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Value of Information: Influences on and Public Perceptions of

Wildfire and Land Management Policy

by

William Kirt Toombs Jr.

A dissertation

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The members of the committee appointed to examine the dissertation of WILLIAM TOOMBS find it satisfactory and recommend that it be accepted.

_____

James W. Stoutenborough, Committee Chair

_____

Kellee J. Kirkpatrick, Committee Member

_____

Keith T. Weber, Graduate Faculty Representative

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Dissertation Abstract--Idaho State University (2019)

Wildfires in the US present a unique problem for land managers who must consider simultaneously the ecological health of public lands along with the community's needs, desires, and perceptions, when making land management decisions. The public, however, typically expresses unqualified or contradicting opinions and desires when it comes to land management policy. This undoubtedly makes the job of the land manager that much more complicated as they seek to develop and implement land management strategies in a variety of emergency management contexts. To help illuminate some of the areas of ambiguity in the public's opinion of land management strategies, a survey was administered in October 2017 to Idaho State University students looking at the influences of knowledge, trust, and behavior on their support or opposition of suggested policies. In addition, as part of the survey, I looked at the influences of knowledge, trust, and behavior on the public's perceptions of the ecological impact of highlighted strategies. The results of both were mixed but provided valuable insights and suggestions for land managers, as well as the public, to consider improving certain aspects of natural resource management. Finally, twenty semi-structured interviews were conducted with federal, state, and local land managers of the western US in order to gain more awareness into what external and internal factors influence their decision making in a post-fire context. The results of this chapter potentially provide valuable information to land managers seeking to improve decision making.

Key Words: Public Opinion, Wildfires, Risk, Land Management, Diffusion, Innovation

CHAPTER ONE

Introduction

Introduction

Wildland fire is a natural, constant, and necessary part of many landscapes and ecosystems across the globe (Lowe et al. 1978; Pyne 1982; Pyne 1997; Noss et al. 2006; Shvidenko et al. 2011; Calkin et al. 2015; Steen-Adams et al. 2017; Abatzoglou et al. 2018; Brooke et al. 2018). Wildland fires consist of any non-structure fire, including prescribed fires, and they typically occur in the forests and rangelands (NWCG 2003). Fires can reduce hazardous fuel loads, improve or damage area wildlife habitats, degrade air and water quality, as well as have a tremendous impact, both short and long term, on human settlements and communities (Mutch 1970; Brooker and Rowley 1991; Silveira et al. 1999; Chuvieco et al. 2010; Bond et al. 2012; Hutto et al. 2015; Coates et al. 2016). According to archaeological evidence, humans have used fire as a multiuse tool as early as a few hundred thousand years ago and continued to attempt to control and manipulate its capabilities, occurrences, and minimize its negative social effects for subsequent generations (Pyne 1982; James et al. 1989; Miller 2013). Largely as a result, some of the landscapes in the more fire prone regions of the world now require human intervention and management, mainly in the forms of coordinated governmental action or industry-based stewardship, to promote optimal ecosystem health and a return to their historical conditions, among other goals (Busenberg 2004; Schoennagel et al. 2004). This is especially true for the United States, where the federal government owns and manages over 46.4% of land in the western half of the country, a region where the majority of America's wildfires occur (Platt 1999; Nelson and Liknes 2007; USGS 2014; Vincent et al. 2017).

Wildfire, similar to wilderness, is a relative term defined in relation to human values and perspectives and not some finite natural standard (Pyne 1982). Historically, societies across the globe have assigned vastly different values, meanings, and uses for wildfire, which largely attempted to address cultural, and not land management, issues (Boyd 1999; Carroll et al. 2009; Norgaard 2014). In the contemporaneous US, federal wildland fire management policy states, "responses to wildland fires is based on ecological, social, and legal consequences of the fire. The circumstances under which a fire occurs, and the likely consequences on firefighter and public safety and welfare, natural and cultural resources, and, values to be protected, dictate the appropriate responses to the fire" (Wildland Fire Leadership Council 2009). In addition, the unfortunate trends witnessed by fire and land management in the western US, like increasing annual fire occurrences and total land burned, budgetary shortfalls, and continued encroachment of human settlements into the wildlands, are also considered when responding to and preparing for wildland fires (Fried et al. 1999; Busenberg 2004; Steelman 2008; Schoennagel et al. 2009; Schoennagel et al. 2017; Radeloff et al. 2018). Therefore, fire and land management policy in the US should consider and attempt to synthesize the varying and inconsistent perceptions, attitudes, and knowledge of the electorate in order to develop and implement publicly acceptable, as well as professionally feasible, programs (Smith 2002; Halvorsen 2003; Vogt et al. 2005; McCaffrey 2006; Toman et al. 2014).

Deciding how to prepare and respond to wildfire, especially in many of the more fire prone regions of the country, can be a controversial and hot button issue (Daniel 1988; Irvin and Stansbury 2004; Shindler et al. 2009; Blades et al. 2014). One that can engender a spirited public debate or outcry, while simultaneously eliciting coordinated responses from multiple and competing interests (Blahna and Yonts-Shepard 1989; Davis 2001; Ananda 2007; Fleming et al.

2015). The reasons for the electorate demonstrating such a passionate response are tenfold and include the public's increasing financial obligation to address public lands issues, perceived waste in governmental spending, differing views on natural resource management, potential for economic gain, and ultimately the threat to human life and livelihoods that wildfires pose (Pyne 1982; Pyne 1997; Wildland Fire Leadership Council 2009). As wildland fires constitute one of the major crises in American environmental policy, including the public in the planning and decision making processes, as well as considering their attitudes, perceptions, and knowledge, would likely yield greater public acceptance for suggested projects, increase trust for land management agencies, and potentially create a more democratic process for addressing a very public issue (Blahna and Yonts-Shepard 1989; Stivers 1990; Tanz and Howard 1991; Moote and McClaran 1997; Dombeck et al. 2003; Busenberg 2004).

Democracy in the US.

The ideal or theoretical concept of democracy, at least in its primitive stages, is nothing new as the merits and inferiority of this political system – i.e. popular government – have been discussed for over twenty-five hundred years (Dahl 1956; Fishkin 1995; Dahl 1998; Dunn 2005). Due in part to the relatively long and continuously evolving existence of democratic systems there is not simply one democratic theory, but rather many competing theories on democracy (Dahl 1956; Dahl 1998; Goodwin 2000; Dalton et al. 2001). For example, in Athens, circa 500 BCE, the city-states' form of democracy – *demokratia* – included popular and equitable participation by a substantial number of citizens and lasted nearly two centuries (Dahl 1998). Similarly, and during the same era, the Romans labelled their early political system, where the right to participate in governing slowly widened from the patrician class to the common people, a republic (Dahl 1998; Benhabib and Resnik 2009). The Vikings a thousand years later organically held democratic local assemblies – called a *Ting* – where free and equal men met to debate, discuss, and decide

important local issues (Dahl 1998; Ferguson 2009). Despite the differences in labels, origins, or delivery, however, these democracies, in some form, provide several processes, institutions, or systems by which ordinary citizens exert a high amount of control and influence over its leaders as well as the affairs that affect the community as a whole (Dahl 1956; Goodwin 2000; Manza and Cook 2002).

The US, since its founding, has experienced a similar evolution of democratic systems and principles (Fritz 2008). As a constitutional republic with democratic institutions, an issue arose that pitted the individual's rights against the sovereignty of the state. Leading the two predominant camps of this debate was the New Yorker Alexander Hamilton – representing the stronger centralized government advocates – and the Virginian Thomas Jefferson – the representative of a powerful, educated, and involved electorate (Glaser 1985; Stivers 1990; Dalton 2006). Hamilton, along with other influential Americans from the elitist class, advocated against an active citizenry to manage public affairs and policy as it was deemed dangerous to the country (Stivers 1990). For Jefferson, after establishing the people as America's new sovereign through the Declaration of Independence, as well as after fighting and winning the revolution that followed, few contemporaries should dispute the superior role of the ordinary citizen and the collective power they maintained through their written constitutions (Cronin 1989; Fritz 2008). Similarly, Alexis de Tocqueville (2000), during his travels of the country in the early 19th Century, noted as much after observing the widespread participation by American citizens in voluntary associations as well as their general influence over governmental affairs (Skocpol 1997). The problem, however, originated when it came to apply this notion of the superiority of the average citizen into practice without compromising the collective sovereignty of the people or rendering their institutions ineffective.

Currently, the US political system promotes a form of representative government that is based on the process of democratically electing the officials who will in turn execute the management of public affairs. This presumed arrangement typically stems from the trustee/delegate debate that purportedly expresses how close an elected representative's decision making corresponds with their constituents' wishes (Rehfeld 2009; Page and Shapiro 1983). Any democracy, according to Rehfeld (2009), will likely specify how closely the laws of the state should reflect its citizens' preferences, which undoubtedly influences the behavior of the decision maker. For instance, those in the pluralist (or delegate) camp take the view lawmakers should promote the interests of their constituents directly, while Burkeans (or trustees) tend to allow for a large amount of autonomy for elected decision makers (Rehfeld 2009;). Still, democratic governance assumes that the preferences of citizens are reflected in policy outputs, regardless of the trustee/delegate relationship set up under a jurisdiction (Page and Shapiro 1983; Manza and Cook 2002). Democracy implies discussion, collective deliberation, and rule-governed decision-making procedures that highlights the linkage between public choice and political responsiveness (Lafferty and Meadowcroft 1996). In fact, US democracy provides ample opportunity for many of its citizens to actively influence policy as well as effectively participate in politics, maintain equality in voting, receive and share information, and exercise final control over their government (Dahl 1998).

However, as many scholars and political pundits have observed, tensions throughout the western world have led some states to shift from traditional representative democracy toward a more citizen-driven, participatory, approach (Fishkin 1995; Dalton et al. 2001; Zakaras 2007; Dalton 2016). These tensions have led to a widespread questioning of traditional citizenship norms, as well as the legitimacy of longstanding political institutions (Dalton 2016). Not

immune to major criticisms themselves, land management agencies have attempted to address these concerns by increasingly turning to a participatory democracy approach that emphasizes public participation based in collaboration (Moote et al. 1997; Newig and Frisch 2009). Nevertheless, this shift has occurred arguably because of transformations in key demographics of eligible voters (i.e. education, employment, gender, age, etc.) and their traditional political behavior and participation have also evolved (Dalton 2016). The emphasis on good citizenship based on political behavior like regular voting, joining a political party or interest group, or running for office is declining and being replaced with behavior like protesting for a social cause or boycotting a product for political reasons. Further, the negatives of representative rule (mainly that decision making is in the hands of a few elites) has led to mass political dissatisfaction that is stoking support for reform that places more emphasis on direct participation and citizen influence over policy decisions (Dalton et al. 2001; Zakaras 2007). As the responsiveness of government policies to citizens' preferences is crucial to any normative or empirical theories of democracy, having consistency between opinion and policy is fundamental.

Role of Public Opinion in a Democracy.

