

HUMAN PERCEPTIONS OF COMPETING INTERESTS IN SPRINGS ECOSYSTEMS
MANAGEMENT ON THE COCONINO AND KAIBAB NATIONAL FORESTS

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ABSTRACT

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Spring ecosystems provide vital services to humans and wildlife in Northern Arizona. Management of springs presents unique challenges due to the diversity of stakeholders and the multiple uses of springs. We employ two methods of data collection to understand the perceptions of springs ecosystem management: interviews and focus groups with stakeholders of springs in Coconino National Forest (CNF) and Kaibab National Forest (KNF) and a national survey aimed towards public perceptions. We analyze the human perceptions of springs to understand variations between stakeholders and how perceptions of stakeholders and the public vary. Our results indicate differences between human perceptions and current management practices. The main competing interests of springs management are cattle grazing, recreation, and Indigenous Nations' cultural significance. The survey respondents, representative of public perceptions, indicate springs management for Indigenous Nations' cultural significance is important. We see positive correlation between concern for threats to springs from grazing and management to prioritize cultural significance indicating respondents prefer springs to be managed for cultural significance. Cattle grazing and other high impact human uses are viewed less favorably than other management scenarios. Stakeholders' perceptions varied and non-Indigenous stakeholders suggested management should be based on multiple uses and management focused on specific attributes of springs valuable to humans. Our results of the survey respondents' perceptions for management of Indigenous culture and some support from stakeholders show a joint management concept might be beneficial for springs management

in the CNF and KNF. Using the information we collected on the perceptions of spring ecosystems management, we discuss mechanisms for springs management to increase the ability for springs to provide cultural significance values to Indigenous Nations by potentially limiting high impact and degrading uses of springs. We provide results and examples of how all stakeholders can have the ability to benefit from the resources springs provide.

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TABLE OF CONTENTS

Chapter 1: Introduction	1
1.1 Purpose and Objectives	1
1.2 Introduction to Spring Ecosystems	1
1.3 Literature review	2
1.3.1 Human perceptions and ecosystem services	2
1.3.2 Climate change and ecosystems	3
1.3.3 Human perceptions providing improved springs ecosystem stewardship on public land	3
1.3.4 Understanding Research through an Indigenous lens.....	4
1.3.5 The Importance of Stakeholder Analysis	7
1.4 Methods.....	7
1.4.1 Northern Arizona University Internal Review Board.....	7
1.4.2 Focus groups with Stakeholders	9
1.4.3 Stakeholder Categorization.....	10
1.4.4 Interviews with Stakeholders.....	10
1.4.5 National Survey	16
Chapter 2: Manuscript.....	19
2.1 Introduction	24
2.1.1 Human perceptions and ecosystem services.....	26
2.1.2 Study Area	29
2.1.3 Spring Management in the Coconino and Kaibab National Forest	31
2.1.4 Indigenous Cultural Significance and Environmental Management.....	31
2.1.5 The Importance of Springs	33
2.2 Materials and Methods.....	33
2.2.1 Stakeholder analysis	35
2.2.2 Focus Groups.....	36
2.2.3 Semi Structured Interviews	37
2.2.4 National Survey	38
2.3 Calculations.....	39
2.3.1 Qualitative Analysis	39
2.3.2 Quantitative Analysis	41
2.4 Results	43
2.4.1 Qualitative	43
2.4.2 Quantitative	50

2.5 Discussion	54
2.5.1 Ranching	54
2.5.2 Cultural significance	56
2.5.3 Recreation	58
2.6 Conclusion.....	60
Chapter 3: Additional Results, Discussion, Conclusions, and Call for Future Research	87
3.1 Results	87
3.1.1 Results from focus groups	87
3.1.2 Results from interviews	87
3.1.3 Perceived threats to springs from the National Survey	87
3.2 Final Discussion and Conclusion	88
3.2.1 Meeting the grant’s objectives.....	90
3.2.2 Limitations.....	90
3.3 Call for future research.....	91
3.3.1 Analyzing how human perceptions vary by demographics.....	91
3.3.2 Survey analyzing preferred mechanisms for spring’s management.....	92

LIST OF FIGURES

	Page Number
1 Perceived threats from Drought to springs	99
2 Perceived threats from Increased Development to springs	100
3 Perceived threats from Groundwater pumping to springs	101
4 Perceived threats from Deforestation to springs	102
5 Perceived threats from Pollution to springs	103
6 Concern with Degradation from Grazing	104
7 Concern with a reduction in Grazing	105
8 Preferences for Restricted Recreation	106
9 Word Frequency of Environmental Advocacy Groups Normalized	107
10 Word Frequency of Municipal Water Providers Normalized	108
11 Word Frequency of Indigenous Nations Normalized	109
12 Word Frequency of Ranchers Normalized	110
13 Word Frequency of Government Agencies Normalized	111
14 White Respondents: Perceived Threats from Recreation	112
15 Non-White Respondents: Perceived Threats from Recreation	113

LIST OF TABLES

	Page Number
1 Stakeholder Focus Groups Date and Times	93
2 Stakeholder Types, Definitions, and Groups	94
3 Spring Attribute Definitions	95
4 Summary Statistics from the Demographic Section of the National Survey	96

LIST OF APPENDICES

	Page Number
A- IRB Exemption Approval Letter	119
B- Focus Group 1 Notes	120
C- Focus Group 2 Notes	123
D- Interviews 1-14 Notes	124
E- Focus Group Notes from National Survey Trial	146
F- National Survey	149
G- National Survey Recruitment	187

PREFACE

This thesis is structured to meet Northern Arizona University standards. Chapter 1 is an introduction section providing context on the importance of human perceptions in ecosystem management and presents methods used to obtain our results. Chapter 2 is a standalone manuscript submitted for peer review to *Groundwater for Sustainable Development* (February 15, 2023). The manuscript entitled “Human Perceptions of Competing Interests in Springs Ecosystem Management on Public Land in Southwestern US” is formatted for that journal’s standards and may differ in format from the specific university requirements that the rest of the thesis adheres to. The manuscript in Chapter 2 contains all substantial results, discussions, and conclusions. The manuscript has its own introduction, methods, results, and conclusion and reflects the focus of the thesis research. Chapter 3 offers additional results, discussion, conclusions, and a call for future research. While repetition was kept to a minimum, due to university formatting standards, repetition of some material is expected.

Chapter 1: Introduction

1.1 Purpose and Objectives

We analyze qualitative and quantitative results from a national survey of the public and interviews and focus groups with stakeholders of springs in the Coconino National Forest (CNF) and Kaibab National Forest (KNF) located in Northern Arizona, USA to provide context and evidence that land managers in the CNF and KNF and forests around the country can use to align human perceptions with management policy-making. We present the results from attitudinal questions, part of a national survey, and textual evidence from the interviews and focus groups through tables, figures, and actual phrases. We analyze human perceptions for springs management in the CNF and KNF to answer the research questions:

1. What are the human perceptions of spring ecosystem management in the CNF and KNF,
2. How do human perceptions vary between stakeholders and,
3. How do perceived threats and human perceptions of management vary between survey responses from the public and stakeholders?

The discussion and conclusion sections in **2.5 and 2.6** provide regional, national, and global examples of how our results on the human perceptions of springs can be implemented into public land management.

1.2 Introduction to Spring Ecosystems

Springs are essential ecosystem in the arid region of Northern Arizona. The main competing interests for spring ecosystem management are management for cattle grazing, recreation, and Indigenous Nations' cultural significance. In Northern Arizona and surrounding the CNF and

KNF there are 22 federally recognized Indigenous Nations, all of whom have cultural significance toward springs on USFS land. The over 3.4 million acres of public land within the CNF and KNF are divided into 66 cattle grazing allotments, which are not only economically significant to the region but also support the way of life for the ranchers who rely on the springs for water sources for cattle. Furthermore, recreational activity is high, causing environmental degradation. In addition, springs are vital hydrologic refuges for the native flora and fauna.

1.3 Literature review

1.3.1 Human perceptions and ecosystem services

Springs in the Coconino and Kaibab National Forests are negatively affected by inefficient management of livestock and recreational activities, however changes in management and reduction in some of these activities can lead to better health for the spring ecosystems (Paffett et al., 2018). Livestock grazing and recreation are examples of how dominance structures, environment values based on human use, are the driving force behind management policies (Manfredo et al., 2017). Eliminating dominance structures can be achieved by using human perceptions from all stakeholders to encourage adaptive change, decentralized policy-making, innovation, and value from the entire diverse group of stakeholders (Manfredo et al., 2017). Incorporating human perceptions also leads to adaptive management with “appropriate structure of governance,” which can foster equity in the policy-making for the ecosystem (Kay et al., 1999). One challenge with traditional ways of analyzing human perceptions for ecosystem services is that they are “reason-blind” -- lacking information as to why people value certain attributes over others (Schutter et al., 2021, O'Neill, 2013). Our qualitative data and subsequent analysis of stakeholders in the region provides evidence for the reasons why there is support or lack of support for different springs attributes.

1.3.2 Climate change and ecosystems

Due to climate change, landscape simplification for agriculture, and other externalities associated with human development, mitigating human caused impacts to ecosystems are becoming even more prevalent (Riechers et al., 2020). Localized environmental issues are now proving to be of national concern as they become part of the larger scale climate issues (Tang et al., 2010).

Adapting the localized, situational, and specific knowledge of Indigenous Nations, through blended knowledge, can be informative for climate change mitigation policies because management tends to be more adaptive (Brugnach et al., 2017). Understanding how humans perceive threats to ecosystems, react to policies mitigating threats, and may change their own behavior to prevent further ecosystem damage is an important tool for policymakers (Leiserowitz, 2006). Understanding perceptions can help policymakers manage for aspects of ecosystems that people and stakeholders care about.

1.3.3 Human perceptions providing improved springs ecosystem stewardship on public land

Few studies examine the human preferences of springs management. Nearly all existing studies use stated preference methods and are focused on estimating nonmarket valuation of springs. Non-market valuation provides a monetary economic estimate of goods or services not traded on an open market (e.g. Mueller et al., 2017). While a useful tool to estimate societal benefits, neoclassical methods involved in non-market valuation may derive incomplete estimates because they do not take into consideration cultural values and human perceptions (Thorsby, 2001). In addition, stronger acknowledgement of cultural and spiritual existence values may present a more complete picture of the benefits that humans derive from nature (Schröter et al., 2014). Faccioli et al. (2020) state that traditional CE studies often cannot reveal the complex psychological and sociological factors that are the reasons behind willingness to pay (WTP)

estimates. The complex relationships and reasons behind WTP estimates are often missing from traditional economic approaches (Costanza et al., 2017). Another challenge with non-market valuation is that participants may not consider some ecosystem services, such as cultural significance, purchasable by money or time (Farber et al., 2002). A purely economic approach to valuing ecosystem services may not consider all intrinsic characteristics of springs. Springs may include values such as spiritual values (Heal, 2000). Spiritual values, such as ceremonies or oral traditions cannot be valued using dollar amounts because their value comes from experiences and meaningful connections which can be more valuable than money.

We provide a different context regarding stakeholders and the public's attitudes and perceptions toward springs to complement the existing non-market valuation literature. The mission of the U.S. Forest Service (USFS) is to "Sustain the health, diversity, and productivity of the Nation's forests and grasslands to meet the needs of present and future generations" (USDA, 2019). We document and analyze the human perceptions of springs management on USFS land. Our research can provide the USFS with data to help support their mission.

1.3.4 Understanding Research through an Indigenous lens

Incorporating perspectives of Indigenous Nations through monetary estimates using traditional non-market valuation methods presents unique challenges. Poelina et al., 2019 & Adamowicz et al., (2004) argue that Indigenous Peoples' perceptions do not easily fit into economic valuation estimates because natural resources are seen as living entities and their value comes from relationships. Therefore, little research exists addressing the values of Indigenous Nations and underrepresented populations. To my knowledge, only one previous study, Mueller et al. (2017), incorporates values of cultural significance into a WTP study regarding springs. Mueller et al.,

(2017) find that US respondents have indicated support for restoration of springs of Indigenous cultural value. However, little information about Indigenous springs management and cultural values has been incorporated by western research projects. Collaboration with Indigenous groups for the incorporation of Indigenous knowledge is currently underutilized in most public land management. This research project deliberately includes a diverse stakeholder group, including Indigenous Nations. Our results provide land managers with useful information to make well-informed policy-making about springs management.

The coproduction of knowledge using stakeholder analysis helps to eliminate some of the problems of one group being the single source of knowledge during the environmental management policy-making (Kauffman & Arico, 2014). Incorporating Indigenous stakeholders of springs in the region, we have the ability to build knowledge rooted in local Indigenous knowledge, history, traditions, perceptions, livelihoods, and cultures. There is a lack of meaningful communication and consultation between Indigenous groups and land managers due to differences in both the attitudes towards values from springs and the processes with which both groups try to achieve environmental management. Prior to colonization, Indigenous nations managed land and springs before being pushed out of the western systems of land management through removal, relocation, and extermination. Cooperation between stakeholders, through communication of research findings that connect these groups, is one way to help bridge these gaps (Lewis & Sheppard, 2006). By building a comprehensive base of knowledge, we contribute analysis that will aim to fill those gaps and create data that land managers can use in policy-making.

Indigenous communities are deeply knowledgeable about the environment which they have lived in and managed for thousands of years the vast array of Indigenous knowledge on ecological

systems is starting to be more widely recognized and incorporated, as we face global environmental issues (McGregor, 2004). Methods which build a respectful relationships between western interviewers and Indigenous interviewees, recognize various parties' roles and responsibilities, and foster an environment which leads to reciprocal growth and learning are essential when gaining meaningful insights (Wilson, 2008).

Culture, and various Indigenous Nations' culture, is often seen as purely mythical and a black box outside the dimension of life that western cultures perceive the world (Head et al., 2005). Deep engagement and proper respect for Indigenous communities is necessary for understanding and adopting these practices of land management (Robinson et al., 2021). Through our deliberate engagement with Indigenous Nations around the Coconino National Forest (CNF) and Kaibab National Forest (KNF) we document the knowledge, values, beliefs, and management practices that can be used in to create more equitable decisions for policies related to springs management. Previous research supports our methods. Indiana Summit, in the Glass Mountains of California, Slaton et al., (2019) showed that involving Indigenous stakeholders and adopting Indigenous forest management practices led to better ecological conditions post fire, creating an overall healthier forest while protecting and managing for the culturally significant species of plants and animals that Indigenous Nations relied on. Similarly, cooperation between divergent methods of land management can be applied to springs in the CNF and KNP. Our research serves as framework for land managers to better understand Indigenous Nations' values and incorporate Indigenous knowledge into management policy-making. Charnley et al., (2007) highlighted the benefits of integrating knowledge from both Indigenous stakeholders and local stakeholders. Similarly, our research directly involves both groups of stakeholders with the goal to foster partnership and cooperation in land management.

1.3.5 The Importance of Stakeholder Analysis

Managing and governing ecosystems with a variety of different stakeholder groups requires balancing the competing values, interests, and preferences (Kooiman et al., 2005). Implementing and linking the perceptions and the choices people articulate to develop policies is an essential component when managing based on human values (Litina et al. 2016). Stresses on ecosystems due to human population growth emphasize the need for a more holistic approach to ecosystem management (Pavlikakis & Tsihrintzis, 2000). We use human preferences and dialogue from stakeholders and marginalized groups to significantly complement other analyses used in environment management. Including all stakeholders in the process is an essential component of policy-making related to environmental management (Mowrer, 1996). We deliberately include all stakeholders of springs in the study areas to foster equity in our comprehensive analysis of human preferences.

1.4 Methods

1.4.1 Northern Arizona University Internal Review Board

The focus groups, interviews and national survey were all deemed “exempt”¹ from the Northern Arizona University (NAU) Internal Review Board (IRB) (**Appendix A**). Once the project was deemed exempt, we were able to reach out to potential focus group/interview participants, schedule the meetings, and conduct the focus groups/interviews. The role of the IRB is “a university committee that performs ethical review of proposed research involving human subjects and monitors continuing research” The IRB is also responsible for providing training on the protection of human subjects in research” (*IRB 2013-2020 Strategic Plan*).

¹ IRB Number: 1804157-5

For this research to be exempt we had to clearly demonstrate that interview and focus group participants were speaking on behalf of their organization, not expressing personal beliefs, and that the national survey data we collected would be properly stored in a secure location with all identifiers from respondents removed or coded.

All team members on this project had to complete the Human Research Social, Behavioral, & Education Research basic course through the Collaborative Institutional Training Initiative (CITI). This training program is offered through NAU. All participants also had to upload their resumes or Bio sketches to the IRB portal. In addition to those team member specific documents to be exempt from the IRB regulations we also had to submit the following documents related to the project:

- Project Narrative
- Project Proposal
- 3 Year Project Budget
- Data Management Document
- List of Project Personal
- Approval of Funding Source (NIFA award letter)
- Recruitment Material
- Consent Form
- Focus Group and Interview Questions
- Complete Draft of the National Survey

Every time a change was made to the research an amendment had to be made and the project had to again be approved for the exemption. We made two amendments to the project. The first

amendment was to add Drs. Stefanie Kunze and Mohammad Mashiur Rahman to the list of project personnel. The second amendment was to get the national survey approved for dissemination. While the initial exemption took nearly four months, the amendments took only weeks to be deemed exempt. Once the final amendment was approved on July 1, 2022, by the IRB we tested the survey and disseminated it on July 14, 2022.

1.4.2 Focus groups with Stakeholders

We recruited focus group participants by local network recruiting, meaning we reached out to connections and people from previous working relationships to identify participants. Local networking works well when some connections already exist, (Casey & Krueger, 1994). We held two focus groups, the first focus group was on November 4, 2022, and the second focus group was on November 9, 2022 (**Table 1**). During these focus groups we provided refreshments from Sodexo including pop, chips, cookies, water, and mixed fruit.

Projects valuing ecosystem services typically start off with identifying the important natural elements of the system (De Groot et al., 2002). The main goal of focus groups was to determine attributes of spring ecosystems most important to the stakeholders. The focus groups lasted 60 minutes and consisted of three types of questions; engagement (2), exploration (2), and exit question (1) (Thomas Jefferson University, 2017). First, the engagement questions were used to pique the interest of the group and introduce them to the topic. Second, exploration questions asked who the participants thought constituents of springs were, what attributes of springs are important, how to level or measure those attributes, and a clear and concise definition of those attributes. Third, exit questions were the last set of questions, giving participants the opportunity to make any last comments and inquires. We had one main moderator for the focus groups (Andrew Lewis), two note takers (Katelyn LaPine and Dr. Abraham Springer), and one assistant

moderator (Dr. Ryan Fitch) who clarified questions and ensured the focus groups ended on time. The minutes or notes collected by the notetakers were taken individually and shared on a projector for the participants to see (**Appendixes B & C**).

1.4.3 Stakeholder Categorization

Grouping stakeholders by culture, economic outlook, and livelihood is a method to condense individual groups of stakeholders into broader categories which makes for clearer analysis (King et al., 2015). Categorizing stakeholders into groups is an essential step before analysis begins (Reed et al. 2009). The “4Rs” tool is a system of analysis involving splitting the stakeholders into groups and analyzing the relationships between groups that have rights, responsibilities, and revenue from the natural resource (Tekwe & Percy, 2001). Similarly, we categorize stakeholders of springs in the CNF and KNF into three groups: Stakeholders of Responsibility, Stakeholders of Investment, and Stakeholders of Interest.

1.4.4 Interviews with Stakeholders

Before interviewing began we had a two-hour training session with the members from the Spring Stewardship Institute on how to perform interviews with people from Indigenous Nations.

During the training session we were taught phrases or words that would not be appropriate to say during the interviews and we were also given advice as how to respond to certain questions or concerns that participants might have.

1.4.4.1 NVivo

We performed three types of textual analysis on the interview data using Nvivo, a qualitative data analysis software by QSR International: thematic content analysis (TCA), word frequency, and sentiment.

The analysis and the final reporting of the focus group and interview data is compiled using an inductive approach which involves analyzing data that has no predetermined theory, structure, or framework. Through this method the data derive the structure of analysis (Anderson, 2007).

Through the inductive method a thematic content analysis (TCA) approach is used. This approach aims to connect common themes from textual data such as transcripts from interviews and focus groups (Anderson, 2007). The basis for TCA is that “interpretation” is kept to a minimum and the goal is present themes that reflect the actual phrases and ideas of the participant (Anderson, 2007). This theory of categorizing textual evidence presents trends, relationships, structures, and discourse to be used in analysis (Mayring, 2000).

To determine the themes and use the TCA method we will use NVivo, a qualitative analysis software. This software will allow us to detect themes and common insight from the meeting notes (Leech & Onwuegbuzie, 2011). When analyzing qualitative data there is the *data corpus* which is the entire body of data collected and there is the *data set*, which is a subset or section of the *data corpus* which can be used for more narrow analyses (Braun & Clark, 2006).

Braun & Clark (2006) outline methods and best practice for using TCA and define a theme as “[capturing] something important about the data in relation to the research question and represents some level of patterned response or meaning within the data set”. TCA is a commonly used method across disciplines to understand preferences for different groups (Hamel et al., 2021, Thomas, 2003, Braun et al., 2016, Chapman et al., 2015). Thematic content analysis is useful in many ways including understanding what the participants feels is important, categorizing perceptions, and understanding what attitudes they hold and how they relate to other groups (Herzog et al., 2019).

TCA can be used to test the predictions of stakeholder preferences relating to environmental issues (Lavallee & Suedfeld, 1997). Using themes to understand what the stakeholder groups value we can understand which policies and management at springs they might prefer. For example, consistent themes that support the biological habitat quality of the spring may indicate support for management that limits the ability of human to use the spring for activities such as recreation and ranching in order for the native flora and fauna to have dominant access.

One step of TCA that is often overlooked is the documentation of the process. Thorough documentation of the different stages in the process leads to a more reflective and transparent process (Herzog et al., 2019). We extracted and coded themes as described in the tables that highlight the different themes (**Chapter 2, Table 1**).

We use the attributes determined during the focus groups to create nodes in NVivo. Creating nodes allowed us to separate each attribute for analysis. We also use the word frequencies code to categorize each stakeholder's responses. Our method delineates and counts each time a respondent mentioned a particular word related to springs management. The display of these results allows for us to see the relationships, commonalities, and differences between stakeholders.

Coding in NVivo isolates certain questions that will illicit results to answer the hypothesis (Castleberry & Nolen, 2018). Using nodes to identify certain words or phrases means NVivo has little to no influence on the research design making it a compatible method to use for TCA. To find the association between different groups in the dataset the relationships code in NVivo can be used (Dhakal, 2022). The sentiments code in NVivo can be used to detect or tag positive or negative word or phrases that the respondents indicated (Dhakal, 2022). Using NVivo we also

use sentiment analysis to identify the feelings [positive or negative] of different attributes related to springs, those feelings can be interpreted as the opinion of the stakeholder groups (Saura et al., 2018).

We use NVivo to answer several questions, including:

i. How do perceptions of springs vary between stakeholder groups?

To answer question (i), we broke down the data corpus into stakeholder groups, ranchers, environmental advocacy Groups (EAG), Indigenous groups, government agencies, and municipal representatives. We use three different types of analysis; one to detect the themes, another to detect word frequency, and the last one to understand the sentiments of the different stakeholder groups. We also determine what each group perceives the most important constituents of springs to be by analyzing the results from the interview where the interviewee was asked that specific question.

To detect the themes from each of different stakeholders we hand coded the most commonly used phrases and ideas that each of the interviewees was stating. Using that hand coded information, we determine the most important themes. Beforehand coding, a document with all the meeting notes for each stakeholder group is created. Each of those documents is analyzed in NVivo by highlighting statements that each of the interviewees said most often or stated most important to them. To summarize by each stakeholder, group the highlighted data that is overlapping from each of the interviewees is highlighted in a different color. Those overlapping themes are determined to be most important and prevailing themes for the entire stakeholder group. This process is repeated for each of the five different stakeholder groups.

To analyze word frequency, we again separate the data by stakeholder group. Using the NVivo word frequency tool we analyzed each group. To obtain the most accurate and relevant results from the word frequency tool, we set the parameter of the tool to output the 15 most used words. A parameter is also set to only output words with a minimum length of three characters, to avoid words that were not the subject of the sentence. To ensure that important words are not left out of the analysis, words with the following structures were lumped together:

- Exact matches (e.g. “talk”)
- With stemmed words (e.g. “talking”)
- With synonyms (e.g. “speak”)

Words that are not meaningful for analyses such as prepositions or conjunctions are removed from the frequency list and replaced with the word with the next highest count that is most relevant.

The last analysis tool used to answer question (i) is sentiment analysis. Using NVivo we perform an automated sentiment analysis. During the automated sentiment analysis NVivo detects when positive, negative, and neutral words are being used. NVivo outputs a chart showing which words and phrases are deemed to be positive, negative, neutral, or mixed. It is essential to delineate what the stakeholder is talking about before performing the sentiment analysis. To understand what the stakeholders are talking about we create a node in each stakeholder group file for each of the following topics: recreation, ranching, cultural significance. Every time the stakeholder mentioned one of those subjects that entire sentence is added to the node with that same subject title. Once each node is created by hand coding, we used the automated sentiment analysis tool to obtain the results.

After analysis of the references from the automated sentiment analysis output, we look over all the references that NVivo made to ensure that the results are correct, accurate, and sentiments are coded correctly. We were unable to perform sentiment analysis for the municipal stakeholder's because there is only one municipal stakeholder, the City of Flagstaff. NVivo was unable to detect any sentiments from a smaller set of data because there was minimal data collected and there was not data collected for each attribute of ranching, Indigenous Nations' cultural significance, or recreation.

The rancher stakeholder's sentiment analysis is first run through the automated sentiment analysis and then also hand coded to correct the many irregularities. After reviewing the references that the automated sentiment analysis output, we notice that many statements that the ranchers made about springs and management for ranching at springs output as negative sentiments. After further analysis of the text and context of the statements, we determine the ranchers spoke about ranching at springs in a positive way, while using negative connotations to make the positive statement. For example, they frequently use words such as "not", "don't", and "wouldn't", while making positive expressions. One of the many pieces of textual evidence to support this claim is the following sentence: "If [name of ranch] didn't use and capture all the spring water it would run in the nearby canyon and disappear." The context of this sentence is that if they did not use the spring water it would not have any other value, therefore their use does not degrade or diminish use for any other constituents. That context shows they have a positive sentiment about management for ranching at springs, but it could not be automatically detected by NVivo because of how it was phrased.

- ii. *In what ways do these perceptions differ, are Indigenous perceptions different?*

iii. What is the overlap between Indigenous views and other stakeholders?

To answer questions (ii) and (iii), We broke down the data corpus into two different groups: Indigenous and non-Indigenous. The non-Indigenous groups contain the EAGs, ranchers, municipal agency, and federal agencies. The analysis to answer these questions is done through three methods: preferences for the attributes ranching, cultural significance, recreation, flow, biological habitation quality, and municipal water supply of each of the two groups (**Table 3**)

The preferences related to spring's attributes are determined by highlighting key concepts throughout the interviews noted related to each attribute. The preferences to come up the most frequently are used for each group. Further details related to interview recruitment and procedure are found in **2.2.3**.

1.4.5 National Survey

The national survey was created in Qualtrics. The survey consisted of an introduction section, 25 attitudinal questions, 6 choice experiment questions, 15 demographic questions, and an optional comment box (**Appendix F**). We used the results from the attitudinal questions and the demographics section. The results from the choice experiment part of the survey will be published as Rahman et al., (2023). Results mapping the Willingness to Pay estimates from the survey will be published in LaPine et al., (2023).

First, we introduce the project, grant, and project team in the beginning of the survey. Section 1 of the survey was created to inform the survey participants about the Coconino and Kaibab National Forests including where it was located in the US. Section 2 of the survey provided information about springs, information on the different attributes of springs, and asked questions about perceived threats and level of concern related to springs. Section 3 of the survey

introduced the 6 attributes: Water Security, Water Flow, Ranching, Recreation, Biological Habitat Quality, and Cultural Significance to the participants including detailed definitions and levels for measuring the attributes. Section 4 was the choice experiment part of the survey and asked participants to choose between hypothetical springs management options. Results from section 4 were not used in this thesis or manuscript research. Section 5 of the national survey asked demographics question such as income, gender, highest level of education etc.

Demographics questions were developed using the same questions asked by the U.S. Census.

The attitudinal questions of the national survey were developed using the information gathered from the focus groups. We documented the attributes of springs which were important to the stakeholders and subsequently formulated survey questions related to those attributes. We also gained information from the focus groups about the threats associated with springs and used that information to formulate questions where survey respondents can indicate their level of concern about those threats on a Likert scale (1-5). For example, we asked survey responds to indicate their level of concern that cattle grazing has on springs. Respondents choose from (1) “not all concerned”, (2) “slightly concerned”, (3) “moderately concerned”, (4) “very concerned”, and (5) “extremely concerned”.

Because cultural significance, biological habitat quality, and recreation were frequently mentioned in the focus groups, we also asked survey respondents if they were willing to restrict their own recreation at springs for the springs protection and to protect Indigenous Nations’ cultural significance. Cattle grazing was also frequently mentioned in the focus groups.

Therefore, we formulated questions asking respondents their level of concern with a reduction in cattle grazing at springs and we asked them to indicate their level of concern with the degradation that grazing can cause at springs.

We employed tmsr Design Delivery LLC as a graphical artist to illustrate images of springs for the six attributes we developed. They created illustrations for springs for different attributes or uses and different levels of those uses. They also created icons to be used in the choice experiment section of the survey. We had several rounds of revisions from the graphical artist to ensure the pictures were both accurate for springs in the CNF and KNF as well unbiased.

Before the national survey was disseminated, we tested it with random participants from around the country (students, family, friends) through two online zoom focus groups.

- Survey Testing Focus Group 1: May 16, 2022
- Survey Testing Focus Group 2: May 17, 2022

After conducting participant focus groups, we corrected some of the issues that were in the coding of the Qualtrics survey as well as clarified some of the language that the participants were confused about. The results from those focus groups and an explanation on how each comment was addressed can be found in **Appendix E**. The national survey was officially disseminated to the public on July 14th 2022. Documentation on how the survey participants were recruited can be found in DiSogra et al., 2011 and in **Appendix G**. Further methods related to survey recruitment and dissemination are found in section **2.2.4**.

To analyze the results from the national survey we use Pearson's Chi-squared and Cramer's V test for significance. We perform three hypothesis tests to test the relationships about grazing, cultural significance, and recreation to further understand complexity of survey respondents and provide evidence for reasons certain attributes of springs management are preferred. Further methods and results relating to this can be seen in section **2.4.2**.

