Cheyenne, WY focus group (N=10)	USFS (2), State agency (4) NGO (4)
Fort Collins, CO focus group (N=10)	BLM (1), USDA (1), NGO (8)
Boise, ID focus group (N=9)	USGS (1), State agency (6), NGO (1), Academia (1)
Prineville, OR (N=9)	BLM (3), State agency (5), NGO (1)

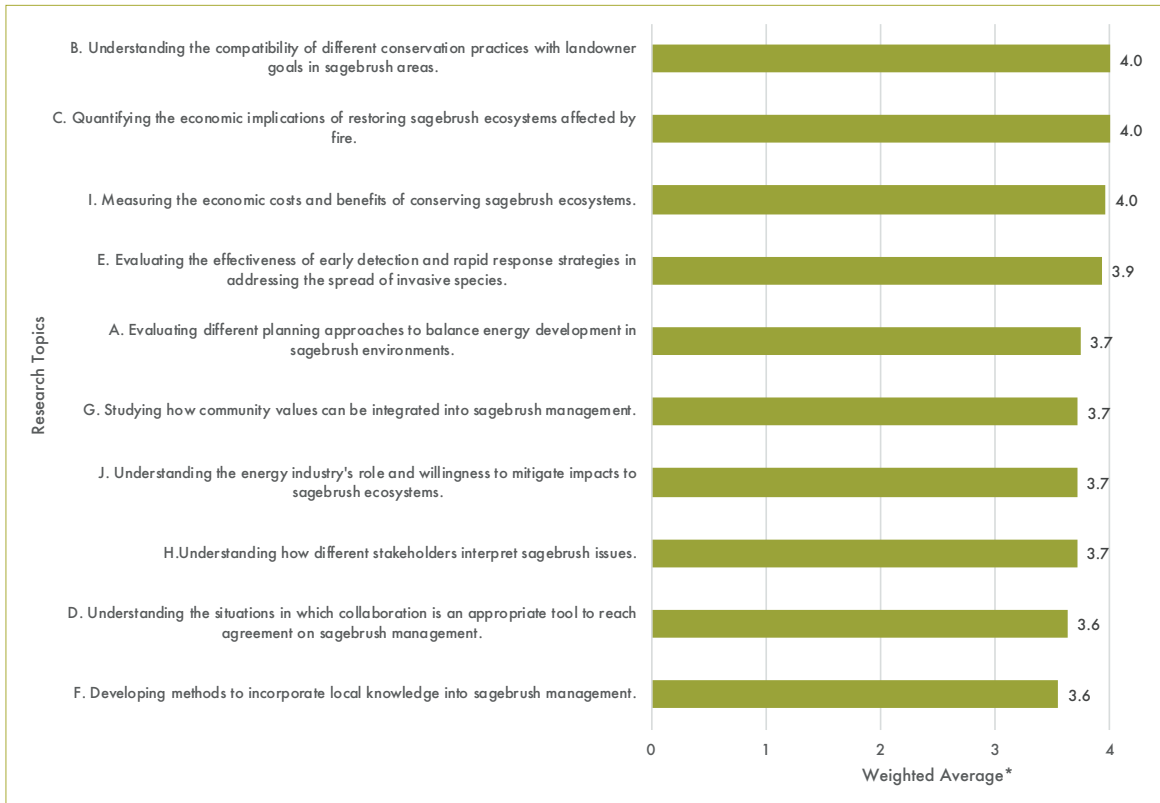
### Results of ranking exercise

Below is a list of the top 10 research topics that emerged from the survey that focus group participants were asked to rank and weight in terms of priority at the beginning of the focus group discussions (Table C2, Figure C1). Participants at the Fort Collins, CO; Boise, ID; and Prineville, OR focus groups were also given the opportunity to re-weight the research topics at the end of the focus group discussions in case their ideas and/or perceptions about the research topics changed in the course of the conversation.

Table C2. Top 10 research topics from the survey. \*

Research topic	
A	Evaluating different planning approaches to balance energy development in sagebrush environments.
B	Understanding the compatibility of different conservation practices with landowner goals in sagebrush areas.
C	Quantifying the economic implications of restoring sagebrush ecosystems affected by fire.
D	Understanding the situations in which collaboration is an appropriate tool to reach agreement on sagebrush management.
E	Evaluating the effectiveness of early detection and rapid response strategies in addressing the spread of invasive species.
F	Developing methods to incorporate local knowledge into sagebrush management.
G	Studying how community values can be integrated into sagebrush management.
H	Understanding how different stakeholders interpret sagebrush issues.
I	Measuring the economic costs and benefits of conserving sagebrush ecosystems.
J	Understanding the energy industry's role and willingness to mitigate impacts to sagebrush ecosystems.

*\*Not in any particular order. These were presented to focus group participants to rank.*



\*Weighted average of a 5-point scale from No Priority (1) to Highest Priority (5).  
 Figure C1. Top 10 research topics from the survey.

Table C3, below, presents the aggregate results from the first iteration (pre-focus group discussion) of the research topic prioritization weighting exercise for all locations. Note that research topics in the tables are organized by score, from highest to lowest priority.

Table C3. Aggregate results from pre-focus group discussion prioritization weighting exercise for all focus groups

Topic	
Iteration 1	I C G B H E D F A J
Total	71 54 45 43 35 34 33 28 22 15

As seen here, focus groups participants afforded the highest priority to research topics related to quantifying the economic costs, including topic I (Measuring the economic costs and benefits of conserving sagebrush ecosystems) and topic C (Quantifying the economic implications of restoring sagebrush ecosystems affected by fire). Other research topics rated highly by participants included topic G (Studying how community values can be integrated in sagebrush management) and topic B (Understanding the compatibility of different conservation practices with landowner goals in sagebrush areas).