Political scientists attempt to provide an explanation as to why governments adopt the policies they do and to what extent the public can impact policy choices through influencing political and economic actors (Goldstein and Martin 2000). Therefore, political scientists have long recognized the importance of understanding how individual behaviors and opinions influence policy preferences (Sears et al. 1980). The start of scientific public opinion surveying in the 1950s and 1960s provided a real opportunity to move beyond the insights of theorists and social commentators and begin to capture more of an accurate snapshot of American attitudes (Fishkin 1995; Dalton 2006). Extant literature has well established that public opinion, or survey-measured collective policy preferences, influences the public policymaking process and that

there is a strong tendency for policy to move congruently with public opinion when the shift is in the liberal direction (Page and Shapiro 1983; Page 1994). This reflects an awareness that relationships between bureaucrats and citizens is important to the actual formation and implementation of public policy (Stivers 1990; McCaffrey 2006). In addition, advocates of public influence on policymaking have often endorsed increased reliance on polls as providing a solution to some of the weaknesses of American political institutions (Manza and Cook 2002). Perhaps more importantly, at least to this study, is that this literature has also demonstrated that public opinion can directly influence the actions of land management agencies and thus environmental goals in general (Buttel and Flinn 1976; Jacobson et al. 2001; Smith 2002; Brunson and Shindler 2004; Buttel and Flinn 2005; Maguire and Albright 2005; Blanchard and Ryan 2007; Shindler et al. 2009; Frederick 2014; Kooistra 2016).

The current role of public opinion in US environmental policy, as well as the public trust in the government, is on a downward trend, even as environmental issues surrounding climate change have reached the highest levels of public consciousness (Dalton 2006; Ostergren et al. 2008; Schoennagel et al. 2017). Although there are some statutory and regulatory justification for citizen involvement in various aspects of environmental policy planning, there persists logistical, philosophical, legal challenges to achieving this mandate (Moote and McClaren 1997). Still, the overall decline in trust of the federal government has arguably contributed to the lesser role of public opinion in decision making concerning natural resource management, despite the relative importance public perception and attitudes can have on this specific policy domain (Blahna and Yonts-Shephard 1989; Smith 2002; Carroll et al. 2005; Dalton 2006; McCaffrey 2006; McCaffrey and Olsen 2012; Frederick 2014). In a natural resource context, public perception and knowledge of any management action can significantly influence the debate and

overall acceptance or rejection of that action (Smith 2002; Halversen 2003; Ostergren et al. 2008; Toman et al. 2014). This is why land managers are constantly concerned about their relationships with the citizenry they serve because if the public does not trust their agency then that agency's proposals will inevitably face resistance, regardless of their quality or necessity (Moote and McClaren 1997; Halversen 2003; McCaffrey 2006; Noss et al. 2006). Further, recent scholars have pointed to the impact that positive public attitudes can have on the overall success of policy implementation in a land management context, which inevitably influences how these land agencies approach an issue (Shindler and Toman 2003; Vogt et al. 2005; McCaffrey 2006; McCaffrey and Olsen 2012; Frederick 2014). Prior research has illustrated that when the public is integrally involved throughout the planning processes, from initiation through decision implementation and monitoring, it increases benefits and boosts efficiency (Tanz and Howard 1991; Moote and McClaren 1997; Irvin and Stansbury 2004; Newig and Fritsch 2009). Still, problems persist in reconciling public opinion with various competing interests and natural resource management.

For land managers, efficiently and thoroughly managing natural resources includes the impartial deliberation of economic opportunities, ecological integrity, conservation and heritage values, and social impacts when considering various management strategies (Anada 2007). In many cases, popular land management policies and strategies directly conflict with these socioeconomic issues and therefore requires broad public support for successful implementation. In natural resource management, public involvement and input ideally should represent these issues through all interested citizens, but instead the process is heavily dominated by special interest groups (Blahna and Yonts-Shephard 1989). Some of the more influential special interest groups in the public land management domain include commercial logging and grazing interests,

as well as predominantly citizen-focused associations related to the myriad of interests important to environmentalists and recreationists. These interest groups, who all are active in some form depending on geographic location, serve as influential actors in natural resource policy and management (Lafferty and Meadowcroft 1996; Lynn 2003; Newig and Fritsch 2009). Collectively, these special interests can influence not only the land managers tasked with ultimate decision-making authority, but also the opinion of the easily swayed general public who is rather ignorant on most environmental issues (Tanz and Howard 1991; Moote et al. 1997; Newig and Fritsch 2009). Nevertheless, the public's actual influence over the land management policies, through meaningful participation throughout the planning and implementation process, is fundamentally important for a participatory democracy and a key focus of this study.

Research Question and Intended Theoretical Contribution

A key question, in relation to wildfire and natural resource management, I am trying to answer is "are policy or decision makers acting in accordance with public opinion?" Arguably, the importance of this inquiry is not only tied to the aforementioned theme of a functioning participatory democracy, but also to the necessity of addressing an exponential increase in wildfire frequency, area burned, longer fire seasons, human settlements in the wildland, and an artificial buildup of hazardous fuels in many areas. As the recent catastrophic fire seasons have demonstrated, the perpetual occurrence and threat that wildfire poses, especially in the western half of the US, is a problem that needs a collaborative solution. Therefore, the intended theoretical contribution of this study is based on three interdependent themes related to public opinion, wildfire, and public land management: 1) public opinion, influence and acceptance of preventative or pre-fire land management strategies as a means to mitigate wildfire risk and promote ecological health, 2) the level of innovativeness land managers demonstrate in a post-fire context, and 3) the factors that mainly influence land managers' policy decisions. Moreover,

it is the primary objective of this project to explore public opinion and knowledge of wildfire issues, including land management strategies, and to evaluate the ultimate level of influence the public exerts over the decision-making process. Although wildfire issues, management, policy, and science are complex, extensive, and without consensus at times, looking at the level of influence the public has on specific pre- and post- fire management decisions could provide valuable insights that could be extrapolated to produce broader policy analyses.

Political History of Wildfire and Land Management in the US

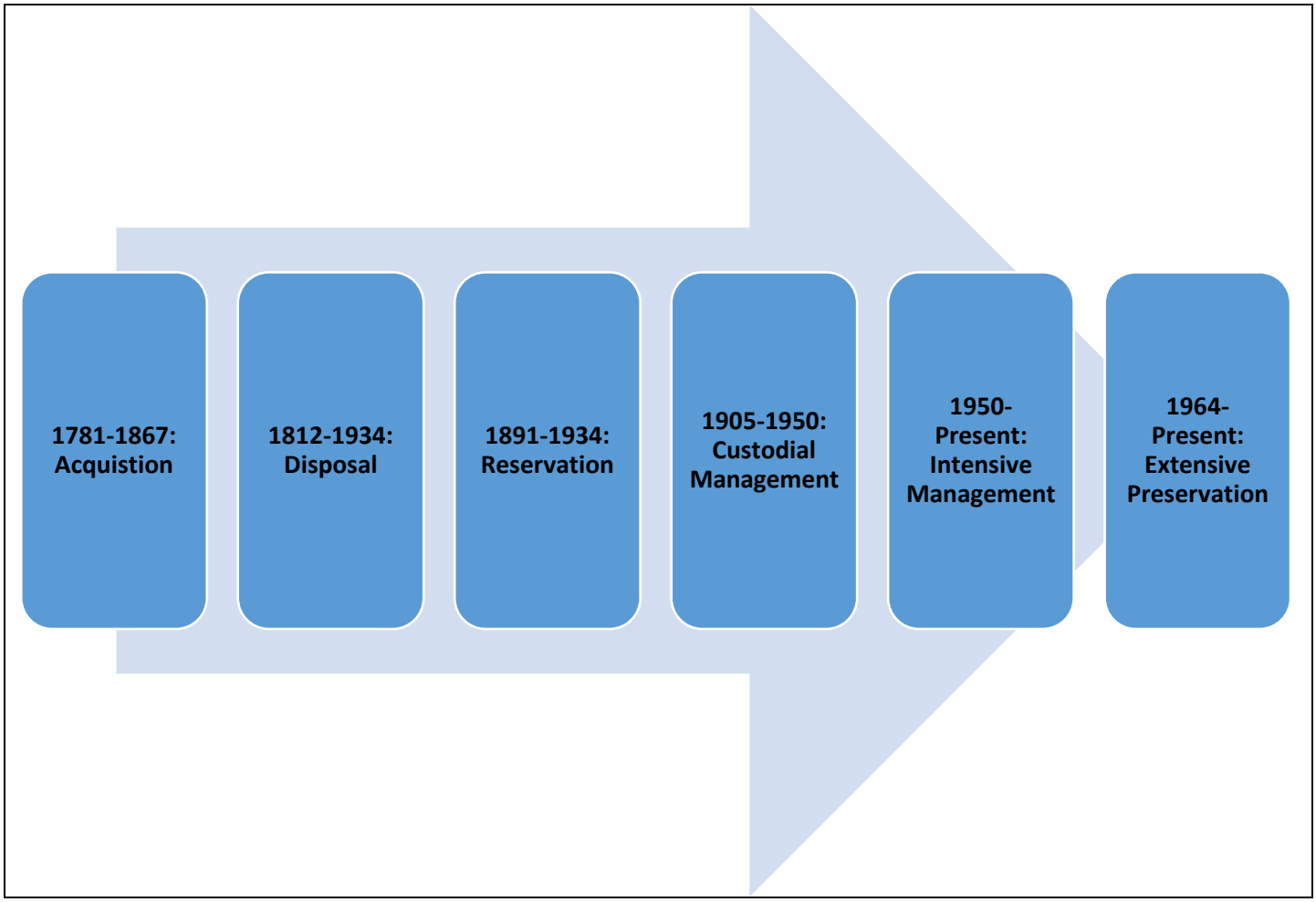
Wildfire and land management policy is one of the most costly, contentious, and complex natural resources issues in the US today (Noss et al. 2006). Federally, the current cost of wildfires is more than $2 billion annually in suppression-related expenses alone, with these costs accounting for only a fraction of the total economic impact of a fire event (Rahn 2009; Western Forestry Leadership Coalition 2009; USFS 2014). Estimating a comprehensive cost of wildfires can be a difficult undertaking given the far-reaching impacts of wildfire across multiple spectrums of the affected ecosystem and regional economy. Moreover, attempting to quantify some of these categories – e.g. a decline in air and water quality, loss of recreational or cultural heritage sites, and increased debris-flow probability – is challenging as they represent indirect costs that might not be realized for several years or decades (Western Forestry Leadership Coalition 2010). Politically, there are many active and competing interests that attempt to influence how elected officials, the public, and land managers respond to a variety of policy scenarios. Public debates surrounding some of these environmental wedge issues can elicit strong emotional responses that makes collaboration and development of comprehensive land management policies difficult. Complicating matters further, these policy scenarios are typically based on the complex field of fire science, which is often without consensus on many key issues (Kodas 2017). Contradictions exist in areas like evaluating the complete socioeconomic costs of wildfires, developing

acceptable debris-flow modelling techniques, and perceiving the effectiveness of adopting and utilizing geospatial tools to enhance job performance, to name only a few (Englin et al. 2002; Robichaud 2009; Western Forestry Leadership Coalition 2010). Collectively, the cost, contention, and contradictions found in land management and wildfire policy today is largely a byproduct of their historical, political, and legal development.