Chapter 2: Manuscript

Human Perceptions of Competing Interests in Springs Ecosystem Management on Public Land
in Southwestern US

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Highlights

- We conduct semi-structured interviews with stakeholders of springs in the Coconino and Kaibab National Forests and disseminate a national survey to understand public perceptions of springs' management
- Indigenous Nations' perspectives are not equally represented in the management of spring ecosystems in the Coconino and Kaibab National Forests
- Survey responses from the public indicate a perceived importance for springs to be managed for Indigenous Nations' cultural significance
- Joint management and targeted management for exclusion of certain human activities is a possible management solution

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Abstract

Spring ecosystems provide vital services to humans and wildlife in northern Arizona. Management of springs presents unique challenges due to the diversity of stakeholders and the multiple uses of springs. We employ two methods of data collection to understand the perceptions of springs ecosystem management: interviews and focus groups with stakeholders of springs in Coconino National Forest (CNF) and Kaibab National Forest (KNF) and a national survey aimed towards public perceptions. We analyze the human perceptions of springs to understand variations between stakeholders and how perceptions of stakeholders and the public vary. Our results indicate differences between human perceptions and current management practices. The main competing interests of springs management are cattle grazing, recreation, and Indigenous Nations' cultural significance. The survey respondents, representative of public perceptions, indicate springs management for Indigenous Nations' cultural significance is important. We see positive correlation between concern for threats to springs from grazing and management to prioritize cultural significance indicating respondents prefer springs to be managed for cultural significance. Cattle grazing and other high impact human uses are viewed less favorably than other management scenarios. Stakeholders' perceptions varied and non-Indigenous stakeholders suggested management should be based on multiple uses and management focused on specific attributes of springs valuable to humans. Our results of the survey respondents' perceptions for management of Indigenous culture and some support from stakeholders show a joint management concept might be beneficial for springs management in the CNF and KNF. Using the information we collected on the perceptions of spring ecosystems management, we discuss mechanisms for springs management to increase the ability for springs to provide cultural significance values to Indigenous Nations by potentially limiting

high impact and degrading uses of springs. We provide results and examples of how all stakeholders can have the ability to benefit from the resources springs provide.

Key Words

Human perceptions, cultural significance, springs ecosystems

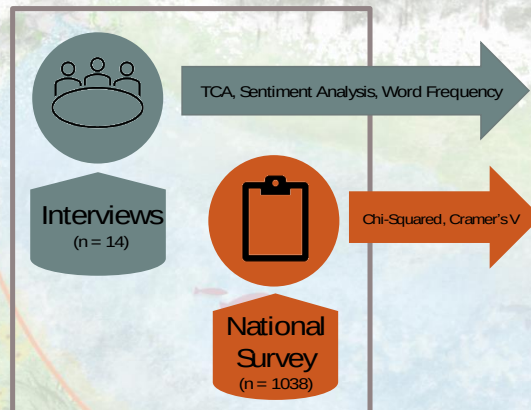
Human Perceptions of Competing Interests in Springs Ecosystem Management on Public Land in Southwestern U.S.

Background

Spring ecosystems are vital sources of freshwater, harbor a high amount of biodiversity, and are hydrologic refuges for the arid landscape of Northern Arizona. The three main competing interests that springs can be managed for are Indigenous Nation's cultural significance, recreation, and cattle grazing.

- What are the human perceptions of spring ecosystem management in the Coconino and Kaibab National Forests,
- how do perceptions vary between stakeholders,
- and how do perceived threats and perceptions of management vary between survey responses from the public and stakeholders?

Your Public Lands



- Our results provide context for public land managers to use in combination with the existing literature on the ecological importance of springs.
- We discuss several mechanisms for springs management to increase the ability for springs to provide cultural significance values to Indigenous Nations. Potentially limiting high impact and degrading uses of springs can ensure all stakeholders can benefit from the resources springs provide.

2.1 Introduction

Springs are essential sources of water for impoverished regions and Indigenous peoples around the world (Cantonati et al 2020, Khadka & Pathak, 2021, Kumar, 2022, Gowling et al., 2020). A reduction in springs discharge, due to human causes, has been observed in the communities that heavily rely on the fresh water springs provide (Jeelani et al., 2021). Current literature on springs and other sources of groundwater on a global scale primarily examines indicators of water quality to be used in management (Laskar et al., 2022, Taloor et al., 2020, Ansari et al., 2015, Chandrajith & Dissanayake, 2020). Management of spring ecosystems as essential water sources is important as springs provide a reliable flow of water in the face of climate change (Margeta, 2022). However, analyses into the human dimensions of springs can provide further context to better manage these systems. Understanding threats and documenting the human perspectives of springs management can lead to capacity development (Scheihing et al., 2022), enhancing the sustainability of these groundwater systems by connecting it to human interactions.

The United Nations (UN) outlines 17 goals for sustainable development (United Nations, 2023). The sixth goal is *Clean Water and Sanitation* which directly relates to research we present. Specifically, target 6.6 is to “protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes” (United Nations, 2023). Our research contributes unique interdisciplinary research directly related to protecting groundwater dependent ecosystems. The global sustainability goals which the UN has deemed important places our research in a global context and our methods can be a framework for future research around the world to ensure the protection of groundwater dependent ecosystems.

Incorporating human perceptions into environmental management is crucial for effective and equitable policy making on public land (Bremer et al., 2015). The US Forest Service (USFS)

manages 781,043 square kilometers of land across the United States for various uses and purposes (USDA, 2013). “Caring for the land and serving the people” is the USFS’s motto, while protecting the natural resources of the land and promoting research on forest resource utilization (USDA, 2019). The main competing interests that springs can be managed for in the Coconino and Kaibab National Forests are Indigenous Nations’ cultural significance, recreation, and ranching. Our objective is to understand the human perceptions of those interests to inform policy decision making on these public lands. We analyze human perceptions for springs management in the Coconino National Forest (CNF) and Kaibab National Forest (KNF) located in Northern Arizona, USA, to answer the research questions:

1. What are the human perceptions of spring ecosystem management in the CNF and KNF?
2. How do human perceptions vary between stakeholders?
3. How do perceived threats and human perceptions of management vary between survey responses from the public and stakeholders?

Our research contributes to the literature by examining diverse perspectives on the driving forces behind springs management, cattle grazing, recreation, and Indigenous Nations’ cultural significance. By comparing stakeholder and survey respondent perspectives, we highlight differing attitudes towards springs ecosystem management. Specifically, we examine the divergence between management for cattle grazing, recreation, and cultural significance. We engage broad community representation in targeted discussions on the perceptions of springs ecosystem services. In addition, we developed and disseminated a survey examining human perceptions of springs ecosystem management in the CNF and KNF. We create a framework that includes a wide variety of data from different demographics and levels of interest in springs ecosystem management. Information gathered from diverse stakeholders provides an ethical

perspective, enhances inclusive decision making, promotes equity, and builds social capital (Mathur et al., 2008). Our methods can be adopted to other management challenges across the globe to promote the sustainable development of groundwater resources.

2.1.1 Human perceptions and ecosystem services

Ecosystems can be managed for the services they provide to humans; however, human uses can compete (Felipe-Lucia et al., 2018, Spangenberg et al., 2014). Adequately integrating humans into the management of ecosystems instead of treating them as external factors is important for effective land management (Waltner-Toews et al., 2003). Gaining people's perspectives can lead to better management by considering humans and the environment together (Camberlain et al., 2021, Bowonder, 1987). Humans' use can negatively impact ecosystems and limit the many benefits they provide; therefore, merging the social and natural sciences creates a framework for understanding human dominated ecosystems (Alberti et al., 2003). We create a base of knowledge on the human perceptions of spring ecosystems to integrate with the existing literature on the ecological functions and management of springs (Stevens et al., 2021, Cartwright et al., 2020, Stevens et al., 2020, Freed et al., 2019, Paffett et al., 2018, Springer & Stevens, 2009, Perla & Stevens, 2008).

Engaging stakeholders is one way to equitably manage an ecosystem for the economic, cultural, human wellbeing, and biophysical values that ecosystems provide (Martinez-Harms et al., 2015). Increasing the synergy between ecosystem uses and stakeholders can be beneficial when managing a system with competing interests (Howe et al., 2014). We present management strategies aimed at limiting use and promoting joint management that can be beneficial for

protection of spring ecosystems' biological habitat quality and Indigenous Nations' cultural significance (CBS News, 2005, Haun, 2020, Diver, 2016, Lawrence 1996, Stevens et al., 2016, Linge, 1999, Freeman, 2007, NPS 2021, Morse et al., 2009, Berigan et al., 2012). Developing research through stakeholder engagement is a crucial component for increasing equitable access to natural resources for human uses. Our research in the CNF and KNF provides context to the larger global issue of equitable access to groundwater resources.

Mitigating human caused impacts on ecosystems is more important than ever as degradation from humans increases with landscape simplification and climate change (Riechers et al., 2020). Understanding human perceptions of threats, reactions to the policies aimed at mitigating them, and knowing if constituents are willing to change their own behavior to prevent further ecosystem damage, is important information for policymakers (Leiserowitz, 2006). We examine human's perceived threats to springs and gain an understanding on a willingness to restrict their activity. Using human perceptions promotes equity in management of ecosystems (Khan et al., 2019, Bertram & Rehdanz, 2015, Kooiman et al., 2005, and Mowrer, 1996). We examine human perceptions to aid in policy making and equitable governing of spring ecosystems through a mixed method approach.

Implementing and linking people's perceptions and their choices to develop policies, is an essential component when managing resources based on human values (Litina et al. 2016). One way to link perceptions to choices is through economic non-market valuation (Mueller et al., 2017). Currently, non-market valuation methods used for springs primarily focus on understanding human values through choice experiments (Mueller et al., 2017). While choice

experiments are a useful tool to estimate societal benefits, the methods may derive incomplete estimates by not taking cultural values and human perceptions into consideration (Thorsby, 2001) and estimates can be “reason blind” (Schutter et al., 2021, O’Neill, 2013), meaning there is no explanation as to why those perceptions are held. Our combination of qualitative and quantitative data allows for an in-depth approach and can provide reasons for why certain perceptions of springs management are held.

In this article, we provide context for people’s attitudes and perceptions toward springs in the Coconino National Forest (CNF) and Kaibab National Forest (KNF) complementing the existing non-market valuation literature and offering suggestions on how spring ecosystem management can be improved. Our results provide valuable information regarding diverse perceptions for spring ecosystem management which can be translated to other environmental management challenges across forests nationwide. Our research furthers the understanding of human perceptions for springs ecosystem management through analysis of:

- Qualitative data from focus groups and interviews with stakeholders of spring ecosystems in the CNF and KNF, and
- Quantitative analysis of attitudinal questions from a survey nationally distributed and representative of the U.S. population.

2.1.2 Study Area

Located in Northern Arizona, US, the Coconino National Forest and Kaibab National Forest comprise approximately 13,759 square kilometers (USDA, 2013). The CNF and KNF consist of ponderosa pine, mixed conifer, red rocks, and alpine tundra. The KNF borders the north and south rims of Grand Canyon National Park, while the CNF stretches across Flagstaff and Sedona southeast to Camp Verde, AZ (**Figure 1**). Several federally recognized Indigenous Nations have heritage connected to and live around the CNF and KNF, including the Navajo, Hopi, Zuni Pueblo, Hualapai, Kaibab Band of Paiute Indians, Havasupai, Yavapai-Apache, and White Mountain Apache (Inter Tribal Council of Arizona).

The USFS oversees 37 cattle grazing allotments in the KNF across three different districts (USDA, Range Management, 2023). The CNF has 29 allotments across three districts (USDA, Grazing Allotment Documents). Livestock grazing is permitted on 299,467 square kilometers of the 781,043 square kilometers of USFS land within the US (USDA, 2020). The fees associated with grazing on USFS land are \$1.35 per animal unit per month. An animal unit includes either a bull, steer, heifer, or cow with a calf (USDA, 2022). Out of the 1.2 million cattle (USDA, 2020) grazing on USFS rangeland around the country and the nearly 9.2 million (USDA, 2022) total cattle grazing in the United States there are 111,487 authorized animal units of cattle in Arizona grazing on USFS land between 367 permittees (USDA, 2020). Because of the unique four season climate of CNF and KNF, compared to the rest of the state, recreation is also very prevalent in these National Forests. Both areas are tourist destinations for the southwestern U.S. and highly trafficked. Popular recreational activities in the forests and therefore around springs include hiking, mountain biking, swimming, fishing, camping, birding, and boating. To Indigenous

peoples, these forests and springs are sites of significance for traditional and spiritual practices, including the collection of herbs and medicines, origin stories, as well as teachings.

The CNF and KNF are home to nearly 700 springs, many of which are directly threatened due to human actions (Paffett et al., 2018). Extensive data documents the important ecological and hydrologic functions of springs and threats to them (Stevens et al., 2021, Springer & Stevens, 2009, Paffett et al., 2018, Stevens et al., 2020). For example, human caused degradation of springs includes overgrazing of cattle, overuse and trampling by recreationists, stream channel disturbances causing increased erosion and decreased water quality, spring habitat destruction from human caused wildfires, and decreased flow due to climate change and groundwater pumping (Cartwright et al., 2020, Donovan et al. 2022, Perla & Stevens, 2008). To date, little research has focused on the human perceptions for springs in the CNF and KNF and the threats that raise the highest level of concern from stakeholders and the public. Some of the threats include groundwater pumping, high impact recreation, cattle grazing, increased development, and drought. These issues are similar to issues effecting groundwater systems around the globe. Ensuring sustainable groundwater development in tandem with social and economically sound human development is an essential component of our research which takes into consideration the value humans receive from spring ecosystems.

2.1.3 Spring Management in the Coconino and Kaibab National Forest

Today, springs in the CNF and KNF are negatively affected by poor management of livestock, as well as recreational activities (Paffett et al., 2018). However, changes in management and reduction in recreation and cattle grazing can lead to better health of the spring ecosystems (Paffett, 2014). Overgrazing has been a long-standing issue in the western U.S. To prevent further overgrazing and better manage grazeland, western ranchers requested grazing districts which led to Congress passing the Taylor Grazing Act of 1934. The Taylor Grazing Act of 1934 regulated and restricted grazing on public land (Stout, 1970). Today 111,487 cattle animal units are grazing in Arizona (USDA, 2020). Recreation is also prevalent with 15,244,000 visits in the southwestern region of US National Forests alone (USDA, 2021). Our data collection and analysis provide evidence for the reasons for support or lack of support for springs' management from both the survey respondents representative of the U.S. population and stakeholders of springs in Northern Arizona.

2.1.4 Indigenous Cultural Significance and Environmental Management

Incorporating the perspectives of Indigenous Nations continues to present unique challenges to western researchers. Indigenous Nations' perceptions are diverse and do not easily fit into dominant western economic valuation estimates because natural resources are seen as living entities and their value rooted in relationships (Poelina et al., 2019 & Adamowicz et al., 2004). As such, Indigenous and western approaches and world views are often at odds with one another. Existence values, which are non-use values motivated by the morality of knowing the values exists for others' benefits (Davidson, 2013), are not purchasable with money or time (Farber et al., 2002). Their significance is derived from culture and spirituality, creating a non-tangible

challenge to western research management approaches. Culture in the framework of environmental management is defined as spiritual enrichment, aesthetic experience, maintenance of social relations, and other non-material benefits derived from the ecosystem (Satterfield et al., 2013, Lee & Diop, 2009). Environmental challenges, including a reduction in springs' habitat quality, cause very tangible cultural losses to Indigenous Nations. Diverging from western methods of economic and natural resource valuation and ensuring adequate participation of Indigenous Nations, significantly prevents problems of inadequate valuation and cultural insensitivity (Gregory & Trousdale, 2009). We pursue a coproduction of knowledge by inviting and incorporating Indigenous stakeholders' views of spring ecosystems and address conflicts of western actors dominating the environmental management decision making process distinctly different from Indigenous management practices (Kauffman & Arico, 2014, King et al., 2015, Lewis & Sheppard, 2006, Slaton et al., 2019, and Charnley et al., 2007). Management methods considerate of expression of cultural perceptions or experiences can lead to a culturally appropriate and inclusive option for environmental management (Satterfield et al., 2013). There are significant ontological differences in how Indigenous stewards of the land approach nature, the environment, and natural resources, as compared to dominant, market-based approaches commonly pursued in economics and resource management. Deep engagement and respect for Indigenous Nations is necessary for understanding and adopting more wholistic and sustainable practices of land management (Robinson et al., 2021). Through our deliberate engagement with individuals from various Indigenous Nations around the CNF and KNF, we document knowledge, values, beliefs, and management practices, which can be used to create more equitable decisions and policymaking related to springs management.

2.1.5 The Importance of Springs

Springs in CNF and KNF are particularly important because they recharge aquifers which provide resilience against drought and aridification of the drought-ridden southwestern US (Vaux, 2010). The recharge of aquifers is related to the hydrogeology of the area and not directly correlated to precipitation alone, giving springs resilience for when extremely low precipitation years lead to water shortages (Vaux, 2010). The discharge of springs can vary significantly due to the distance between drainage and recharge areas, the hydrology of the area, the climate, and landcover and land management of the region (Staśko & Buczyński, 2018, Wyatt et al., 2015). While snowmelt and precipitation events can increase discharge, that increase can be delayed by years due to sediment and depth of the aquifer, making some springs more resilient to extreme drought periods (Staśko & Buczyński, 2018). The delayed flow response of springs may obfuscate the impacts climate change has on springs, as the impacts of droughts would be delayed as well. Examining stakeholder management and survey respondents perceptions provides an opportunity to diversify springs management based on human needs and ecosystem functionality, making management of springs more inclusive and dynamic.

2.2 Materials and Methods

We implement two types of qualitative data collection, focus groups and interviews, and one type of quantitative analysis, a national survey. Focus groups and interviews were conducted with stakeholders who work, live, and rely on springs in the CNF and KNF. All focus group and interview participants spoke on behalf of their respective organizations or Indigenous Nation.

The goal of the interviews was to reach stakeholders who fit under the categories of: Environmental Advocacy Groups (EAG), Ranchers, Federal Agencies, Municipal Water Suppliers, and Indigenous Nations. The goal of the survey was to reach survey respondents who were representative of the broader U.S. population. The Northern Arizona University (NAU) Institutional Review Board (IRB) deemed the national survey, focus groups, and interviews “exempt”².

Analyzing qualitative [interviews] and quantitative [national survey] results together allows us to understand some of the reasons why certain preferences are held. Similarly, in other fields of study, qualitative and quantitative results have been used in combination to answer the same research question; this method is often referred to as triangulation (Morse, 1991). One common model for integrating qualitative and quantitative results, is to formulate hypotheses with qualitative methods and test hypotheses using quantitative methods (Kelle & Erzberger, 2004). Our methodology is similar, the qualitative and quantitative results complement each other in the following ways:

- 1) We use the results from the focus groups to determine the attributes springs can be managed for and subsequently formulate the national survey based on those results
- 2) We formulate hypothesis tests based on the interviews with stakeholders and use the results from the national survey to test our hypotheses
- 3) We use the textual evidence from the interviews with stakeholders to provide further explanation of the Likert scale results we received from the national survey

² IRB Number: 1804157-5

2.2.1 Stakeholder analysis

It is essential to understand the perceptions of stakeholders for effective multiuse land management (Seppelt et al., 2011). We define stakeholders as separate from the public, and those who rely on springs for economic incentives, have the authority to manage springs, contribute to springs restoration, have cultural ties to springs, or advocate for different uses of springs.

Stakeholders contribute critical and distinctive insights because of their utilization of and reliance on springs. For example, ranchers graze at springs on USFS allotments because of the availability of water and grasses which are less abundant in other parts of the forest.

Policymaking is complex and often happens in rapidly changing contexts. Stakeholder analysis is a beneficial tool (Brugha & Zsuzsa, 2000) to include marginalized groups and can complement other approaches for policy making. Current methods of stakeholder analysis and participation are often deficient in their ability to reach marginalized groups because of lack of information regarding who those stakeholders are and how to effectively involve them in the research process, leading to missing substantial and important contributions to the literature and policymaking (Johnson et al., 2004). Our study offers unique and inclusive approaches to current studies on springs through implementing targeted sampling, outreach, and building off existing relationships to deliberately seek out and include marginalized groups ensuring equitable representation. Our policy recommendations in CNF and KNF springs ecosystem management are based on diverse stakeholders' perceptions.

Considerable diversity exists within Indigenous Nations in northern Arizona. However, for this analysis our goal to understand how Indigenous perceptions for springs management varies between other stakeholders and the public, not how Indigenous Nations' perceptions vary

between each other. In our stakeholder interviews, we found no evidence of competing views on springs management between different Indigenous Nations and therefore discuss the perceptions of Indigenous Nations together.

2.2.2 Focus Groups

We recruited focus group participants through local network recruiting, meaning we reached out to contacts and people from previous working relationships to identify possible participants.

Local networking is effective when some connections already exist (Casey & Krueger, 1994).

Previous years of field work, research and relationship building among team members facilitated connections. We held two focus groups with four participants each. Stakeholders included ranchers, government agencies, environmental advocacy groups, and Indigenous peoples (**Appendix A**). Generally, projects valuing ecosystem services tend to begin with identifying the most important natural elements of the system (De Groot et al., 2002). In our study, our main goal for focus groups was to determine the attributes of spring ecosystems most important to the participating stakeholders.

The focus groups consisted of various stakeholder representatives who were asked three types of questions: engagement, exploration, and exit questions (Thomas Jefferson University, 2017).

First, the engagement questions were used to pique the interest of the group and introduce them to the topic. Second, exploration questions asked who the participants thought constituents of springs were, what attributes of springs are important, how to level or measure those attributes, and a clear and concise definition of those attributes. Third, exit questions gave participants the opportunity to make last comments and ask questions. Focus groups took place in a conference room on the Northern Arizona University campus, lasted 60 minutes, and consisted of six open ended questions. The minutes or notes collected by the moderators were taken individually and

shared on a projector for the participants to see. We used the results from the focus groups to develop the national survey.

2.2.3 Semi Structured Interviews

We use local networking and snowball sampling methods for interview participant recruitment. The snowball method is especially useful for reaching vulnerable and marginalized groups who may be less willing to participate in research studies without a personal connection to the interviewers (Sadler et al., 2010). The snowball method is considered culturally sensitive and fosters a trusting environment based on a common connection, such as a shared contact, between the participant and the interviewee (Sader et al., 2010). All interview participants were offered lunch as an incentive. However, some participants preferred a video conference, in person office meeting, or coffee instead. The fourteen semi-structured interviews lasted 60 minutes, the questions for the interviews were the same as for the focus groups (**Appendix B**).

During each of the interviews we recorded the stakeholder's affiliation, date of the interview, and a description of the setting (**Appendix A**). The setting of the interview could potentially influence the respondents' answers. However, all interviews took place in an informal setting and of the choosing of the interview participant. The interview data were collected by written notation. When a respondent was not answering a question directly, their response was still recorded to ensure all possible data was collected. We did not audio-record, as respondents feel more comfortable and are more open and honest with their responses when they are not being audio-recorded (Byron, 1993, Harvey, 2011). Our approach fostered a more trusting and casual environment.

Indigenous culture is not singular and is different among various Indigenous Nations however for the purpose of the study we examine the differences between perceptions of springs ecosystem management of Indigenous Nations, other stakeholder groups, and the American public. Indigenous Nations in our study have cultural significance toward springs although the various traditions and culture surrounding springs varies.

Our methods deliberately engage broad community representation, including Indigenous Nations, to understand the various perceptions for springs management in the CNF and KNF. The data we collect on the human perceptions is used to make policy recommendations that promote equity in the decision-making process. Incorporating Indigenous knowledge and integrating Indigenous people in this process has proven to be successful and promote equity (Winter et al., 2023, Simpson, 2017). We present and examine data which supports policy recommendations that have been shown to work in other sustainable development challenges.

Spirituality is very important to Indigenous Nations' value or perceptions of the environment (Turner et al., 2000). Through specifically asking questions on how springs can be measured we were able to understand how the spirituality of certain medical plants and ceremonies can be indicators for springs cultural significance. We do not intend to speak on Indigenous spirituality as outsiders, as we do not have the knowledge, nor have the right to share it if we did. Our methods and results attempt to document the significance of spirituality that has been stated by the Indigenous interview participants.

2.2.4 National Survey

.4 National Survey

We disseminated a national survey designed to analyze the attitudes of the general public towards springs ecosystems in the CNF and KNF to complement the interview data of the perspectives of stakeholders familiar with the region, measure the perceived threats to springs, and the importance of springs. We used Marketing Systems Group (MSG) to recruit survey participants that are representative of the U.S. population through probability and non-probability panels (DiSogra et al., 2011). Survey panels are a cost-effective way to obtain a large quantity of complete responses from diverse groups or respondents (Hays & Kapteyn, 2015). Analyzing data from both interviews and surveys together is most effective when the survey questions are focused on the respondents' attitudes (Klausch et al., 2013). To this end, we designed the national survey to encompass previously recorded attitudes from the focus groups and interviews.

2.3 Calculations

2.3.1 Qualitative Analysis

Following the interviews, we performed three types of textual analysis on the interview data using NVivo, a qualitative data analysis software by QSR International: thematic content analysis (TCA), word frequency, and sentiment.

TCA automatically identifies common themes in textual data collected from the interviews (Anderson, 2007). TCA allows for categorization of textual evidence presenting trends, relationships, structures, and discourse (Mayring, 2000). Before performing TCA, we hand-coded what the respondent indicated was most important and the most commonly used phrases and ideas each of the interviewees stated. Next, we ran the automated TCA to identify common themes and concepts. Through TCA we report the actual phrases and ideas of the participant

(Anderson, 2007). The phrases were kept intact to preserve their meaning. TCA data were separated into different files organized by stakeholders. Our approach allowed us to extract the main differences between each of the stakeholders' perceptions and sentiments.

Next, we used word frequency analysis to document and report the most stated words by each of the stakeholders. Frequency analysis results justified the themes from the TCA. The results provided context for the most important attributes of springs given the repeated use of a word and phrase and provided indicators for 1) defensive word use and 2) different uses for springs important to stakeholders. The NVivo word frequency tool was used for each stakeholder's recorded responses. To obtain the most accurate and relevant results from the word frequency tool, we set the parameter of the tool to output the 15 most used words. This allowed for a number great enough to display a meaningful range of results while not having too many words convoluting the results.

Lastly, automated sentiment analysis in NVivo was used to detect positive, negative, or neutral phrases in the responses (Dhakal, 2022). A sentiment is an attitude or opinion toward something (e.g., an opinion on the management for recreation at springs) (Mejova, 2009). Those sentiments can be interpreted as the opinion of the stakeholders (Saura et al., 2018). In our analysis, they represented feeling towards management of springs for recreation, ranching, and Indigenous Nations' cultural significance. Furthermore, we used nodes, a term used in Nvivo, which indicate that a certain passage belongs to a specific topic (Wong, 2008). For sentiment analysis, we created a node in each stakeholders file for each of the following topics: recreation, ranching, and Indigenous Nations' cultural significance. The automated sentiment tool outputs a chart showing shared sentiments for each of the stakeholders by topic.

2.3.2 Quantitative Analysis

We tested relationships between variables from our survey responses using Pearson's Chi-squared test, a commonly used method when comparing categorical variables (Peck et al., 2005). The Chi-squared distribution is determined by the degrees of freedom and differs for various degrees of freedom (Turney, 2022). The Chi-squared distribution describes the sum of squared random variables and the distribution starts at zero (Turney, 2022). The Chi-squared test compares expected frequency (no association between variables) with the actual frequency to determine a relationship. The null hypothesis for a Chi-squared test is “no significant relationship between the variables” (Sharpe, 2015). The alternative hypothesis is a relationship between variables. The Chi-squared coefficient is a sum of all the differences between the actual data and the expected data if there is no difference (Sharpe, 2015). The chi-squared equation is:

$$X^2 = \sum \frac{(O_i - E_i)^2}{E_i}$$

Where:

$X^2 = \text{chi squared}$

$O_i = \text{Observed value}$

$E_i = \text{expected value}$

The Chi-squared test is two tailed and does not explicitly state the direction of the relationship (Tallarida, & Murray, 1987). The Chi-square test in combination with frequency counts from cross-tabulation tables determines a positive or inverse relationship. In other words, we can look to see if the relationship is with the “YES” variables or “NO” variables by examining which two

of the four numbers in the cross tabulations table have the relationship. For example, we look at the frequency for the two YES variables and determine that their frequencies are proportional determining the relationship the Chi-squared test detected.

We also use Cramer's V equation to understand the strength of association between the categorical variables. Cramer's V statistical measure provides further evidence to support the results achieved through the Chi-squared test. Cramer's V is calculated by taking the Chi-square value, and then dividing that number by the sample size, and taking the square root of that value (Field, 2013).

The numeric value of Cramer's V allows us to qualitatively explain the relationship between the variables in the following way (Field, 2013):

- > 0.25 = Very Strong
- > 0.15 = Strong
- > 0.10 = Moderate
- > 0.05 = Weak
- > 0 = no or very weak

Using the Chi-squared test for significance and Cramer's V measure of association we test the following relationships:

- Concern with threats from grazing and prioritizing management for cultural significance
- Concern with human caused threats to springs ecosystem and willingness to restrict recreation to preserve cultural significance
- Concern with threats from recreation and a willingness to restrict recreation for the protection of spring ecosystems

2.4 Results

2.4.1 Qualitative

The results from the national survey were used to compare survey respondents' perceptions with stakeholder's perceptions from the interviews. Results from the interviews show the relationship, contrasting opinions, and differences in management perceptions from the different stakeholders. The following results are from the stakeholder interviews conducted after the focus groups and in tandem with the national survey:

2.4.1.1 Rancher Stakeholders

Ranchers consistently defend their ability to access springs and their need to use it. For example, one of their most frequently used words from the interviews is “without” (9), often in reference to how impossible or prohibitively costly ranching would be *without* spring water access, how their ranch would not be located where it is *without* a spring on it, and how different The City of Flagstaff would be *without* ranching. Ranching was one of the early industries of the EuroAmerican settlement of Flagstaff (circa 1881), ranches expressed it was a founding industry and integral to the local economy.

The way in which other stakeholders perceive ranching as a degrading to the ecosystems appears to lead ranchers to be more outspoken. Ranchers defend their commitment to the environment, to the public land they use, the wildlife, protection of forest health, including springs, and ranching's ability to enhance other stakeholders' activities such as recreation. One rancher stated, “Cattlemen are not the enemy of springs, to say that is offensive and foolish” (**Interviewee 4**). To justify their position and defend their ability to ranch on public lands and springs, ranchers often mentioned the immense benefits ranching has on the community, such as providing food

for families, land conservation through setting up non-governmental organizations (NGO), and bringing in tax revenue to the city and state from the cattle industry.

Textual evidence from the interviews shows ranchers' goals of sustainability are constantly being called into question by other stakeholders. While economic incentives and means of supporting their livelihood are reasons behind ranchers' perceptions of management of springs, we also see a persistent preference to protect ranching lifestyle or as **Interviewee 11** described it, "cowboy culture". Ranchers solidified their stance on environmental sustainability by outlining land stewardship goals, emphasizing a choice to run less cattle, below USFS limits, to ensure they are not overgrazing, thus taking forest management into their own hands. One rancher stated, "A good cattleman is exactly an environmentalist" (**Interviewee 4**). **Table 1** shows the themes from the stakeholders' interviews.

Based on automated sentiment analysis, ranchers had mixed (10%) sentiments regarding ranching at springs (**Figure 3**). Ranchers highlighted a noticeable difference in ranching on USFS land versus land they are deeded to. For instance, one rancher stated other ranchers often show less stewardship on USFS land compared to land they own. Even though ranchers show less stewardship on the USFS land, there are a lot of benefits associated with having these grazing allotments. By grazing on USFS allotments during the summer, ranchers are able to produce more cattle than they otherwise would be able to, leading to positive (54%) sentiment results. The ranchers' responses indicate a strong perception that prioritization of ranching at springs is important. **Interviewee 7** stated that 65% of their water for cattle comes from springs. Grazing rotations are based around spring meadows and spring-fed cattle tanks are essential as "no one can make a living constantly running [transporting] water to cattle" (**Interviewee 7**). **Interviewee 7** stated springs provide resilience to the ranch; having to drill a well for water

could cost upwards of \$200,000, be costly to maintain, and put a significant financial strain on the ranch.