When prompted to describe why they prioritized certain topics over others, participants in each of the focus group discussions described the importance of being able to describe sagebrush conservation and management in terms of economics:

- *“Money drives everything we do,” said one participant in the Cheyenne, WY focus group. “It’s easier to convince people to do something [with economic data].”*
- *“People relate to stories when it’s told [in terms of] economics. On topics like invasive [species], it’s an easier story to tell when there’s economics.”*
- *“Sociology is fine, but I live a dollar and cents world now,” said another participant in the Fort Collins, CO focus group. “Being able to show economic benefits is important for landowners that need to understand how [management decisions] impact their bottom line.”*
- *“For any management decision that goes on, we’re working with limited funds. We need to be able to prioritize where to invest those funds.”*
- *“Economics is what matters at the end of the day.”*
- *“Economics are the drivers and the threats [to sagebrush ecosystems]. Subdivisions, energy developments—those are the driving threats.”*
- *“I ranked economic topics high because money is a way the public can understand and relate to [the issues].”*

Particularly among participants in the Prineville, OR focus group, there was a perceived need for economic information to help communicate the importance of conserving and managing sagebrush ecosystems to urban populations that live outside sagebrush areas, although this sentiment was also communicated in the Cheyenne, WY focus group as well.

While there was general agreement regarding the importance of being able to frame sagebrush conservation and management issues in terms of economics, not all focus group participants felt economics was the most important research topics to study. Indeed, some focus group participants said they chose not to prioritize economics-related research topics specifically because, “we already know a ton about the economic pieces of these issues.”

In addition to the research topics focused around economics, participants also noted the importance of pursuing research topics that get at gaining a better understanding of community and landowner values regarding sagebrush conservation and management. Although this perspective was present in each of the focus group discussions, it was particularly evident in the Fort Collins, CO focus group, where a spirited debate ensued about whether economic values vs. other values (e.g., human, cultural, familial, etc.) should be prioritized. We surmise this may be due to the increased representation at the Fort Collins focus group by stakeholders from non-governmental organizations (NGOs) who work more closely with landowners and/or communities. Here, participants noted the following:

- *“I think economics alone will not get us where we need to go.”*
- *“We can’t be successful at conserving sagebrush unless the people living [in those areas] are behind it.”*
- *“Conservation is not simply a dollar and cents conversation, it’s way more complex than that.”*

Still, participants at other focus groups also showed interest in prioritizing research topics that seek to understand values beyond economics:

- *“It seems fundamental to understand where people are coming from,” noted one participant in the Cheyenne, WY focus group*
- *“[We should] focus on [understanding] people’s attitudes [...] If we [know how] to work with people, it would help with the tougher issues.”*
- *“It’s important to talk to people face to face to learn about the concerns of locals, not just landowners.”*

When asked to discuss why they chose not to prioritize certain research topics, focus participants noted that, even though some topics were ranked lower, it did not necessarily mean those topics were not important. Moreover, some topics simply were not relevant in certain contexts. For example, research topics related to energy development were ranked lower priority in both the Boise, ID and Prineville, OR focus groups—locations where energy development is not exceedingly prevalent.

Following the discussion of research topic priorities, the focus group facilitators prompted participants in each of the focus group discussions to think about how best to integrate social science research into management decisions. By far the most common response we heard was to disseminate and communicate research findings in a digestible way. Participants in the Cheyenne, WY focus group noted the importance of telling stories that people can relate to using real-world examples. Participants in the Fort Collins, CO focus group emphasized the importance of not only sharing information, but also gathering feedback from the public in response to that information, and incorporating public feedback into management decisions. Participants in several of the focus groups described the importance of relationship building and trust building among partners and the public as a necessary component for incorporating social science research into management decisions and actions. When asked about particular avenues or opportunities for communicating research, participants indicated how University Agricultural Extension programs can be a great source of information for landowners, and participants in both the Cheyenne, WY and Fort Collins, CO focus groups described organizations like the Sage Grouse Initiative as a trustworthy source of information for practitioners on the ground. Above all, participants described the need for any communication around social science research findings to be tailored to the intended audience (i.e., public, landowners, agency personnel, policymakers, etc.).

Next, the facilitators asked focus group participants to identify and describe any perceived barriers to incorporating social science research information to sagebrush conservation and management decisions. Participants raised several ideas, ranging from inadequate funding for social science research and a lack of social science researchers working in sagebrush management generally to the rural—urban divide. Participants noted that social science research tends to take a considerable amount of time to conduct and that conclusions—when they can be reached—are often riddled with uncertainty; several participants noted that this creates a barrier for social science becoming better integrated into management decisions due to people’s impatience and an unwillingness to embrace uncertainty. Other participants admitted a flat-out bias against social science research because it is not perceived to be quantifiable. Additional barriers identified by focus group participants tended to be topic-specific. For example, one participant in the Cheyenne, WY focus group identified a lack of what he called “weed awareness,” referring to an inadequate understanding on behalf of the public regarding the severity of the threat of invasive species to sagebrush ecosystems. Others noted agency turnover and information overload as additional barriers to incorporating social science into sagebrush conservation and management decisions.

When asked if there were other social science research topics that hadn’t been discussed that they thought were important to inform a future social science research agenda for sagebrush conservation and management, participants noted a range of potential topics, including:

- *Providing baseline data about urban populations’ knowledge of sagebrush issues;*
- *Looking at other industries that have benefited from having social science research integrated, and developing a research agenda based on the lessons learned;*
- *Performing a cost/benefit analysis of grazing;*
- *Focusing on gaining a better understanding of landowner motivations and decision-making;*
- *Improving interagency coordination around sagebrush issues, and identifying regulatory barriers for agencies working together;*
- *Enhanced training for land managers on value-based discussions with the public;*
- *Researching the political ramifications of decision-making and the influence of the public on management decision.*

Finally, the facilitators asked focus group participants: “If you had the opportunity to fund a social science research project, what would you fund and why?” Participants responded with a range of ideas, including:

- *How to better engage leadership in sagebrush ecosystem management;*

- *Dynamics that lead to longevity and resilience of decisions and planning efforts;*
- *Understanding the social science and economic value of ranching/land stewardship to sagebrush steppe ecosystems;*
- *Ways to mitigate wildfire risk (e.g., what are the social, economic, policy barriers?)*
- *Studying the value of sagebrush ecosystems/communities long-term vs. development;*
- *Understanding the cost to graze on public and private lands (e.g., determining the breakdown of USFS, BLM, State lands; what is the decision point for landowners to go out of business or sell?)*
- *Understanding the factors and thresholds that drive decisions by landowners;*
- *Understanding the regulatory, legal, and social barriers to implementing habitat conservation;*
- *Studying how the general public values public land and sagebrush ecosystems, and how that information can be used to target communications and public relations campaigns.*

Before concluding the focus group discussions, the facilitators gave participants the option to again weight the list of research topics elicited from the pre-focus group survey in case their attitudes or perceptions of the research topics changed in the course of the discussion. Table C4, below, presents the results of the post-discussion exercise, as well as totals from the first iteration of the exercise for reference.