The history of federal land management in the US has gone through several significant phases (i.e. acquisition, disposal, reservation, custodial management, intensive management, and extensive preservation), with each marking a sort of strategic policy shift from its predecessor (Culhane 1981). Starting with the Northwest Ordinances that established a precedent for a proactive and paternal-like federal hand in land acquisition and distribution, and essentially stalemating with the current outright ownership and stewardship of most land in the western half of the country, US public land policy has not existed without significant transformations (Pyne 1982; Kodas 2017). For instance, what was once a heavily federal domain, in both control and responsibility, is now a more collaborative and interdependent field where cooperation among a variety of stakeholders is preferred (Davis 2001). Interests from a variety of contradictory perspectives – i.e. agriculture/ranching, recreation, environmental, logging, etc. – are represented throughout the planning and implementation process (Loomis et al. 1989; Bell and Oliveras 2006; Weber and Gokhale 2011; McCaffrey et al. 2013). Further, major federal land management agencies also must coordinate and maintain a working relationship with state and local governments, as well as with local populations, which can place a heavy demand on the resources of service personnel in some parts of the country (Kaufman 1960). Similarly, state land management agencies are also facing increasing strains on their resources, but their burden is nowhere near the federal government's obligatory responsibility (Wildland Fire Leadership

Council 2009; USGS 2014). Despite this reality, land management agencies are experiencing growing hostility regarding federal land ownership across several western states that could hinder future cooperation on management and policy.

Figure 1. Six Phases of Land Management for the United States Federal Government



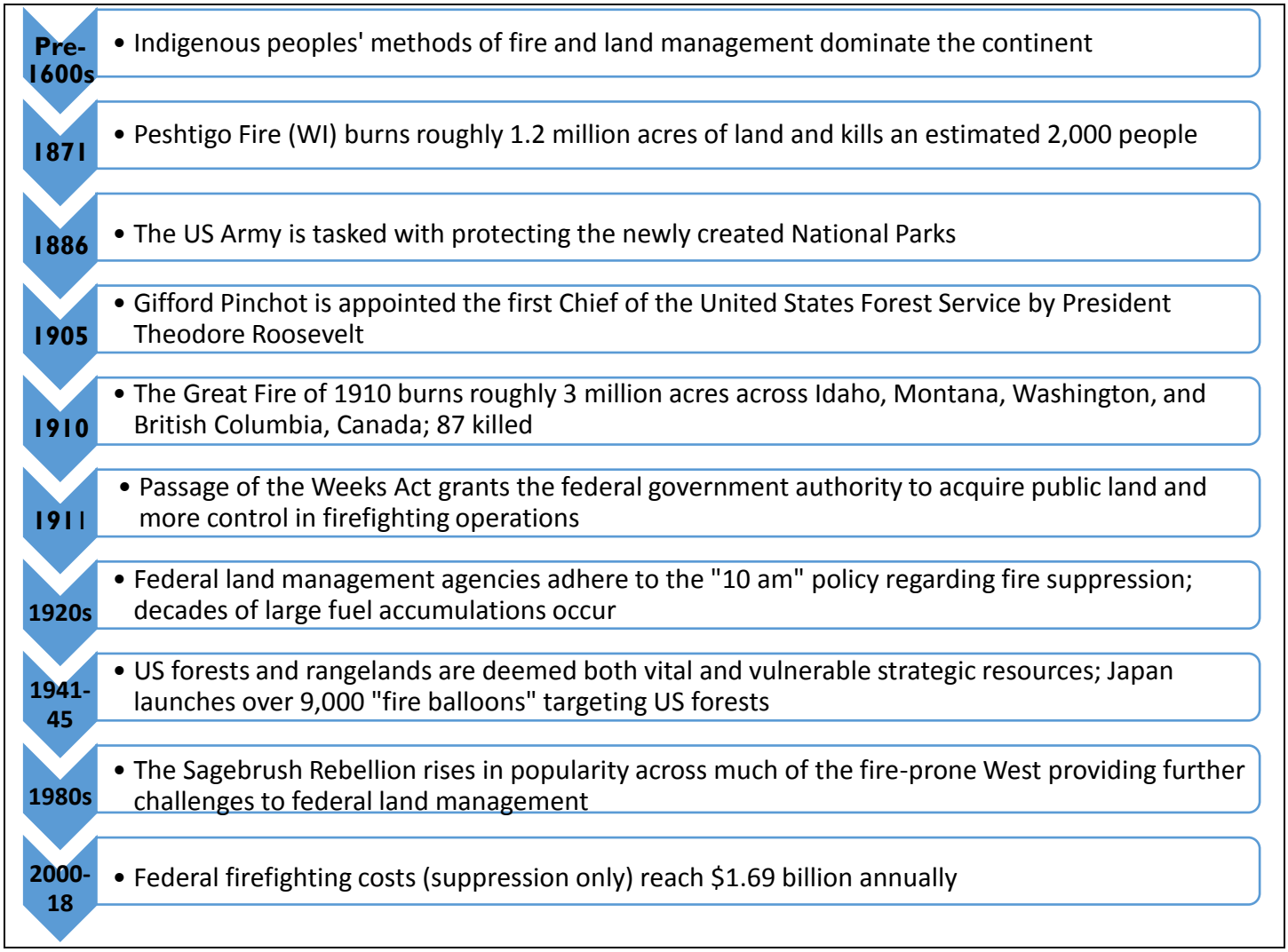
Fire history in the US is marked by two distinct approaches and phases led by two contrasting land management philosophies. One strongly emphasizes the practices of fire-dependent Native American communities who arguably had a more accepting and adaptable approach when it came to fire and land management (Norgaard 2014). The other is grounded in

a more Eurocentric land management philosophy that seemingly stresses fire exclusion over all other stewardship goals. The former, utilized prescribed and controlled fires to promote healthy forests, big game proliferation, debris removal, and general ecological health (Norgaard 2014). There was a general acceptance of reoccurring fire and an adaptability-like quality in the attempt to control the burn for socioecological benefits among Native managers (Norgaard 2014). On the other hand, the Eurocentric approach attempted to control and manipulate the landscape through sheer force and intensive management. Fire was viewed as the enemy to human progress and a natural nuisance that, through careful and unrelenting attention, could be controlled and eventually eradicated from the wildland (Pyne 1982). Despite wildfire history on the continent being somewhat tumultuous ever since the first wave of European settlers expanded westward towards the Pacific Ocean and established permanent settlements, these first fire pioneers have had a lasting impact land management policy and philosophy.

Officially, federal forest-fire management began in 1886 when the US Army was called upon to patrol the newly created national parks (Stephens and Ruth 2005). Their efforts were significantly extended after the two world wars when surplus military equipment was reoutfitted to protect and patrol tens of millions of acres of federally owned land and strategic natural resources (Pyne 1982). Further, through a series of sweeping legislation beginning in 1911 with the Weeks Act, the federal government took more control when it came to wildfire policies affecting federal, state, and local capabilities to fund firefighting operations (Davis 2001). Around this same time, the federal land management agencies began to adhere to a strategy referred to by the time of day the managers would expect the blaze to be controlled, the "10 am policy" (Sparhawk 1925). Subsequently, over the next several decades the extensive fire exclusion that occurred in many fire-prone regions of the country produced a proliferation of

hazardous fuels and changed ecosystems across the West (Pyne 1982). As a response, Congress continued to dump money into the land agencies' fire suppression accounts without adequately funding other vital programs that had the potential to reduce fuel load buildups and promote optimal ecological health (Pyne 1982). More importantly, however, is that larger and more intensive fires began to occur more frequently as a result, which produced serious socioeconomic and ecological issues for contemporary land managers to attempt to address (Kodas 2017).

Figure 2. Timeline of Wildfire and Land Management History in the United States



Key Land Management Agencies.

In the West, there are two primary federal land management agencies – the Bureau of Land Management and the Forest Service. Located within the Department of Interior and Department of Agriculture respectively, these two agencies alone account for ownership of over twenty-two percent of the land for the contiguous US. Although there are several other major federal land-owning management agencies (i.e. the National Park Service, US Fish and Wildlife Service, etc.) the Bureau of Land Management and Forest Service ultimately take the lead on any joint fire or rehabilitation response. This is not to say that these smaller agencies are without primary responsibilities and duties, as these agencies serve essential functions in effectively managing public land. However, the pressing issues faced by the larger multiple-use agencies, like the Bureau of Land Management and the Forest Service, are much more controversial than those facing smaller land agencies like the National Park Service or Fish and Wildlife Services (Culhane 1981). Some of these issues, which surround timber, grazing, wilderness programs, and many others, have historically engendered passionate public responses, both positive and negative (Culhane 1981). For western states in particular, some of these issues take on a states' rights or individualist perspective that inevitably envelops not only federal land management agencies but also their state counterparts (Davis 2001). Nevertheless, land management agencies, both state and federal, are tasked with an almost herculean like task. They must manage and preserve our nation's strategic natural resources while simultaneously cultivating commercial interests and balancing public opinion.

Coinciding Social Movements and Influential Actors.

Throughout fire and land management history in the US, several policy changes occurred simultaneously with other major social movements, or as a result of some influential individuals' efforts to bring about systemic change, that are worth noting. First, Theodore Roosevelt and

Gifford Pinchot are arguably two individuals who did more to modify and modernize environmental policy in the US than any other individuals before or since. Early in the twentieth century, President Roosevelt created the Forest Service and appointed Gifford Pinchot to lead the ambitious new agency. Roosevelt also greatly expanded the federal government's public land domain and spearheaded a conservationist movement that reached circles of the American elite (Pyne 1982). Pinchot, the first chief forester, almost immediately established the Forest Service as a professional and competent agency that aggressively fought forest fires throughout their territory (Davis 2001; Pyne 2001). In the 1960s, an environmentally and ecologically conscious movement took hold that brought to the general public's awareness the ultimate degradation of the environment. Rachel Carson's (1960) *Silent Spring*, and the large public outcry and change of opinion that came as a result, encapsulates this mass awakening well. Arguably riding on these coattails, movements that brought about the spread of "Earth" day in the 1970s also sought to not only change public opinion but simultaneously attempt to alter individual behavior for the better. However, as a sort of countermovement, issues of federal land ownership in the West spurred the 1980s version of American secessionism known as the "sagebrush rebellion" (Cawley1993). Upset with the amount of federal land owned in several western states, and the perceived mismanagement of these lands, individuals increasingly relied on acts of deviance and disobedience to bring mass awareness to their cause (Cawley 1993). Remnants of this movement still persist today and present real barriers to effective land management (Cawley 1993).