Our analysis highlights that ranchers' value from the springs is potentially significantly greater than the cost of the technological inputs necessary to replace the water flow attribute function of the spring. Additionally, valuing springs in terms of replacement value is an underestimate because of the intrinsic value springs bring to ranchers' ways of life, culture, and the stewardship ranchers strive for the springs they graze at.

Ranchers were persistent in emphasizing the importance for springs on public lands to be managed for ranching. The word frequency analysis showed the words "need" (17) and "produce" (20) as the most frequently stated words, which expressed a *need* for spring water access to *produce* cattle.

Interestingly, the way ranchers expressed their views of spring water use and resulting threats triggered from other stakeholder's mismanagement of springs, automated false negative sentiments. The errors needed to be corrected because some ranchers expressed concern and had negative sentiments relating to other stakeholder's management of springs not necessarily relevant to the topic of springs themselves. For example, ranchers stated forest thinning projects degrade the springs more than ranching, which, looking at the context, would incorrectly output a negative sentiment. Examples of poorly managed and executed forest thinning operations exist in the CNF and KNF. In the CNF timber access roads built near or through springs and spring meadows negatively impact springs' condition and ability to function as an ecosystem (Paffett et al., 2018). To ranchers, poorly executed management strategies are the perceived threats to springs.

Ranchers perceived other stakeholders should also have the right to use springs including wildlife and municipal water suppliers. Most interviewed ranchers perceived recreationists as constituents who should have access to springs even though ranchers perceive recreationists as causing more degradation at springs than ranchers do. For example, the trampling of plants, litter left behind, and overuse by recreationists is a perceived threat of ranchers.

2.4.1.2 Environmental Advocacy Group Stakeholders

Through the TCA we identified themes from Environmental Advocacy Groups (EAG) perceiving the importance of springs management for wildlife and that wildlife should be managed for human benefits (i.e., creating opportunities for wildlife viewing, hunting, and fishing). EAG is a broad category and can include stakeholders with differing goals. For example, EAGs include organizations advocating for wildlife, hunting rights, and volunteer organizations whose goals align with the USFS. EAGs perceived ranching as a threat to springs. EAGs perceive ranching as a tradition in the area and economically important to the local economy however ranchers need to pay sufficient prices for their grazing permits to account for the degradation grazing causes. In our word frequency analysis, “cultural” (8) showed up as one of the most frequently used words by EAGs. **Interviewee 8** stated that cultural significance values are often invisible when looking through a standard management lens, which makes them harder to manage. Therefore, **Interviewee 8** supported prioritizing cultural significance in management. EAG’s sentiment analysis supports the themes derived from most of the stakeholders. EAGs show positive (60%) sentiments toward management for cultural significance, negative (5%) and positive (60%) sentiments for management for recreation, and positive (20%) and negative (40%) sentiments for ranching (**Figures 2, 3 and 4**). One

explanation for both positive and negative sentiments for ranching and recreation is because the stakeholders categorized under EAG are very diverse.

2.4.1.3 Municipal Water Providers and Federal Agency Stakeholders

Municipal stakeholders and government agencies show similar themes. Both stakeholders state the economic gains springs provide and recognize springs as essential components that contribute to the health of the watersheds and forests (**Table 1**). Both stakeholders have responsibility to manage springs and show similar perceptions.

The sentiment analysis of government stakeholders shows mostly negative (46%) and neutral (46%) sentiments on ranching and only (6%) positive sentiments (**Figure 3**). The textual evidence from the interview notes highlights that while the USFS receives revenue from ranchers buying permits, the revenue does not totally compensate for the degradation they perceive. Government agencies perceived concern about some of the poorly managed livestock operations. Government stakeholders stated springs can negatively affect stream morphology and lead to more erosion problems. In addition, overgrazing is also leading to more remediation work the government agencies must do.

2.4.1.4 Indigenous Stakeholders

Sentiment analysis from interviewees from Indigenous Nations showed positive (80%) and neutral (20%) sentiments for cultural significance (**Figure 4**). Recreation and ranching at springs leads to not only degradation at the springs, but also less availability for use by Indigenous peoples for ceremonies and other culturally significant practices. Therefore, we see negative sentiments relating to both recreation and ranching from Indigenous respondents. In addition to the negative (25%) sentiments, there are some positive (16%) sentiments regarding management for ranching at springs. Some Indigenous farmers maintain small herds of cattle and rely on

springs to support their livestock. Furthermore, some Indigenous Nations also lease out grazing rights on USFS land to ranchers.

Responses from interviewees from Indigenous Nations differed from the other stakeholders in that they perceived livestock watering and management for wildlife as areas of interest and perceived concern shown by the overlapping word frequency results. **Table 2** shows the normalized (frequency count divided by number of stakeholders interviewed) counts of each of 15 most stated words for Indigenous and non-indigenous stakeholders, red indicates a difference in the top stated words while green highlighted words that are underlined indicate the same 15 most stated word. However major differences arise in perceptions of springs' management for economic benefits such as large-scale cattle production dependent on low-cost water supply. Indigenous Nations rely on spring water for subsistence agriculture and the water flow (2) is an important cultural resource compared to other stakeholder's view of spring water as a "free" water supply focused on economic value (5.4). The discrepancies highlight a stark difference in the perceptions for spring ecosystem management between stakeholders.

Interviewees from Indigenous Nations preferred springs management that does not separate management for wildlife, water flow, and culture. Most other non-Indigenous stakeholders viewed spring management more like an equation which controlled for each attribute and prioritized human economic values. The Indigenous interviewees perceived a holistic method for spring management considering the entire ecosystem together as one unit as most important. The holistic outlook differs from the perceptions of non-Indigenous respondents, who expressed tradeoffs between attributes. Differences in perceptions can be summarized with one quote; "spring water is life". This phrase was stated by nearly all Indigenous interviewees and emphasizes that spring water and spring ecosystems in themselves are more important than the

specific attributes that they can be managed for. The phrase itself is deeply rooted in Indigenous peoples' interactions with settler society and colonialism, connecting other aspects of life, and is a fundamental part of Indigenous culture (Robison et al., 2018). Spring water is an essential and integral part of all spring attributes and to life itself so choosing one or some of the attributes for preferred management plan is not synchronous with traditional cultural knowledge.

Another major difference between the Indigenous and non-Indigenous stakeholders was the concept of culture. While non-Indigenous stakeholders mentioned Indigenous cultural significance, they also consistently mentioned “cowboy culture” or culture which encompasses cattle grazing, hunting, recreation, and the overall western lifestyle that the forests and the springs within them afford. From a settler-colonial perspective, components of culture have strong economic ties, such as the springs' importance for the cattle industry and the timber industry, founding EuroAmerican industries of the area. Perceptions of non-Indigenous stakeholders for cowboy culture in comparison to Indigenous culture significance values again show disconnect between stakeholders about perceptions of springs management (**Table 1**). Differences between Indigenous and non-indigenous stakeholders mainly stem from cultural value and perceived importance of what spring ecosystems provide. Undertraining perceptions from all stakeholders is extremely important to categorize because the relationships they have with springs are derived from different means such as necessity, economic benefit, culture, and enjoyment.

2.4.2 Quantitative

2.4.2.1 Survey data

We are interested in understanding the public's perceptions of springs ecosystem management. To incorporate quantitative analysis of survey data into our mixed methods approach, we disseminated a quantitative survey to a total of 1,038 individuals through Marketing Systems Group (MSG). We received 751 completed responses from a non-probability panel and 287 completed surveys from a probability panel. Out of those 1,038 observations 58% were female, 40% were male, 5% were residents of Arizona, and 64% identified as white. The median time it took the respondents to complete the survey was 11.5 minutes.

2.4.2.2. Respondent attitudes

All survey respondents rated their level of concern for threats to springs on a scale from 1-5: (1) not at all concerned, (2) slightly concerned, (3) moderately concerned, (4) very concerned, or (5) extremely concerned. Over 80% of survey respondents indicated they were moderately, very, or extremely concerned with the threats to springs from grazing. In addition, 62% of survey respondents indicated they were not at all to moderately concerned with a reduction in grazing. Our results indicate survey respondents generally perceived grazing at springs to be degrading to the ecosystem and were not concerned with the reduced use of springs for cattle grazing.

When survey respondents were asked, “Are you willing to restrict your **own** recreation on National Forests to reduce environmental degradation of springs from recreation?”, over 84% indicated YES. We also asked respondents to select the recreational activities they are willing to restrict to reduce the environmental degradation at springs. The top five selected answers were to restrict off road vehicle (ORV) riding (52%), hunting (47%), boating (37%), fishing (37%), and

camping (36%). The responses highlight a willingness to reduce high impact recreational activity to benefit spring ecosystem health.

We asked respondents, “Are you willing to restrict your **own** recreation on National Forests to preserve springs with cultural significance for Indigenous Peoples?” Over 83% of the respondents said YES. Indicating the survey respondents are willing to change their own behavior to support management of springs for Indigenous Nations.

2.4.2.3. Hypothesis tests

Results from the survey responses show perceptions of springs management supported by a willingness of respondents to adjust behaviors. We test three relationships about grazing, cultural significance, and recreation to further understand complexity of survey respondents and provide evidence for reasons certain attributes of springs management are preferred (**Table 3**).

To test the public’s perceptions of spring’s management for *cultural significance* in relation to perceiving threats to springs, we asked survey respondents to indicate their level of concern on a scale of 1 to 5 where 1 “is not at all concerned” and 5 is “extremely concerned” for the following statement, “Prioritizing management to protect springs with cultural significance to Indigenous Peoples.” 52% indicated they were “very concerned” or “extremely concerned.” We also asked respondents to indicate their level of concern for threats to springs from grazing. 50% of respondents indicated they were “very concerned” or “extremely concerned” for threats to springs from grazing. We code the level of concern variable = 1 if “very concerned” or “extremely concerned” and 0 otherwise. We use a Chi-squared test at a 5% level of significance to determine if a relationship exists between the nominal variables and examine the nature of the relationship using the crosstabulation table (**Table 3**). We find a statistically significant

relationship between concern with threats from grazing and concern with prioritizing management for the preservation of cultural significance ($\chi^2 = 178.728$, $df = 1$, $p < 0.001$). The Cramer's V value was 0.415 indicating a very strong association between variables. The positive correlation indicates respondents who are concerned about grazing as a threat are also more likely to be concerned about prioritizing management to protect springs with cultural significance to Indigenous peoples.

We are also interested in whether respondents' *concern for threats* to springs is related to potential behavioral responses to support springs management. On a scale of 1 to 5, survey respondents indicated they were "very concerned" or "extremely concerned" with the following threats: pollution (71%), increased development (64%), and groundwater pumping (53%). We also ask respondents, "Are you willing to restrict your **own** recreation on National Forests to preserve springs with cultural significance for Indigenous Peoples?" 84% responded YES. We code the level of concern variable = 1 if "very concerned" or "extremely concerned" and 0 otherwise. YES variables are indicated by a 1 and NO variables are indicated by 0.

We use a Chi-squared test with a 5% level of significance and calculated Cramer's V with the YES or NO question individually for each of the threats: pollution ($\chi^2 = 88.132$, $df = 1$, $p < 0.001$), increased development ($\chi^2 = 55.274$, $df = 1$, $p < 0.001$), and groundwater pumping ($\chi^2 = 44.164$, $df = 1$, $p < 0.001$). Results from the Chi-squared tests show a relationship and the Cramer's V statistical measure shows a strong or very strong association (**Table 3**). The survey respondents perceive threats to springs from human caused activities and there is a relationship between perceiving those threats and being willing to restrict their activity for preservation of Indigenous culture. Again, highlighting the perception that springs management for cultural

significance is important, especially when human caused threats to springs are perceived. We find a positive correlation between willingness to restrict recreation to preserve springs with cultural significance for Indigenous Peoples and perceived threats to springs. Therefore, our results show respondents who are more concerned with threats to springs may be more likely to change their behavior to support management changes.

To test the perceived *concerns from recreation* to springs and how that relates to the survey respondents willingness to restrict recreation, we asked survey respondents the following question, “Are you willing to restrict your **own** recreation on National Forests to reduce environmental degradation of springs from recreation?” 84% responded YES indicated by a 1 and 16% responded NO indicated by a 0. We also asked respondents to indicate their level of concern from threats to springs from recreation. 45% of the respondents indicated they were “very concerned” or extremely concerned”. Again, we recode the level of concern variable = 1 if "very concerned" or "extremely concerned" and 0 otherwise. We compared the two variables using the Chi-squared test and Cramer’s V to understand if the survey respondents perceptions of threats from recreation made them more willing to reduce their own recreation. Results show a significant relationship between perceiving threats to springs from recreation and a willingness to reduce own recreation for springs’ protection ($\chi^2 = 23.952$, $df = 1$, $p < 0.001$). The Cramer’s V value of .153 indicates a strong association (**Table 3**). Results show survey respondents perceiving threats to springs from recreation may be more willing to restrict their own recreation.

2.5 Discussion

Our study examines the human perceptions of spring ecosystems in the CNF and KNF. We collected, compiled, and analyzed data from stakeholder interviews, focus groups, and a broadly disseminated national study to further understand how perceptions vary between stakeholders and analyze differences between the survey respondents and stakeholders. Results from focus groups indicate three competing interests for springs management in the CNF and KNF are cultural significance, recreation, and cattle grazing. We incorporated results from focus groups into a national survey to understand public perceptions of springs management. Analyzing the results from both interviews with stakeholders and the national survey of the public we see perceptions do vary between stakeholders and the public. The variation and differences in perceptions shed light on what different stakeholders and the public perceive as important. Our results provide insight on the structure of springs ecosystem management and can be used by USFS land managers to use to align human perceptions with springs management while meeting the mission of health, diversity, and productivity for present and future generations (USDA, 2019).

2.5.1 Ranching

The survey respondents and ranching stakeholders had different perceptions of grazing. Ranching on public land has been shown to provide rural communities with economic stability and sustainability (Pearce et al., 1999), which ranchers adamantly stated during the interviews. Similar to results from other studies (Whittlesey et al., 1993), other stakeholders and the public showed perceived concern about grazing on public land. The many competing interests that public land can be managed for create conflict when activities such as grazing and recreation overlap (Lewin et al., 2019). Public perception of threats from cattle grazing has led to a decline

in grazing permit allocation (Pearce et al., 1999, Lewin et al., 2019). Past examples show ranchers have perceived high levels of concern from overgrazing. Western ranchers requested regulations and restrictions for grazing on public land which eventually led to the Taylor Grazing Act of 1935 (Stout, 1970).

Other studies we found support evidence for only one of the following 1) the market value of grazing (Lewin et al., 2019, Torell & Doll, 1991) or 2) the concern for environmental degradation caused by grazing on public land (Manley et al., 1995, Hess & Holechek, 1995). Our study contributes perceptions incorporating evidence from both sides of the competing interests of multiuse public land management in a single study. The inclusion of the competing interests around grazing provides crucial evidence for policymaking because it incorporates diverse perspectives for the multiple interests and uses the springs can be managed for. Our results show concern for the threats to springs and potential support for management of springs to preserve cultural significance to Indigenous peoples. Management solutions to limit the number of grazing units include buyout options or conservation permits available on USFS grazing allotments (Steinbach & Thomas, 2007). One example of successful grazing limitations on public land is Big Brow Bench ranch on the Colorado Plateau. The Grand Canyon Trust, an environmental organization, purchased Big Brown Bench Ranch in 2005. After acquiring the ranch, Grand Canyon Trust destroyed a pipeline from a spring that used to feed the ranch's livestock operation. The Grand Canyon Trust does not permit nor graze on the allotment. Allotments must be grazed at least every six out of ten years (CBS News, 2005 and Haun, 2020). Regulations allowing other environmental organizations to purchase grazing rights and let them go unused could be a possible market-based solution to springs management. Our finding supports prior studies showing the public perceives grazing not reflecting the full cost of the

externalities associated with it, which is one of the reasons for lack of public support for grazing permits on public land (Whittlesey et al., 1993). Raising the price of grazing permits to account for externalities could increase positive public sentiment without specifically limiting the allowed number of animal units in a particular allotment.

2.5.2 Cultural significance

Most stakeholders and survey respondents perceived springs' management for cultural significance as important. However, one of the major differences is that while survey respondents perceive springs' management for cultural significance as important, they also demonstrate a willingness to restrict their own use of springs to preserve Indigenous cultural significance. While stakeholders indicate cultural significance as an important attribute in our focus groups and interviews, we found little evidence of willingness from stakeholders to reduce their access or use of springs for Indigenous Nations. However, in contrast, Indigenous stakeholders' perceptions for springs management aligned with the public's perception of the importance of springs management for cultural significance.

Stakeholders perceive springs management for cultural significance as important in combination with the strong support from the survey respondents. Joint management occurs when relevant stakeholders, such as government agencies and Indigenous Nations, collectively manage an area with shared rights, interests, and obligations (Smyth, 2001). Joint management in the CNF and KNF would provide Indigenous Nations the ability to manage for attributes of springs aligned with Indigenous traditional knowledge and tradition (Poelina et al., 2019 & Adamowicz et al., 2004). The USFS has successfully implemented joint management in other areas. For example, the USFS and Karuk Tribe have "collaborate agreements" giving the Indigenous Nation increased access to their ancestral territory (Diver, 2016) in Six Rivers National Forest in

Northern California. Joint management of preserved land is also successful in Australia, where Aboriginal owned protected areas are managed in cooperation with governments to promote “social justice, community development and the preservation of cultural identity” (Lawrence, 1996). Castle springs in the KNF is an example of collaborated management between the USFS and Indigenous Nations in Northern Arizona. Members of the USFS, Hopi Tribe, the North Kaibab Piute Band, Grand Canyon Trust, and the Spring Stewardship Institute rehabilitated Castle Springs, KNF, to preserve Indigenous culture and increase the biological habitat quality of the spring. Stakeholders of the spring worked together to accomplish goals to cooperatively plan springs restoration, directly implement a plan with collaborators, and provide education and outreach about spring restoration to develop closer working relationships between different stakeholders (Stevens et al., 2016). Monitoring of joint management frameworks has shown to be successful, allowing for traditional ecological knowledge to be implemented in management, and supporting Indigenous culture identity while meeting conservation goals (Stacey & Izurieta, 2010).

Implementing joint management between Indigenous Nations and the USFS is a possible solution to address the perceived importance that we found for management of springs for Indigenous Nation’s cultural significance. Our results of the survey respondents' perceptions for management of Indigenous culture and some support from stakeholders show a joint management concept might be beneficial for springs management in the CNF and KNF.

An example of prioritizing management of sites with conflicting interests for Indigenous cultural significance is Devils Tower National Monument, Wyoming a site of cultural significance to the surrounding Indigenous tribes and habitat for many important plant and animal species (Linge, 1999). To the Arapahoe, Cheyenne, Crow, Kiowa, Lakota, Shoshone tribes, “Bear Tipi”, “Bear

House”, “Bears Lodge”, “Bears Peak” is part of oral history and considered a sacred, ceremonial place (Freeman, 2007). In 1995, the national monument voluntarily implemented a management plan to restrict climbing of the tower for the month of June, the most sacred month for ceremonies by Indigenous Nations. Similar management plans can be implemented by the CNF and KNF in coordination with the surrounding Indigenous Nations to prioritize springs sites harboring high cultural significance. Our analysis of the survey respondents and stakeholder’s perceptions provides evidence indicating strong support for springs to be managed for cultural significance. Implementing similar management strategies could be a possible solution to management for Indigenous Nation’s cultural significance.

2.5.3 Recreation

Recreation on USFS land is significant. In 2020 alone, the USFS’s managed lands received 168 million visits (US Forest Service’s National Visitor Use Monitoring program). Recreation is an important attribute of public land. Ensuring recreational activities are available while protecting the ecosystems within them, such as springs, is crucial for not only the ecosystems health but also for continued recreational activities. Stakeholders rely on springs and can be tasked with management making them stewards of springs. Using survey respondent perceptions to reduce certain types of high impact recreation can be used in policy decision making to promote less degrading recreational activities without severely limiting the uses and benefits the public and stakeholders perceive. Stakeholders and survey respondents both recognize the need for access to recreation on public land and demonstrate concern for the degradation that recreation causes. The survey respondents, representative of the public, indicated a willingness to restrict what they perceive as highly degrading types of recreation at springs such as ORV riding (52%), hunting (47%), and boating (37%) for springs protection. Human perceptions are a valuable resource to

use when making policy decisions around recreation. For instance, Zion National Park in Utah allows for public comment on pilot programs which would require visitors to have permits for certain hikes such as Angels Landing and Lava Point Campground (NPS, 2021). Springs can be managed the same way, where stakeholders and the public can be given opportunities to indicate their level of concern on specific springs in the CNF and KNF being closed off for recreation. Responses could be used to build off the data we present to further protect spring ecosystem based off human perceptions.

Problems with management of recreation include issues of scale such as the number of visitors, size of area, and incongruent boundaries (Morse et al., 2009). Similar problems can be seen in the CNF and KNF, where recreation activity is very high and cities, neighborhoods, and other high trafficked areas are scattered around the forests. Springs tend to be, in some cases, in more remote areas compared to popular hiking trails or other activities. Studies have shown evidence of public support for reduced recreation for ecosystem protection and for higher quality recreation activities (Schneller et al., 2021).

Over 449,201 square kilometers of land is designated “wilderness” across 803 individual areas established with the Wilderness Act of 1964. The goal of the Wilderness Act of 1964 is to preserve and protect the natural conditions of specific areas against the threats of increased settlement and increasing populations by limiting or restricting activities. Similarly, the USFS manages for protected sites by creating Protected Activity Centers (PAC) for California spotted owl habitat. Nest sites, roost location, and foraging areas are used as indicators for PACs to be implemented (Berigan et al., 2012). One potential management option is to create a cultural significance indicator into PACs for springs. National Heritage Areas, designated by congress, protect cultural resources on public land and form cohesive management for areas with cultural,

natural, historic, and recreational importance (Laven et al., 2010). Similar management strategies can promote joint management of cultural resources in the CNF and KNF.

2.6 Conclusion

Stakeholders are intimately involved in management and have a strong reliance on springs. Indigenous perspectives are not equally represented in the management of springs, however survey respondents perceived cultural significance as being of importance. We saw support from survey respondents for management of springs for cultural significance, as well as a marked perception of threats to springs from cattle grazing and recreation. Spring ecosystem health is essential for the three uses of springs we tested across: recreation, ranching, and Indigenous Nations' Cultural Significance. Management focused on preserving the ecosystem health and subsequently allocating the management of springs can reduce threats and ensure equal opportunities for spring users. Our research aligns the perceptions of stakeholders and the public, which can be used to create or formulate management solutions to protect the health of ecosystems without significantly limiting the use of springs.

As aridification continues across the western United States (Mankin et al., 2021) protection and equitable management of springs becomes even more imperative. Anthropogenic externalities from groundwater pumping, high impact recreation, pollution, climate change, and cattle grazing significantly and negatively impact springs ecosystems which have immense social and ecological benefits. Our comparison of the perceptions between stakeholders and survey respondents on springs in the 13,759 square kilometers of land between the CNF and KNF provide valuable insight for forest management across the 781,043 square kilometers of USFS land around the county. Our results provide land managers information on land management policies that may be well-received by the public. Our stakeholder results provide understanding

regarding which stakeholders may not support policies. Our results include the valuable and less often incorporated perspectives of Indigenous Nations. Including diverse perspectives in policy decision making promotes equity (Hill et al., 2012) ensuring management is rooted in human dimension.

Stakeholders possess the ability to translate the work they have done in other areas of the forests and integrate it into springs management. Babbitt Ranches, located in northern Arizona, established the Environmental Monitoring and Assessment Foundation, a framework for organizations, landowners, government agencies to collect data on important environmental features of the landscape and improve issues relating to soil science. Babbitt Ranches donated the Foundation along with a 30-acre parcel land to Northern Arizona University (NAU) (Frederick, 2002). Babbitt Ranches also demonstrates a commitment to conservation and donated one of the largest conservation easements in the country (161km²) to The Nature Conservancy (Williams News, 2021). Babbitt Ranches, Arizona Game and Fish Department, and the Arizona State Land Department created the SP Crater Golden Eagle Conservation Complex which protects areas around the nesting sites of eagles (Williams News, 2021). The Diablo Trust also partnered with researchers from Northern Arizona University to research the effects that cattle grazing has on grasslands to better manage and protect grassland ecosystems (Loesar et al., 2001). Similar programs can be adopted and used to monitor and protect springs on grazing allotments throughout the forests. Such initiatives can increase the positive perceptions of grazing on public land by diversifying use of springs ecosystem which provide immense benefits to multiple users all while protecting the use of springs for recreationists, ranchers, and Indigenous Nations. Programs similar to the Castle Springs example mentioned earlier shows the possibility of cooperative efforts between Indigenous Nations and other stakeholders.

Our research provides insight on the unique differences between stakeholder perceptions, the dominance structures that guide management, and a complex analysis of the public's perceptions of different attributes that affect springs. Understanding relationships and differences can help better manage springs and other ecosystem types across the county. We contribute comprehensive mixed methods results that can be applicable to other publicly managed lands with multiple stakeholders. To ensure Indigenous Nations have the ability to play a role in policy making on public land capacity building frameworks may need to be developed and applied (Van der Voorn, 2008, Van der Voorn et al., 2017). When capacity building frameworks are adopted, Indigenous voices can be represented stronger and have a seat at the table which promotes equity.

While our research aims to contribute significant human perception data from a wide variety of perspectives for increased equity in policy decision making on public lands, there are limitations to the mixed-methods approach. A limitation to mixed methods research is that it can often be complex requiring an interdisciplinary team to adequately collect and interpret the results. In addition, mixed methods research can be more costly due to the extra resources required. Significance tests such as the Chi-squared method can be sensitive to sample size. While collecting data from all stakeholders is possible, reaching all individual stakeholders in the Coconino and Kaibab National Forests would be prohibitively difficult, yet may introduce perspectives we were not able to capture.

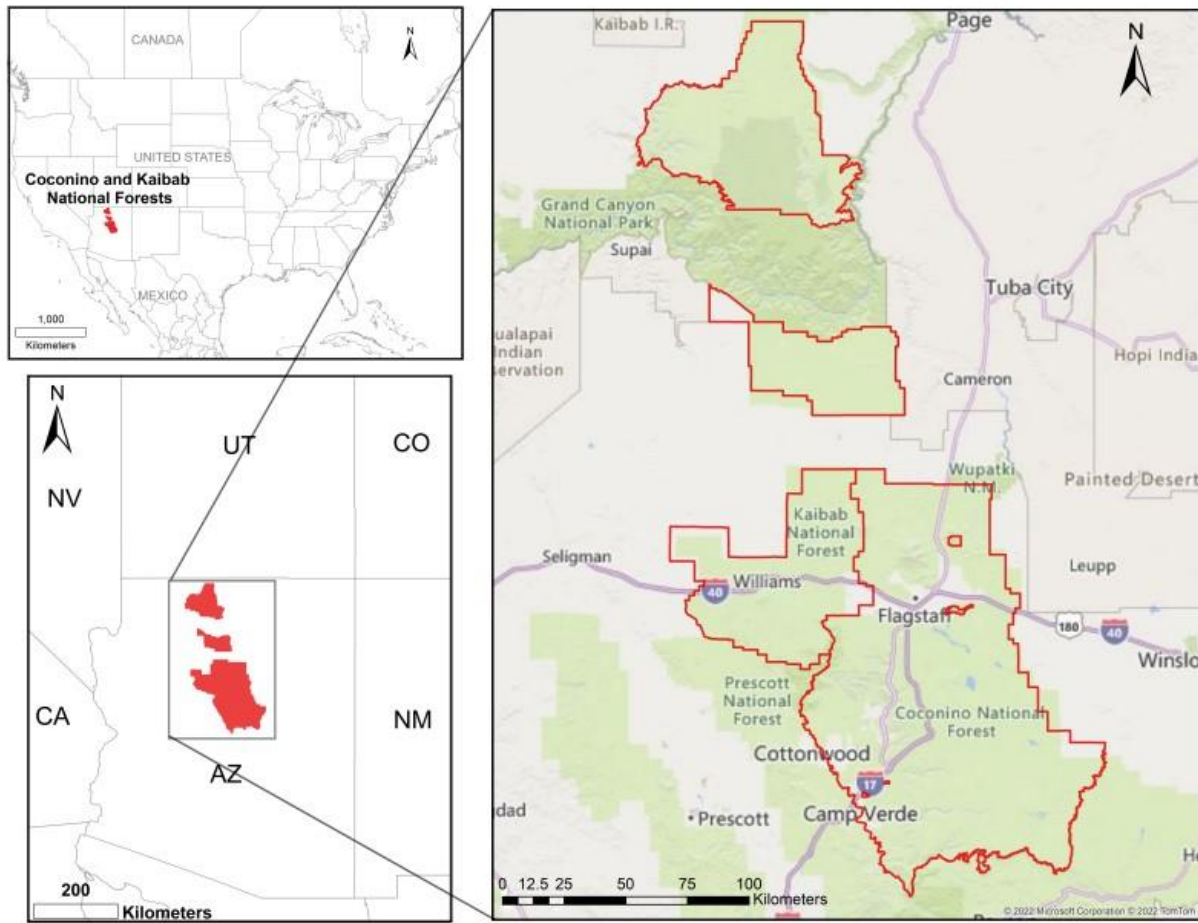
A notable contribution of this study is the purposeful incorporation of Indigenous perspectives, which have been historically overlooked and marginalized by academia and in research. This particular aspect might also be somewhat challenging to replicate, however, our outreach to

Indigenous communities will likely allow future researchers to create comparable representation of marginalized groups, such as Indigenous voices.

The authors acknowledge there is significant cultural diversity amongst humans (Van der Voorn, 2008) including Indigenous Nations, however our analysis examines the stark differences of Indigenous Nations views on springs management versus other stakeholder groups and the public. Views from Indigenous Nations are challenging to incorporate through a western lens. Our research team leveraged considerable connections, experience, and community knowledge to recruit focus group participants. While we tried to mitigate any misinterpretations from Indigenous interviewees, it is difficult to capture the essence of Indigenous views through methods of western academia and the English language. More research on the perceptions of stakeholders and the public together is needed to ensure equitable management of springs in the CNF and KNF. Another limitation to the study is cultural bias. The authors of this research are all European American and European and are cultural outsiders to Indigenous Nations. We do not intend to infer or describe any cultural practices not our own. For the purpose of this study, we examine the differences between Indigenous Nations as a whole, other stakeholder groups, and the American public. However, Indigenous cultures are diverse and vary between nations, which we are unable to account for in the scope of this study. Further research and analyses on the differences in the perceptions of Indigenous Nations would be beneficial and ideally conducted by Indigenous researchers. Such varied approaches would complement our research. While differences in perceptions of management, particularly management for Indigenous Nations cultural significance, vary between stakeholders and the survey respondents, we outline mechanisms for management solutions. We provide examples of successful diversified management which can be applied to springs in the CNF and KNF. Stakeholders in the CNF and

KNF demonstrate an ability to adapt and implement unique solutions. Our results of the human perceptions are a tool stakeholders can use to manage springs while ensuring benefits to all stakeholders are protected.