Table C4. Aggregate results from pre- and post-focus group discussion prioritization weighting exercise for all focus groups.

Topic											
Iteration 1	I	C	G	B	H	E	D	F	A	J	-
Total	71	54	45	43	35	34	33	28	22	15	-
Iteration 2	I	G	B	H	C	E	F	A	D	J	K (Other)
Total	49	48	30	28	27	13	13	10	9	4	29

Results from the second iteration of the weighing exercise at the conclusion of the focus group discussions revealed slight changes in participants ideas about what research topics to prioritize. Although topic I (Measuring the economic costs and benefits of conserving sagebrush ecosystems) remained the top priority in both the first and second iteration of the weighing exercise, participants showed a greater interest in prioritizing research topics focused on understanding community values (topic G) and landowner goals (topic B) following the focus group discussions. Notably, topic C (Quantifying the economic implications of restoring sagebrush ecosystems affected by fire) dropped substantially in priority between the first and second iteration of the topic weighing exercise. Topic H (Understanding how different stakeholders interpret sagebrush issues) stayed fairly consistent in terms of perceived research priority on behalf of participants throughout both weighing exercises.



## Appendix D - Literature Synthesis

### Key findings

We identified 95 papers meeting the following criteria for inclusion: 1) the research was conducted within the distribution of North American sagebrush and 2) the research included human dimensions or social science methods such as economic analyses, surveys, interviews, and case studies. We coded the 95 studies using variables within an established social-ecological-systems framework. We focused our coding efforts on resource issue(s), social issue(s), geographical region, and additional research needs. The literature focused primarily on resource issues related to grazing, land use, sage-grouse, and rangeland management, while social issues emphasized collaboration, decision making, stakeholder perceptions and attitudes, and governance. Some themes from the literature synthesis overlapped with identified research needs from our other research activities including economics, conservation practices and incentives, fire, and invasive species. Below we highlight findings from existing research on these topics to ground our recommendations on future research priorities on what has already been addressed in the literature. Calls for additional research include assessing effective communication methods and information delivery systems, tools and methods to establish and maintain successful and inclusive collaboration in ecosystem management. Significant research gaps remain to better understand and integrate human dimensions into management and conservation efforts in sagebrush landscapes.

### Methods

We used principles similar to systematic reviews to extensively search for social science literature relevant to the management and conservation of sagebrush ecosystems. We defined social science quite broadly to include fields such as sociology, human geography, economics, anthropology, law, and policy studies. For our literature search we used Web of Science databases and focused our search exclusively on peer-reviewed journal articles while excluding grey literature such as agency reports, conference proceedings, and books. We included papers that had an explicit consideration of social and human dimensions and a clear connection or relevance to sagebrush management. Multiple primary search terms (e.g., sage\*, sagebrush\*, rangeland\*, and 'sage grouse') and numerous secondary search terms were combined to identify literature (a full outline of our search terms and results is provided after the literature list below). Identified journal articles were then coded to characterize the geographic focus of the study, the methods used, and the general resource and social issues addressed.

### Results

Our searches yielded 171 potentially relevant articles that we examined more closely to confirm relevance to our search goals. After screening our initial results, we identified 95 articles that met our inclusion criteria. The identified articles varied in their geographic focus and addressed a diversity of resource and social issues.

#### Geographical focus

Figure D1 provides an overview of the geographic focus of the identified literature and shows approximately 25% of the peer reviewed articles were focused on the Western US, the largest category. 8%-14% of the papers focused on Wyoming, Idaho, Colorado, Oregon, or Utah (ascending in that order). Another 13% of the papers had a national scope, and less than 4% of the studies were conducted in Montana, Arizona, California, Nevada, or Washington.

#### Resource issues addressed

Rangeland, defined here as undeveloped land that supports large wild and domestic grazing and foraging animals, was the most frequently addressed resource issue (Table D1), representing 20% of the studies. Approximately 13% of the papers focused on one of each: land use, grazing, or sage grouse. Other resources issues studied included biodiversity, restoration, fire, or ecosystem services (descending from 7%-5% of papers). Less than 4% of the studies addressed one of each: wild horses and burros, invasive species, climate change, carbon sequestration, or drought.

#### Social issues addressed

The most prevalent social issue (Table D1) in our identified literature was governance, representing over 18% of studies. Papers themed under governance include formation of Rangeland Fire Protection Associations, as well as implementation of federal, state, and local laws and regulations. Perceptions & attitudes, collaboration, and decision making represented 14%-10% of the studies (descending in that order). Economics studies constituted over 8% of the papers, with an additional ~6%-7% of studies focused on resource management, adaptive management, and conservation practices & incentives. Less than 4% of the papers focused on political movements, recreation, local knowledge, and energy development.

Figure D1. Geographic focus of the 95 peer-reviewed papers addressing social science issues relevant to sagebrush ecosystems.