Public Opinion, Decision Making, and Complex Issue Domains

The effective management of public land depends highly on the relationship managers have with the public, as well as how informed the public is or can be on specific and complex issues. When certain issues are not particularly well known to the public it can be difficult to identify a

real general consensus on any given front. In addition, when the public is familiar with an issue but not real knowledgeable about its functions, impacts, or causes, land managers are stuck attempting to consolidate the wishes of an ill-informed electorate and the necessities of good management. Land managers are subsequently forced to dedicate resources toward the development of mass public education campaigns to attempt to shorten this knowledge gap, as well as change irresponsible behavior. The insertion of competing special interests into the policy arena further complicates the matter as their goals and objectives often run contradictory to each other. When this occurs, qualified public opinion is arguably even more necessary to land managers who are attempting to find the right balance between stewardship and not inappropriately interfering in commercial interests or economic livelihoods of natural resource dependent communities.

Salience.

For certain issues the public can have no true opinion on any particular question, but they still expect the problem to be solved under certain guidelines and methods (Lowell 1921). Issue salience, which can be measured imperfectly by isolating the proportion of respondents answering "don't know" or "no opinion" to survey questions, arguably plagues many facets of both fire and land management (Page and Shapiro 1983; Smith 2002). Still, political responsiveness to natural resource policy might be greatest concerning highly salient issues for which the scope of conflict is broad (Schattschneider 1960; Page and Shapiro 1983; Manza and Cook 2002). Typically, although policy will tend to mirror public opinion, there is extensive variations in the extent of responsiveness across different issues and at different points in time (Manza and Cook 2002). For most environmental issues, salience began to diminish in the early 1990s despite the public continuing to show substantial interest overall (Kraft 2007). In the realm of wildfire and land management, the public often has competing and contradictory

expectations (Smith 2002). For instance, while some contemporary strategies have placed a high premium on public participation and opinion in land management decision making, forest restoration can have different meanings for different communities and therefore can provide incongruity between management and the public's attitude (Ostegren 2008). Issue salience among elected officials and the public is also a major, as well as perennial, problem of emergency management with a natural disaster context (Sylves 2008). Despite the inconsistencies in the public's collective opinion, as well as the recognition of a lack general knowledge on the subject, there is still an expectation the problem will be sufficiently addressed (Lowell 1921).

Knowledge.

Knowledge on any given issue is key to forming and discussing a qualified opinion, yet most people are ignorant on most issues outside one or two specific subjects (Iyengar and Kinder 1987; Carpini and Keeter 1996; Smith 2002). Unfortunately, this is the case for many natural resource policies or issues regardless of geographical location, especially those related to wildfire and land management (Tanz and Howard 1991). Particularly with land management in a wildfire context, the public is relatively ignorant and inconsistent on many issues related to mitigating wildfire risk and reducing some its ramifications (Tanz and Howard 1991; McCaffrey 2006). Even prior direct experience with a wildfire does not necessarily mean the individual or community will be any more knowledgeable on the issues or even alter their behavior as a result (Jacobson et al. 2001; Shindler et al. 2009). Currently, the field is heavily dominated by specialists and subject matter experts, and certain stakeholders to an extent, that are increasingly dedicating more time to public education than collaboration (Kodas 2017). This large "knowledge deficit" among the public raises the issue of how policy can reconcile the inputs of specialists and laypersons in environmental decision making (Lafferty and Meadowcroft 1996).

Moreover, the lack of a general natural resource management education among the public tends to lead to misunderstanding in the planning and decision-making process, which significantly increases the cost of collaboration (Tanz and Howard 1991).

Competing Interests.

Land managers are not only faced with an unknowledgeable public and complex issue domain, but a policy arena that is comprised of influential and competing special interests. Some of the major competing interests concerning natural resource management, and fire and land management policy in particular, are logging, grazing, recreationally, and environmentally based. Commercial logging and grazing, for instance, can represent a specific subsection of the population that participate in an occupation that has potentially strong cultural or historic significance (Bell and Oliveras 2006; Stephens et al. 2012; McCaffrey et al. 2013). Recreationist like hunters, hikers and bikers, or outdoor enthusiasts also have a significant base that pride themselves on their public land use, as well as have strong opinions on land management strategies (Englin 1996). Finally, environmentalist make up another powerful section of special interest groups that have been progressively more active since the turn of the twenty-first century (Pyne et al. 1996). From successfully advocating for the special protection of certain vulnerable nonhuman animal species to outright ending commercial logging operations in targeted areas, environmental groups have proven their effectiveness in impacting land management policy (Borchers 2005). Nevertheless, these interests are often on opposite sides of any given policy issue and frequently conduct contradictory public opinion campaigns that can stall comprehensive and ecologically sufficient land use policies (Haider-Markel 1997; Borchers 2005).

Summary

Geologists and other academics have proposed the planet has exited the relatively brief Holocene era and entered a new human dominated epoch – the Anthropocene (Monbiot 2013; Lorimer 2015). The acceptance of this thesis entails an understanding and acceptance of irreversible human influences on the planet, as well as a conception of how American democracy, environmental politics, and natural resource management will also be impacted as a result. As the focus of this current research is to examine these issues through the spectrum of wildfires, land management, and public opinion, placing the project within the broader context of a world completely dominated by humans is important in that it stresses a sort of collective responsibility to engage in essential decision-making. Further, exploring the nuances of natural resource management, by examining the broader relationship between the public and the bureaucracy, will ideally add to our overall understanding of the role of public opinion plays in bureaucratic decision-making. Although by no means a conclusive study, this research aims at contributing to the current literature by applying certain democratic principles and practices directly to an administrative case study like pre- and post-fire land management decisions.

To attempt to answer my research question – are policy or decision makers acting in accordance with public opinion? –, this project will do three things: 1) examine public opinion and survey data pertaining to pre- and post- fire land management strategies, public behavior, knowledge, and general demographic information, 2) explore the internal and external factors that influence land managers' policy decisions, and 3) compare and analyze these results looking for overall patterns that could be extrapolated to bring clarity to the broader policy domain. The second chapter examines public behavior, opinion and knowledge of wildfire issues as it relates to their direct support or opposition to land management techniques. Similarly, the third chapter tackles the same issue but is more concentrated on the public's perception of environmental or

ecological impacts as a result of a particular land management strategy. When taken together, these two chapters should provide valuable context to understanding public perceptions and opinions of complex natural resource management issues and how this potentially influences the collective decision-making process. The fourth chapter examines some of the primary factors, both internal and external, that influence land managers' decision-making in a post-fire context, with the objective being to illustrate whether the public is adequately, over- or under-represented in the process. Finally, I will provide a brief discussion and analysis of the primary findings of this project and some concluding remarks on their broader implications.

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CHAPTER TWO

Chemical Treatments, Mechanical Thinning, Livestock Grazing, and Prescribed Fire: Public Perceptions of Wildland Fuel Management

Introduction

Increasingly, land management agencies in the West are facing sharp increases in fire occurrences, sizes, and longer fire seasons, further contributing to an already tumultuous situation. Wildfires in the western United States, although not always detrimental, can have tremendous negative impacts on local ecosystems, economies, and communities that can last several years after a fire is extinguished. As for costs, what is reported by the media is often only a fraction of the actual economic impact of a fire and typically excludes rehabilitation or other direct and indirect costs that can persist well after containment (Dombeck et al. 2003). In fact, some of the societal impacts of wildfires – e.g. effects on health, recreation, air and water quality, employment, infrastructure closures, wildlife habitat loss, and damage to cultural heritage sites – have been estimated to cost taxpayers hundreds of millions of dollars annually on top of the suppression-related expenses (Western Forestry Leadership Coalition 2010; Jones et al. 2015; Hyde et al. 2017; Miller 2017; Rappold 2017). This sort of ambiguity in reporting can certainly contribute to a high level of distrust between the public and the land management agency that can weaken much needed collaboration. Recently, scholars have noticed the growing concerns among the public, wildfire researchers, and policymakers that reported cost represents a partial measure of the actual socioeconomic impact from wildfire, which ultimately limits the effectiveness of the decision- and policy-making process (Richardson et al. 2012).

In an effort to address these concerns as well as take proactive measures before a destructive fire occurs, many land management agencies have attempted to reduce fuel loads and

wildfire risk by engaging in pre-fire mitigation strategies like prescribed burns, mechanical thinning, chemical treatments, and targeted livestock grazing. Further, as wildfires in the western U.S. continue to increase in size and frequency, land managers will likely continue to attempt to reduce the risk of catastrophic fires by adopting fuel reduction strategies on public land. The public, however, may serve as a barrier to implementation for these treatments based off some sort of mixture between their wildfire knowledge, experience, and perception of the method. Land management agencies must therefore increase collaborative projects while simultaneously educating the public on their work and general wildfire issues (Swanson and Gilgert 2009). Still, this will not eradicate years of distrust, mismanagement, and lack of coordination between the agency and the public.

Due largely to a century of public land policy that encouraged the immediate suppression of all fires, many areas of the West have experienced a substantial amount of growth of invasive species – mainly *Bromus tectorum* (cheat grass). Cheat grass, along with mass accumulation of other surface and subsurface fuels, significantly increases the likelihood of a significant fire event occurring in the area (Miller et al. 2015). Land management agencies therefore have attempted to eradicate some of the risk by implementing prefire mitigation techniques. Depending on the region, however, managing fuel loads and removing or reducing the immediate risk of a large wildfire through fuel reduction techniques may be controversial. Whether the public's concern arises from a fear of losing access to recreational outlets, a lack of general fire knowledge, or even a high level of distrust for the land management agency in charge of implementing the fuel reduction strategy, the local populations' attitude can be very influential (Shindler and Cheek 1999; Jacobson et al. 2001; Brunson and Shindler 2004; Maguire and Albright 2005; Blanchard and Ryan 2007; Shindler et al. 2011). Therefore, land managers

have been particularly cognizant of the public's opinion and attitude towards various mitigation strategies and have consistently sought ways to bring the local population into the decision making process.

This contemporary arrangement raises an important question, what influences the public's support or opposition for pre-fire fuel treatments – specifically chemical treatments, mechanical thinning, livestock grazing, and prescribed burns– as a land management technique? To attempt to answer this question, I analyzed data collected from a public opinion survey conducted on Idaho State University's Pocatello campus two months after a couple of wildfires occurred less than five miles from city center (Evensen 2017; Evensen 2017). Due to the proximity of the fires to the city, as well as the location of Pocatello being in a fire-prone region, public opinion derived from the survey should closely resemble that of the broader population in the West. It is the goal of this project to provide a clearer picture of the potential reasons behind a population's support or opposition of land management strategies. Thus, garnering more insights into why a community, particularly in a fire-prone region, would oppose or support a specific strategy or policy, could be impactful for land managers and policymakers. The remainder of this project will briefly outline the history of wildfire in the West, public opinion, wildfire costs, wildfire risk, and land management techniques before exploring social scientific theories that will ultimately aid in our understanding some of the results.