Figure 1 Map of Coconino and Kaibab National Forests



Map Created by Katelyn LaPine

Table 1 Thematic content analysis of stakeholders analyzed from interviews

EAG	Ranchers	Indigenous	Municipal Agency	Government Agencies
Stewardship is the #1 goal. They focus on the altruistic value of springs. The main priority is managing the springs for the wildlife so the wildlife can be used for human benefits Ranching is a tradition in this landscape but that does not justify the degradation they cause Ranchers and other uses need to pay sufficient prices for permits in order to account for their degrading costs	Springs have a ripple effect on the rest of the environment There wouldn't be a livestock industry in Flagstaff without springs. Wildlife and livestock should be considered as much as human uses. The spring does provide for their way of life, aka cowboy culture.	Springs value come from their existence value. Springs are the veins and arteries of the earth Springs should be respected, honored, and taken care of Water is life. Spring water is more spiritual than other water because it comes right from the earth	Water is the most important characteristic of springs The reason they want to capture the water is because they have the right to it Spring water is the cheapest source Main Priorities are watershed health, and ability to provide water and maintain ecosystem health Spring water provides the City of Flagstaff with water that contributes to its water security	Without the ability to lease federal land and without the use of springs ranching wouldn't be cost efficient Forest springs should be managed for their own health, there is room and if there is the ability to manage for social good as well then you can do that Management must include the Indigenous values It is important to preserve the spring for the native wildlife

Figure 2 Sentiment analysis of stakeholders on management of springs for recreation

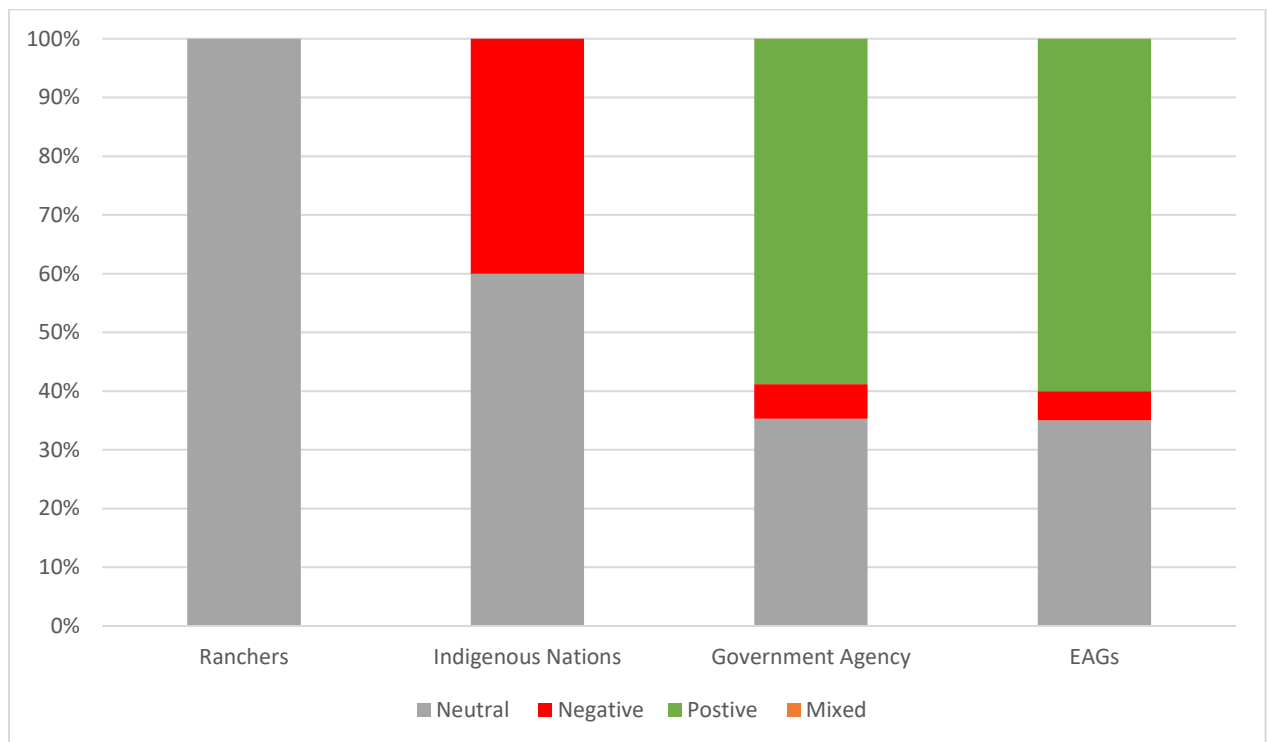


Figure 3 Sentiment analysis of stakeholders on management of springs for ranching

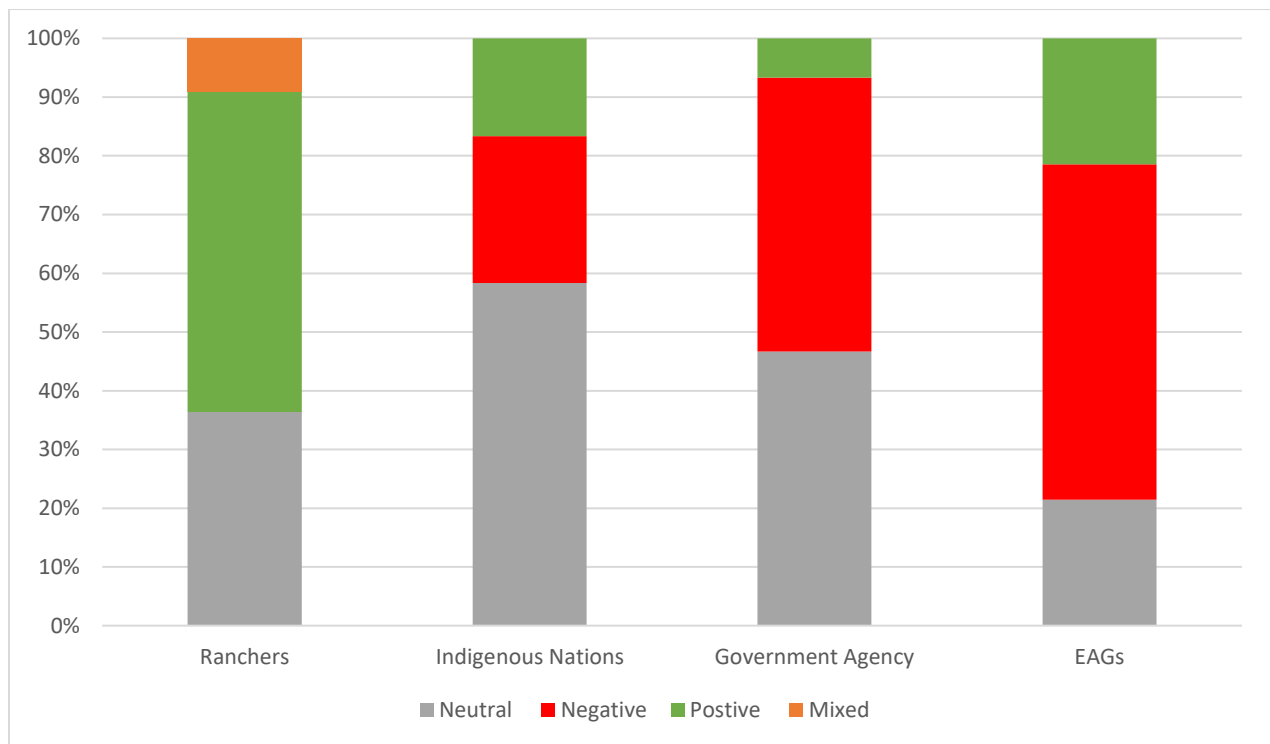


Figure 4 Sentiment analysis of stakeholders on management of springs for Indigenous Nations' cultural significance

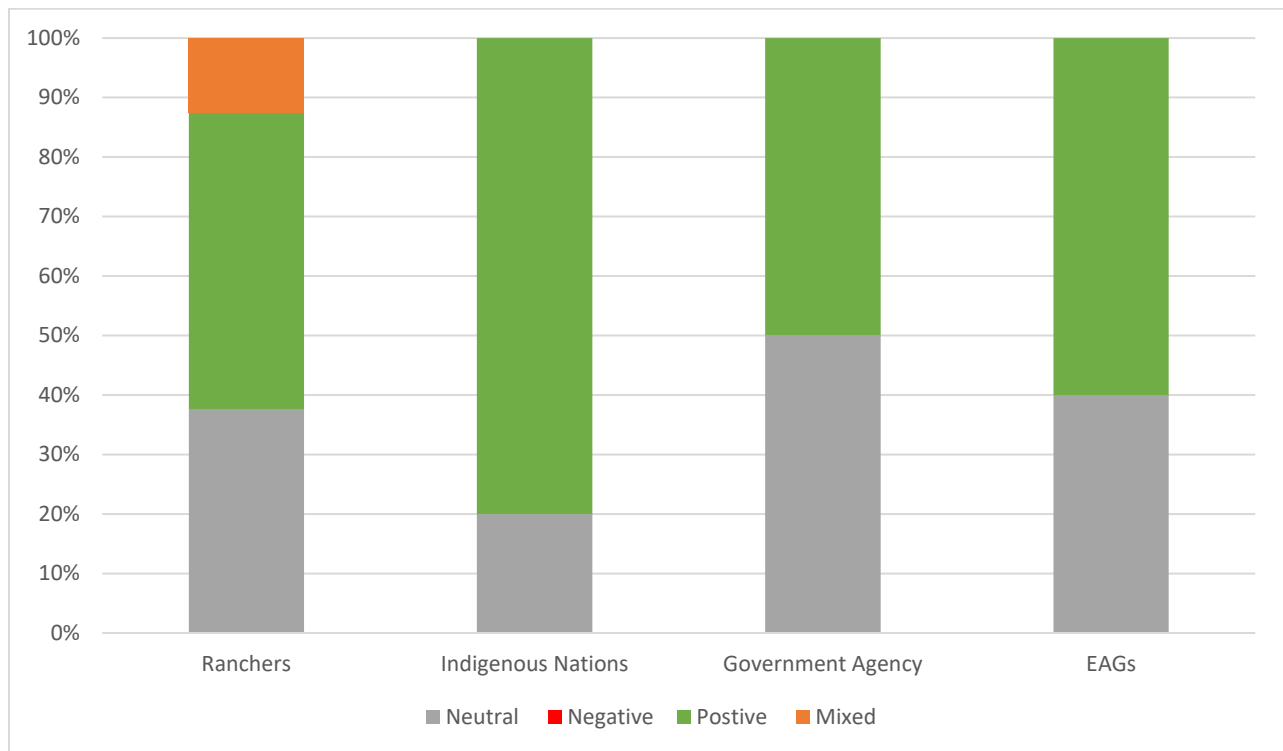


Table 2 Indigenous versus non-Indigenous word frequency results. Green and underlined means same words while red and no underline means different word

Non-Indigenous Stakeholders	Normalized Count	Indigenous Stakeholders	Normalized Count
<u>Springs</u>	20.3	<u>Springs</u>	23.75
<u>Water</u>	13	<u>Water</u>	15.5
Capture	7.6	<u>Use</u>	12
<u>Use</u>	6.7	Produce	6
Land	6	Life	5.5
Value	5.4	<u>Important</u>	5.25
Beneficial	4.7	<u>Wildlife</u>	3.75
<u>Important</u>	4.3	Plants	3.75
<u>Wildlife</u>	4	Right	2.75
Management	3.1	Crops	2
Animals	2.8	Flow	2
Need	2.7	Cultural	2
Ranch	2.5	Livestock	1.75
Cattle	2.2	Travel	1.5
Forest	2	People	1.5

Table 3 Hypothesis Tests

#	H ₀	H _A	P value	Chi-squared coefficient	Cramer V	Result	Relationship Type
1	There is no significant relationship between concern with threats from grazing and concern with prioritizing springs management for Indigenous nation's cultural significance	There is a relationship between concern with threats from grazing and concern with prioritizing springs management for Indigenous nation's cultural significance	<0.001	178.728	.415	We reject the null hypothesis and conclude a very strong statistically significant relationship between concern with threats from grazing and prioritizing management for Indigenous People's cultural significance.	Positive
2	There is no significant relationship between willingness to restrict recreation for the preservation of Indigenous culture and perceiving human caused threats to spring ecosystems	There is a relationship between the public willingness to restrict recreation for the preservation of Indigenous culture and perceiving human caused threats to spring ecosystems	<0.001	Pollution 88.132 Increased development 55.274 Ground water pumping 44.164	Pollution .294 Increased development .232 Ground water pumping .208	We reject the null hypothesis and conclude a strong relationship between willingness to restrict recreation for the preservation of indigenous cultural and concern for human cause threats to spring ecosystems.	Positive
3	There is no significant relationship between a	There is a relationship between a willingness	<0.001	23.952	.153	We reject the null hypothesis and	Positive

	willingness to reduce recreation for the spring's health and perceiving recreation as a significant threat to springs	to reduce recreation for the spring's health and perceiving recreation as a significant threat to springs				conclude a strong relationship between willingness to reduce own recreation and perceiving recreation as a threat.	
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Appendix A: Dates, stakeholder type, and setting for focus groups and interviews

Type	Date	Stakeholder	Setting
Focus Group 1	Thursday, November 4, 2021	EAG	NAU Conference Room with refreshments
Focus Group 1	Thursday, November 4, 2021	Indigenous	NAU Conference Room with refreshments
Focus Group 1	Thursday, November 4, 2021	Government Agency	NAU Conference Room with refreshments
Focus Group 1	Thursday, November 4, 2021	Rancher	NAU Conference Room with refreshments
Focus Group 2	Tuesday, November 9, 2021	Government Agency	NAU Conference Room with refreshments
Focus Group 2	Tuesday, November 9, 2021	Government Agency	NAU Conference Room with refreshments
Focus Group 2	Tuesday, November 9, 2021	Government Agency	NAU Conference Room with refreshments
Focus Group 2	Tuesday, November 9, 2021	EAG	NAU Conference Room with refreshments
Interview 1	Friday, February 11, 2022	Indigenous	Lunch
Interview 2	Wednesday, February 16, 2022	Indigenous	Zoom
Interview 3	Wednesday, February 16, 2022	EAG	Zoom
Interview 4	Thursday, February 24, 2022	Rancher	Lunch
Interview 5	Thursday, March 3, 2022	Indigenous	In person meeting
Interview 6	Monday, March 7, 2022	Municipal	In person meeting
Interview 7	Wednesday, March 23, 2022	Rancher	Lunch
Interview 8	Wednesday, April 6, 2022	EAG	Coffee
Interview 9	Thursday, April 7, 2022	Indigenous	Lunch
Interview 10	Friday April 15, 2022	Government Agency	Lunch
Interview 11	Wednesday June 22, 2022	Rancher	In person meeting
Interview 12	Friday June 24, 2022	Government Agency	Coffee
Interview 13	Thursday, July 21, 2022	EAG	Coffee
Interview 14	Thursday, July 28, 2022	Government Agency	Coffee

Appendix B Focus Group and Interview Questions

Discussion Objectives

- Clearly define the project decision space
- Identify and discuss critical details of the survey question:
 - potential project attributes
 - attribute descriptions
 - attribute levels

Introduction and summary of research

1. Introductions of NAU team
2. Discussion of Choice Experiment methodology

Define decision space

1. Who has standing in this study?
2. Do any groups warrant targeted sampling?

Attribute list brainstorming session

1. What characteristics of spring ecosystem services are important?
2. Ranking of characteristics by perceived importance

Describing attributes

1. What is a clear and concise definition of the attribute?
2. How can the attribute be represented in different levels?

Concluding remarks and plans moving forward

Thank you for your time and valuable contributions.

Appendix C Chi-Squared results from the analysis of the survey data

Hypothesis Test 1			
Management for cultural significance is important	High concern with grazing		
	NO	YES	TOTAL
Yes	351	234	585
NO	168	285	453
TOTAL	519	519	1,038
P value	<0.001		
Cramer's V	0.415		
Pearson's Chi-Squared coefficient	178.728		
Hypothesis Test 2			
Willing to restrict recreation for Indigenous culture	High concern with GWP		
	NO	YES	TOTAL
YES	116	48	164
NO	363	492	855
TOTAL	479	540	1,019
P value	<0.001		
Cramer's V	0.2082		
Pearson's Chi-Squared coefficient	44.164		
Willing to restrict recreation for Indigenous culture	High concern with pollution		
	NO	YES	TOTAL
YES	97	67	164
NO	196	659	855
TOTAL	193	726	1,019
P value	<0.001		
Cramer's V	0.2941		
Pearson's Chi-Squared coefficient	88.132		
Willing to restrict recreation for Indigenous culture	High concerned with increased development		
	NO	YES	TOTAL
YES	100	64	164
NO	262	593	855
TOTAL	362	657	1,019
P value	<0.001		
Cramer's V	0.2329		
Pearson's Chi-Squared coefficient	55.274		
Hypothesis Test 3			
Willing to restrict own recreation for a springs protection	High concern with recreation		
	NO	YES	TOTAL

YES	116	43	159
NO	443	410	853
Frequency	559	453	1,012
P value	<0.001		
Cramer's V	0.1538		
Pearson's Chi-Squared coefficient	23.952		

Chapter 3: Additional Results, Discussion, Conclusions, and Call for Future Research

3.1 Results

3.1.1 Results from focus groups

Based off the focus groups' discussion and knowledge of springs in the area, we divided the stakeholders into five groups Environmental advocacy groups (EAG), Government agencies, Municipal water provider, Ranchers, and Indigenous Nations. We then categorized those stakeholders into three different types of stakeholders for spring ecosystem in the CNF and KNF based off their roles and responsibilities (**Table 2**).

The focus groups allowed us to identify the six most important attributes of spring ecosystems in the CNF and KNF: Municipal Water Security, Water Flow, Ranching, Recreation, Biological Habitat Quality, and Cultural Significance. Using the focus groups' data, we created clear and concise definitions for the attributes (**Table 3**).

3.1.2 Results from interviews

We ran three types of analysis for the interview data: thematic content analysis (TCA), sentiment analysis, and word frequency analysis. **Figures 9-13** show the word frequency analysis for each of the stakeholders. Further results from the interviews are in **Section 2.4.1**.

3.1.3 Perceived threats to springs from the National Survey

Most of the significant results gained from the attitudinal questions from the national survey are presented in **Section 2.4.2**. In addition to those results we also have several figures (**Figures 1-8**) showing specific results from individual questions asked. These figures show the level of concern participants felt toward different threats to springs. **Table 4** shows the summary

statistics from the demographic section of the national survey. **Tables 9-13** are the frequency table results from each of the hypothesis tests.

3.2 Final Discussion and Conclusion

The significant discussion and conclusion sections can be found in **Sections 2.5 and 2.6**.

Through the focus groups, interviews, and national survey we present evidence from local and national perspectives on springs ecosystems in the CNF and KNF. We were able to learn a significant amount of information from the focus groups and interviews. These results are important for equitable springs management because they include the perceptions of all stakeholders involved including the public who are the beneficiaries of public land.

Recreation is an important use of public land. Managing for recreation in a way that does not degrade the ecosystem it takes place in is important for the quality of use and the future ability for use. Our results, which outline the threats perceived around certain recreation activities, can be used to limit the recreation activities perceived as highly degrading. For example, 52% of survey respondents thought that off road vehicle riding (ORV) should be restricted from use at springs. Land managers in the Coconino and Kaibab National Forests can implement policies that aim at reducing the use of ORVs on public land and specifically springs.

Cattle grazing was one of the most polarizing attributes of springs management that we uncovered in this research. Rancher stakeholders adamantly supported the right to manage springs for cattle grazing. However, we did not see that same support from the rest of the stakeholders or the survey respondents. For example, over 80% of survey respondents indicated they were moderately, very, or extremely concerned with the threats to springs from grazing. In addition, 62% of survey respondents indicated they were not at all to moderately concerned with

a reduction in grazing. Our data shows a distinct disconnect with the perceived threats the public has versus the ranchers who are actually grazing at the springs. These results are very important as they show a void in preferences between a single stakeholder group and all other groups reached in the thesis research. We provide examples of local stakeholders and ranchers in northern Arizona taking conservation efforts of ecosystems into their own hands in **Section 2.5.1**. However, much work remains to be done to thoughtfully and accurately represent Indigenous voices in land management policies.

Indigenous Nations' cultural significance was a key component in this thesis research. We deliberately and intentionally sought feedback and insights from Indigenous stakeholders to ensure their perceptions and voices were included. The results from the focus groups and interviews were emphasized by the significant support for management for cultural significance we saw from the survey respondents. Survey respondents were asked "Are you willing to restrict your **own** recreation on National Forests to preserve springs with cultural significance for Indigenous Peoples?" 84% responded YES. Results from the national survey, focus groups, and interviews all show significant support to manage springs for Indigenous Nations cultural significance. The importance the public shows toward Indigenous Nations' Cultural Significance is an imperative outcome of this research and a launching point for further research on equitable management of public land.

Research involving diverse stakeholders is intricate. Properly integrating diverse perspectives must be intentional and respectful. By meeting the standards of the IRB, training on the appropriate ways to communicate and display results, we contribute this thesis as a framework for equitable human perceptions research for ecosystems on public land.

3.2.1 Meeting the grant's objectives

This thesis is funded by Agricultural Economics and Rural Communities: Environment, grant no. 2020-67023-33262/ project accession no.1024576, from the USDA National Institute of Food and Agriculture. According to the grant proposal, Objective 1 is: *Estimate the non-market values of springs ecosystem services across the Coconino and Kaibab National Forests in Northern Arizona*. This thesis contributes to Objective 1 and supports NIFA's program priorities of understanding an ecological approach to agriculture and advancing economic applications embracing production and sustainable resource management simultaneously in the following ways:

- Answering research questions about springs management in the CNF and KNF using mixed methods
- Reporting interview and survey data explaining, providing context, and contributing an understanding on the human perceptions of the ecological components of spring ecosystem management.
- Using the results of the research to provide possible management solutions for springs in our study area to simultaneously manage for productivity of the land and other attributes of springs such as cultural resources.
- Contributing evidence supporting stakeholders' and the public's support for spring's management for Indigenous Nations' Cultural Significance.

3.2.2 Limitations

In addition to the limitations found in **Section 2.6** we also acknowledge a weakness in the application of Person's Chi-Squared Test. We distorted the distribution of the Likert scale results when we ran analyses on the "(4) Very Concerned" and "(5) Extremely concerned"

variables instead of including all 5 of the variables. While we find it important to report this limitation, we feel it has no significant impact on the validity of our results.

3.3 Call for future research

Further research of the human perceptions of springs management is needed. We consider the two main calls for further research:

1. Analysis of how the responses of the attitudinal question from the national vary by demographics using regression analysis.
2. Development and dissemination of another national survey asking respondents about preferred mechanisms for springs management or specific springs management policies.

3.3.1 Analyzing how human perceptions vary by demographics

Race (Borg et al., 2011), income (Khan & Zhao, 2018), education (Khan & Zhao, 2018), and gender (Bord et al., 1997) can also play a role in how different groups of people may prefer certain attributes of environmental features over others. Mohai & Bryant (1998) found that African Americans showed greater concern for local issues due to the inequitable burden of the environmental issues and environmental racism. Slimak & Dietz (2006) found that ethnicity did not affect level of perceived ecological risk, but people who were more educated and had higher income had less concern for risks.

Figures 14 shows the results of the level of concern to springs from recreation by survey respondents who identified as white. **Figure 15** shows the level of concern to springs from recreation by survey respondents who identified as non-white. The levels of concern do not appear to vary between groups however, methods such as regression analysis may be able to

detect difference in perceptions of springs by this demographic variable or other demographic variables.

3.3.2 Survey analyzing preferred mechanisms for spring's management

Our analysis examines what stakeholders and survey respondents perceived as important for springs to be managed for (recreation, ranching, Indigenous Nations' cultural significance). We then provide examples of different management options that can be used to align those perceptions with management policy-making (**Section 2.5**). Instead of inferring on what mechanisms might align those perceptions best we can deliberately ask survey respondents if they prefer joint management, market-based solutions, or reductions in grazing or recreation. This further research would contribute valuable information to understand what management policies people might prefer and to build off the results we present in this paper.

Table 1 Stakeholder Focus Groups Date and Times

Type	Date	Stakeholder type
Focus Group 1	Thursday, November 4, 2021	EAG
Focus Group 1	Thursday, November 4, 2021	Indigenous
Focus Group 1	Thursday, November 4, 2021	Government Agency
Focus Group 1	Thursday, November 4, 2021	Rancher
Focus Group 2	Tuesday, November 9, 2021	Government Agency
Focus Group 2	Tuesday, November 9, 2021	Government Agency
Focus Group 2	Tuesday, November 9, 2021	Government Agency
Focus Group 2	Tuesday, November 9, 2021	EAG

Table 2 Stakeholder types, definitions, and groups

	Definition	Groups
Stakeholders of Responsibility	This type of stakeholder has authority to manage, make policies and regulate the spring systems.	• Forest Service • Arizona Department of Game and Fish
Stakeholders of Investment	This type of stakeholders invests or pays into the system. They rely on the system for some type of economic incentive or gain some tangible value from the spring system.	• Ranchers • Hunters • Backpackers • Friends of Northern Arizona Forests • Local Indigenous tribes
Stakeholder of Interest	This type of stakeholder only invests time into the springs system for their own benefit. Their investment into the system only includes their own time and investment into their own gear which allows for them to gain value from the spring system	• Bird watchers • Mountain bikers • Hikers • General public

Table 3 Spring Attribute Definitions and Levels

Attribute	Definition
<i>City Water security</i>	Spring contributes to a city's water security, including residential public and commercial buildings
<i>Cultural significance</i>	For the purpose of this study a spring is considered culturally significant if it has traditional, religious/spiritual, or existence value to Indigenous Nations
<i>Recreation</i>	Springs are the source of many recreational activities including: hiking, camping, boating, fishing, hunting and wildlife viewing.
<i>Ranching</i>	Springs provide support for ranching activities. Livestock graze and use spring water for drinking, which is a clean and free source of water especially in drought years. Spring promotes the cowboy culture and lifestyle. Ranching is permitted at some springs and not at others.
<i>Flow</i>	Springs amount of water discharge can vary for many reasons such on the geology or the season. The flow of springs also provides a sense of resilience to the ecosystem

Table 4 summary statistics from the demographic section of the national survey

	Count	Percent
Gender		
Male	401	40.79%
Female	571	58.09%
Non-Binary / third gender	8	0.81%
Prefer not to say	3	0.31%
Income		
Less than \$10,000	94	9.56%
\$10,000 - \$14,999	74	7.53%
\$15,000 - \$19,999	55	5.60%
\$20,000 - \$24,999	70	7.12%
\$25,000 - \$29,999	64	6.51%
\$30,000 - \$34,999	60	6.10%
\$35,000 - \$39,999	59	6%
\$40,000 - \$44,999	32	3.26%
\$45,000 - \$49,999	59	6%
\$50,000 - \$59,999	72	7.32%
\$60,000 - \$74,999	96	9.77%
\$75,000 - \$99,999	99	10.07%
\$100,000 - \$124,999	56	5.70%
\$125,000 - \$149,999	43	4.37%
\$150,000 - \$199,999	25	2.54%
\$200,000 or more	25	2.54%
Ethnicity		
White / non-Hispanic	620	64.12%
Hispanic	168	17.37%
Prefer not to say	45	4.65%
other	134	13.86%
Education		
No high school diploma	48	4.89%
High school graduate, or GED	387	39.41%
Some college but no degree	199	20.26%
Associates degree (2-year program)	58	5.91%
Bachelor's degree (4-year program)	188	19.14%
Master's Degree and beyond	102	10.39%
Employment		
Fulltime	344	33.05%
Employed part time	118	11.34%

Unemployed looking for work	59	5.67%
Unemployed not looking for work	32	3.07%
Retired	243	23.34%
Student	22	2.11%
Disabled	82	7.88%
Self Employed	39	3.75%
Military	3	0.29%
Homemaker	70	6.72%
Unable to work	21	2.02%
Prefer not to say	8	0.77%
Age		
18-25	104	10.59%
26-35	167	17.01%
36-45	183	18.64%
46-55	150	15.27%
56-65	170	17.31%
66-75	165	16.80%
Above 75	43	4.38%
Race		
White	681	71.23%
Black or African American	158	16.53%
American Indian or Alaska Native	28	2.93%
Asian	68	7.11%
Native Hawaiian or Pacific Islander	5	0.52%
Prefer not to say	16	1.67%
Political Affiliation		
Democrat	335	34.08%
Republican	276	28.08%
Independent	278	28.28%
Prefer not to say	94	9.56%
Arizona Resident		
YES	49	5.02%
NO	928	94.98%
Member of an Environmental Organization		
NO	851	87.19%
YES	125	12.81%
Visited a spring		
YES	443	43.26%
NO	581	56.74%
Visited CNF or KNF		

	YES	106	10.31%
	NO	922	89.69%
Visited a spring in CNF or KNF			
	YES	65	60.75%
	NO	42	39.25%