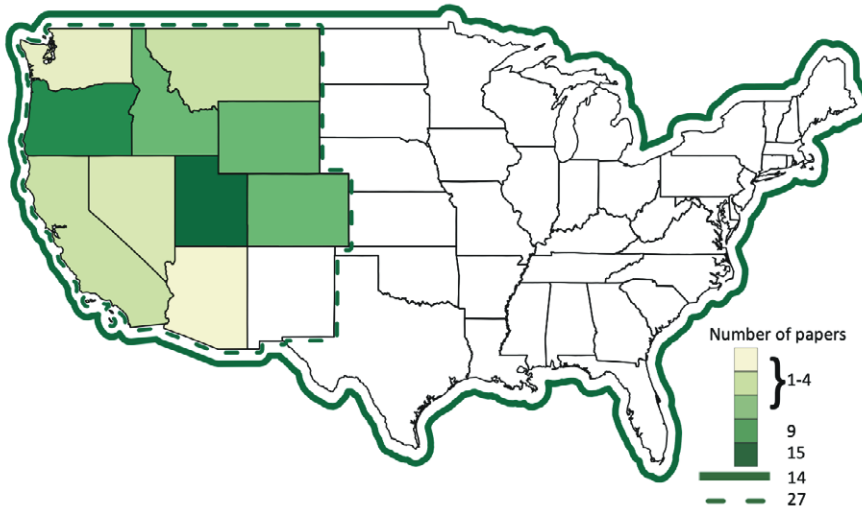


Figure D1. Matrix showing the number of articles that overlap with social science topics and natural resource issues (gradient: fewer articles = light green, while dark green = more articles).

	Energy Develop.	Local Knowledge	Recreation	Adaptive Management	Political Movements	Conservation Practices & Incentives	Resource Management	Economics	Other Actor Attributes	Collaboration	Decision Making	Perceptions & Attitudes	Governance
Drought				1					1		2	2	
Carbon Sequestration												3	1
Climate Change				2					1		2	1	
Invasives							2	1			1	2	
Wild Horses & Burros								1				2	4
ESS						3		1		1	1	1	
Fire								2			1	2	4
Restoration					1		3		1	2	1	1	
Biodiversity	1					2	3		1	2	2		1
Sage-Grouse		1	1			2	1					1	5
Grazing			1	2	1		2	4	1	1	3	2	3
Land Use			2		3			1	5		2	4	4
Rangeland	1	2		4		3	2	3	3	3	3	2	7

## Supplemental

### List of Identified Social Science Literature Relevant to Sagebrush Management

Abrams, J., Davis, E.J. & Wollstein, K., 2017. Rangeland Fire Protection Associations in Great Basin Rangelands: A Model for Adaptive Community Relationships with Wildfire? *Human Ecology*, 45(6), pp.773–785.

Abrams, J., Wollstein, K. & Davis, E.J., 2018. State lines, fire lines, and lines of authority: Rangeland fire management and bottom-up cooperative federalism. *Land Use Policy*, 75(January), pp.252–259.

Aslan, C.E. et al., 2009. Practical challenges in private stewardship of rangeland ecosystems: Yellow starthistle control in Sierra Nevada foothills. *Rangeland Ecology and Management*, 62(1), pp.28–37.

- Bartlett, E.T. et al., 2002. Valuing Grazing Use on Public Land. *Journal of Range Management*, 55(5), pp.426–438.
- Bastian, C.T. et al., 1999. Opportunity Costs Related to Feral Horses: A Wyoming Case Study. *Journal of Range Management*, 52(2), pp.104–112.
- Beall, A. & Zeoli, L., 2008. Participatory modeling of endangered wildlife systems: Simulating the sage-grouse and land use in Central Washington. *Ecological Economics*, 68(1–2), pp.24–33.
- Belton, L.R., Frey, S.N., Dahlgren, D.K., 2017. Participatory research in sage-grouse local working groups: case studies from Utah. *Human-Wildlife Interactions*, 11(3), pp.287–301.
- Belton, L.R. & Jackson-Smith, D., 2010. Factors influencing success among collaborative sage-grouse management groups in the western United States. *Environmental Conservation*, 37(3), pp.250–260.
- Bentley Brymer, A.L., Wulffhorst, J.D. & Brunson, M.W., 2018. Analyzing Stakeholders' Workshop Dialogue for Evidence of Social Learning. *Ecology and Society*, 23(1), pp.42.
- Berger, J. & Beckmann, J.P., 2010. Sexual predators, energy development, and conservation in greater Yellowstone. *Conservation Biology*, 24(3), pp.891–896.
- Birdsong, B.C., 2005. Road Rage and R.S. 2477: Judicial and Administrative Responsibility for Resolving Road Claims on Public Lands. *Hastings Law Journal*, 56(3), pp.523–583.
- Boies, R., 2017. Confessions of a collaborator: Shoesole and Stewardship Alliance of Northeast Elko County, Nevada. *Human-Wildlife Interactions*, 11(3), pp.327–338.
- Boyd, Chad S. and Svejcar, T.J., 2009. Managing Complex Problems In Rangeland Ecosystems. *Rangeland Ecology & Management*, 62, pp.491–499.
- Boyd, C.S. et al., 2014. Of grouse and golden eggs: Can ecosystems be managed within a species-based regulatory framework? *Rangeland Ecology and Management*, 67(4), pp.358–368.
- Briske, D.D. et al., 2011. Origin, persistence, and resolution of the rotational grazing debate: Integrating human dimensions into rangeland research. *Rangeland Ecology and Management*, 64(4), pp.325–334.
- Briske, D.D. et al., 2017. Assessment of USDA- NRCS rangeland conservation programs : recommendation for an evidence-based conservation platform. *Ecological Applications*, 27(1), pp.94–104.
- Brown, M. & Bachelet, D., 2017. BLM Sagebrush Managers Give Feedback on Eight Climate Web Applications. *Weather, Climate, and Society*, 9(1), pp.39–52.
- Brunson, M.W. & Gilbert, L., 2003. Recreationist Responses to Livestock Grazing in a New National Monument. *Journal of Range Management*, 56(6), pp.570–576.
- Brunson, M.W. et al., 2008. Ranching as a Conservation Strategy : Can Old Ranchers Save the New West ? *Rangeland Ecology & Management*, 61(2), pp.137–147.
- Brunson, M.W. & Steel, B.S., 1996. Sources of Variation in Attitudes and Beliefs about Federal Rangeland Management. *Journal of Range Management*, 49(1), pp.69–75.
- Brunson, M.W., 2012. The elusive promise of social-ecological approaches to rangeland management. *Rangeland Ecology and Management*, 65(6), pp.632–637.
- Brunson, M.W. & Shindler, B.A., 2004. Geographic variation in social acceptability of wildland fuels management in the western United States. *Society and Natural Resources*, 17(8), pp.661–678.
- Brunson, M.W. & Tanaka, J., 2011. Economic and social impacts of wildfires and invasive plants in American deserts: Lessons from the Great Basin. *Rangeland Ecology and Management*, 64(5), pp.463–470.