Increase in human populations living near wildland-urban interface (WUI)

One of the most difficult to manage, as well as costly, changes in land use has been the increased number of homes close to the wildlands, which now accounts for one-third of all homes in the US (Theobald and Romme 2007; Martinuzzi et al. 2015). The wildland urban interface (WUI), where undeveloped wildland and human development meet, has made fire management

increasingly more costly and difficult (Calkin et al. 2015). WUI fires represent one of the most difficult problems agencies must manage because of the potential for loss of life, livelihoods, health, and property (Curth et al. 2012). In addition, individuals residing within the WUI are from varying socioeconomic backgrounds and their capacity to mitigate risk, protect property, and stimulate recovery differs (Bowker et al. 2008; Gordon et al. 2010). As public lands typically border private property, the need for coordination and cooperation between the two is necessary for policies to be successful (Weible et al. 2005; McCaffrey et al. 2013).

Current cost of wildfires

As the wildfire season and total acres burned have more than doubled in the past fifty years, specifically in the more arid western states, the total financial burden placed primarily on federal land management agencies is negatively impacting their budgets (USFS 2014). In response, land managers have begun exploring options to reduce hazardous fuel buildups and promote recovery to affected land post-fire (Burns and Cheng 2007; Schnase et al. 2014). Although fuel treatment methods account for a relatively small portion of these agencies' overall budget, the potential short and long term impact of a more aggressive, while successful, risk mitigation campaign can significantly cut into the overall wildfire costs.

The current cost of wildfires in the US is more than $2 billion annually in suppression-related expenses alone, with these costs accounting for only a fraction of the total economic impact of a fire event (Rahn 2009; Western Forestry Leadership Coalition 2009; USFS 2014). Estimating a comprehensive cost of wildfires can be a difficult undertaking given the far-reaching impacts of wildfire across multiple spectrums of the affected ecosystem and regional economy. Attempting to quantify some of these categories – e.g. a decline in air and water quality, loss of recreational or cultural heritage sites, and increased debris-flow probability – is

challenging as they represent indirect costs that might not be realized for several years or decades (Western Forestry Leadership Coalition 2010). Still, without a wide-ranging and aggressive fuels treatment policy, the total costs of each subsequent fire season is likely to increase continuously (Thompson et al. 2012).

The controversy of fuel treatment methods

Proactive land managers have several wildfire mitigation methods at their disposal. The most common techniques are chemical treatments, mechanical thinning, livestock grazing, and prescribed burns. Furthermore, the location of the proposed fuel treatments largely influences the type of methods used as well as public acceptability of the mitigation techniques. Whereas conventional management responses to wildfire (e.g. suppression, mechanical fuels reduction, prescribed fires, and timber salvage) were once unquestioned, they now face increasing public scrutiny (Borchers 2005). Without widespread public support for such treatments, the likelihood of successfully designing and implementing these fuel reduction strategies is low (Swanson and Gilgert 2009.

Livestock grazing on public lands, whether to reduce hazardous fuel buildups or to forage for economic gain, is a controversial issue for many ranching, environmental, and recreational groups (Englin et al. 1996; Diamond et al. 2009; Weber and Gokhale 2011). Environmental and recreational groups point towards the potential for soil, vegetation, and water degradation from aggressive grazing practices, while others point to the ecological benefits of well managed grazing practices (Holechek 1981; Loomis et al. 1989; Armour et al. 1991; Lacey et al. 1993; Pyne 1996; Savory 1999; Brunson and Tanaka 2011; Weber and Gokhale 2011). Some of these groups also argue livestock grazing on public lands significantly limits the forage available for big game – elk, moose, mule and whitetail deer – which over time limits the quantity of wildlife

in the area (Lacey et al. 1993). Ranching interests, however, claim they are heavily restricted in which public lands they can access and are generally unhappy about the level of involvement federal land agencies have over their land use (Center for Western Priorities 2014). Through the media, the public is typically only exposed to these two competing ideals over livestock grazing and little attention is given to determining the actual effects grazing has in reducing fuel loads in rangelands and forests (Steelman et al. 2014; Crow et al. 2016). In fact, the positive ecological impact livestock grazing on public lands can generate through reducing fuel buildups in grass and shrub communities is largely unnoticed by the public and media (Menke 1992; Diamond et al. 2009; Swanson and Gilgert 2009; Brunson and Tanaka 2011; Bruegger et al. 2016; Strand et al. 2016).

Concerns over the use of chemical treatments – i.e. unintended contamination, health risks, etc. – as a land management technique to reduce fuel and litter buildup is not as controversial or well known among the general public as livestock grazing (Paveglio et al. 2016). However, the deployment of chemicals to public lands to halt invasive species' germination and growth, is not without its own controversies. Mainly, many of the public's concerns of chemical treatments relate to issues like cost, effectiveness, and potentially negative outcomes for native flora and fauna (Shindler et al. 2009). As the public knows very little about the chemical treatment process, their concerns over cost and effectiveness could be addressed through outreach and educational campaigns provided by land management agencies (Bell and Oliveras 2006; Gordon et al. 2010; Hamilton et al. 2016; Paveglio et al. 2016).

The public's general perceptions on the use of mechanical thinning to mitigate wildfire risk is somewhat mixed, with a large portion of the WUI population supporting the efforts and an equal sized group rejecting the technique as hazardous and industry driven (McCaffrey et al.

2013). Environmentally oriented organizations suggest mechanical thinning is essentially an excuse by the commercial timber interests to log in areas otherwise restricted (Bell and Oliveras 2006). They argue these private companies are not simply removing the worthless underbrush that competes for water with mature tree stands and creates an unnecessary fire risk in dry regions, but actually harvesting valuable timber (Bell and Oliveras 2006; Reynolds et al. 2011). In addition, when mechanical thinning operations entail the use of heavy equipment, the issue of both long and short term ecological damages occur (Weible et al. 2005). Environmentalists suggest the use of heavy equipment can have a tremendous impact on already vulnerable ecological systems – i.e. irreparable flora or soil damage – that may not be able to recover naturally (Stephens et al. 2012; McCaffrey et al. 2013). Those residing within the WUI, however, are more likely to support mechanical thinning operations than other methods because of health, risk, and aesthetic perceptions (Weible et al. 2005; McCaffrey et al. 2013; Wibbenmeyer et al. 2013; Engebreston et al. 2016).

Prescribed fire is arguably the most controversial fuel reduction project a land management agency can undertake (Loomis et al. 2001; Bell and Oliveras 2006; Shindler et al. 2009; Gordon et al. 2010; Engebreston et al. 2016; Paveglio et al. 2016). Typically, the public's perception of prescribed fire is presented as negative due to either health concerns, loss of recreational opportunities, past experiences, limited trust of officials implementing the controlled burn, and portrayals of all fires through media and public outreach campaigns as bad (Bell and Oliveras 2006; Brown et al. 2007; Shindler et al. 2009; Gordon et al. 2010; Engebreston et al. 2016; Paveglio et al. 2016; Crow et al. 2017). Poor health effects associated with respiratory issues, negative past experiences, and powerful narratives or images of wildfire are extremely influential public concerns that can dissuade any land manager from attempting the fuels

reduction method (Paveglio et al. 2009). Evidence suggests, however, the public is more tolerant of the smoke from prescribed fires if their wildfire risk perception is high and they were at least somewhat informed or involved in the planning and implementation process (Paveglio et al. 2009). Equally important to the public's acceptability of prescribed fire is related to the level of trust the land management agency has in that particular area (Shindler et al. 2009; Paveglio et al. 2009; McCaffrey et al. 2013).

Major factors influencing public attitudes towards fuel treatment methods

Political scientists have long recognized the importance of understanding how individual behaviors and opinions influence policy preferences (Sears et al. 1980). The start of scientific public opinion surveying in the 1950s and 1960s provided a real opportunity to move beyond the insights of theorists and social commentators and begin to capture more of an accurate snapshot of American attitudes (Fishkin 1995; Dalton 2006). Extant literature has well established that public opinion, or survey-measured collective policy preferences, influences the public policymaking process and that there is a strong tendency for policy to move congruently with public opinion when the shift is in the liberal direction (Page and Shapiro 1983; Page 1994). This reflects an awareness that relationships between bureaucrats and citizens is important to the actual formation and implementation of public policy (Stivers 1990; McCaffrey 2006). In addition, advocates of public influence on policymaking have often endorsed increased reliance on polls as providing a solution to some of the weaknesses of American political institutions (Manza and Cook 2002). Perhaps more importantly, at least to this study, is that this literature has also demonstrated that public opinion can directly influence the actions of land management agencies and thus environmental goals in general (Buttel and Flinn 1976; Jacobson et al. 2001; Buttel and Flinn 2005; Shindler et al. 2009; Frederick 2014; Kooistra 2016).

According to the literature, the three major factors influencing whether the public supports or opposes a fuel treatment plan is 1) personal experience with wildfire, 2) their use of public lands, and 3) trust in land management agencies (Holechek 1981; Englin et al. 1996; Winter et al. 2002; Winter et al. 2004; Bell and Oliveras 2006; Brown et al. 2007; Steelman et al. 2015; Hamilton et al. 2016). These experiences and perceptions can directly affect the probability that a treatment method will be implemented or even successful (Gordon et al. 2010). Due to the importance land managers place on garnering public support for such mitigation techniques, they make serious efforts to consider how various subgroups of the population – e.g. recreationists, the aging and vulnerable, and homeowners – will be impacted by such fuel reduction strategies (Shindler and Cheek 1999; Jacobson et al. 2001; Brunson and Shindler 2004; Maguire and Albright 2005; Blanchard and Ryan 2007; Shindler et al. 2011).

Experiencing significant wildfire events personally can have a tremendous influence on whether an individual supports or rejects certain fuel treatment plans (Shindler et al. 2009). For example, if an individual has a significant to moderate respiratory condition, as well as experienced negative health effects as a result of smoke-related particulates from wildfire, this would likely lead to them not supporting a prescribed burn in the area (Bell and Oliveras 2006; Kochi et al. 2010; Engebreston et al. 2016; Liu et al. 2016). However, if a person has experienced some sort of property damage or threat of property or structure loss from a wildfire they are likely to support aggressive fuel treatment plans to reduce the risk (Bell and Oliveras 2006; Burn and Cheng 2007; Crow et al. 2017). Irrespective of the specific personal experience or circumstance, these situations have a significant effect on an individual's perceptions and opinions on how land managers should go about reducing the risk of catastrophic fires.

Another key influencing factor on attitudes towards fuel reduction is how individuals interact with public lands. Recreational activities like hunting, hiking, biking, birding, and many others require various ecological conditions to be in place for full enjoyment and the destruction, or improvement, from wildfire events can be a significant driving force behind these recreationists' opinions (Lacey et al. 1993; Englin et al. 1996; Loomis et al. 2001; Hesseln et al. 2003; Brown et al. 2007; Brunson and Tanaka 2011). If various activities are restricted or temporarily banned due to a fire event, then those that are directly affected will likely support less invasive fuel reduction treatments that will not negatively influence their recreational activities (Englin et al. 1996). Contrarily, those recreationists like big game hunters who could see benefits – e.g. an increase in targeted game in the area – from certain low- to moderate fire burns would advocate for or support less invasive treatment methods (Brown et al. 2007). However, those that use public lands for profit – like ranching operations – will have different attitudes towards certain fuel reduction techniques as it may impact their ability to utilize the land for their own personal gain (Holechek 1981; Swanson and Gilgert 2009; Strand et al. 2014). In these cases, how fuel treatments improve or harm these various activities or one's profits will directly influence their attitudes and perceptions towards any wildfire risk mitigation.