Figure 1

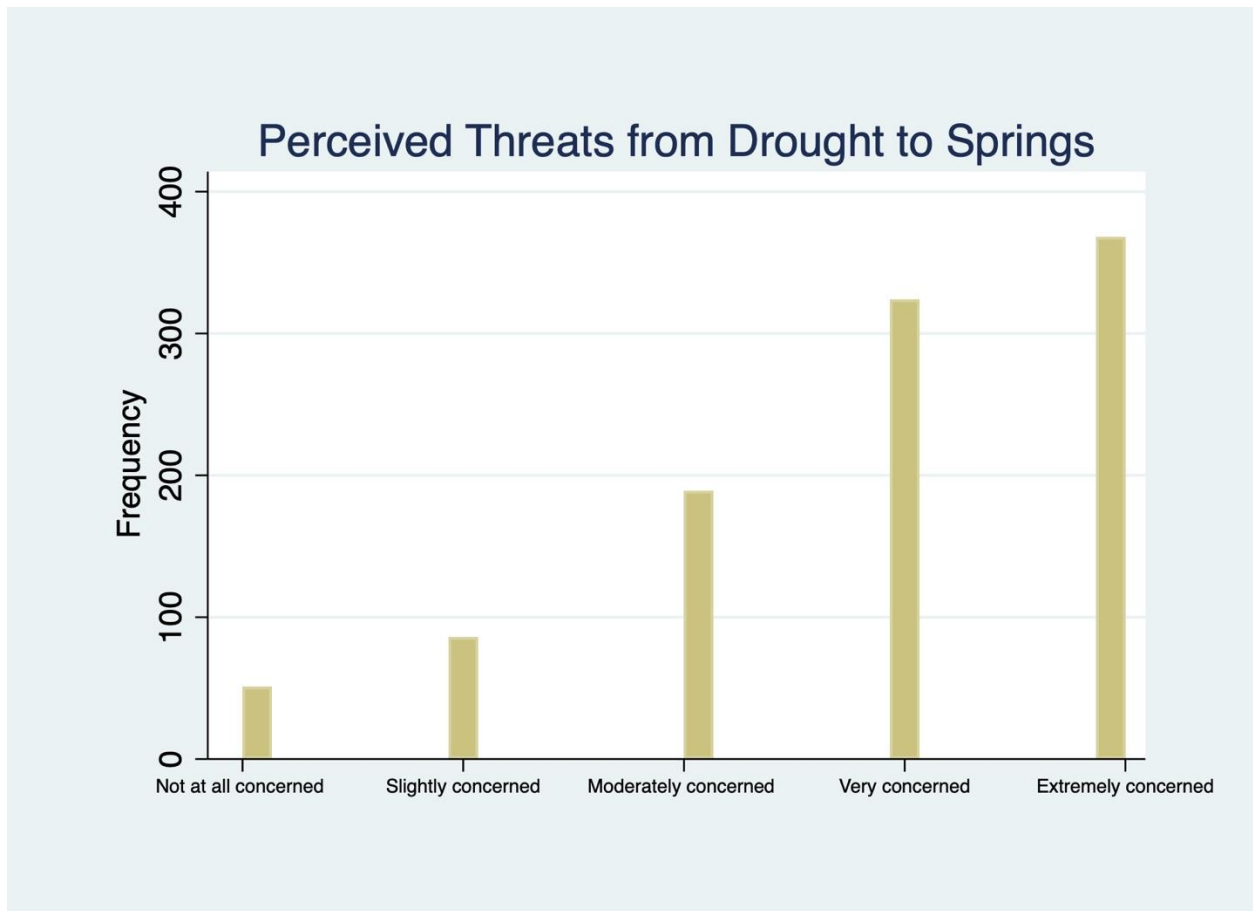


Figure 2

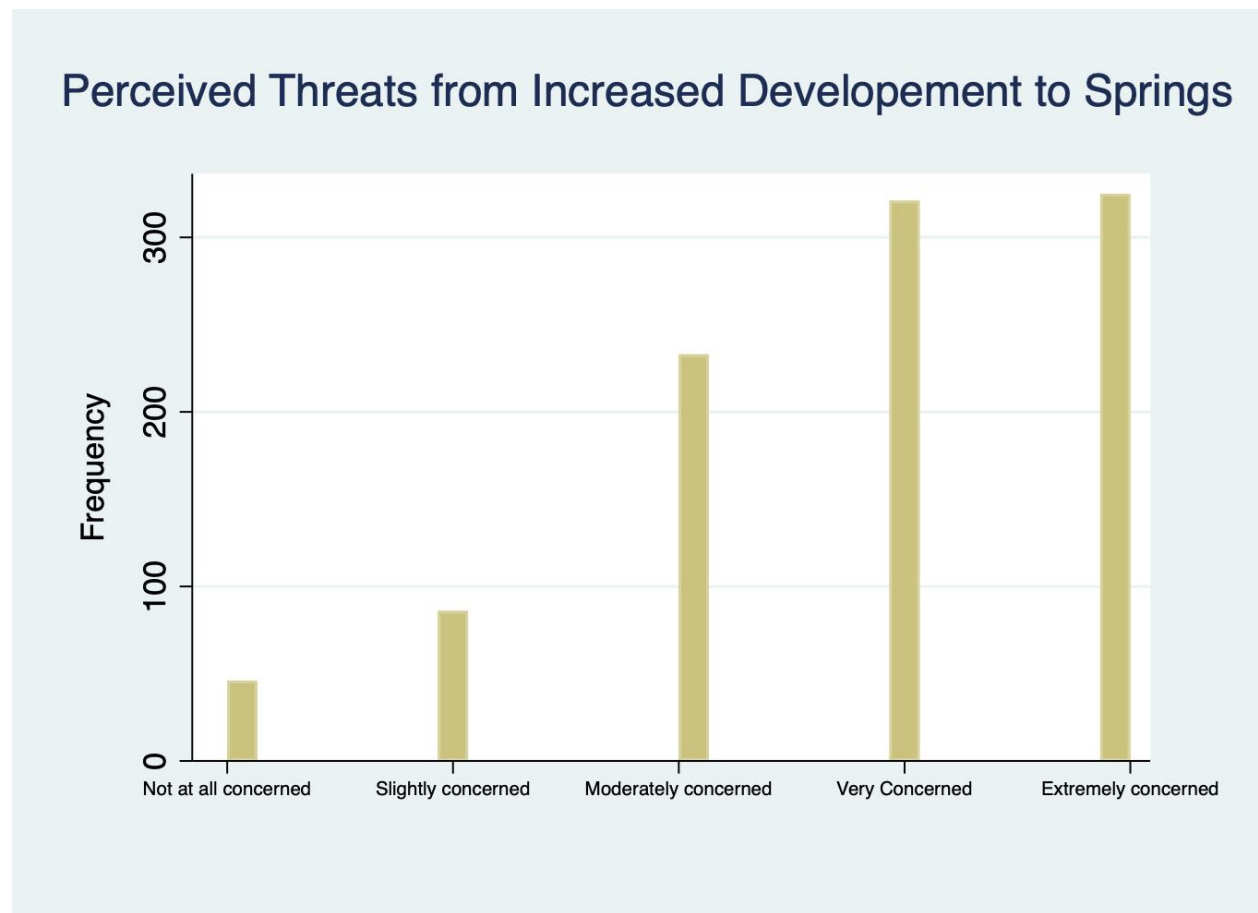


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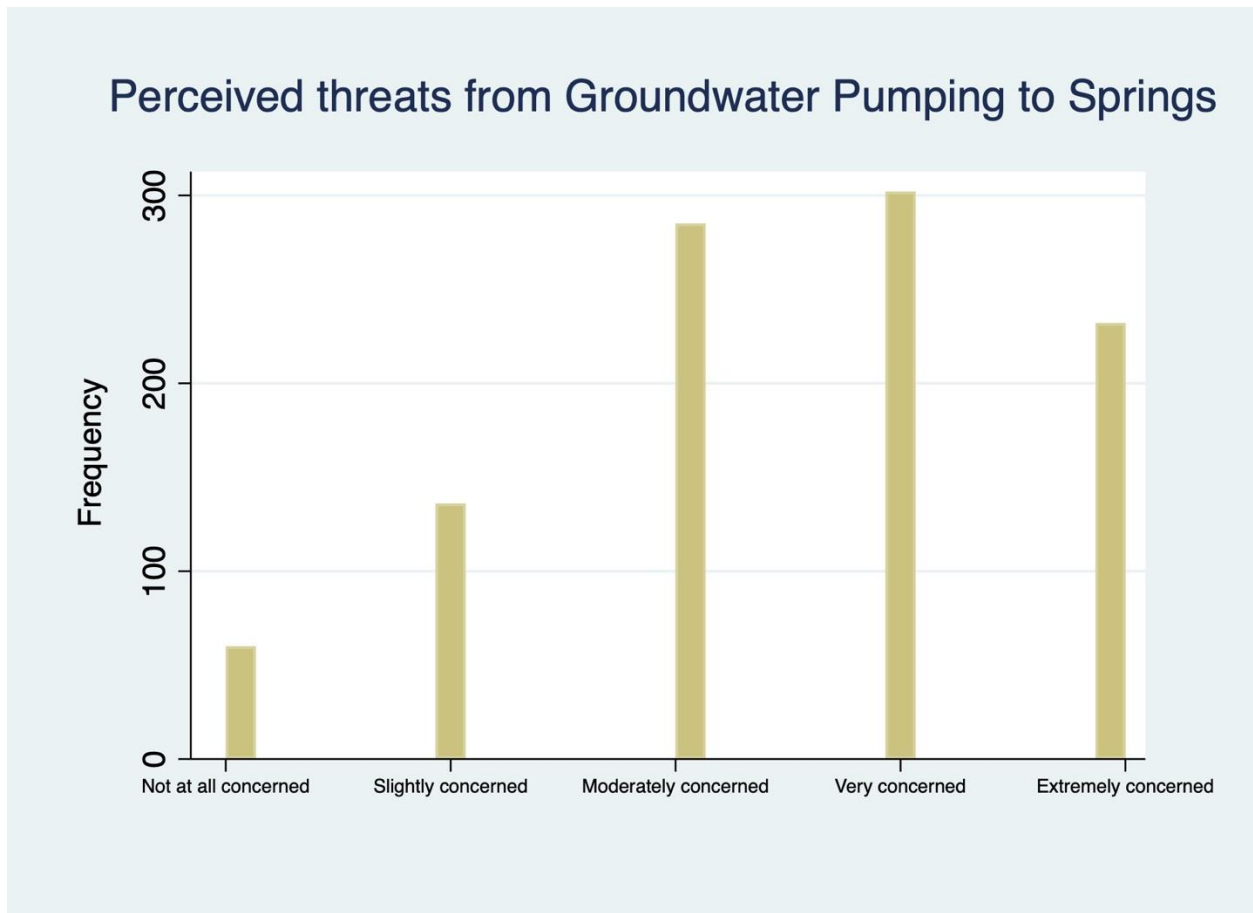


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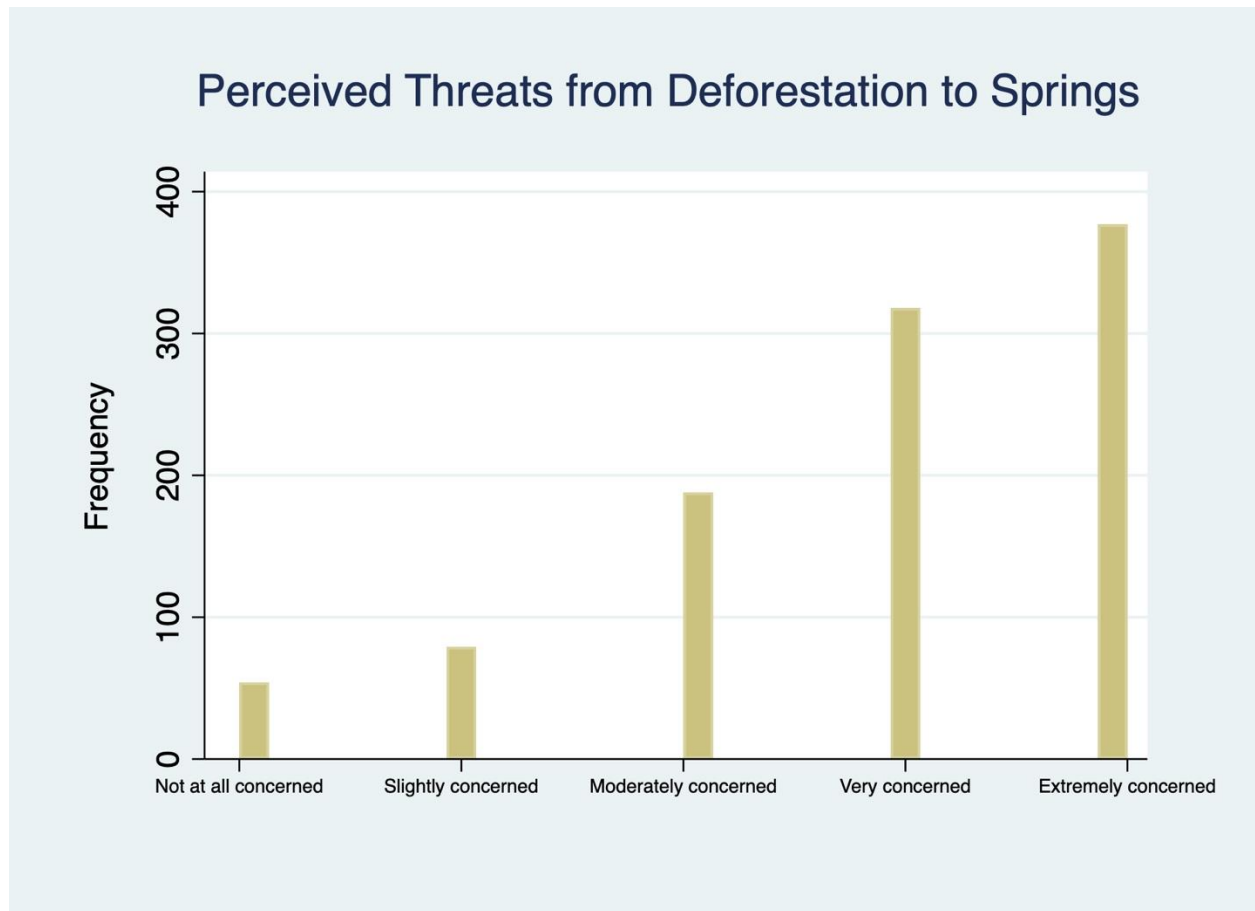


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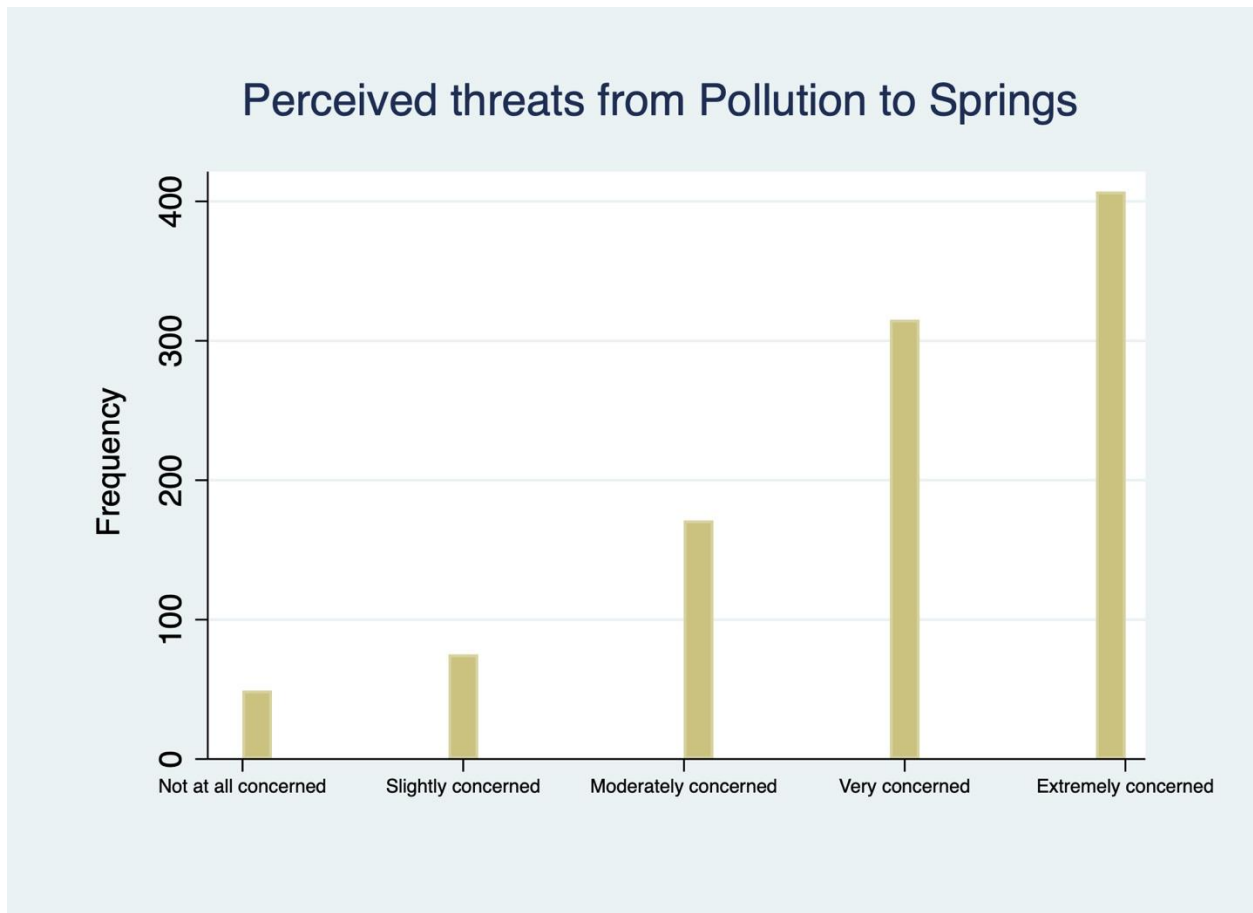