- Brymer, A.L.B. et al., 2016. A social-ecological impact assessment for public lands management: application of a conceptual and methodological framework. *Ecology and Society*, 21(3), pp.1–12.
- Charnley, S. et al., 2018. Cattle grazing and fish recovery on US federal lands: can social–ecological systems science help? *Frontiers in Ecology and the Environment*, 16, pp.S11–S22.
- Christiansen, T.J., Lorien, B.R., 2017. Wyoming sage-grouse working groups: lessons learned. *Human-Wildlife Interactions*, 11(3), pp.274–286.
- Clark, A.G. et al., 2017. Utah’s Watershed Restoration Initiative: Restoring watersheds at a landscape scale. *Human-Wildlife Interactions*, 11(3), pp.302–310.
- Cochran, J., Houck, J. & Peterson, G., 2017. The Gunnison Basin sage-grouse strategic committee: A Colorado county’s fight for conservation self-determination. *Human-Wildlife Interactions*, 11(3), pp.320–326.
- Cook, S.L. & Ma, Z., 2014. The interconnectedness between landowner knowledge, value, belief, attitude, and willingness to act: Policy implications for carbon sequestration on private rangelands. *Journal of Environmental Management*, 134, pp.90–99.
- Cook, S.L. & Ma, Z., 2014. Carbon sequestration and private rangelands: Insights from Utah landowners and implications for policy development. *Land Use Policy*, 36, pp.522–532.
- Coppock, D.L., 2011. Ranching and multiyear droughts in Utah: Production impacts, risk perceptions, and changes in preparedness. *Rangeland Ecology and Management*, 64(6), pp.607–618.
- Coppock, D.L. & Birkenfeld, A.H., 1999. Use of livestock and range management practices in Utah. *Journal of Range Management*, 52, pp.7–18.
- Davenport, J., 2018. Making the Buffalo Commons New Again: Rangeland Restoration and Bison Reintroduction in the Montana Highline. *Great Plains Quarterly*, 38(16), pp.199–225.
- Davis, C. & Ellison, B.A., 1996. Change on the range?: Policy reforms and agenda control. *Society and Natural Resources*, 9(4), pp.395–409.
- Didier, E.A. & Brunson, M.W., 2004. Adoption of range management innovations by Utah ranchers. *Journal of Range Management*, 57, pp.330–336.
- Duvall, A.L., Metcalf, A.L. & Coates, P.S., 2017. Conserving the Greater Sage-Grouse : A Social-Ecological Systems Case Study from the California-Nevada Region. *Rangeland Ecology & Management*, 70(1), pp.129–140.
- Garrott, R.A., 2018. Wild horse demography: Implications for sustainable management within economic constraints. *Human-Wildlife Interactions*, 12(1), pp.46–57.
- Goleman, M.J., 2011. Wave of mutilation: the cattle mutilation phenomenon of the 1970s. *Agricultural history*, 85(3), pp.398–417.
- Gordon, R., Brunson, M.W. & Shindler, B., 2014. Acceptance, Acceptability, and Trust for Sagebrush Restoration Options in the Great Basin: A Longitudinal Perspective. *Rangeland Ecology and Management*, 67(5), pp.573–583.
- Gosnell, H. & Travis, W.R., 2005. Ranchland Ownership Dynamics in the Rocky Mountain West. *Rangeland Ecology & Management*, 58(2), pp.191–198.
- Guttery, M.R. et al., 2016. Declining populations of greater sage-grouse: Hunter motivations when numbers are low. *Animal Conservation*, 19(1), pp.26–34.
- Gutwein, M. & Goldstein, J.H., 2013. Integrating conservation and financial objectives on private rangelands in northern Colorado: Rancher and practitioner perceptions. *Rangeland Ecology and Management*, 66(3), pp.330–338.
- Hansen, K. et al., 2018. Rancher Preferences for a Payment for Ecosystem Services Program in Southwestern Wyoming. *Ecological Economics*, 146, pp.240–249.