Arguably, one of the more influential factors for determining individual attitudes and opinions towards various fuel reduction treatments is their trust of the land management agency in charge of carrying out such plans (Davis 2001; Winter et al. 2002; Winter et al. 2004; Crow et al. 2017). Bowker et al. (2008) highlights certain levels of trust among the public is largely influenced by race and socioeconomic status, with those in lower income brackets and belonging to minority groups having very low levels of trust for federal and state land management agencies. Moreover, those that have negative experiences with land managers or their agencies –

e.g. through past perceived mistakes on behalf of these agencies or failure to respond adequately to fire events – also are more skeptical of any aggressive treatment plan that is proposed (Steelman et al. 2015; Paveglio et al. 2016). Land managers can attempt to earn public trust, however, if they are transparent with their mitigation strategies and involve the public in every facet of the planning and implementation process (Winter et al. 2002; Lijeblad et al. 2009). This can be done by notifying the local community about a proposed plan, elicit meaningful feedback, and keep the residents up-to-date about its progress. Without earning or maintaining the public's trust, land managers face an uphill battle in implementing much needed fuels reduction strategies throughout the West.

This study hopes to contribute to the existing literature by providing an examination into the determinants of public perceptions on fuel load reduction techniques by looking at residents of a WUI and their use of public lands, knowledge of wildfire, and trust in state and federal government. Although several studies previously mentioned have looked at issues like behavior, attitude, trust, and knowledge to help explain why the public opposes or supports fuels treatment, none of have, to my knowledge, examined these variables collectively. By examining the more influential behaviors, attitudes, and knowledge of a WUI population, land managers will ideally be able to select a fuel mitigation strategy the meshes with the local populace and receives widespread public support.

Methods

To understand what predicts the likelihood of the public supporting or opposing fuel treatment methods as a land management technique, a public opinion survey, using a convenience sample to select respondents, was conducted using undergraduate and graduate students, over the age of

eighteen, at ISU in the fall 2017. Ultimately, 338 students agreed to participate in the survey sometime in October of that year.

Table 2.1: Coding and Questions for Primary Dependent, Independent, & Control Variables

Variables	Survey Question	Coding
Bike (behavior)	How frequently do you engage in the following activities on public lands?	1= Never 2= Less than once a month 3= Once a month 4= 2-3 times a month 5= Once a week 6= More than once a week
Hike (behavior)	How frequently do you engage in the following activities on public lands?	1= Never 2= Less than once a month 3= Once a month 4= 2-3 times a month 5= Once a week 6= More than once a week
Hunt (behavior)	How frequently do you engage in the following activities on public lands?	1= Never 2= Less than once a month 3= Once a month 4= 2-3 times a month 5= Once a week 6= More than once a week
Regional Concern (knowledge)	Wildland fire is a major concern to Idaho and most other western states.	1= Strongly disagree 2= Disagree 3= Neither agree or disagree 4= Agree 5= Strongly Agree
Frequency (knowledge)	Wildland fires are decreasing in both size and frequency across the western United States every year.	1= Strongly disagree 2= Disagree 3= Neither agree or disagree 4= Agree 5= Strongly Agree
Costs (knowledge)	The cost to suppress wildland fires across the western United States is more than the cost to rehabilitate the land post-fire.	1= Strongly disagree 2= Disagree 3= Neither agree or disagree 4= Agree 5= Strongly agree
Federal Government (trust)	Please indicate your level of trust in the following.	1= Strongly distrust 2= Distrust 3= Neither trust nor distrust 4= Trust 5= Strongly trust
State Government (trust)	Please indicate your level of trust in the following.	1= Strongly distrust 2= Distrust 3= Neither trust nor distrust

		4= Trust 5= Strongly trust
Age (demographics)	What is your age?	1= 18 to 30 years of age 2= 31 to 45 years of age 3= 46 and older
Female (demographics)	What is your gender?	1= Male 2= Female 3= Other
Political Ideology (demographics)	Which of the following best describes your political orientation?	1= Very liberal 2= Liberal 3= Moderate 4= Conservative 5= Very conservative
Year in School (demographics)	Which of the following best represents your classification at ISU?	1= Freshman 2= Sophomore 3= Junior 4= Senior 5= Fifth-year Senior or higher 6= Master's student 7= Doctoral student
Student SEC (demographics)	In terms of income, how would you classify yourself?	1= Working class 2= Lower-middle class 3= Middle class 4= Upper-middle class 5= Upper class
Prescribed Fire	Land managers should use prescribed fire as a technique to mitigate wildland fire risk.	1= Strongly disagree 2= Disagree 3= Neither agree or disagree 4= Agree 5= Strongly agree
Chemical Treatments	Land managers should use chemical treatments as a technique to mitigate wildland fire risk.	1= Strongly disagree 2= Disagree 3= Neither agree or disagree 4= Agree 5= Strongly agree
Mechanical Thinning	Land managers should use mechanical thinning as a technique to mitigate wildland fire risk.	1= Strongly disagree 2= Disagree 3= Neither agree or disagree 4= Agree 5= Strongly agree
Livestock Grazing	Land managers should use livestock grazing as a technique to mitigate wildland fire risk.	1= Strongly disagree 2= Disagree 3= Neither agree or disagree 4= Agree 5= Strongly agree

The dependent variables for this analysis assessed the public's likelihood that they will support or oppose one of the four fuel loads reduction methods – chemical treatments, mechanical thinning, livestock grazing, and prescribed burns – in order to reduce the risk of costly and catastrophic wildfires. To measure the dependent variables, the study used a question battery to ascertain the levels of agreement, or disagreement, with each of the fuel treatments garnered from the public. The survey question(s) – "Land managers should use [chemical treatments, mechanical thinning, livestock grazing, and prescribed burns] as a technique to mitigate wildland fire risk" – were evaluated using a Likert scale where 1 = strongly disagree, 2= disagree, 3 = neither agree nor disagree, 4 = agree, and 5 = strongly agree, and asked respondents to grade their position for land managers using a given fuel reduction technique to reduce wildland fire risk. Further, due to the way the dependent variable is coded, an ordered logit is the most appropriate analytical strategy and statistical model.[1]

The primary independent variables used in this study are trust in government, wildfire knowledge, and public land use (Table 2.1). First, this study examined the influence of trust by measuring an individual's trust in federal and state governments. I anticipated that those who have greater trust in both federal and state government will be more likely to support proposed fuel loads reduction projects.

Second, I examined the influence of wildfire knowledge by measuring the respondents' knowledge of wildfire frequency, regional susceptibility, and total costs of a fire event. I anticipated that individuals who demonstrate a relatively accurate representation of wildfire issues will be more likely to understand the consequences of wildfire and therefore would support aggressive prefire land management techniques.

[1] See Appendix A for a more comprehensive description.

Finally, I looked at the influence different types of public land use – specifically biking, hiking, and hunting – by individuals played in determining their likelihood to support or oppose hazardous fuel reduction methods. Again, I anticipated individuals who frequently use public lands for recreational activities would have stronger opinions toward fuel loads reduction techniques than those who infrequently recreate on public land.

The statistical model used in this study will also control for a variety of additional influences – i.e. basic demographics – that previous research suggests may be important for predicting the likelihood the public will support or oppose fuel reduction strategies (Loomis et al. 2001; Lijeblad et al. 2009; Kooistra 2016; Kolden 2019). Specifically, I will examine the influences that age, gender, political ideology, class standing, and a students' socioeconomic condition have on individuals' opinion or perception on land management techniques. Although I will not focus on these variables, they are still significant to the study as they serve as controls and guiding markers for our model.

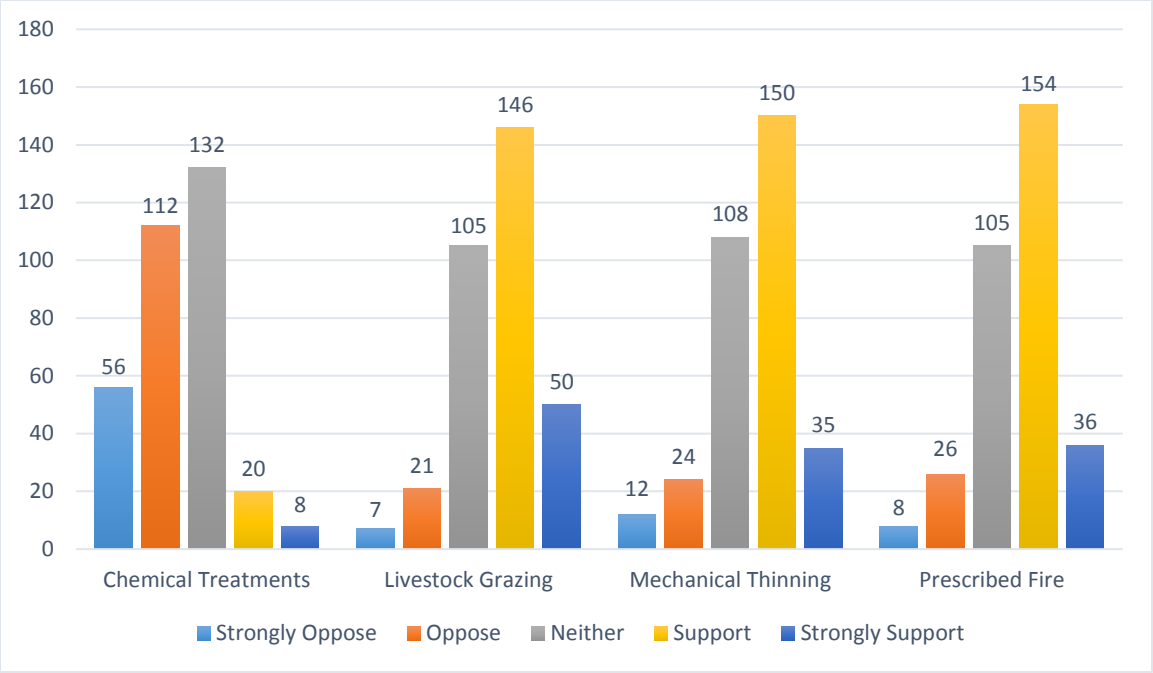
The main goal of this study was to provide a more nuanced understanding of what drives public perceptions of controversial fuel loads reduction methods. Given this, I hypothesized (H1) that individuals who recreate on public lands will support hazardous fuel reduction treatments, (H2) individuals who demonstrate high levels of knowledge about wildfire issues will support hazardous fuel reduction treatments, and (H3) individuals who have high levels of trust for federal and state governments will support hazardous fuel reduction treatments.