Figure 6

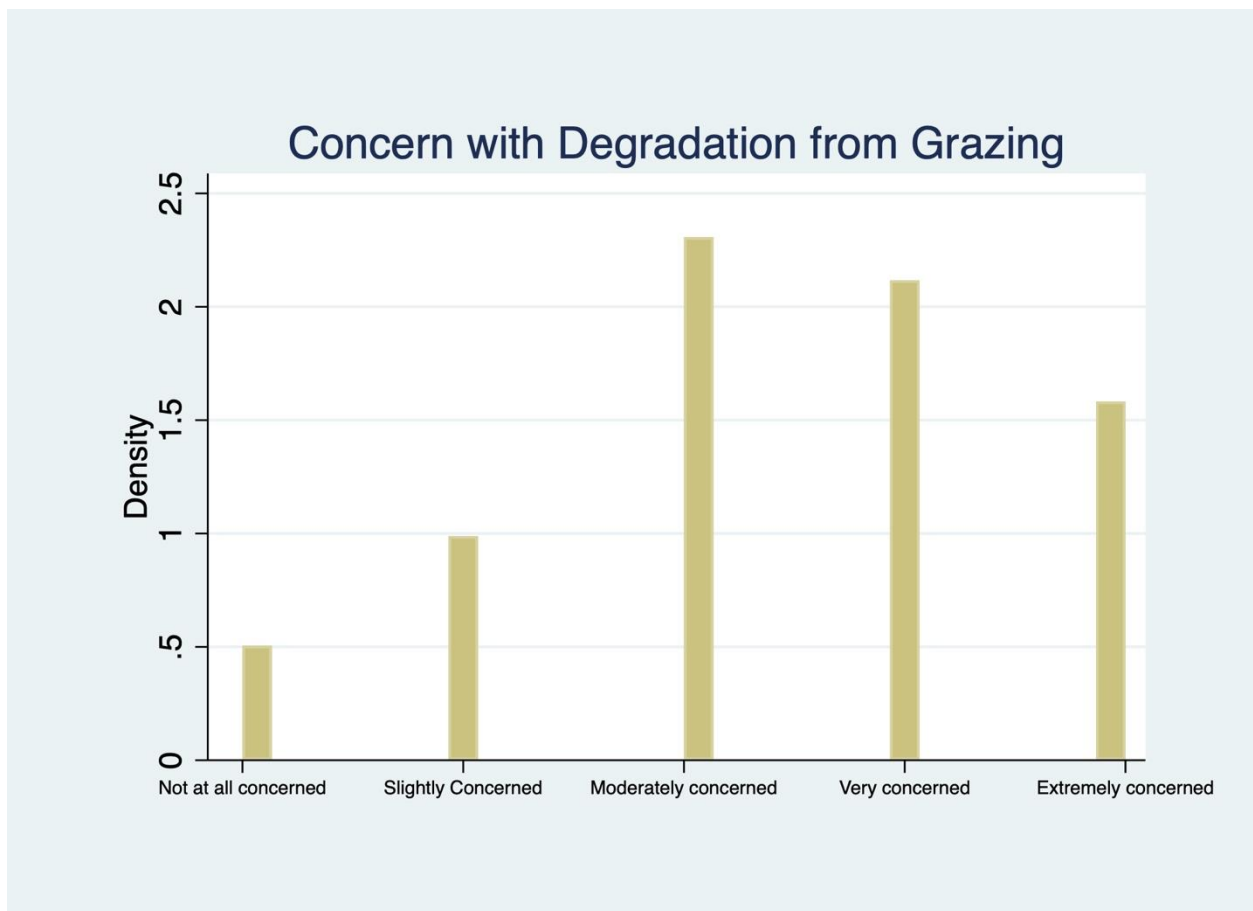


Figure 7

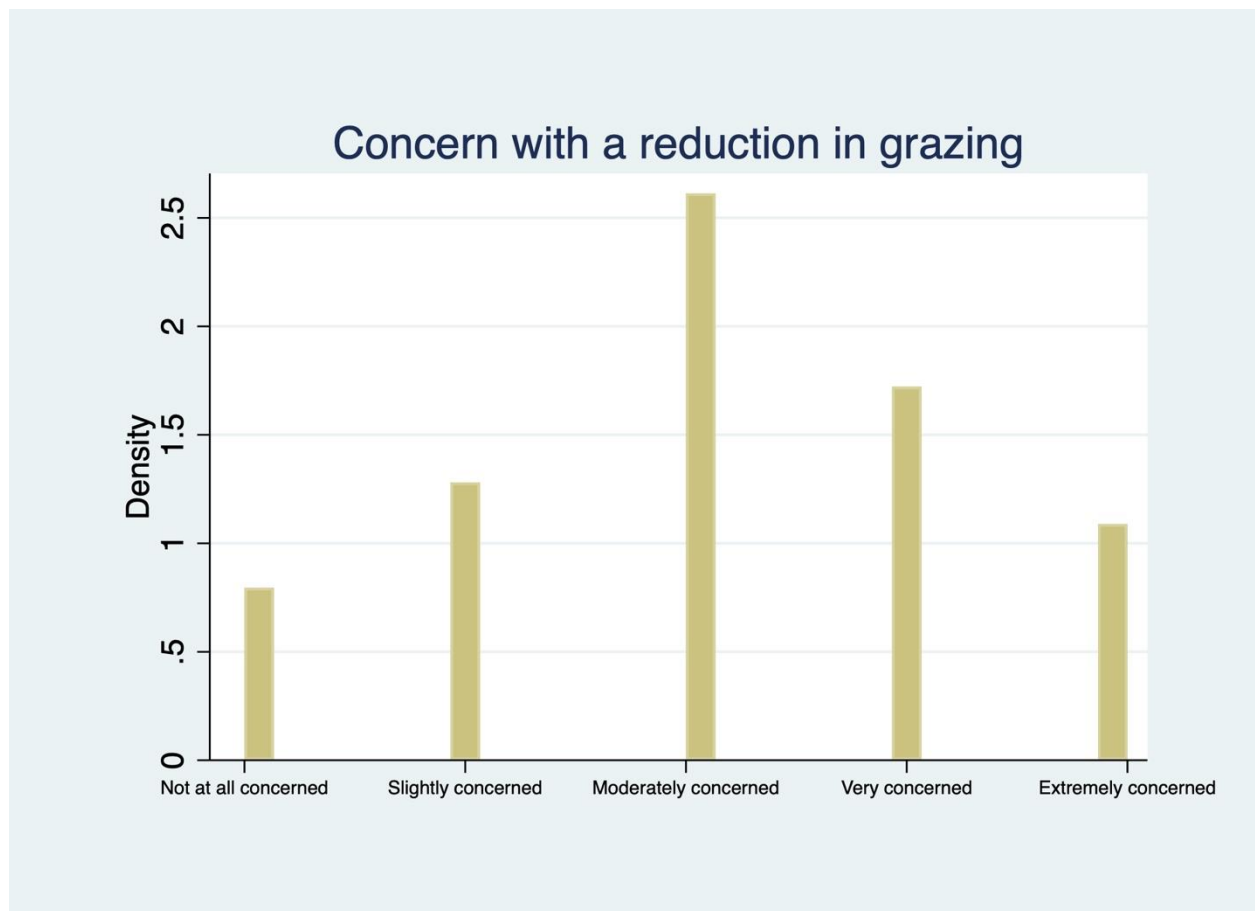


Figure 8

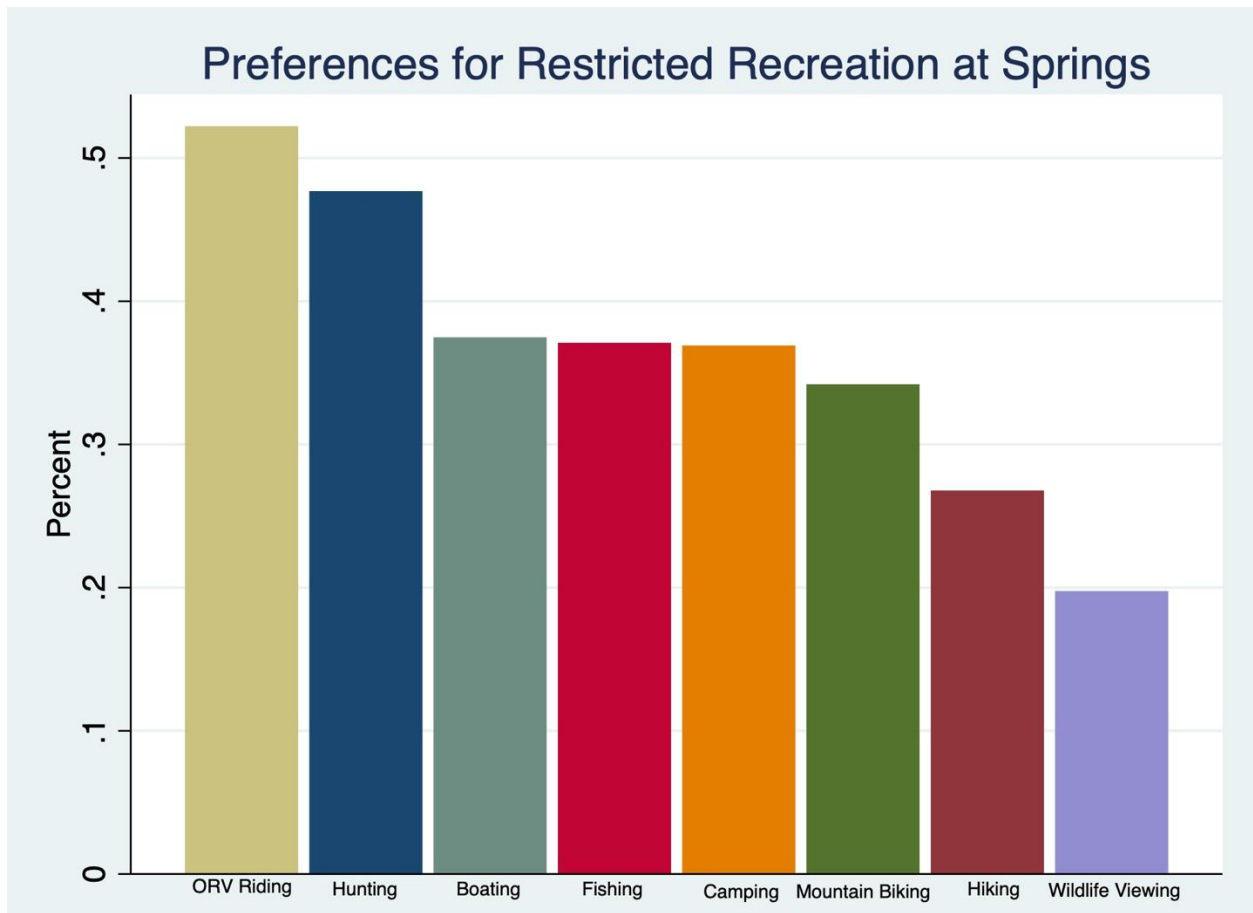


Figure 9

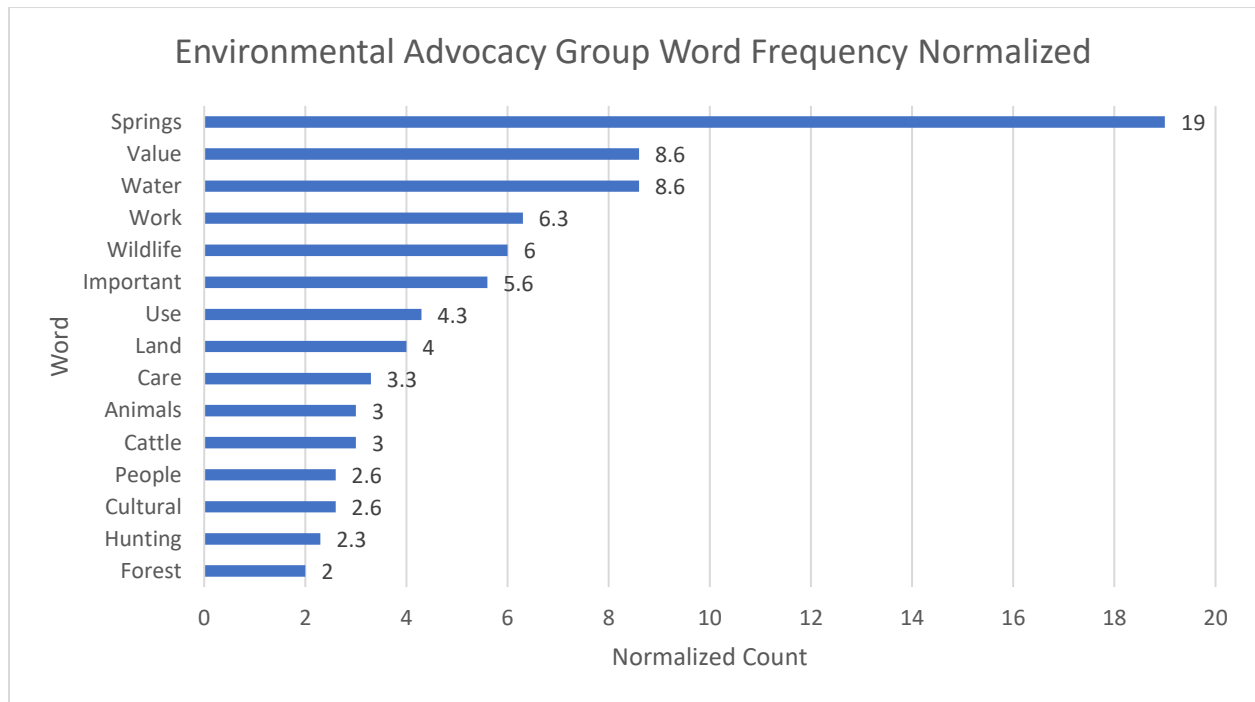


Figure 10

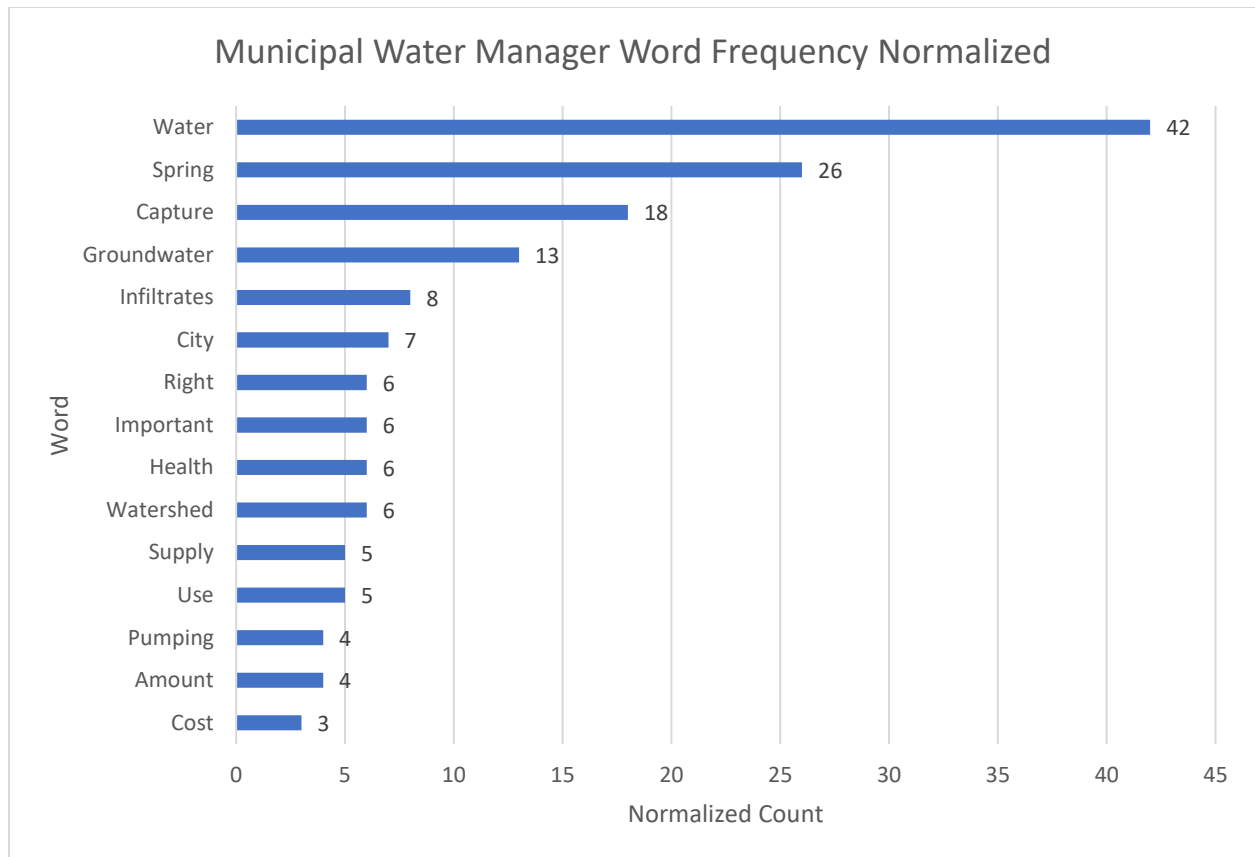


Figure 11

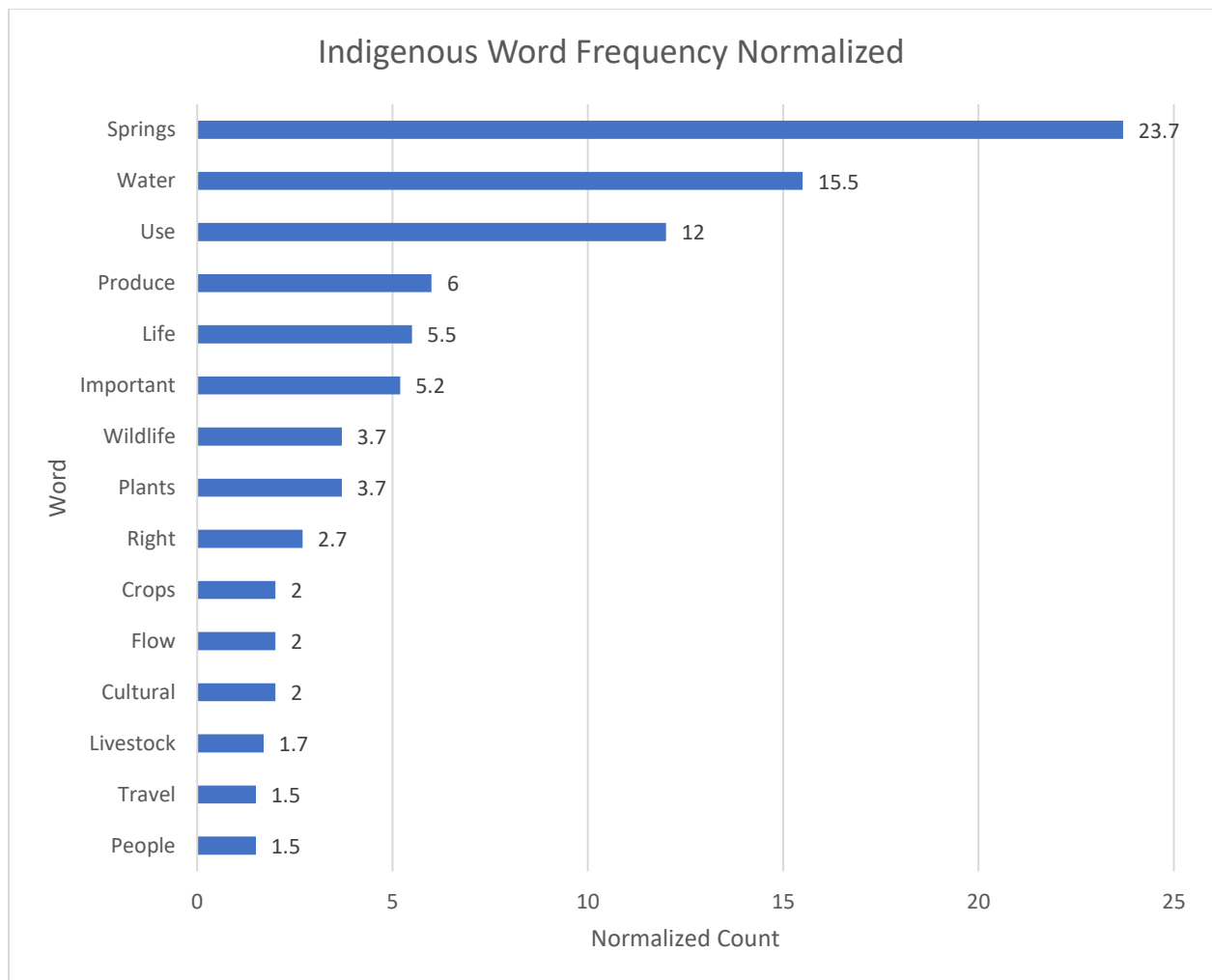


Figure 12

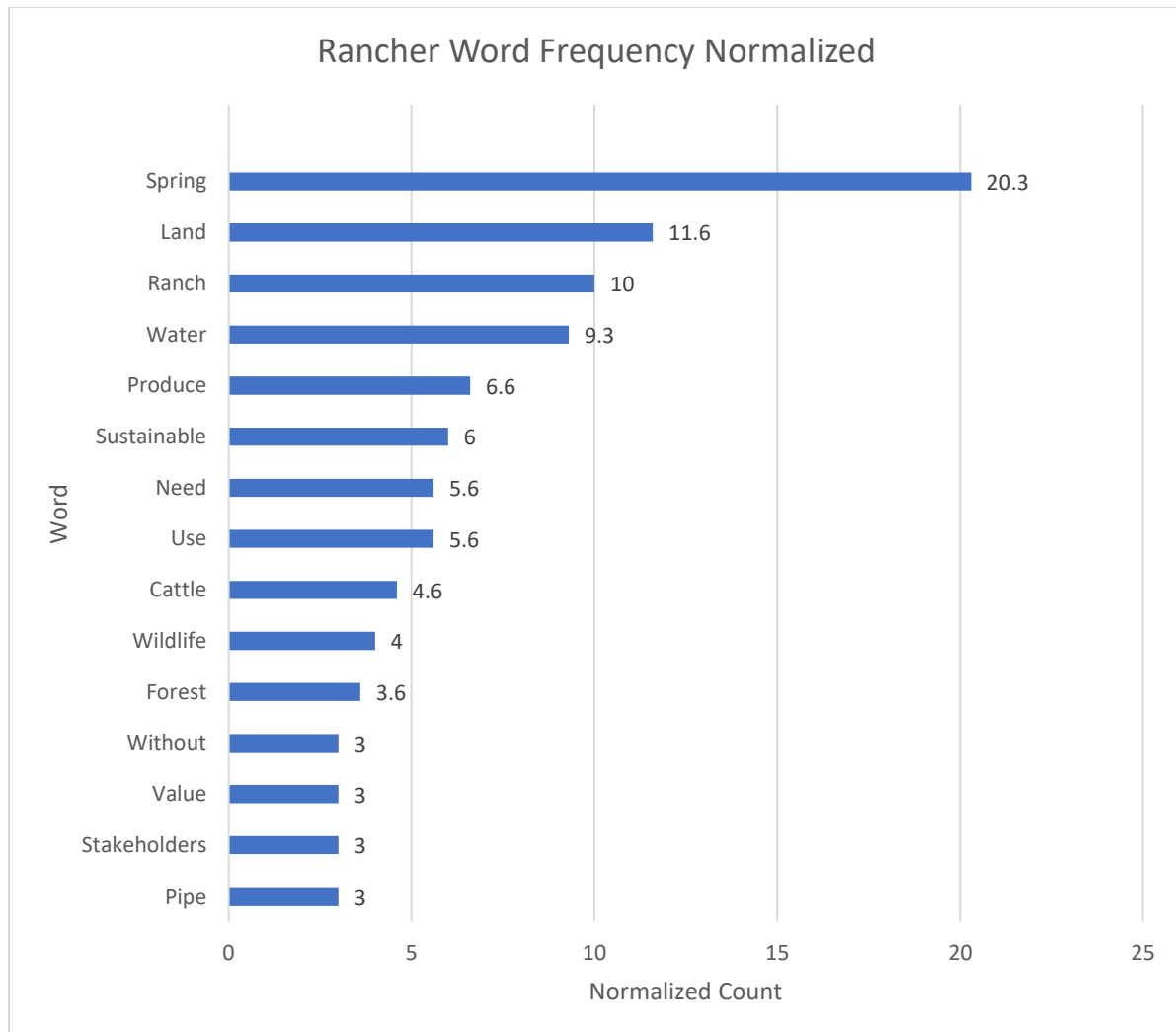


Figure 13

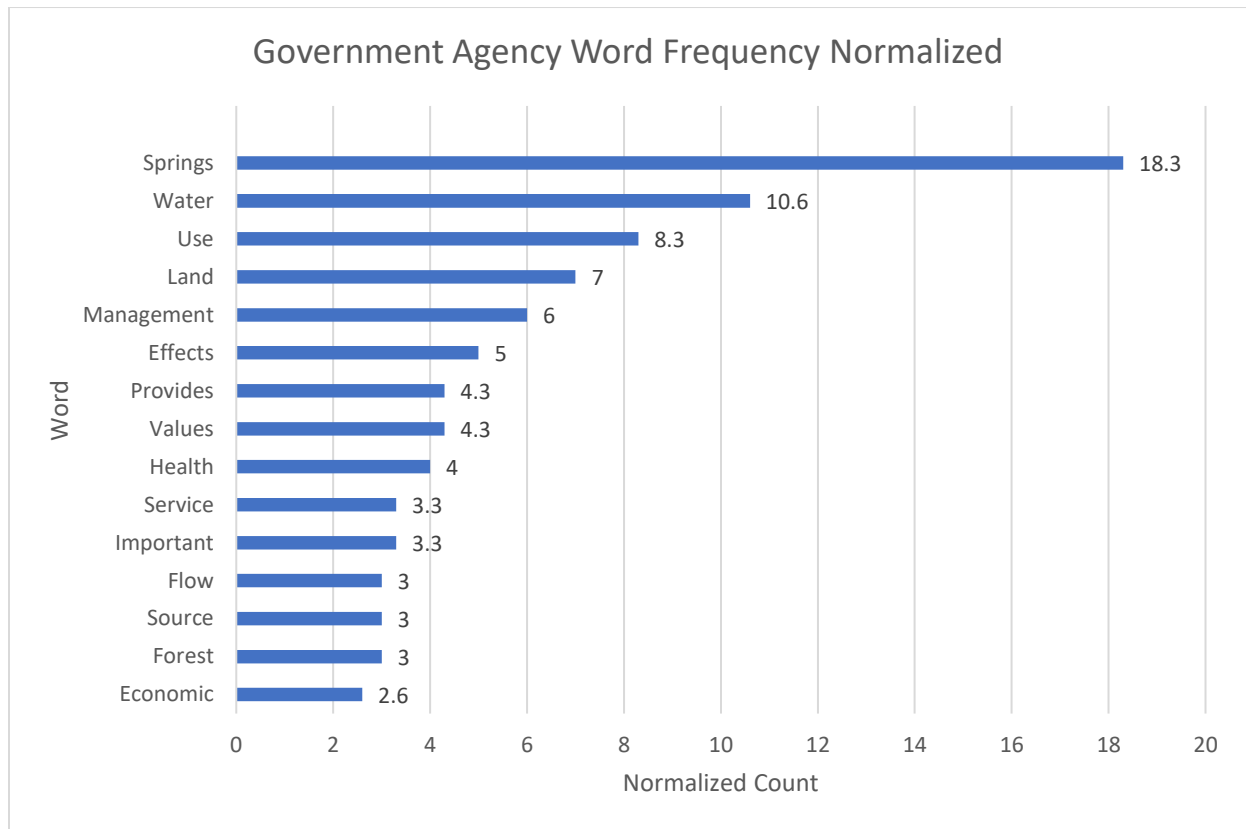


Figure 14

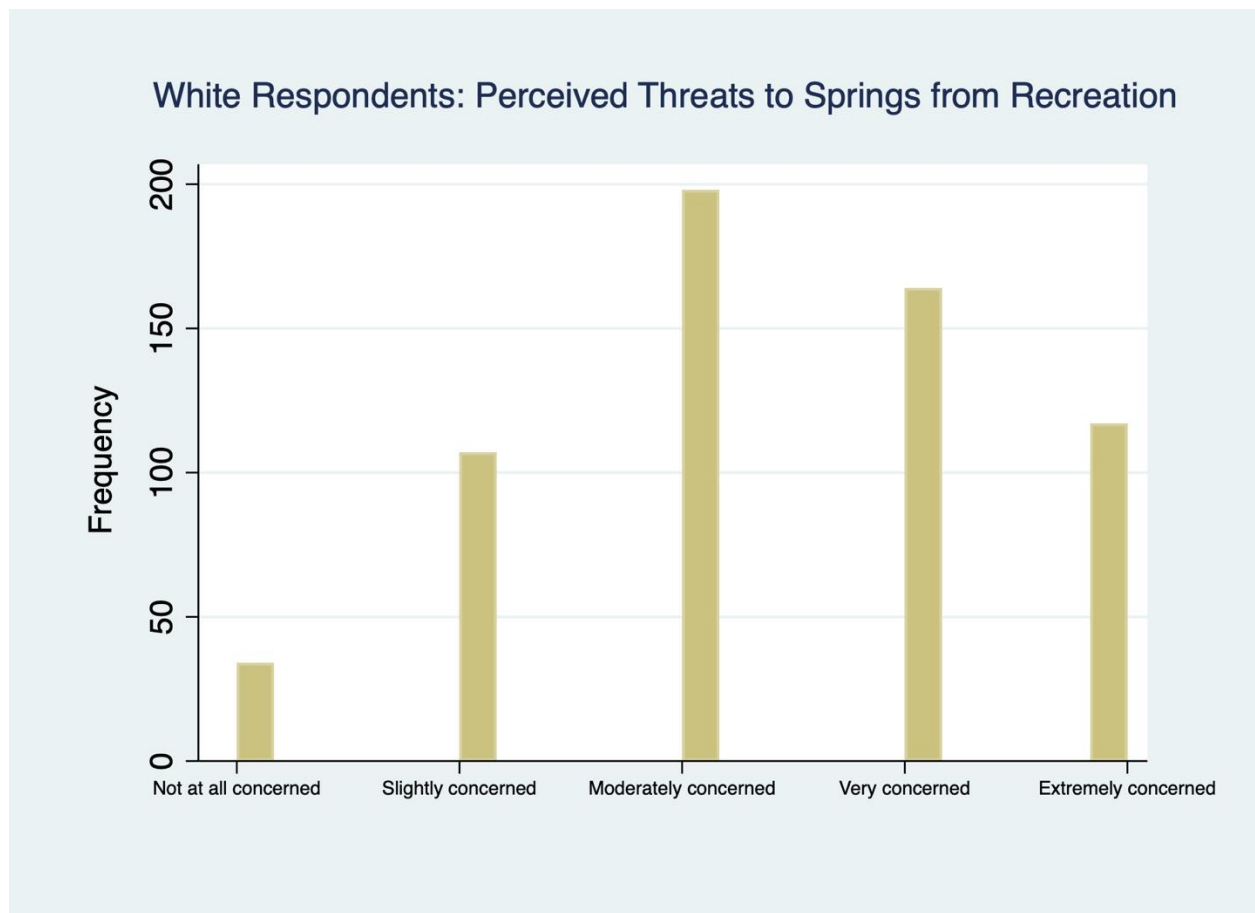
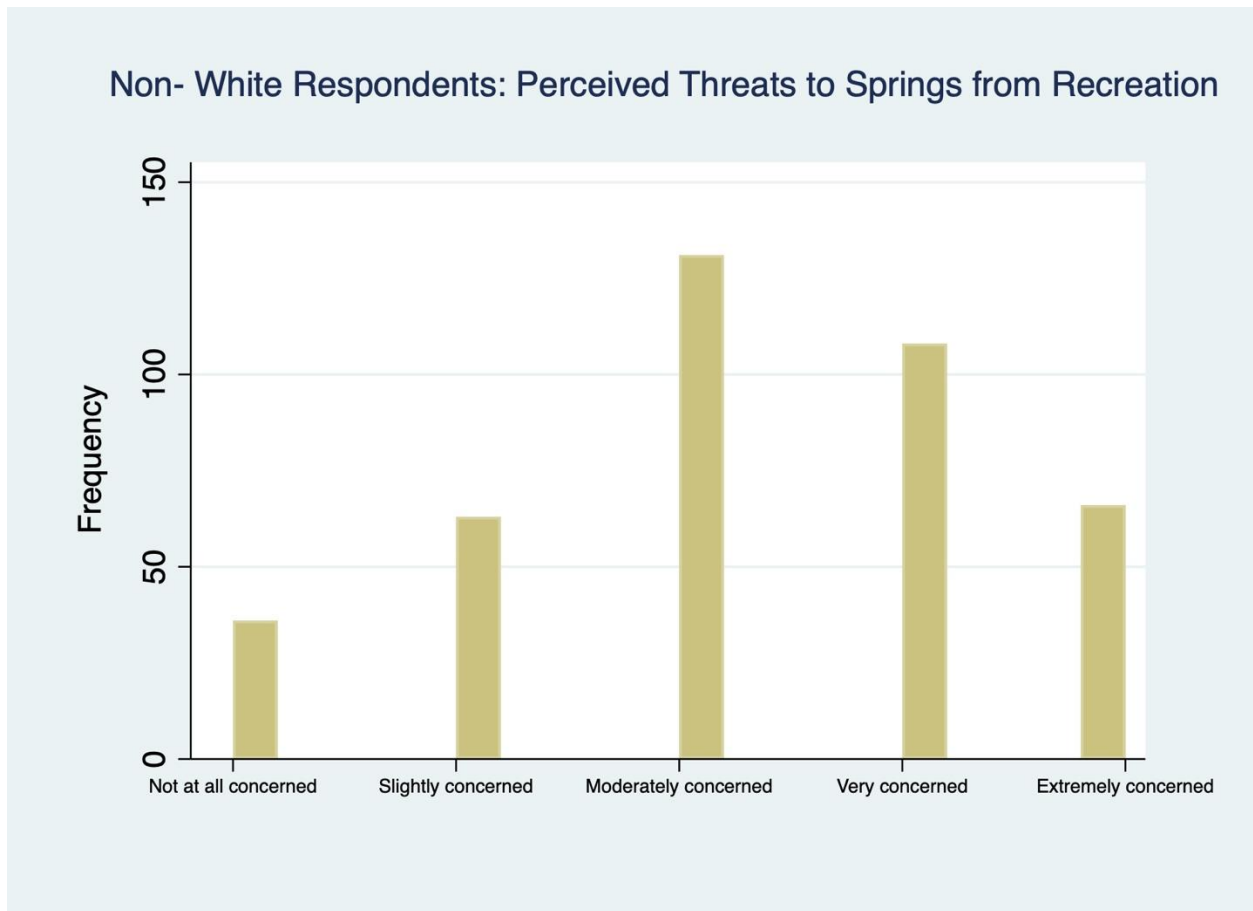


Figure 15



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Appendix A: IRB exempt Approval Letter



Office of Research Compliance

Institutional Review Board for the
Human Research Protection Program

525 S Beaver St
PO Box: 4062
Flagstaff AZ 86011
508-523-9551
<https://www.nau.edu/IRB>

To: Julie Mueller
From: NAU IRB Office
Approval Date: July 1, 2022

Project: NIFA Project: Non-Market Valuation of Spring Ecosystems in the Coconino and Kaibab National Forests
Project Number: 1804157-5
Submission: Amendment/Modification
Review Level: Exempt Review
Action: EXEMPT
Project Status: EXEMPT

Review Category/ies: **Exempt Approval 45 CFR 46.104(d)(2):** Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) if at least one of the following criteria is met: (i) The information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects; (ii) any disclosure of the human subjects, responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects, financial standing, employability, educational advancement, or reputation; or (iii) The information obtained is recorded by the investigator in such a manner that the identity of the human subjects can readily be ascertained, directly or through identifiers linked to the subjects, and an IRB conducts a limited IRB review to make the determination required by § 11.111(a)(7).

This submission meets the criteria for exemption under 45 CFR 46.101(b). This project has been reviewed and approved by an IRB Chair or designee.

- Northern Arizona University maintains a Federalwide Assurance with the Office for Human Research Protections (FWA #00000357).
- All research procedures should be conducted in full accordance with all applicable sections of the guidance.
- Exempt projects do not have a continuing review requirement.
- This project should be conducted in full accordance with all applicable sections of the guidance and you should notify the IRB immediately of any proposed changes that affect the protocol.
- Amendments to exempt projects that change the nature of the project should be submitted to the Human Research Protection Program (HRPP) office for a new determination. See the guidance Minimal Risk or Exempt Research for more information on changes that affect the determination of exemption. Please contact the HRPP to consult on whether the proposed changes need further review.
- You should report any unanticipated problems involving risks to the participants or others to the IRB.

Appendix B: Focus Group 1 Notes

Focus Group #1

11-4-22

Government Agency Stakeholder :

- livelihood :people who visit, existence value, from wildlife: hunters, game populations rely on springs, wildlife watchers, 90-95% of wildlife depend on springs at some time in their life,
- Recreational use, National wildlife report (USFW), permits, tags, boating, wildlife viewers, hunters, anglers, backpackers (rely on spring for aesthetics and water)
- People who use the springs recreationally, private land owners, fisherman, hatcheries
- People connected to spring either through livelihood or existence
- Recreationist of springs emerging in streams (wet beaver, sycamore)
- Private land owners within the forest
- Fishing, anglers, fish hatcheries
- USFWS does regular national recreational report, ~\$5M / year in county

Indigenous Stakeholder :

- Indigenous cultures view springs as sentient beings. Tribes use springs for agriculture, economic use, spiritual/religious use,
- cultural values, creation stories, medicinal, traditions, story telling, springs have native names and trade routes are closely tied to springs, water is taken as well as minerals, tobacco found near springs, link between biodiversity and cultural value?
- tribal members, specifically members working closely with the springs, wants to raise awareness of the value
- Tribes categorically consider springs sacred
- Places of spiritual or economic use
- Some springs tied into migration and creation stories
- Hualapai people still visit some springs on the peaks to translate stories
- Hopi have the Kachinas tied specifically to the Peaks or the snow on the mountain
- Kachinas actually take water from the peaks to the people for agriculture
- Many springs have native names
- Some trade routes tied specifically to springs
- Non-use, existence values
- Look to engage tribal interests stronger in the next part of the project process
- Raising awareness of the values of springs would be one of the most important things.
-
- Wild tobacco collecting, wild sumac made for baskets
- Diversity is highly prized as symbol of a healthy system

EAG Stakeholder:

- Research value, Direct use, Biodiversity: role springs plays in the landscape and role of ecosystems, protect endangered species, points of hope, springs dependent species versus distribution of species at the springs, Landscape contributes to surrounding springs
- springs produce water for ranching/wildlife, aesthetics, biodiversity increases with springs, hunting (ambush site), recreation (hiking), springs provide water for cattle in times of drought, stable water resource during times of fire, mineral collecting, issues are worldwide, shading is linked to biodiversity, antiquities act
- Produce about ½ M ac-ft water that goes back into the ground and other local uses
- Basic aesthetics
- Assurance from climate change
- Biodiversity value, higher species density and diversity
- Recreational value of hiking
- Springs used as ambush sites for prey for hunters (both humans and native-bear)
- Protection of lifeways (ranching), especially in drought and dry periods
- Potable water use by ranches
- City of Flagstaff uses interbrain springs
- Resilience of springs in landscapes (such as fire), regeneration points
- Pigment gathering at some springs
- Water may be used for ceremonial purposes (Vasey's Paradise)
- Lifeway protections that springs provide (ranching)
- Many rare plants and other species are springs dependent
- These issues are globally applicable! Note: broader implications. Larry's recent global paper.
- Migratory species
- Research value for ecological processes, but intertwined with value on landscape
- Springs are points of hope on the landscape
- Number and importance of springs dependent species, likely not plants

Ranching Stakeholder:

- Migratory link, 2 springs on ranch, cattle drink from spring, link with cowboy lifestyle
- General population, judicial groups
- New management framework (opportunity), art, look at relationship
- Thinks the municipalities might be more interested since the city is using a lot of water
- Adjudication of water rights is the highest level need and want
- The opportunity to redefine what management means for springs.
- Biological diversity and the social intersection of people and policy relationship
- Cited Babbitt Ranches philosophies. Talk to a philosopher.
- Value of art
- Regenerative ecological process framework leads to better management of springs.
- Don't be afraid to come up with new terminology. Helps people change their frame of reference and think about your terms, instead of existing retreaded terms.

- Crenonomics “Water’s invisible values”,
 -
 - How do our valuation approaches address climate change?
 - Make sure all of our values and attributes are inclusive, not exclusive

Appendix C: Focus Group 2 Notes

Focus Group #2

11-9-22

EAG Stakeholder:

- Animals deer elk, logging was developed around springs
- Flow, temperature, biodiversity, existence value, recreation, habitat for unique/spring dependent species/vegetation
- Level of human disturbance

Government Agency Stakeholder :

- Domestic use, direct use, habitat for species, tourist destination, hunters, ranching, cultural value, volunteer groups, forest service specifically: livestock operations, domestic use, residential use, camping grounds, hunting and fishing, climbers, ecosystems supported, wildlife watchers, geologist, industrial(some springs were developed for mining), cow tank/stock ponds are springs
- Recreation (hunters, hikers, “play”, UTV, campers), cultural value, permitted programs
- Sustainable use, sustainable functional condition
- Fishing
- Naturalists
- Industrial, some developed for mining interests (more important to forests in Southern Arizona)
- Logging efforts

Government Agency Stakeholder:

- Sustainable use for multi-use management.
- Existence value

Government Agency Stakeholder:

- Park service study, sampling specific regions (eight)
- Historic flow rates, wetted areas
- Passive vs direct use, geology, maintenance for others, cultural (value of the process/outcome)
- Flow/wetted area, bio habitat, vegetation, cultural ecosystem services
- - Limited # of springs in the area, springs are perceived differently around the U.S.

Appendix D: Interview 1-14 Notes

Interview #14 Government Agency Stakeholder 7-28-22

- 28,400 acres postage stamp land .
- Owned by the army and Department of Defense .
- Leased from the army to the Army National Guard.
- They are tasked with the management .
- The facility stores commodities for other Department of Defense entities such as the air force and navy.
- They don't have all the funding the forest service has but they have a lot less land to manage.
- The land is situated between the Coconino and Kaibab National forest .
- In 1942 they took of the land from the Coconino and the other half from the Kaibab.
- They also had to purchase some private land that was there .
- There was a time where the land could have gone back to the forest service, but they decided to make Camp Navajo permanent .
- In the lease they are responsible for the land management .
- Their main goal is to provide conditions for the Military to train .
- They manage the land for military training.
- They manage the land to .
 - Set up military camps.
 - All different types of training .
- They manage the natural resources such as springs for military missions .
- They really protect their springs, they don't train at them, one is used as a campsite.
- Soldiers are good at taking orders so when they ask them not to mess with the springs they usually listen .
- No springs are currently being restored.
- One spring provided water for the whole base.
- Attributes Ranked.
 - Flow.
 - Wildlife.
 - Recharge.
- The reason they care about recharge so much is because they have a shallow aquifer and a well for the secondary water supply.
- One of their springs is completely dried up .
- Leveled by
 - The water treatment plant.
 - Cameras to track wildlife at springs .
 - Springs survey like at SSI.

- No more grazing on the base since 2002.
- There are currently no more signs of grazing.
- The habitat is now in good shape.
- Reasons for no more grazing .
 - The lease was up.
 - Was expensive and they weren't really making money.
 - Soldiers were complaining about the effects of the cattle and all the degradation and feces.
 - They rested the land after the lease was up and decided not to renew.
 - Their permit system was model after the forest service permits.
 - The fence maintenance was also expensive.
- They don't have any elk or deer enclosures around springs.
- No NGO come to help and restore the land like on Forest Service land, it becomes a logistical issues.
- Constituents
 - Soldiers .
 - Hunters.
 - Recreationists.
- They have 300 tags for all the animals on their per season, included turkey elk deer etc.
- Game and Fish Provides the tags and they people are vetted additionally and allowed to hunt at Camp Navajo.
- They allow hunting to control the elk population, hunting is the only tool Game and Fish really use to control elk herds.
- If the military operation is able to provide recreation opportunities they are obligated too (Some act passes year back).
- There are training exercises were they will move water from one spring to another
- Hunters camp at springs .
- The springs are very well protected, in most area they are hard to access.
- There is one springs that is not that well protected and that's where the hunters camp.
- One springs is half diverted to a 1 acres reservoir and the other half is diverted to a treatment plant to supply the base with water.
- The reservoir is used for training .
- The reservoir also used as a dip spot for wildfires.
- They also train how to dip spotting.
- They use to allow fishing at the reservoir and stock it with trout, they don't do that anymore.
- This site was picked because of the spring water supply.
 - Also because of the open prairie .
 - Away from the ocean.

- Close to the railroad.
- No one lives on the as full time .
- Private that they bought use to be a sheep farm, it was there because of the spring too.
- The base was mostly built by the Navajo and Hopi workers.
- The Hopi and Navajo also was used to more around ammunitions at the base.
- The camp has a tribal liaison/ cultural resource manager.
- There is a human built infrastructure at each spring, cattle tank, pipe etc.
- The cattle tanks are still there and used by other wildlife.
- None of the springs are free flowing .
- There is a landfill for ammunitions in the middle of the base, moved from 2000 acres to 700.
- We feel springs are important, we protect them, we have no plans for them to receive any less attention.

Interview #13 EAG Stakeholder 7-21-22

- Constituents
 - Anybody who assigns use.
 - Indigenous culture.
 - Tribal entities.
 - Anyone who is educated and made aware.
 - Anyone who gets benefits from using the spring.
 - Livestock producers/ cattle producers.
 - Anyone who values wildlife.
 - Game animals and non-game animals.
 - People that value the aesthetics of springs.
 - People who reap the benefits of public land .
 - Municipalities who use ground water pumping because springs are related to aquifer health.
- Attributes
 - The importance of springs to wildlife .
 - Wildlife brings value to flagstaff, springs support and are important and bring value to the wildlife.
 - If they are important to wildlife, then they are important to their organization.
 - Aesthetics are important, but some springs have large fences around them because they have to be protected from ungulates and then that diminish the aesthetic value.
- But fences can also exclude other wildlife other than ungulates who need the water and do not damage the spring ecosystems.