- Havstad, K.M. et al., 2007. Ecological services to and from rangelands of the United States. *Ecological Economics*, 64(2), pp.261–268.
- Hendrickson, C., 2018. Managing healthy wild horses and burros on healthy rangelands: Tools and the toolbox. *Human-Wildlife Interactions*, 12(1), pp.143–147.
- Huffaker, R.G., Wilen, J.E. & Gardner, B.D., 1989. Multiple Use Benefits on Public Rangelands : An Incentive-Based Fee System. *Agriculture & Applied Economics Association*, 71(3), pp.670–678.
- Inwood, J.F.J. & Bonds, A., 2017. Property and whiteness: the Oregon standoff and the contradictions of the U.S. Settler State. *Space and Polity*, 21(3), pp.253–268.
- Jackson-Smith, D., Kreuter, U. & Krannich, R.S., 2005. Understanding the multidimensionality of property rights orientations: Evidence from Utah and Texas Ranchers. *Society and Natural Resources*, 18(7), pp.587–610.
- Johnson, D.D. et al., 2011. Perceptions of ranchers about medusahead (*Taeniatherum caput-medusae* (L.) Nevski) management on sagebrush steppe rangelands. *Environmental Management*, 48(3), pp.400–417.
- Joyce, L.A. et al., 2013. Climate change and North American rangelands: Assessment of mitigation and adaptation strategies. *Rangeland Ecology and Management*, 66(5), pp.512–528.
- Kachergis, E.J. et al., 2013. Tools for resilience management: Multidisciplinary development of state-and-transition models for northwest Colorado. *Ecology and Society*, 18(4).
- Kachergis, E. et al., 2014. Increasing flexibility in rangeland management during drought. *Ecosphere*, 5(6), pp.1–14.
- Kaye, T.N. et al., 2015. Conservation Projects in Prison: The Case for Engaging Incarcerated Populations in Conservation and Science. *Natural Areas Journal*, 35(1), pp.90–97.
- Knapp, C.N., Stuart Chapin, F. & Cochran, J.O., 2015. Ranch Owner Perceptions and Planned Actions in Response to a Proposed Endangered Species Act Listing. *Rangeland Ecology and Management*, 68(6), pp.453–460.
- Knapp, C.N. and Fernandez-Gimenez, M.E., 2009. Knowledge in Practice : Documenting Rancher Local Knowledge in Northwest Colorado. *Rangeland Ecology & Management*, 62(6), pp.500–509.
- Knapp, C.N. & Fernandez-Gimenez, M., 2008. Knowing the Land : A Review of Local Knowledge Revealed in Ranch Memoirs. *Rangeland Ecology & Management*, 61(2), pp.148–155.
- Kobayashi, M., Rollins, K. & Taylor, M.H., 2014. Optimal Livestock Management on Sagebrush Rangeland with Ecological Thresholds, Wildfire, and Invasive Plants. *Land Economics*, 90(4), pp.623–648.
- Kreuter, U.P. et al., 2006. Property Rights Orientations and Rangeland Management Objectives : Texas, Utah, and Colorado. *Rangeland Ecology & Management*, 59, pp.632–639.
- Kreuter, U.P. et al., 2012. Framework for comparing ecosystem impacts of developing unconventional energy resources on western US rangelands. *Rangeland Ecology and Management*, 65(5), pp.433–443.
- Lafrance, J.T. & Watts, M.J., 1995. Public Grazing in the West: the Impact of “Rangeland Reform ‘94”. *Agriculture & Applied Economics Association*, 77(3), pp.447–461.
- Ma, Z. & Coppock, D.L., 2012. Perceptions of Utah ranchers toward carbon sequestration: Policy implications for US rangelands. *Journal of Environmental Management*, 111, pp.78–86.
- Mccluskey, J.J. & Hausser, G.C., 1999. Federal Grazing Reform and Avoidable Risk. *Journal of Agriculture and Resource Economics*, 24(1), pp.140–154.
- McCurdy, H.E., 1984. Public Ownership of Land and the “Sagebrush Rebellion.” *Policy Studies Journal*, 12(3), pp.483–490.
- Mealor, R.D. et al., 2011. New Rangeland residents in Wyoming? A survey of exurban landowners. *Rangeland Ecology and Management*, 64(5), pp.479–487.

- Melkonyan, T. & Taylor, M.H., 2013. Regulatory policy design for agroecosystem management on public rangelands. *American Journal of Agricultural Economics*, 95(3), pp.606–627.
- Messmer, T. et al., 1998. Cooperative wildlife management units: achieving hunter, landowner, and wildlife management agency objectives. *Wildlife Society Bulletin*, 26(2), pp.325–332.
- Mollison, R.M. & Eddy, R.W.J., 1982. The sagebrush rebellion: a simplistic response to the complex problems of federal land management. *Harvard Journal on Legislation*, 97, pp.97–141.
- Moote, M.A. & McClaran, M.P., 1997. Implications of Participatory Democracy for Public Land Planning. *Journal of Range Management*, 50(5), pp.473–481.
- Muñoz-Erickson, T.A., Aguilar-González, B. & Sisk, T.D., 2007. Linking Ecosystem Health Indicators and Collaborative Management: a Systematic Framework to Evaluate Ecological and Social Outcomes. *Ecology and Society*, 12(2), pp.1–19.
- Olander, L.P., Cooley, D.M. & Galik, C.S., 2012. The potential role for management of U.S. Public lands in greenhouse gas mitigation and climate policy. *Environmental Management*, 49(3), pp.523–533.
- Paulson, D.D., 1998. Collaborative management of public rangeland in Wyoming: Lessons in co-management. *Professional Geographer*, 50(3), pp.301–315.
- Peters, D.T. & Ward, L., 2017. Greater sage-grouse in Montana: Mapping archetype viewpoints across stakeholder groups using Q methodology. *Wildlife Society Bulletin*, 41(1), pp.34–41.
- Petrzelka, P., Ma, Z. & Malin, S., 2013. The elephant in the room: Absentee landowner issues in conservation and land management. *Land Use Policy*, 30(1), pp.157–166.
- Pilliod, D.S. et al., 2018. Survey of Beaver-related Restoration Practices in Rangeland Streams of the Western USA. *Environmental Management*, 61(1), pp.58–68.
- Pocewicz, A. et al., 2011. Effectiveness of conservation easements for reducing development and maintaining biodiversity in sagebrush ecosystems. *Biological Conservation*, 144(1), pp.567–574.
- Ranglack, D.H. & Du Toit, J.T., 2016. Bison with benefits: Towards integrating wildlife and ranching sectors on a public rangeland in the western USA. *Oryx*, 50(3), pp.549–554.
- Richards, R.T. & Huntsinger, L., 1994. Variation in BLM Employee Attitudes toward Environmental Conditions on Rangelands. *Journal of Range Management*, 47(5), pp.365–368.
- Riley, L.E. et al., 2015. Best Management Practices: An Integrated and Collaborative Approach to Native Plant Restoration on Highly Disturbed Sites. *Natural Areas Journal*, 35(1), pp.45–53.
- Roche, A.L.M. et al., 2015. On-Ranch Grazing Strategies: Context for the Rotational Grazing Dilemma. *Rangeland Ecology & Management*, 68(3), pp.248–256.
- Rowe, H.I., Bartlett, E.T. & Swanson, L.E.J., 2001. Ranching Motivations in 2 Colorado Counties. *Journal of Range Management*, 54, pp.314–321.
- Sayre, N.F., 2015. The Coyote-Proof Pasture Experiment: How fences replaced predators and labor on US rangelands. *Progress in Physical Geography*, 39(5), pp.576–593.
- Sayre, N.F. et al., 2012. “The range problem” after a century of rangeland science: New research themes for altered landscapes. *Rangeland Ecology and Management*, 65(6), pp.545–552.
- Scasta, Derek J.; Hennig, Jacob D.; Beck, J.L., 2018. Framing contemporary U.S. wild horse and burro management processes in a dynamic ecological, sociological, and political environment. *Human-Wildlife Interactions*, 12(1), pp.31–45.
- Shindler, B. et al., 2011. Public perceptions of sagebrush ecosystem management in the great basin. *Rangeland Ecology and Management*, 64(4), pp.335–343.