Results

The results of our statistical model will be divided into four sections – chemical treatments, mechanical thinning, livestock grazing, and prescribed fire – and I will discuss how knowledge, trust, and types of public land use influenced the public's perceptions of these treatment

methods. The results of all four models will be presented in the same table, Table 2.2, to allow comparisons across models.

Figure 2.1: Public opinion of fuel loads reduction methods.



Chemical Treatments

This section will explain how the independent variables of knowledge, trust, and public land use, influences the dependent variable of public perceptions of chemical treatments to reduce hazardous fuel loads.

Knowledge

First, I will focus on the results for the fuel loads reduction strategy of chemical treatments and the influences that knowledge of wildfire issues has on public opinion. In Table 2.1, the results illustrate that knowledge of wildfire issues in regards to regional concern and total costs was not a predictor of whether an individual will support or oppose chemical treatments. However, perception of chemical treatments and the knowledge on fire frequency in the West was a

predictor. In other words, those who perceived wildfire frequency as on the rise in the western U.S. were also more likely to support chemical treatments as a land management technique.

Table 2.2: Determinants of Public Support for Hazardous Fuel Treatments

	Chemical		Livestock		Mechanical		Prescribed	
	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
Behavior								
Bike	-.134 (.086)	0.120	-.083 (.105)	0.427	.062 (.094)	0.512	.195 (.089)	0.030
Hike	-.086 (.098)	0.382	.034 (.097)	0.723	.061 (.104)	0.560	-.011 (.101)	0.911
Hunt	.029 (.120)	0.803	.409 (.154)	0.008	.223 (.141)	0.114	.269 (.130)	0.039
Knowledge of wildfire								
Regional Concern	-.195 (.174)	0.262	.727 (.171)	0.000	.294(.158)	0.064	.198 (.171)	0.249
Frequency	.462 (.148)	0.002	-.225 (.151)	0.136	-.139 (.130)	0.286	-.120 (.145)	0.406
Costs	.209 (.143)	0.144	.270 (.152)	0.076	.153 (.166)	0.355	0.037 (.154)	0.808
Trust								
Fed. Govt.	-.121 (.144)	0.399	.009 (.120)	0.938	.043 (.143)	0.760	.325 (.154)	0.035
State Govt.	.023 (.172)	0.893	.227 (.156)	0.145	.140 (.181)	0.439	.076 (.170)	0.652
Demographics								
Age	-.004 (.002)	0.105	-.005 (.002)	0.007	.000 (.002)	0.829	.003 (.002)	0.079
Female	-.046 (.228)	0.838	.109 (.223)	0.623	.079 (.248)	0.749	-.171 (.242)	0.480
Political Ideology	-.088 (.139)	0.527	.365 (.151)	0.016	.036 (.154)	0.815	.176 (.147)	0.231
Year in School	.039 (.066)	0.550	.042 (.069)	0.542	.101 (.061)	0.099	.188 (.068)	0.006
Stud. SEC	-.042 (.125)	0.738	.103 (.115)	0.371	-.087 (.127)	0.493	-.210 (.138)	0.129
Cut Point 1	-2.252 (.873)		.311 (.795)		-.120 (.814)		-1.347 (.950)	
Cut Point 2	-.490 (.843)		1.853 (.737)		.015 (.782)		.203 (.913)	
Cut Point 3	2.010 (.820)		4.124 (.811)		1.944 (.803)		2.146 (.945)	
Cut Point 4	3.245 (.822)		6.631 (.886)		4.484 (.855)		4.835 (.994)	
Number of Cases	295		295		294		295	
Wald Chi²	55.47	0.00	30.18	0.004	32.76	0.001	25.53	0.019
Log Pseudolikelihood	-338.038		-354.581		-365.281		-365.108	

Robust standard errors in parentheses. Two-tailed tests.

Trust

Turning our attention to the next variable, I found that individual's trust in both federal and state government are not predictors of their support of the use of chemical treatments. Therefore, there is likely little relationship, positive or negative, between the trust in government and support of chemical treatments.

Behavior

Perhaps an individual's behaviors and familiarity with this environment will influence their support for chemical treatments. Specifically, this analysis examines those who bike, hike, and hunt. The results suggest that individuals' public land use activities is not a predictor of whether an individual will support or oppose chemical treatments. Therefore, there is likely little relationship, positive or negative, between individuals' use of public land and support for chemical treatments.

Demographics

Looking at the control variables, I found that demographical influences on opinions of chemical treatments were nonexistent. Therefore, there is likely little relationship, positive or negative, between demographical characteristics and support of chemical treatments.

Prescribed Fire

This section will explain how the independent variables of knowledge, trust, and behavior, influences the dependent variable of public perceptions of prescribed fire to reduce hazardous fuel loads.

Knowledge

I begin with an analysis of the respondents' wildfire knowledge and its influence over the public's perception of prescribed fire. Focusing on Table 2.2, the results highlight that

knowledge of wildfire issues – i.e. regional concern, frequency, and total costs – was not a predictor of whether an individual will support or oppose prescribed fire. Therefore, I can state that there is likely no relationship, positive or negative, between the selected issues on wildland fire knowledge and prescribed fires.

Trust

Turning our attention to the next variable, I found that individual's trust in both federal and state government as predictors of their support of prescribed fire were mixed. Looking at Table 2.2, trust in state government agencies was not a predictor of whether the public would support or oppose prescribed burns. On the other hand, trust in federal government agencies and support for prescribed burns was a predictor, which suggests those who expressed trust in the federal agencies were more likely to support prescribed burns as a strategy to reduce wildfire risk and fuel loads.

Behavior

Looking at public land use, or behavior, and its influence over the public's perception of prescribed fire provided mixed results. Turning to Table 2.2, the results illustrate that two of the public land use activities – biking and hunting – are strong predictors in determining whether an individual will support or oppose prescribed burns, while hiking was not a factor. Further, I see a relationship between the two independent variables and the dependent variable with a positive correlation, which indicates support for the method. Therefore, there is likely a positive relationship between those individuals who recreate by either biking or hunting and their support for prescribed fires as a method to reduce hazardous fuel buildups.

Demographics

Turning our attention to the demographical information, I found that age was a predictor of whether an individual will support or oppose prescribed fire with older individuals supporting the technique more so than their younger counterparts do. Moreover, individuals who described themselves as being upper classmen or higher were more likely to support prescribed burns than those from the lower class rankings.

Mechanical Thinning

This section will explain how the independent variables of knowledge, trust, and public land use, influences the dependent variable of public perceptions of mechanical thinning to reduce hazardous fuel loads.

Knowledge

The results of the influence of wildfire knowledge on public perceptions of mechanical thinning were mixed. In Table 2.2, the results illustrate that knowledge of regional concerns of wildfire were strong predictors in determining if an individual would support mechanical thinning operations to reduce hazardous fuel loads. Therefore, there is likely a positive relationship between individuals' wildfire knowledge and their support for mechanical thinning. Additionally, I can state that those who perceive wildfire as a serious concern for the state of Idaho, as well as the other western states, were more likely to support mechanical thinning as a measure to reduce wildfire risks in the region. Further, much like the prior results of knowledge on perceptions of prescribed burns, the opinions on the frequency of fires as well as the total costs of wildfires were not strong predictors, either positive or negative, on views of mechanical thinning.

Trust

Focusing on trust, I found that individual's trust in both federal and state government are not predictors of their support of the use of mechanical thinning. Therefore, there is likely little relationship, positive or negative, between the trust in government and support of chemical treatments.

Behavior

Turning to the next variable, I found that respondents' public land use activities – i.e. biking, hiking, and hunting – and its influence over the public's perception of mechanical thinning are not strong predictors. Therefore, there is likely little relationship, positive or negative, between behavior and support of mechanical thinning.

Demographics

Turning our attention to the demographical information, I found that age was a predictor of whether an individual will support or oppose prescribed fire with older individuals supporting the technique more so than their younger counterparts do. Moreover, individuals who described themselves as being upper classmen or higher were more likely to support prescribed burns than those from the lower class rankings.

Livestock Grazing

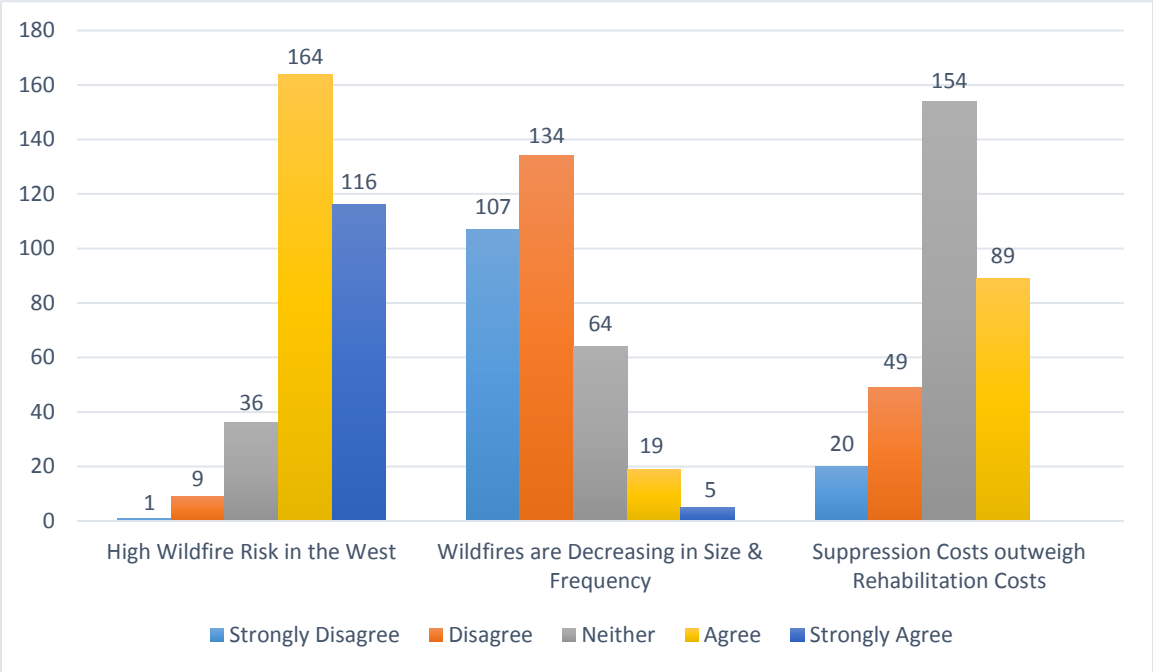
This section will explain how the independent variables of knowledge, trust, and public land use, influences the dependent variable of public perceptions of livestock grazing to reduce hazardous fuel loads.