- Springs are being manipulated by ranchers.
- Cattle growers need to pay for the water like we pay for tap water, cattle growers have minimal responsibility .
- Vegetation is a very important part of springs.
- When springs are free flowing, they have wetlands and provide for riparian ecosystems.
- The springs vegetation also provides for pollinators, ducks and geese which attract other wildlife for food and habitat.
- The vegetation of a spring gives it values and makes it more favorable then other areas for the wildlife.
- \$1.35 per animal unit per month on federal land for grazing permits. This includes a mother and her calf as one unit.
 - Levels/ measuring .
 - They don't really measure; they depend on other NGOs such as SSI.
 - They work with people who can identify the springs which need the restoration .and the ones that needs the priority for restoration.
- They work that organization does.
 - At places like Hoxworth they maintain the fences.
 - They play a stewardship role .
 - They build and maintain exclusion fences, there area bout 50 which are at springs.
 - They visit the cites about twice a year.
 - Their goal is top keep ungulates out .
 - They work with silviculturists.
 - They remove hazards such as trees away from the fences and take down trees that have fallen.
 - They also make aspen enclosures .
 - They do some minor erosion control work and build Zuni bowls and do minor channel redesign.
 - The gap they fill is maintenance that the forest service is unable to do .
 - They work with organizations such as .
 - AZ game and fish.
 - Grand Canyon trust.
 - US Forest Service .
 - AZ department of water resources.
 - Forest foundation.
- Biggest frustration is that there is not enough of this research actually be “put to the ground”, too many studies not enough work.
- Create a management framework for the three stakeholder groups.
- There is a frustration that there are some stakeholders who don't pay such as campers biker etc.
- Excise tax .

- These groups [stakeholders of interest] do not have money on the table.
- The tourists have a lack of respect for the wildlife and leave garbage everywhere .
- One way to get them to care more is to relate springs to something like care about.
- The way to solve these problems is through education because the forest service doesn't have the budget for enforcement.
- Water for wildlife is the priority .

Interview #12 Rancher Stakeholder 6-28-22

- Stakeholders are disjointed .
- There are stakeholders with accountability and without accountability.
- Stakeholders who have impact needs to have responsibility for their impact .
- Policies needs to be based off of stakeholders who have responsibility not just ones who have interests.
- There are value differences.
- Stakeholders needs to be separated and defined differently .
- Ranchers who lease are only responsible for their livestock and not for the land .
- Babbitts have more stewardship and show more sustainability then other rancher.
- If ranchers are causing harm they needs to be removed.
- Just using one term for all stakeholders is taking too large of bite out of an apple.
- You have to have input from all different types of stakeholders.
- Create a stakeholders web or framework for policy making around springs [model].
- You need to include the science in policy making but the social side is just as important and needs to be used more because the science is already incorporated in social part because it is coming from the stakeholders who use the science .
- They regularly meet with .
 - Forest Service .
 - AZ state land department
 - AZ game and fish.
 - US Fish and wildlife.
 - Bureau of land management..
 - Wapitki National Monument .
 - Navajo Nation.
 - Coconino National Forest.
- They believe at their ranch there values and the values of the nearby tribes are the same.
- They are going to be a dark sky reservation.
- The Forest service is responsible the land and there ranching supports the FS values.
- They want to maintain the integrity of the spring .

- Springs have a ripple effect on the rest of the environment .
- Areas miles away from the springs still rely on it .
- Ecosystem of the springs really important .
- There is a lot of interconnectedness of springs .
- The flow of the water is very important as well.
- All of their springs are altered they are all piped for drinking .
- They have a spring at cedar ranch which is a conservation easement and the easement was given to the fish and wildlife .
- Water is life.
- Water is the essence of everything that is here .
- There is aesthetic value .
- The volume of the water can increase the spirituality.
- He believes in a vertical integration conservation framework.
- He doesn't like the word protection, he believes that that term should be providing for the health of the spring.
- Springs are very important to cowboy essence.
- You don't want to just know and control the spring you have to use the springs deliberately so that its impacts count.
- 135 years ago when the ranch started springs were the only source of water .
- All ranches and everything started where springs are .
- If there was no water then there wouldn't be any animals.
- They have replaces many of the functions of springs with artificial sources of water such dirt tanks that collect surface water.
- They pipe 100 miles of water around the ranch.
- There use to be a lot less deer now there are lot more because they have this piped water that they can use instead of only relying on springs (not saying this is a good thing).
- Babbitts would not be founded were it is if it wasn't for the springs.
- There wouldn't be a livestock industry here without springs.
- Antelope springs was the original name of Flagstaff.
- Constituents
 - Land owners and management entities because they are actually responsible .
 - Wildlife and the livestock.
 - Domestic.
 - Recreation spiritual .
- Livestock and wildlife should be in the category because they both influence the springs and the wildlife are pretty domesticated for example elk are and introduced species and managed very tightly .

Interview #11 Government Agency Stakeholder 6-24-22

- Municipal- provides water in times when other resources were limited. Prevents a city from needing to develop other resources to obtain water.
- Ranching- established the ability to produce cow on federal land, without springs it wouldn't be cost efficient.
- Recreation- direct use of springs for backpackers, fishing, boating.
- Cultural significance- benefits derived from springs that are related to indigenous culture.
- Biological habitat quality- supports ecosystem services for plants and animals .
- Flow- magnitude of services provides support for other attributes. Gives the spring the ability to provided services to the other constituents and attributes.
- Constituents
 - Tribes.
 - Ranchers.
 - Recreationist.
 - Backpackers.
 - Hikers.
 - General public .
 - Municipal industries.
- Can be leveled by:
 - Volume of water is important.
 - Water quality.
 - Biodiversity.
 - Utility that the livestock get from the water including industrial use .
- Access to swimming is important .
- Cultural benefits are important .
- City aquifer health is important .
- Optimized bundles include.
 - economic values.
 - Social directions .
 - cultural values.
 - social goods.
- Forest springs should be managed for their own health, there is room and if there is the ability to manage for social good as well then you can do that .
- Recreation.
- There are values relating to economic and non-economic .
- There are altruistic values.
- There are passive uses .
- There are economic gains to support community .
- The forest service has relationships with General public .
- The major barrier to communication between the stakeholders.

- The relationship between the federal and NGO. Jurisdictional and interest group.
- There is an interesting relationship between those to have jurisdiction and those that don't.
- The economic logic seems to break down when we look at springs because people don't seem to protect them because they seem like a free resource. But we economics might tell you that you should protect them the most because they are the cheapest source of water.
- You can value the spring through the economics benefits receives, agricultural use, municipal drinking water use, and the market value of water.
- Non economic values can be seen by seeing if you are meeting the target population viability and meeting the management plan.
- Management has to include the indigenous values.
- Is the management in line with the stakeholders.
- Quantity and quality of the water is a measure .

Interview #10 Government Stakeholder 4-15-2022

Definition: Groundwater emerges due to geologic differences, permanent or temporary, includes ecosystems.

- Springs are life
- Giving life from underworld to surface world
- It is delicious water
- Constituents
 - Wildlife
 - Ranchers
 - Tribal partners use them and restore them
 - Recreationists
- Its rare to find water in this region so when you see it springs in makes an impression on people
- Essential source of water
- Backpacking trips are based and routed around springs
- Water is connected to everything
- If you don't treat a spring well it show throughout the entire ecosystem
- What do you expect, of course there will be drought if you don't support the ecosystem
- Springs are destination points
- ORV users use springs to fill up there drinking water
- Jacob lake and their lodge use spring water
- US forest service uses the spring water at big springs
- Springs are used at a meeting place for FS
- Fire crews the springs as a water source
- Cattle tanks at built at springs
- A lot of the springs in the KNF have trough for the cattle
- Characteristics

- How permanent the flow is
 - Visuals such as the lush vegetation
 - Water quality
 - Location is important
 - Municipal use
 - The amount of water
 - Bio diversity
 - Amount of endemic species
 - Recreational uses
 - Wildlife view
 - Hunting
 - Drinking water
- There have been studies on the long term effects of uranium mining
- If the spring water is built into their[permit holders] management plan then they have access to it.
- There are archeological resources at springs such as petroglyphs
- Levels
 - NEPA planning tools can be used to quantify the changes in the spring
 - That can be a standard way to understand the scenic beauty
 - The site density of archeological components can be used to determine value (components per human or area)
 - Species composition and abundance
 - Qualitive assessment to describe the spring site
- Ruining once part of the springs can affect the others
- What values can they bring in:
 - Biodiversity
 - Sacred to indigenous communities more than others
 - Flow amounts
- Resilience to climate change
 - It is important to preserve the spring for the native wildlife who have evolved with that water source
 - Fencing the natural water source to keep out the cattle and buffalo is important
 - As surface water dries up springs become even more important
 - Springs create micro climates cooling effects
 - There is a research value to springs
- Threats
 - Ground water pumping
 - The uncertainly of the effects of pumping
 - Unmanaged or poorly managed livestock
 - Invasive spices
 - Over use by recreationists
 - Grazing effects the stream morphology and erosion which lowers the water table
 - Severe burns leads to severe erosion an d can threaten the springs
- Thinning and light burring are good for the springs

- Fossil Creek is the most popular spring in the KNF, there is swimming, camping, picnicking, and fishing
- Springs have unique geologic features which have proven its resilience. Example travertine springs have kept out or gotten rid of crawfish which is a very damaging invasive species

Interview #9 Indigenous Stakeholder 4-7-2022

- Most of the native American ruins that we see are related to springs, relic of when the Europeans and later the BIA came in
- Springs were pristine until the introduction of livestock when the native Americans did not have
- There are many cultural uses
- A few springs are used for flood irrigation farming
- Livestock producers use springs
 - Some of those springs are destroyed
- If the spring has cultural significance they would still use the spring for livestock or farming but they would make sure to protect the source if it was a very sacred one
- Attributes:
 - Cajole Willow
 - Cat tails
 - New Mexico Olive tree
 - Sumac
 - All those are only found at springs besides sumac
- They do prayer offerings at springs to connect with the water and ask for rain
- Ask the [spring] water for [rain] water
- Almost all ceremonies are geared toward rain
- Water is so important that even if they go to the ocean they will cup the ocean water in their hands and toss it toward their home to encourage or ask for the more water at springs or for rain
- Spiders bugs and Minos rely on springs
- The organic matter that settles in the bottom of spring stream beds also has cultural significance
- They have names, connections, and stories for springs in the Coconino national forest even though they do not have access to them
- Biodiversity and species count can be used to level the springs
- They have put a lot of work into getting rid of the Russian olive which was brought in as an ornamental plant
- Working on fighting off invasive weeds at springs
- Tames, was brought in to combat erosion at springs built has dried up on lot of springs
- Because of climate change flow has really dropped invasive trees are sucking up the water , the effects of severe drought might take a while to show up at springs because the of the time lag of how long it takes for the water to travel
- Limited
 - Recreation, too many people
 - Extensive recreation at the fragile ecosystems

- Farming irrigation
 - Livestock
- Excluded
 - Swimming, pollutes the water r
 - Livestock grazing at SOME sites
 - ORV
- Some daily drinking water use
- Ranked
 - Cultural/daily use
 - Recreation
 - Livestock
- Drought and climate change are the biggest threats to spring ecosystems
- The amount of groundwater on the Hopi is a huge threat
- The pumping that is done on the Coconino and Kaibab is a huge threat
- Light grazing or a light burn will be better for the spring ecosystem
- There should be a combination of management for human and non-human uses
- Threats
 - Noxious weeds
 - Livestock
- Feral horses do a lot of damage right at springs
 - It's the only resource they have for their water
- They try to contain the wild horses

Interview #8 EAG Stakeholder 4-6-2022

- Constituents for springs-
 - Everybody
 - Ranchers hikers backpackers
 - Hunters
 - Deer, elk, turkey
 - Microscopic organisms
 - Cultural resources
- Some people see the value and some don't
- Some people see the value but never go to springs
- Some people just appreciate them
- Cattle significantly damage the springs
- Cattle can be beneficial to the springs
- Through aeration of the soil cattle grazing can increase the diversity of the grass species, there are plots that are studying that on the diablo trust
- Springs are very significant to the Hopi, many of which are on the peaks
- You can see that through bushes full of prayer flowers which are at springs at the peaks
- Target sampling
 - Hopi, Navajo, other indigenous groups
 - AZ game and fish

- They have banned uranium mines around the Grand Canyon and the springs there in order to protect the water
- Characteristics
 - Biodiversity of the ecosystem
 - Clean water, quality
 - Cultural resources, historic and prehistoric
- There is intrinsic value of the spring
- Definition: Quality of the Water- Potable being able to drink the water is the highest quality . No cows, and the water can sustain wildlife
- Spring water has turned blue from copper mining on the borders of AZ and Mexico. His dogs were in in and he tried to get them out, it made him think of the wildlife that depend on that spring water and unhealthy it is for them and potentially there only water source.
- Biggest threats to springs
 - Climate change
 - Groundwater pumping
 - Mining
- He has seen a decline in spring water at cattle tank and at the spring themselves
- Large farm are moving in and drilling deep wells and taking water from small farms' springs.
- The absence of springs is so defining, it forced the Hopi to farm the way they do, with no irrigation
- Septic system are effecting springs
- Veit springs on the Peaks have both significant cultural and recreation value
- Level for water quality
 - Combination of the chemistry of the water
- Leveled recreation
 - Flow
 - Biodiversity around the spring
 - Only optical for the scenic value
- Cultural
 - Non-renewable resource
 - archeological value
 - These cultural values are the totally invisible so they should be most valuable or most consideration for protection
 - Just because a minority [indigenous groups] uses it [springs] doesn't mean they should get the minority voice
 - Indigenous cultural is way more important than ranching
- Just because something is traditional, doesn't make it right
- Ranching is a tradition in this landscape but that does not justify the degradation they cause
- Springs are harder to value and get people to care about because its values or attributes are less visible compared to something like an archeological site. Springs are harder to value and manage
- Attributes ranked
 - Wildlife

- Cultural
 - Recreation
 - Ranching
- Should any activity be excluded from springs?
 - Yes –mining
 - Maybe- ranching
 - Yes- future Development
- Ranchers need to pay more, increase their fees
- There should be limited grazing on US forest service land
- And we should in return pay more for beef
- Ferrell horses and burros are a big problem at springs they runoff cattle and wildlife

Interview #7 Rancher Stakeholder 3-23-22

- Constituents:
 - Ranchers
 - Wildlife
 - Wildlife Managers
 - Tribes
 - Recreationists
 - Cattle
- The spring on flying M is almost all captures
- Water is transferred 6 miles to HQ
- They use it for domestic purposes
- Irrigation commercial garden and they sell the produce from it
- It is the only water they have in dry years where is no snow melt
- They are in “deep doo doo” without the spring
- Flying M has one spring for all there uses
- Bar T Bar has more
- They do not the use the spring water to irrigate any land for grass for grazing
- When settlers first came over anywhere the spring water was the people were there
- All homesteads were founded on springs
- Most of the springs on the diablo Trust land cannot be lived near or at because they are in difficult and hardship locations
- Most of the springs are hard to get to
- There are usually very small amount of grazing land around the Diablo Trust springs because they are coming out of canyons etc.
not much wildlife could survive on the springs
- If Flying M didn't use and capture the spring water it would run in the nearby canyon and “disappear”
- #1 use it the domestic supply for the houses (7 in total) aka HQ
- #2 use is for the cattle
- They are able to water way more animals by piping the spring
- Due to the pipe they are able to have 12 square miles of usable land compared to 1 square mile they would be able to use without piping

- The spring does provide for their way of life, aka cowboy culture
- The spring wouldn't have value if they didn't use it or pipe it
- Their spring comes out of the side of the rim of the canyon and then they pipe it to HQ
- HQ is:
 - Corrals
 - Ranch staff houses
 - Main house
 - All cattle go through HQ
 - 7 houses total
- The ranch would not be located there if it wasn't for the spring
- The spring didn't go far until they piped it
- Without the spring they would have to pay \$200,000 for a well and have the cost of pumping and storing the water
- Without the spring the Flying M Ranch and the Diablo Trust would not be here and they would not be able to reach their goals of land conservation and stewardship
- If it wasn't for the ranch the land would have been developed and that would lead to more degradation than the ranch does
- 80% of the money that is earned from the ranch goes directly back to the city (getting the point across that they are better for the city)
- They care about the viability of the aquifer
- They can tell by the growth of the trees that the spring used to flow more
- Forest management can increase the flow of the spring
- More important to wildlife than to them
- They value the spring attracting wildlife for hikers
- The spring provided seasonal hunting on trust land
- The spring pipe was first built by sheep herders
- There is significant economic value because they don't have to drill or buy and truck in water
- The spring on Flying M went from 80 gallons per minute to 30 gallons per minute
- HQ and ranch would be in a different location
- "water is for fighting over and whisky is for drinking"
- Flying M yearly supply of beef to 800 families per year (when families ate 72 pounds per year)
- Livestock and lumber is the reason that Flagstaff is here (taking credit)
- This is a natural resource based city/economy
- Flying M ranch spring wouldn't be able to supply a large housing community
- If there is fast snow melt the spring box may overflow and go into the canyon, but it is rare
- Spring provides resilience to the ranch
- Kit's grandparents ranched this land since 1896
- Their cattle compacting the ground seals the water into the ground
- Ranching on this land started with sheep because they need less water
 - Sheep are often stepping stone to raising beef
 - Flying M raises their cattle until about 7-8 months and they sell them

- Can't fatten up cattle in AZ

Interview #6 Municipal water manager 3-7-22

- Coconino Plateau Watershed Partnership, TAC technical advisory committee meeting dates_
 - March 24
 - April 28
 - May 26
- Constituents
 - Local population
 - Wildlife
 - The local environment such a flora and fauna
- Water is the most important characteristic of springs
- The discharge area of the spring so that it infiltrates to the water system so the city can capture it
- The over watershed health is important
- The natural flow regime is important
- The health of the spring is important so ti can continue to provide and infiltrate into the city catchment basins
- The natural infiltration into the cities pipelines is important
- The reason they want the water is because they have the right to it
- They have specific rights water for springs
- 20% of the summer water supply, for the avg snow year, comes from springs
- They have underground perforated pipes/ infiltration galleries that catch the water
- It is piped down Shultz pass and treated for turbidity and has UV disinfection
- They allow the water the water to naturally flow out the springs and then they capture once it starts to infiltrate the ground
- Springs they have water rights to are on forest service land and in wilderness areas
- DEFINITION; “spring water provides the city of flagstaff with water that contributes to its water security”
- The spring water offsets the groundwater pumping need/demand
- Gore and the hospital all us the city water supply (industrial demand)
- Hospital likely gets some of the spring water because of its location
- In the winter there is 0% spring water used
 - Don't know where it goes
 - Sometimes it is diverted from the water treatment plant to the Rio de Flag
- In May they start using the spring water again
- Spring water is 5% of the annual water budget
-
- It is mor expensive to pump groundwater, spring water use can offset cost and make the water cheaper to residents
- During the 1800s spring water was 100% of the water use

- They are currently investing all their money into groundwater pumping
- The reason they are getting less spring water could be because of the poor and unmaintained infrastructure that they have or it could be less discharge or could be both
 -
 - Developing the spring water in the inner basin, where they get nearly all their water, preserves it because it would be infiltrating all the way down to the C aquifer
 - They springs that they are capturing are in the inner basin and off of Shultz pass rd.
 - Not every spring that they have a water right t is being captured
 -
 - The water emerges from the earth- then infiltrates the ground and then they capture the water
 - They don't measure each induvial spring
 - How it can be leveled
 - But it could be leveled and the total spring water is leveled in gallons per minute, gallons per day.
 - The amount they have water right to (paper water)
 - Relative cost to produce the water
 - \$13 per acre foot to produce water with wells AND springs in the inner basin
 - Target sampling: Tribes connected to the springs to see if the cities development is offense to them
 - Because they collect water after it infiltrates the ground you may not even know the spring water is being captured and the ecosystem remain intact
 - They charge costumers based on the cost of service/water transmission : to break even
 - Ranked:
 - Watershed health
 - Providing water
 - Ecosystem health
 - Spring water is the cheapest water they use
 - Spring are important to the aquifer health which enables them to do groundwater pumping especially during emergencies

Interview #5 Indigenous Stakeholder 3-3-22

- Springs used for campsites when traveling
- Some people purposely don't camp right at springs in order for wildlife to be able to access the spring.
- They may only from a spring when the season changes
- Springs feed the rivers which they also use
- Water is used for prayers, sometimes when pollen isn't available (pollen would traditional be used in the prayer but spring water would be a substitute)
- Climate change has made pollen harder to find so they have to use spring water more often for prayers

- Spring water is used for baptism when they are babies, done by Catholics and Lutherans
- They have a belief that “water is always beneath you when you walk”
- Leveled by:
 - the importance of the story or tradition associated with it. Some springs are more important than others
 - Could also be leveled by how much water they can use from the spring
- Water is life, but especially in the desert because it is so desolate
- Spring water is a living entity
- Creator made the water and he put himself into it therefore the water is living too
- Wells are destroying springs
- When a spring dries up it is desolate and there is no more life
- The focus of spring should not just be for human beings
- Told me stories that when they have prayed over springs more water comes out. First just a couple drips and as they pray more water has come out
- They use it for food, farm use, and for life in general
- Life and respect of the spring is the most important
- Springs are at the top of the list when it comes to water
- By age 10 you would know where every spring was because you needed to
- Some springs have more living power than others due to their healing properties
- Springs should be respected, honored, and taken care of
- Paths to springs are used as travel routes (you would go from one spring to another)
- Barbara learned how to work with springs from her grandfather
- Her grandmother would always say that is water all around you and she would dig in the ground and it would fill with water
- Springs are increasingly less available
- Some springs are more important
- There are specific stores attached with springs
- Springs are the veins and arteries of the earth
- They are used for daily life but especially when traveling
- Springs value comes from not just what you can consume but also their existence value
- They eat some plants found at springs such as water cress
- Reeds
- Willows for basket making
- Certain plants and herbs are found at springs
- Used for cleansing
- They would use the springs for sweats. Build a little sweat lodge right at the spring
- Sacred water plants such as cat tails are found at springs, they use that pollen for ceremonies and prayers
- She used to take her weekly bath in the spring when she was a child
- Use for wildlife around the springs, used for cattle tanks

- Use the herbs to make medicine from springs
- Who springs matter to
 - Elders within the native community
 - Few young people
- They would bring back jugs of spring water because it is more pure
- It more spiritual because it comes right from the earth
- When the water comes right from the earth it shows more power
- Water is life
- They would dam up the spring with a ring of rocks to make a little pool and wash their hair in it. Then make sure to put all the rocks back and let the spring go back to its natural flow
- Their major crops; squash, corn, beans, tobacco, can be grown at spring sites
- The Apache or nomads so traditionally they travel from one spring to another

Interview #4 Rancher Stakeholder 2-24-22

- Their grazing rotations are based around spring meadows
- There is 6 months of grazing that would not be possible without springs
- 65% of their water comes from springs
- Their ranch is Hopi owned, he runs all the ranch land not on the reservation
- He said they could survive without their grazing allotments from the forest but they would have to scale back, some ranches would not be able to survive. Some of their land they own some if forest land
- Most ranchers go to summer forest land allotments
- Their goals are sustainable management of the land and to make money
- “cattle is my currency, but land is my life”
- Their #1 interest is land stewardship
- No one can make constantly “running” [transporting] water to cattle
- They run less cattle than allowed in order to be more sustainable
-
- They don't run the cattle when the land is in bad shape due to the drought
- They run head counts before they are mandated by the forest service that way they can sustain the land and eventually go back
- Never leave a ranch worse off than before, increase profits without increase head
- His reason for wanting a sustainable ranch is for his “own ego”
- Constituents of springs
 - Cattleman
 - General public, population of the area, not tourist
 - Recreationists i.e. bird watchers
 - Animal rights groups
 - Game and Fish
 - Environmentalists
- Forest thinners are doing more damage to springs than ranchers are
- They have been asked to bring cattle back to areas they were asked to leave and graze to protect the springs. They were kicked out---> recreationists ruined it --->

ranchers were asked to come back to either exclude recreationists or being the meadows back to an environment that made recreation possible.

- “we lease the grass”
- Cattle are not the enemy of the spring, to say that is offensive and foolish
- There are being sustainable by building spring boxes to entice more water from the spring and encourage more wildlife
-
- Most cattlemen have “this is my ranch” attitude on forest land which they don't really own
- Ranchers have less stewardship on forest service land compared to land that they own
- All ranches have a finite amount of head [cattle] that they can support during ALL time (available spring be could be one of those determining factors)
 - Add more cattle on good years
 - Keep baseline to make money and sustain the land
- Good land management is your ranches legacy and reputation, they want to uphold that
- There gals are to keep up with the times and keep getting better
- Tech and science makes ranching easier and more efficient (specifically his iphone)
- These springs are beautiful because we ranch them
- They need to be accessible to all wildlife

Levels

- A less assessable spring [to the public] is better for ranching
- Volume of water it produced PERPETUALLY
- Size of meadow area that the spring supports
- Amount of retained water
- All ranches were founded on springs 100% [in this area]
- Good cattleman is exactly an environmentalist
 - He wore a bandana, cowboy hat, vest and had one eye
 - I asked how the food was and he said “hot, brown, and plenty of it”
 - He worked on John Wayne’s ranch
 - He wrote a book, and yes I just ordered it
 - He ordered the most cowboy meal ever
 - He always had a “cute story”

Interview #3 EAG Stakeholder 2-16-22

- Simply the presence of water is a value
- It supports wildlife
- Springs can be life or death it can be the only source of water for miles
- The presence of water equals the presence of wildlife
- Spring bring in tourism dollars for hunting

- He believes connecting the value of the \$ the hunters spend to the value of a spring
 - Ranchers and animals will perish without springs
 - Stock tanks are an important use of springs
 - Simply having the ability to sit by the water/spring is an important characteristic
 - Artists and writers appreciating and working in the spring's environment is important
 - There are natural history and environmental ethics values related to springs
 - Springs can be used as a hunting ambush site
 - The trails to springs can be used as a hunting tool
 - Target sampling should be for; recreationists, artists, and hunters
 - He talked about how the larger the distance between springs makes them more valuable
 - Seems like ranchers and hunters are very focused on how the water is of human use
 - Attribute levels could be flow, size of spring, how good the hunting is, how big of an area a hunter will cover around the spring, and municipal use
 - Some people only want to live in an area because of a spring
 - Springs can be used for backpackers and to water horses when riding
 - Hunters will prefer wet meadows over rocky pools unless they are bighorn sheep hunting
- Ranked importance
1. Hunting value
 2. Abundance up springs on the landscape
 3. Vegetation of the spring ecosystem that supports wildlife and draws in wildlife for hunting
 4. Ranching, which can be leveled as simply a yes or no
- He believes Target sampling is warranted for anyone or any Community who 100% relies on springs for their water use

Interview #2 Indigenous Stakeholder 2-16-22

- They maintain the springs for the animals.
- Significant to all life on the Kaibab plateau
- Drink and to grow certain crops when water with scare it was used for everything.
- Used for personal use and for the animals not for development
- never claimed ownership, all springs are to be shared.
- They value the simplicity of water
- Water is a sacred element that can take and give life.
- “No other use besides what we use it for”
- No ownership of springs
- What is the importance of Springs? – “Do you want to live or do you not want to live”
- Irrelevant to some of their beliefs some springs are used by Ranchers who pipe into the springs.
- They believe water is a living thing.

- They water gardens and they have community gardens that use springs, also water cattle and horses also use it.
- Spring water is used while hunting and gathering to give them some sort of subsistence to get back home
- No one ONLY uses spring water for daily use in their tribe
- One way to level a spring flow is to use a stick, if the water does not come up high on the stick they would not use it. Therefore it would be available for wildlife.
- I asked if there was anything that separates spring water from other water and he said no
- The number one thing that these springs matter to is wildlife
- They believe that the spring is breathing and moving, the flow of the spring is like blood
- If it's not flowing it gets sick just like us
- They do use some of the plants and harvest some of the animals that are around springs
- They make cultural items out of some plants that are grown at springs, some of those plants have medicinal use
- their goal is to not influence any ecosystems if they have a willow at one spring and not at another they would not transplant it even though they might make baskets out of the willow and be able to make more baskets with more willow trees
- All life warrants target sampling

Interview #1 Indigenous Stakeholder 2-11-22

- Water is life, Tu is the word for water
- Holy is used to describe spring water because sacred and so overused
- Springs are holy, they are at the top of the pyramid of water
- Water from springs is thought to be alive
- Cowboy culture hurts springs
- Some of uses related to springs are water flow, bugs, plants, drinking water
- spring water is put into water bottles and used as medicine
- Old ladies will wash their hair with spring water to show it is of greater importance than other one
- Holy men use it for healing specifically from a certain spring, some specif springs' water will be used for certain ailments, holy men are also known as medicine man
- They measure the water in CFS
- They make baskets with willows that grow near the springs and then wash those baskets in the spring water
- The water is leveled as regular or big/cho
- Big is a relative scale because they see something like the Verde as a big river even though it is not. It is only big for the region, they have a localized interpretation of the word big or cho.
- He emphasized that people follow the water and springs were especially used in cases of drought, sometimes that was the only place that they can live
- Water is connected to everything: math, science, culture, religion, the indigenous people do not think in compartmentalized ways like we do.

- One reason Springs are important is because they are untouched from animals and people; they are the most important of all water.

Appendix E: Focus Group Notes from National Survey Trial

Focus Group #1

5-16-2022

Average time: 16 minutes (6)

Longest time: 26 minutes (1)

Feedback/ participant comment	How we incorporated it/ our comment	Completed
Participant was confused why they saw a choice set with a fully diverted stream and high biological habitat quality	We need to change the language from <i>fully diverted</i> to <i>mostly diverted</i>	
There was no back arrow to get out the choice set section	Fixed	
Participants wanted to see less text and more bullet points	We did not accept this feedback	
Participant wanted less busy looking screen	We are adding icons and removing some of the illustrations	
Participant took the survey on their phone and did not like that they had to scroll to see the whole question	We are considering suggestions to fix this; grid lines will help as well	
Participant was confused about payment vehicle	Definition of cost added with hover over feature	
Add in question about being an AZ resident	We think this is a good idea, we can add in a dummy variable for this and see the differences in WTP for AZ residents	
Add in question asking if they are more likely to visit the Coconino and Kaibab after taking this survey or ask if they are more willing to recreate at springs in general	We feel this would be useful for stakeholder engagement once the project is completed	
Add in zip code	MSG said this is intrusive, Mohammad believes we can get latitude and longitude from Qualtrics	
Still confused about the Map	Make the US map bigger and get rid of Mexico and Canada	
Participants wanted to see the “big picture” clearer	We can add in another sentence about how this can be applied to other forests or National Forests	
Misspelling of the word “concerned”	Corrected	
Participants wanted to see pictures	Makes the survey biased, we are not incorporating this feedback	

Focus Group #2

5-17-2022

Average time: 14 minutes (6)

Feedback/ participant comment	How we incorporated it/ our comment	Completed
Hard to keep track of all the different attributes and levels during the choice sets, recommends grid lines	We are adding grid lines and icons	
Graphics were too small	We are replacing some illustrations with icons	
Participants said they were choosing based on the bundle of attributes not the price	This is a problem	
Graphics were too small and the illustrations were distracting	We are adding icons to the CE and definitions	
For the choice sets change YES to Supports and change NO to Not Support	Does not fit management scenario	
Participant wanted clearer language, i.e. what is HIGH recreation?	We can make the language clearer	
Participant said the survey was confusing at first, but they got the hang of it	Clearer language added in the beginning of the survey	
Line spacing in the CE was weird and thought it was hard to compare the bundles	We are adding in grid lines for the CE section	
They want citations for how we came up with the definitions	We can add in a sentence saying that these definitions came from many rounds of focus groups	
They thought some definition seemed bias	We can change some of the language	
For the demographics section employment question, the questions said check all the apply but they could only check one of the answers i.e. he was military and full time employed but he could not indicate that	We need to fix that	
The participants thought that that there were too many options for low income ranges and less options for high income ranges	I think this was taken from the census and we don't need to change	

For the question about internet use the participant was confused if that included screen time and social media use	We can change the language to screen time instead of internet use, but I don't know if MSG wants us to change the calibration questions	
Participant recommended we bold the definition or the important parts of the definitions to help them remember	We can change that	

Appendix F: National Survey

6/6/22, 9:25 AM

Qualtrics Survey Software



Default Question Block

Dear Respondent:

You are invited to participate in a research survey titled "Non-Market Valuation of Spring Ecosystems in the Coconino and Kaibab National Forests." This work is supported by the USDA National Institute of Food and Agriculture [grant no. 2020-67023-33262] . The research is conducted by Dr. Julie Mueller, Dr. Abe Springer, Dr. Ryan Fitch, and Dr. Mohammad Mashiur Rahman along with Master's of Science candidates Andrew Lewis and Katelyn LaPine of Northern Arizona University (NAU). The purpose of the research is to help policy makers understand public preferences for springs ecosystem services and management across the Coconino and Kaibab National Forests in Northern Arizona. The study results will be used to inform development of incentive-based forest management plans that simultaneously promote efficient grazing use and springs conservation. The results produced from this study are also intended to inform land resources management in other forest areas.