- Stasiewicz, A.M. & Paveglio, T.B., 2017. Factors Influencing the Development of Rangeland Fire Protection Associations: Exploring Fire Mitigation Programs for Rural, Resource-Based Communities. *Society and Natural Resources*, 30(5), pp.627–641.
- Switalski, A., 2018. Off-highway vehicle recreation in drylands: A literature review and recommendations for best management practices. *Journal of Outdoor Recreation and Tourism*, 21(May 2017), pp.87–96.
- Theobald, D.M., Gosnell, H. & Riebsame, W.E., 1996. Land Use and Landscape Change in the Colorado Mountains II: A Case Study of the East River Valley. *Mountain Research and Development*, 16(4), pp.407–418.
- Toombs, T.P. & Roberts, M.G., 2009. Are Natural Resources Conservation Service Range Management Investments Working at Cross-Purposes with Wildlife Habitat Goals on Western United States Rangelands? *Rangeland Ecology & Management*, 62, pp.351–355.
- Tzankova, Z. & Concilio, A., 2014. Controlling an invasive plant at the edge of its range: towards a broader understanding of management feasibility. *Biological Invasions*, 17(1), pp.507–527.
- Vantassell, L.W. & McNeley, S.M., 1997. Factors Affecting Private Rangeland Lease Rates. *Journal of Range Management*, 50(2), pp.178–184.
- Watson, W.D., 1996. Preserving natural environments on coal lands at minimum cost. *Energy Journal*, 17(1), pp.91–127.
- Wollstein, K.L. & Davis, E.J., 2017. A “hammer held over their heads”: Voluntary conservation spurred by the prospect of regulatory enforcement in Oregon. *Human-Wildlife Interactions*, 11(3), pp.258–273.
- Wulforth, J.D., Rimbey, N. & Darden, T., 2006. Sharing the rangelands, competing for sense of place. *American Behavioral Scientist*, 50(2), pp.166–186.
- Yoder, J. et al., 2003. The Economic Logic of Prescribed Burning Law and Regulation. *Journal of Range Management*, 56(4), pp.306–313.
- Yung, L. et al., 2015. Drought Adaptation and Climate Change Beliefs among Working Ranchers in Montana. *Weather, Climate, and Society*, 7(4), pp.281–293.
- Zanocco, C. et al., 2018. Great Basin land managers provide detailed feedback about usefulness of two climate information web applications. *Climate Risk Management*, 20, pp.78–94.

## Search terms used in literature synthesis.

### First search:

sage\* +

• range* manage*	599 titles			
• range* manage* social*	19 titles	14 relevant	13 prev. captured	1 new
• eco* social*	106 titles			
• eco* manage*	589 titles			
• 'human dimensions'	3 titles	2 relevant	1 prev. captured	1 new

### Second and focal search

sagebrush\* +

• manage*	742 titles			
• eco* manage*	419 titles			
• manage* social*	14 titles	10 relevant		
• land* manage*	387 titles	19 relevant	5 prev. captured	14 new
• conserv*	352 titles			
• manage* conserve*	227 titles			
• steward*	4 titles	1 relevant	0 prev. captured	1 new
• percept*	18 titles	8 relevant	6 prev. captured	2 new
• accept*	29 titles	2 relevant	2 prev. captured	0 new
• partner*	8 titles	3 relevant	3 prev. captured	0 new
• attitude*	5 titles	4 relevant	3 prev. captured	1 new
• collabora*	14 titles	5 relevant	5 prev. captured	0 new
• econ*	53 titles	8 relevant	7 prev. captured	1 new
• institut*	6 titles	4 relevant	4 prev. captured	0 new
• govern*	51 titles	8 relevant	8 prev. captured	0 new
• participat*	9 titles	5 relevant	4 prev. captured	1 new
• integrat*	83 titles	3 relevant	3 prev. captured	0 new
• use*	1,118 titles			
• use* social*	23 titles	9 relevant	9 prev. captured	0 new
• use* manage*	425 titles			
• valu*	269 titles			
• valu* use*	153 titles			
• valu* manage*	98 titles	7 relevant	7 prev. captured	0 new
• valu* conserv*	31 titles	7 relevant	7 prev. captured	0 new
• valu* social*	2 titles	1 relevant	1 prev. captured	0 new
• 'social eco*'	13 titles	12 relevant	12 prev. captured	0 new
• 'public land*'	45 titles	13 relevant	10 prev. captured	3 new
note: one new paper had been in previous searches				
• incentiv*	5 titles	3 relevant	3 prev. captured	0 new
• privat*	34 titles	9 relevant	7 prev. captured	2 new
• place*	92 titles	5 relevant	5 prev. captured	0 new

### Added to second search

rangeland\* +

-note: some search terms required more narrow scoping. If the results were unmanageable I added all of three terms in this order: US ; America\* ; West