We truly value your input, and pledge to keep all results strictly anonymous. Completing the survey involves minimal risks and should take no more than 20 minutes of your time. You may not directly benefit from this research; however, your input will be used to inform research that may impact decisions regarding the springs of the Coconino and Kaibab National Forests.

If you decide not to complete the survey, there are no penalties. If you choose to withdraw or skip a question, there are also no penalties or loss of services. Whether or not you participate in this project, your decision will have no impact on your relationship with NAU, now or in the future.

If you have questions about this project, you may contact the Principal Investigator, Dr. Julie Mueller,

https://nau.co1.qualtrics.com/Q/EditSection/Blocks/Ajax/GetSurveyPrintPreview?ContextSurveyID=SV_6x3LYzVblq97E6W&ContextLibraryID=UR_2... 1/38

at (928) 523-6612 or Julie.Mueller@nau.edu. If you have any questions concerning your rights as a research subject, you may contact the NAU Institutional Review Board (IRB) Office at irb@nau.edu or (928) 523-9551. This research project is exempt per NAU IRB.

By clicking the forward arrow button and beginning this survey, you affirm that you are over 18 years of age, have read and understood the information presented, and agree that your responses may be used in the research project described above.

Block 25

Overview of the survey

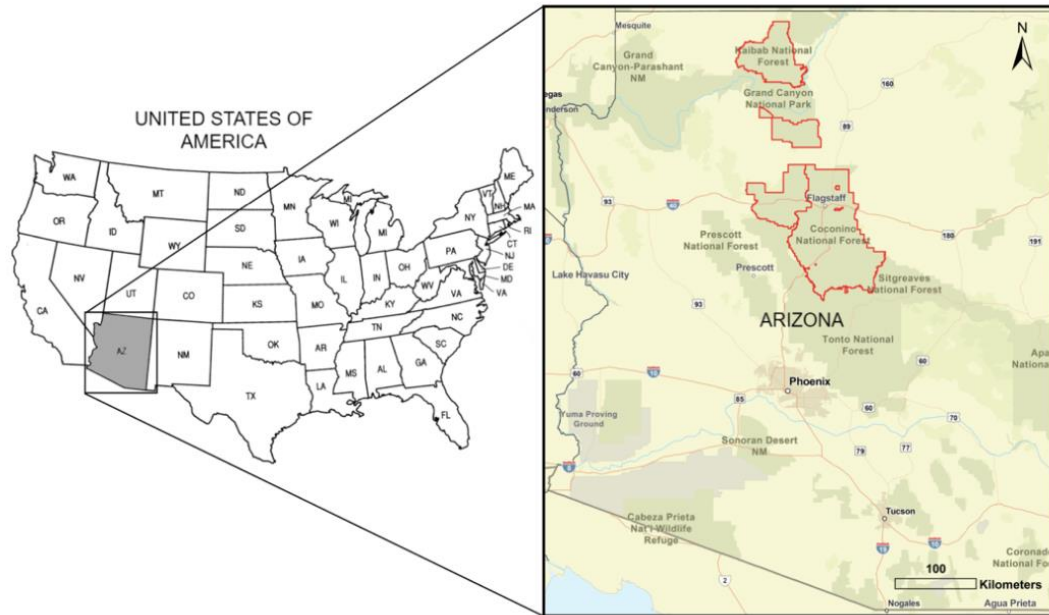
The survey has five sections. The survey is based on information obtained from experts and tested with focus groups.

- Section 1 is an overview of the Coconino and Kaibab National Forests
- Section 2 provides general information about springs
- Section 3 describes characteristics of springs management
- Section 4 asks you to choose between hypothetical springs management options, and
- Section 5 requests information about you and members of your household.

Block 1

Section 1: The Coconino and Kaibab National Forests

The Coconino and Kaibab National Forests are located in Northern Arizona (see map). The Kaibab National Forest borders the North and South Rims of Grand Canyon National Park. The Coconino National Forest stretches across Flagstaff and Sedona southeast past Camp Verde, AZ.



Block 2

Section 2: Springs on the Coconino and Kaibab National Forests

A spring in the Coconino and Kaibab National Forests is defined as a surface-linked groundwater-dependent ecosystem where groundwater emerges and often flows from the Earth's surface or

groundwater emerging into a meadow/stream bed.



Springs are essential to water supplies in the Coconino and Kaibab National Forests because of the semi-arid climate and relatively low humidity. The Coconino and Kaibab National Forests are home to approximately 700 springs. The springs and the ecosystems that they support are vital for biodiversity, wildlife, and habitat for threatened and endangered species in this region.

Have you ever visited a spring?

- ☐ Yes
☐ No

Have you ever visited the Coconino or Kaibab National Forests in Northern Arizona?

- ☐ Yes
☐ No

Have you ever visited a spring in the Coconino or Kaibab National Forest?

- ☐ Yes
☐ No

Block 3

Threats to Ecosystems

Several factors threaten spring ecosystems. Human use, including recreation, can lead to pollution and degradation of spring ecosystems. Increased groundwater pumping for municipal and agricultural use from groundwater aquifers reduces the surface flow of springs. Drought also decreases water flow and threatens spring ecosystems. Moreover, deforestation and increased development can have an adverse impact on spring ecosystems.

On a scale of 1 to 5 where 1 is "Not at all concerned" and 5 is "Extremely concerned", please state your concern for each potential threat to springs.

	Not at all concerned	Slightly concerned	Moderately concerned	Very concerned	Extremely concerned
Recreational use	☐	☐	☐	☐	☐
Groundwater pumping	☐	☐	☐	☐	☐
Drought	☐	☐	☐	☐	☐
Deforestation	☐	☐	☐	☐	☐
Pollution	☐	☐	☐	☐	☐
Increased development	☐	☐	☐	☐	☐

Block 4

Threats to Ecosystems

Within the Coconino and Kaibab National Forests, 77% of the springs are ecologically degraded with much of the degradation occurring as a result of grazing practices. Approximately 70% percent of the land within the Coconino and Kaibab National Forests is considered suitable for grazing.



Ranchers with grazing permits in the Coconino and Kaibab National Forests use springs as vital water supplies for their cattle. The water can also be used to grow feed for cattle. Springs allow ranchers to save money that would have to be spent hauling water and therefore support the cattle ranching industry.

However, grazing can substantially reduce the quality of the spring ecosystems for the native wildlife that rely on the spring. For example:

- Excessive grazing of native vegetation can make soil prone to erosion and trampling through the stream bed can cause muddy water
- Overuse of the spring water can diminish habitat quality and reduce water availability for native wildlife, and
- Pollution from cattle feces can impact water quality.

On a scale of 1 to 5 where 1 is "Not at all concerned" and 5 is "Extremely concerned", please state your concern for each issue listed below:

Not at all concerned	Slightly concerned	Moderately concerned	Very concerned	Extremely concerned
-------------------------	-----------------------	-------------------------	-------------------	------------------------

	Not at all concerned	Slightly concerned	Moderately concerned	Very concerned	Extremely concerned
Degradation of springs ecosystems from grazing	☐	☐	☐	☐	☐
Reduction of ranching because of restricted grazing permits	☐	☐	☐	☐	☐

Block 5

Your Recreation Activity



National Forests provide abundant opportunities for recreational activities. Please indicate which, if any, recreational activities you have participated on National Forest or other public lands. Check all that apply:

- ☐ Hunting
- ☐ Hiking
- ☐ Mountain Biking
- ☐ Camping
- ☐ Boating
- ☐ Fishing
- ☐ Wildlife Viewing
- ☐ Off-road Vehicle (ORV) Riding

☐ Others, please specify

Recreational activities can lead to environmental degradation of springs resulting in loss of species habitat, decreased flow from springs, and less availability of water and surrounding vegetation to be utilized by native wildlife.

Which of the following activities are **you** willing to restrict to reduce environmental degradation of springs from recreation? Check all that apply:

- ☐ Hunting
- ☐ Hiking
- ☐ Mountain Biking
- ☐ Camping
- ☐ Boating
- ☐ Fishing
- ☐ Wildlife Viewing
- ☐ Off-road Vehicle (ORV) Riding
- ☐ Others, please specify

Are you willing to restrict your **own** recreation on National Forests to reduce environmental degradation of springs from recreation?

- ☐ No
- ☐ Yes

On a scale of 1 to 5 where 1 is "Not at all concerned" and 5 is "Extremely concerned", please state your concern for the degradation of springs from each recreation activity

listed below:

	Not at all concerned	Slightly concerned	Moderately concerned	Very concerned	Extremely concerned
Hunting	☐	☐	☐	☐	☐
Hiking	☐	☐	☐	☐	☐
Mountain Biking	☐	☐	☐	☐	☐
Camping	☐	☐	☐	☐	☐
Boating	☐	☐	☐	☐	☐
Wildlife Viewing	☐	☐	☐	☐	☐
Off Road Vehicle (ORV) Riding	☐	☐	☐	☐	☐

Block 12

Cultural Significance of Springs

Springs in the Coconino and Kaibab National Forests are culturally significant to Indigenous Peoples. Indigenous Peoples have historically lived on the lands of the Coconino and Kaibab National Forests and still reside across these traditional landscapes. In Indigenous belief systems and ways of life, springs are often considered sacred as water is life and it comes directly from the earth. Therefore, the springs in the Coconino and Kaibab are culturally and religiously significant to Indigenous Peoples across tribal nations. Some springs are the sites for traditional, religious, and ceremonial gatherings.



Before taking this survey, were you familiar with the cultural significance of springs to Indigenous Peoples?

- ☐ Yes
☐ No

On a scale of 1 to 5 where 1 is "Not at all concerned" and 5 is "Extremely concerned", how concerned are you about prioritizing management of springs on National Forests to protect springs with cultural significance to Indigenous Peoples?

	Not at all concerned	Slightly concerned	Moderately concerned	Very concerned	Extremely concerned
Prioritizing management to protect springs with cultural significance to Indigenous Peoples	☐	☐	☐	☐	☐

Are you willing to restrict your **own** recreation on National Forests to preserve springs with cultural significance for Indigenous Peoples?

- ☐ No
☐ Yes

Block 20

Section 3: Attributes of Springs

Spring can be managed based on several attributes/characteristics. Each attribute can be managed at different levels. In this section, you will see the description of the following spring management attributes/characteristics and their respective levels:

- City Water Security
- Cultural Significance
- Recreational Activities
- Ranching
- Biological Habitat Quality
- Flow

Block 2

Section 3.1. City Water Security



Springs contribute to a city's water security, including providing water for residential, commercial, and public use. Springs can be mostly to fully diverted, partially diverted, or not used for city water security.

	Mostly Diverted Springs can be Mostly Diverted for a city's water security, potentially limiting other uses
	Partially Diverted Springs can be Partially Diverted for a city's water security, leaving some water for other uses
	Not Diverted Springs can be Not Diverted and left free-flowing for other uses

Block 3

Section 3.2. Cultural Significance



All springs are important to Indigenous Peoples. However, any spring referred to directly in oral histories, used in ceremonies, or serving as a primary water source will be considered culturally significant for the purposes of this study. Landscapes can be managed to prioritize the preservation of springs with cultural significance. For example:

	Yes - The spring will be managed to preserve its cultural significance
	No - The spring will not be managed to preserve its cultural significance

Block 4

Section 3.3. Recreational Activities



Springs are the source of many recreational activities including: hiking, camping, boating, fishing, hunting, ORV use and wildlife viewing. The landscape surrounding springs can be managed for different human impacts of recreation. For example:

	High Springs can be managed for High Impact recreation such as ORV use
	Moderate Springs can be managed for Moderate Impact activities such as camping, boating, and mountain biking
	Low Springs can be managed for Low Impact activities such as hiking and wildlife viewing

Block 5

Section 3.4. Ranching



Springs provide support for ranching activities. Livestock graze and use springs as a clean and free source of water, especially in drought years. Springs promote the cowboy culture and lifestyle. Ranching is permitted at some springs and not at others. For example:

	Yes - The spring will be managed to include ranching
	No - The spring will be managed to exclude ranching

Block 6

Section 3.5. Biological Habitat Quality

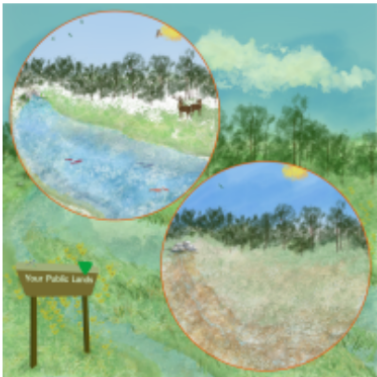


Springs provide a habitat for various types of fauna and flora and contribute to the landscape surrounding the springs. Vegetation of the spring ecosystem supports many different species and increases with the size of the springs. Springs can be managed to have varying levels of quality of biological habitat. For example:

	Excellent Springs can be managed to provide Excellent biological habitat for an abundance of fauna and flora
	Average Springs can be managed to provide Average biological habitat for some species
	Low Springs can be managed to provide Low to no support for different flora and fauna

Block 7

Section 3.6. Flow



The amount of water discharging or flowing from springs can vary depending upon the landscape, season, or other environmental conditions. The flow of springs provides resilience for the ecosystems supported by springs. Some springs have year-round flow, even during extreme drought. Other springs may have intermittent or seasonal flow. For example:

	Yes - Spring within the management scenario has year-round flow even during extreme drought
	No - Springs within the management scenario have intermittent or seasonal flow

Block 13

Section 4: Your Chance to Choose

The following questions ask you to choose between three potential springs management scenarios, Option A, Option B, or Neither. Option A and B have characteristics explained in the last section with multiple levels and a corresponding fee. The management fee is a one-time payment on your Federal tax return to support each management scenario. Fees would go directly to a Springs Management Fund used solely for springs management in the Coconino and Kaibab National

Forests. Please consider your household income and budget when choosing your preferred project.

You can use the back arrow as needed to review other sections of the survey. The definitions from the previous section will be visible by hovering your mouse over each of the characteristics of the springs.

CE_Block1 - May 11, 2022

Among the following management options, which one do you prefer?

	Option A	Option B	Neither
City Water Security	Partial 	No 	
Cultural Significance	Yes 	No 	
Recreational Impact	High 	Low 	
Ranching	No 	Yes 	
Biological Habitat Quality	Low 	Average 	
Flow	No 	Yes 	
Cost	\$10	\$300	\$0

Option A

Option B

Neither

Your choice:

☐
☐
☐

Among the following management options, which one do you prefer?

	Option A	Option B	Neither
City Water Security	Partial 	No 	
Cultural Significance	Yes 	No 	
Recreational Impact	Moderate 	Low 	
Ranching	Yes 	No 	
Biological Habitat Quality	Average 	Low 	
Flow	No 	Yes 	
Cost	\$300	\$550	\$0

Option A

Option B

Neither

Your choice:

☐
☐
☐

Among the following management options, which one do you prefer?

	Option A	Option B	Neither
City Water Security	Mostly 	No 	

Cultural Significance	No 	Yes 	
Recreational Impact	High 	Moderate 	
Ranching	Yes 	No 	
Biological Habitat Quality	Average 	Excellent 	
Flow	No 	Yes 	
Cost	\$100	\$1000	\$0

Option A

Option B

Neither

Your choice:

☐☐☐

On a scale of 1 to 10, where 1 is "Not at all certain" and 10 is "Completely certain", how certain are you of your answer?



CE_Block2 - May 11, 2022

Among the following management options, which one do you prefer?

	Option A	Option B	Neither
City Water Security	Mostly 	Partial 	
Cultural Significance			

	No	Yes	
Recreational Impact	Moderate	Low	
Ranching	Yes	No	
Biological Habitat Quality	Excellent	Low	
Flow	No	Yes	
Cost	\$10	\$100	\$0

Option A

Option B

Neither

Your choice:

☐☐☐

Among the following management options, which one do you prefer?

	Option A	Option B	Neither
City Water Security	Mostly	No	
Cultural Significance	Yes	No	
Recreational Impact	High	Low	
Ranching	No	Yes	
Biological Habitat Quality	Excellent	Average	
Flow	Yes	No	

Cost	\$300	\$50	\$0
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Option A

Option 2

Neither

Your choice:

☐☐☐

Among the following management options, which one do you prefer?

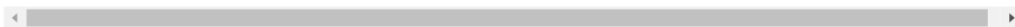
	Option A	Option B	Neither
City Water Security	Partial 	Mostly 	
Cultural Significance	No 	Yes 	
Recreational Impact	High 	Low 	
Ranching	No 	Yes 	
Biological Habitat Quality	Average 	Low 	
Flow	No 	Yes 	
Cost	\$550	\$10	\$0

Option A

Option B

Neither

Your choice:

☐☐☐

On a scale of 1 to 10, where 1 is "Not at all certain" and 10 is "Completely certain", how certain are you of your answer?

**CE_Block3 - May 11, 2022**

Among the following management options, which one do you prefer?

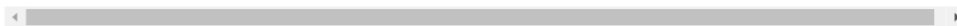
	Option A	Option B	Neither
City Water Security	Mostly 	No 	
Cultural Significance	Yes 	No 	
Recreational Impact	Moderate 	High 	
Ranching	No 	Yes 	
Biological Habitat Quality	Low 	Excellent 	
Flow	No 	Yes 	
Cost	\$1000	\$10	\$0

Option A

Option B

Neither

Your choice:

☐☐☐

Among the following management options, which one do you prefer?

	Option A	Option B	Neither
City Water Security	Mostly 	No 	
Cultural Significance	No 	Yes 	
Recreational Impact	Low 	Moderate 	
Ranching	No 	Yes 	
Biological Habitat Quality	Average 	Excellent 	
Flow	Yes 	No 	
Cost	\$300	\$100	\$0

Option A

Option B

Neither

Your choice:

☐☐☐

Among the following management options, which one do you prefer?

	Option A	Option B	Neither
City Water Security	No 	Partial 	
Cultural Significance	Yes 	No 	
Recreational Impact	Moderate 	Low 	
Ranching			

	No 	Yes 	
Biological Habitat Quality	Average 	Excellent 	
Flow	No 	Yes 	
Cost	\$550	\$1000	\$0

Option A

Option B

Neither

Your choice:

☐☐☐

On a scale of 1 to 10, where 1 is "Not at all certain" and 10 is "Completely certain", how certain are you of your answer?

1

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CE_Block4 - May 11, 2022

Among the following management options, which one do you prefer?

	Option A	Option B	Neither
City Water Security	Mostly 	Partial 	
Cultural Significance	No 	Yes 	
Recreational Impact	High 	Low 	
Ranching			

	No 	Yes 	
Biological Habitat Quality	Low 	Average 	
Flow	No 	Yes 	
Cost	\$50	\$550	\$0

Option A

Option B

Neither

Your choice:

☐☐☐

Among the following management options, which one do you prefer?

	Option A	Option B	Neither
City Water Security	Partial 	Mostly 	
Cultural Significance	Yes 	No 	
Recreational Impact	High 	Low 	
Ranching	Yes 	No 	
Biological Habitat Quality	Low 	Excellent 	
Flow	Yes 	No 	
Cost	\$50	\$100	\$0

Option A

Option B

Neither

Option A

Option B

Neither

Your choice:

☐☐☐

Among the following management options, which one do you prefer?

	Option A	Option B	Neither
City Water Security	No 	Partial 	
Cultural Significance	Yes 	No 	
Recreational Impact	High 	Moderate 	
Ranching	Yes 	No 	
Biological Habitat Quality	Low 	Average 	
Flow	No 	Yes 	
Cost	\$300	\$10	\$0

Option A

Option B

Neither

Your choice:

☐☐☐

On a scale of 1 to 10, where 1 is "Not at all certain" and 10 is "Completely certain", how certain are you of your answer?

1

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CE_Block5 - May 11, 2022

Among the following management options, which one do you prefer?

	Option A	Option B	Neither
City Water Security	No 	Partial 	
Cultural Significance	Yes 	No 	
Recreational Impact	Low 	High 	
Ranching	No 	Yes 	
Biological Habitat Quality	Average 	Excellent 	
Flow	No 	Yes 	
Cost	\$10	\$550	\$0

Option A

Option B

Neither

Your choice:

☐☐☐

Among the following management options, which one do you prefer?

	Option A	Option B	Neither
--	-----------------	-----------------	----------------

City Water Security	Partial 	Mostly 	
Cultural Significance	No 	Yes 	
Recreational Impact	Moderate 	High 	
Ranching	No 	Yes 	
Biological Habitat Quality	Low 	Average 	
Flow	No 	Yes 	
Cost	\$300	\$1000	\$0

Option A

Option B

Neither

Your choice:

☐☐☐

Among the following management options, which one do you prefer?

	Option A	Option B	Neither
City Water Security	Partial 	Mostly 	
Cultural Significance	No 	Yes 	
Recreational Impact	High 	Moderate 	
Ranching	Yes 	No 	

Biological Habitat Quality	Low 	Excellent 	
Flow	No 	Yes 	
Cost	\$10	\$50	0

Option A

Option B

Neither

Your choice:

☐☐☐

On a scale of 1 to 10, where 1 is "Not at all certain" and 10 is "Completely certain", how certain are you of your answer?



CE_Block6 - May 11, 2022

Among the following management options, which one do you prefer?

	Option A	Option B	Neither
City Water Security	No 	Mostly 	
Cultural Significance	No 	Yes 	
Recreational Impact	High 	Low 	
Ranching	No 	Yes 	
Biological Habitat			

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Qualtrics Survey Software

Quality	Average 	Low 	
Flow	Yes 	No 	
Cost	\$100	\$550	\$0

Option A

Option B

Neither

Your choice:

☐
☐
☐


Among the following management options, which one do you prefer?

	Option A	Option B	Neither
City Water Security	Partial 	No 	
Cultural Significance	Yes 	No 	
Recreational Impact	Low 	Moderate 	
Ranching	No 	Yes 	
Biological Habitat Quality	Excellent 	Low 	
Flow	No 	Yes 	
Cost	\$50	\$1000	\$0

Option A

Option B

Neither

Your choice:

☐
☐
☐

Among the following management options, which one do you prefer?

	Option A	Option B	Neither
City Water Security	Mostly 	No 	
Cultural Significance	No 	Yes 	
Recreational Impact	Moderate 	High 	
Ranching	Yes 	No 	
Biological Habitat Quality	Low 	Excellent 	
Flow	Yes 	No 	
Cost	\$100	\$1000	\$0

Option A

Option B

Neither

Your choice:

☐☐☐

On a scale of 1 to 10, where 1 is "Not at all certain" and 10 is "Completely certain", how certain are you of your answer?

1

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Block 21

If you chose "Neither" for any of the choice questions in your choices, please help us understand why. (Select all that apply)

- ☐ The spring management fee is too high
- ☐ I do not consider spring management as a critical issue
- ☐ It is not fair for me to pay for spring management because I already pay enough taxes
- ☐ It is the responsibility of the Forest Service to manage springs
- ☐ Other (please explain)

While making your choices, how important were the following attributes in choosing the management scenarios? (Check one box for each question)

	Less important	Somewhat important	Very important
How important was city water security in your choice?	☐	☐	☐
How important was cultural significance in your choice?	☐	☐	☐
How important was recreation in your choice?	☐	☐	☐
How important was ranching in your choice?	☐	☐	☐
How important was biological habitat quality in your choice?	☐	☐	☐
How important was flow in your choice?	☐	☐	☐

Block 22**Section 5: About You**

What is your age?

- ☐ 18-25
- ☐ 26-35
- ☐ 36-45
- ☐ 46-55
- ☐ 56-65
- ☐ 66-75
- ☐ above 75

What is the highest degree or level of school you have completed? (If currently enrolled, highest degree received)

- ☐ No high school diploma
- ☐ High school graduate, or GED
- ☐ Some college but no degree
- ☐ Associates degree (2-year program)
- ☐ Bachelor's degree (4-year program)
- ☐ Master's degree and beyond

What was your estimated gross annual household income in 2021?

- ☐ Less than \$10,000
- ☐ \$10,000 - \$14,999
- ☐ \$15,000 - \$19,999
- ☐ \$20,000 - \$24,999

- ☐ \$25,000 - \$29,999
- ☐ \$30,000 - \$34,999
- ☐ \$35,000 - \$39,999
- ☐ \$40,000 - \$44,999
- ☐ \$45,000 - \$49,999
- ☐ \$50,000 - \$59,999
- ☐ \$60,000 - \$74,999
- ☐ \$75,000 - \$99,999
- ☐ \$100,000 - \$124,999
- ☐ \$125,000 - \$149,999
- ☐ \$150,000 - \$199,999
- ☐ \$200,000 or more

Are you an Arizona resident?

- ☐ Yes
- ☐ No

How many members are in your household

How many children are in your household?

Block 23

How would you describe your gender?

- ☐ Male
- ☐ Female
- ☐ Non-binary / third gender
- ☐ Prefer not to say

Please describe your race: Please choose all that apply.

- ☐ White
- ☐ Black or African American
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Native Hawaiian or Pacific Islander
- ☐ Prefer not to say
- ☐ Other

Please describe your ethnic background:

- ☐ White/Non-Hispanic
- ☐ Hispanic
- ☐ Prefer not to say
- ☐ Other

Employment Status: Please choose all that apply.

- ☐ Employed full time
- ☐ Employed part time
- ☐ Unemployed looking for work
- ☐ Unemployed not looking for work
- ☐ Retired
- ☐ Student
- ☐ Disabled
- ☐ Self employed
- ☐ Military
- ☐ Home maker
- ☐ Unable to work
- ☐ Prefer not to say

Are you a member of an environmental organization?

- ☐ No
- ☐ Yes

What is your political affiliation?

- ☐ Democrat
- ☐ Republican
- ☐ Independent
- ☐ Prefer not to say

Approximately, how many hours of television do you watch on an average day?

- ☐ 0-1 Hour
- ☐ 2-4 Hours

- ☐ 5-8 Hours
- ☐ More than 8 hours

In a typical week, about how many hours do you spend on the internet for personal use?

- ☐ 0-10 Hours
- ☐ 11-20 Hours
- ☐ 21-30 Hours
- ☐ More than 30 Hours

Do you usually try new products before other people do?

- ☐ Never
- ☐ Sometimes
- ☐ Most of the time
- ☐ Always

Block 25

Thank you for taking the time to complete our survey. We appreciate your input. Please let us know if you have any additional comments.

Appendix G

Panel Recruitment

SSRS Opinion Panel members are recruited randomly based on nationally representative ABS (Address Based Sample) design (including Hawaii and Alaska). Additionally, we recruit hard-to-reach demographic groups via our Omnibus survey platform. The SSRS Omnibus survey is a nationally representative (including Hawaii and Alaska) bilingual telephone survey designed to meet standards of quality associated with custom research studies. The SSRS Omnibus completes more than 50,000 surveys annually with 80% cell allocation.

The advantage of this recruiting design is that it relies on a high-quality ABS design that yields a higher response rate. Additionally, it leverages our Omnibus platform to ensure adequate representation of typically under-represented groups in public opinion polls such as Hispanics, African Americans, lower educated, or lower income population.

Survey Mode

The SSRS Opinion Panel is a multi-mode panel. All internet respondents participate via web and all non-internet/web reluctant respondents participate via phone. SSRS's own research on non-internet respondents suggests that more than 8 in 10 non-internet respondents are unwilling to take surveys via web. SSRS has therefore made a decision not to provide internet access to non-internet respondents as providing internet access does not effectively address the coverage bias of non-internet respondents. By definition, non-internet cases need to be contacted via a non-internet mode.

For studies that need completion via a singular web mode yet seek to ensure national representation, the SSRS Advanced Methods team has developed a proprietary propensity weighting solution that takes estimates derived for the U.S. adult internet population and adjusts them to mirror the full U.S. adult population (see the section on weighting).

SSRS web surveys comply with industry best practices. They are optimized for smartphone/mobile device administration and are adapted to all operating systems and browsers.

SSRS Opinion Panel Data Weighting

SSRS Opinion Panel data is weighted to be representative of the entire residential adult population in the United States. The first step in the weighting is the application of a base weight that accounts for the ABS sample design and the within-household sampling of one adult. We then apply a proprietary model-based non-internet propensity adjustment so that results are representative of all adults and not just those who have access to the internet. (This adjustment is made only to studies that have no telephone component for non-internet/web reluctant respondents.)

Following the base weight, survey data are calibrated to correct for differential nonresponse along demographics such as age, race, sex, region, and education. Benchmark distributions are obtained from the most recently available data from Current Population Survey (CPS) or American Community Survey (ACS). Additionally, online panelists are known to be more civically engaged than the general population. To correct for this potential bias, we often include volunteerism and interaction with neighbors when calibrating online samples. These benchmark distributions are derived from the Civic Engagement and Volunteer Supplement to the Current.

How are SSRS Opinion Panel Surveys Conducted?

During the recruitment process, full demographic information on panelists is collected. This data is stored securely and used to determine eligibility for specific studies (if needed). We also rely on these data to improve the survey experience for panelists by avoiding the need to re-ask demographic questions for each survey. Samples are drawn among panel members to best meet the study criteria. Selected panelists are sent an email invitation to participate in the survey, including unique survey login credentials. The respondent logs in and completes the self-administered online survey. Our contact protocol also includes a text survey reminder for panelists that have consented to receiving text messages.

The SSRS Opinion Panel also includes panelists who are primarily Spanish speakers. We translate and conduct surveys in Spanish as required by a specific project.

SSRS Opinion Panel Standard Deliverables

SSRS Opinion Panel standard deliverables include access to an online dashboard that provides near real-time project updates during data collection, a weighted SPSS data file including standard demographic variables, and an AAPOR compliant methodology statement with response rate calculations provided upon completion of all data collection and weighting.