• 'human dimensions'	13 titles	8 relevant	0 prev. captured	8 new
• social* US	35 titles	11 relevant	5 prev. captured	6 new
• social* America*	39 titles	13 relevant	8 prev. captured	5 new
• social* West	48 titles	9 relevant	6 prev. captured	3 new
• conserv*	1,452 titles			
• steward*	39 titles	18 relevant	5 prev. captured	13 new
note: Pulled 6 additional papers from the original 7 new after region clarification				
• percept*	229 titles			
• percept* US	9 titles	5 relevant	4 prev. captured	1 new
• percept* America*	12 titles	5 relevant	3 prev. captured	2 new
• percept* West	15 titles	5 relevant	1 prev. captured	4 new
• accept*	194 titles			
• accept* US	12 titles	3 relevant	3 prev. captured	0 new
• accept* America*	13 titles	1 relevant	1 prev. captured	0 new
• accept* West	11 titles	1 relevant	1 prev. captured	0 new
• partner*	63 titles	15 relevant	2 prev. captured	13 new
• attitude*	88 titles	25 relevant	10 prev. captured	15 new
• collabora*	110 titles			
• collabora* US	10 titles	5 relevant	3 prev. captured	2 new
• collabora* America*	9 titles	5 relevant	5 prev. captured	0 new
• collabora* West	13 titles	5 relevant	3 prev. captured	2 new
note: identified one paper that had been part of previous results				
• econ*	1197 titles			
• econ* social*	277 titles			
• econ* social* US	17 titles	3 relevant	3 prev. captured	0 new
• econ* social* America*	14 titles	3 relevant	2 prev. captured	1 new
• econ* social* West	22 titles	3 relevant	3 prev. captured	0 new
• institut*	315 titles			
• institut* US	11 titles	6 relevant	5 prev. captured	1 new
• institut* America*	9 titles	2 relevant	1 prev. captured	1 new
• institut* West	28 titles	4 relevant	4 prev. captured	0 new
• govern*	423 titles			
• govern* US	20 titles	3 relevant	3 prev. captured	0 new
• govern* America*	24 titles	4 relevant	4 prev. captured	0 new
• govern* West	31 titles	4 relevant	4 prev. captured	0 new
• participat*	243 titles			
• participat* US	7 titles	1 relevant	1 prev. captured	1 new
• participat* America*	11 titles	3 relevant	3 prev. captured	3 new
• participat* West		22 titles	2 relevant	2 prev. captured 0 new
• integrat*	714 titles			
• integrat* US	26 titles	4 relevant	4 prev. captured	0 new
• integrat* America*	32 titles	5 relevant	5 prev. captured	0 new
• integrat* West	43 titles	3 relevant	3 prev. captured	0 new
• use*	5,255 titles			
• use* social*	360 titles			
• use* social* US	19 titles	6 relevant	6 prev. captured	0 new
• use* social* America*	21 titles	8 relevant	8 prev. captured	0 new
• use* social* West	33 titles	7 relevant	7 prev. captured	0 new
• use* manage*	2,720 titles			
• valu*	1,715 titles			
• valu* use*	1,129 titles			
• valu* manage*	851 titles			
• valu* manage* US	35 titles	2 relevant	2 prev. captured	0 new
• valu* manage* America*	56 titles	8 relevant	6 prev. captured	2 new
• valu* manage* West	43 titles	6 relevant	6 prev. captured	0 new

• valu* conserv*	339 titles			
• valu* conserv* US	10 titles	2 relevant	2 prev. captured	0 new
• valu* conserv* America*	29 titles	5 relevant	5 prev. captured	0 new
• valu* conserv* West	18 titles	3 relevant	3 prev. captured	0 new
• valu* social*	118 titles			
• ‘social eco*’	91 titles	11 relevant	9 prev. captured	2 new
• ‘public land*’	202 titles	48 relevant	29 prev. captured	19 new
• incentiv*	99 titles	17 relevant	7 prev. captured	10 new
• privat*	311 titles			
• privat* US	19 titles	4 relevant	4 prev. captured	0 new
• privat* America*	25 titles	6 relevant	6 prev. captured	0 new
• privat* West	30 titles	7 relevant	6 prev. captured	1 new
• place*	442 titles			
• place* US	10 titles	2 relevant	2 prev. captured	0 new
• place* America*	21 titles	4 relevant	2 prev. captured	2 new
• place* West	29 titles	4 relevant	4 prev. captured	0 new

## Final search

‘sage grouse’				
• social*	43 titles	9 relevant	5 prev. captured	4 new
• steward*	3 titles	2 relevant	1 prev. captured	1 new
• manage*	449 titles			
• eco* manage*	229 titles			
• land* manage*	202 titles	27 relevant	19 prev. captured	8 new
• conserve*	359 titles			
• public*	48 titles	19 relevant	18 prev. captured	1 new
• percept*	8 titles	5 relevant	4 prev. captured	1 new
• accept*	15 titles	0 relevant	0 prev. captured	0 new
• partner*	15 titles	7 relevant	4 prev. captured	3 new
• attitude*	0 titles			
• collabora*	16 titles	8 relevant	7 prev. captured	1 new
• econ*	17 titles	6 relevant	6 prev. captured	0 new
• govern*	26 titles	8 relevant	6 prev. captured	2 new
• institut*	2 titles	2 relevant	2 prev. captured	0 new
• adapt*	56 titles	7 relevant	6 prev. captured	1 new
• integrat*	43 title	3 relevant	3 prev. captured	0 new
• participat*	13 titles	8 relevant	8 prev. captured	0 new
• ‘human dimensions’	3 titles	3 relevant	3 prev. captured	0 new
• ‘social eco*’	11 titles	7 relevant	7 prev. captured	0 new
• ‘public land*’	34 titles	13 relevant	13 prev. captured	0 new
• use*	522 titles			
• use* social*	23 titles	5 relevant	5 prev. captured	0new
• use* manage*	292 titles			
• valu*	97 titles	9 relevant	9 prev. captured	0 new
• incentiv*	5 titles	3 relevant	3 prev. captured	0 new
• privat*	22 titles	7 relevant	7 prev. captured	0 new
• place*	40 titles	6 relevant	6 prev. captured	0 new