Knowledge

The results of the respondents' perceptions of livestock grazing provide the strongest predictor of support for any of the fuel treatment methods based off knowledge of wildfire issues. Although knowledge of wildfire frequency is not an indicator of whether the public would support or oppose

livestock grazing to reduce fuel loads, both perceived knowledge on total fire costs and regional concern are strong predictors. Looking at Table 2.2, the results illustrate that knowledge about regional concerns of wildfire and total costs of fire events have a positive correlation.

Figure 2.2: Public knowledge of wildfire issues.



Trust

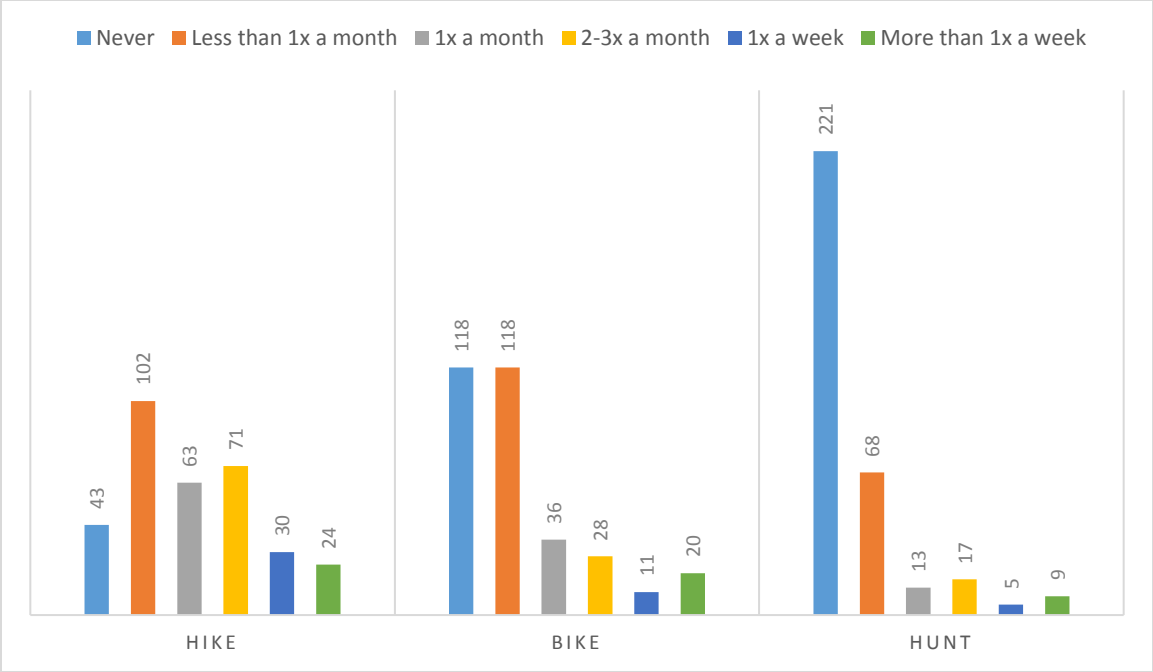
Similar to the prior results on mechanical thinning, the respondents' trust in both federal and state government and its influence over the public's perception of livestock grazing were not strong predictors. Therefore, there is likely little relationship, positive or negative, between trust and livestock grazing.

Behavior

The results of behavior on public land and its influence over the public's perception of livestock grazing to reduce fuel loads were mixed. Looking at Table 2.2, specifically at the rows covering

biking and hiking on public land, I see no indicators that these recreational activities are predictors in determining whether an individual supports or opposes livestock grazing as a land management technique. However, the results do highlight that hunting on public lands is a very strong predictor that an individual will support livestock grazing. Further, as the relationship is a positive one, I suggest that those individuals who recreate on public lands by hunting will also be more likely to support livestock grazing to reduce fuel loads.

Figure 2.3: Frequency of public land use by activity.



Demographics

Looking at the control variables, I found that demographical influences on opinions of livestock grazing were mixed. Only political ideology – specifically conservatism – was a strong predictor for whether individuals would be more likely to support this treatment method.

Discussion and Conclusion

I started this project in order to gauge perceptions of fuel loads reduction strategies. As land managers have become increasingly dependent on the approval of the public for implementing pre- and post- fire land management projects, inquiring about the perceptions of those who reside in a fire prone region is important. Moreover, their responses, and the subsequent results, will assist land managers, wildfire researchers, WUI residents, and local stakeholders in determining what influences the public's overall support or opposition of land management techniques.

My first hypothesis – individuals who recreate on public lands will support hazardous fuel reduction treatments – was largely rejected as individuals who recreate on public lands were not necessarily in favor of these fuel loads reduction treatments uniformly. The only recreational activities that demonstrated influence over public perception were by individuals who hunt – which were only likely to support prescribed fires and livestock grazing – and those who biked – which were only likely to support prescribed fires. Previous relevant literature, as well as theory, on recreating on public lands and the opinions of those individuals who participate in these activities suggest that I should have seen acceptance, or support, for the highlighted fuel treatment methods. One potential explanation as to why our results did not support the findings of previous studies is that there might be little salience among the survey population about how wildfires on public lands could negatively impact recreational activities for several years after the fire is contained and extinguished. Another possible explanation could be that the respondents know very little about the fuel reduction methods themselves and this could have resulted in the limited belief in their efficacy to reduce fire risk.

The second of my hypotheses – individuals who demonstrate high levels of knowledge about wildfire issues will support hazardous fuel reduction treatments – was also largely rejected

as individuals' knowledge on wildfire issues did not translate to widespread acceptance of treatment methods. Although the results of knowledge and the subsequent perceptions of fuel reduction treatments more closely fits with previous research and theory, it too had mixed results. Knowledge on wildfire frequency influenced an individuals' support for chemical treatments but had little impact on the other treatment methods. Similarly, knowledge on the increasing costs of wildfire only predicted an individual's opinions on livestock grazing, while regional concern for fire played a role on opinion for both livestock grazing and mechanical thinning. According to theory and prior research, I should have seen fire knowledge influencing individuals' perceptions of support for each fuel treatment technique. Again, a possible explanation could be that the respondents know very little about the fuel reduction methods themselves and this could have resulted in the limited belief in their efficacy to reduce fire risk. Despite the recent fire a couple of miles from town, there appears to be a lack of understanding about the risks and costs of fire and the primary mechanisms for reducing the risk of fire. This suggests that public education campaigns are likely necessary.

Finally, the last hypothesis – individuals who have high levels of trust for federal and state government will support hazardous fuel reduction treatments – was almost universally rejected, as trust in government did not translate to acceptance of the fuel treatment plans. Trust in federal government only predicted the public's support of prescribed fires, while trust in state government was not a predictor in any model. One possible explanation for these results is that the respondents are unfamiliar with the duties and work of land management agencies and therefore did not see them as being a necessary entity in ensuring successful treatment methods are implemented.

For future research on this or similar topics, I would suggest expanding the battery of questions on all independent variables – trust, knowledge, and public land use – to be as comprehensive as possible. Due largely to space constraints on this particular survey, I was unable to provide more than a handful of questions on each variable, which leaves the possibility that a key element of the public's perception on reducing fuel loads was missing. In addition, although ISU's student population provides a solid mixture of traditional and nontraditional students, which more closely mirrors the demographics of the region than a typical university would, perhaps broadening the respondents' pool to include local residents would provide a more accurate depiction of the opinions of the targeted WUI community.[2] Another potential option to consider would be to conduct the survey during the heart of fire season, or even while an area wildfire was burning, to ensure more salience of the topic. This alteration may lead to more variations in the responses and perceptions of the public who would be contemporaneously facing the actual impacts of wildfires rather than possibly thinking hypothetically.

[2] See Appendix B for a table on the descriptive statistics of survey respondents.

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CHAPTER THREE

Perceptions of Environmental Impacts: Public Opinion of Wildland Fuel Management

Introduction

Wildfire, as an essential ecological process, is necessary to the health of western forests, rangelands, and wetlands (Kauffman 2004). Although not always detrimental, wildfires in the western United States can have tremendous negative impacts on local ecosystems, economies, and communities that can last several years after a burn (Rahn 2009; Western Forestry Leadership Coalition 2009; USFS 2014). The total cost of wildfire for the U.S. is often far greater than what is reported by the media and strains the already limited resources of land management agencies. The hundreds of millions of dollars used to suppress wildfires are typically reported as the actual cost of the fire. However, this estimate normally does not include rehabilitation or other direct and indirect costs that persist well after a fire has been extinguished (Dombeck et al. 2003). The full costs related to watershed damage resulting in debris flows, flooding, soil erosion, and in some cases an increase in invasive plant species, might not be fully realized until years or decades after a fire. These costs can easily surpass suppression expenses (Western Forestry Leadership Coalition 2010). Richardson and colleagues (2012) note concerns are growing among the public, wildfire researchers, and policymakers that the reported costs represent only a partial measure of the actual socioeconomic impact from wildfire, limiting the effectiveness of the decision- and policy-making process. For example, some of the societal impacts of wildfires – effects on health, recreation, air and water quality, employment, infrastructure closures, wildlife habitat loss, and damage to cultural heritage sites – have also been underreported. As negative externalities stemming from wildfires, these should be included

in the total cost of a fire event to gain a more accurate portrayal of the social and economic impacts of wildfire.

In an effort to address these concerns and be proactive before a destructive fire occurs, many land managers have attempted to reduce fuel loads and wildfire risk by engaging in pre-fire mitigation strategies like prescribed burns, mechanical thinning, chemical (herbicide) treatments, and targeted livestock grazing. As wildfires in the western U.S. continue to increase in size and frequency, land managers will likely continue to attempt to reduce the risk of catastrophic fires by adopting fuel reduction strategies on public land.

Due largely to over a century of public land policy encouraging the immediate suppression of all fires, many areas of the West have experienced substantial expansion of invasive species – mainly *Bromus tectorum* (cheat grass) – and an accumulation of fuels which increase the likelihood of a significant fire event occurring in the area. Depending on the region, however, managing fuel loads and removing or reducing the immediate risk of a large wildfire through fuel reduction techniques may be controversial. Whether the public's concern arises from a fear of losing access to recreational outlets, harming the ecosystem, a lack of general fire knowledge, or even a high level of distrust for land management agencies in charge of implementing the fuel reduction strategy, the local populations' attitude can be very influential (Shindler and Cheek 1999; Jacobson et al. 2001; Brunson and Shindler 2004; Maguire and Albright 2005; Blanchard and Ryan 2007; Shindler et al. 2011). Therefore, land managers have been particularly cognizant of the public's opinion and attitude towards various mitigation strategies and have consistently sought ways to bring the local population into the decision making process.

This raises an important question, what influences an individual's perception of the ecological ramifications from one of the pre-fire fuel treatments – specifically chemical treatments, mechanical thinning, livestock grazing, and prescribed burns?

Increase in human populations living in the wildland-urban interface (WUI)

One of the most difficult to manage and costly changes in land use has been the increased number of homes close to, or intermixing with, wildlands, which now account for one-third of all homes in the US (Theobald and Romme 2007; Martinuzzi et al. 2015). Despite the differences in way land management agencies define the WUI, three components – human presence, wildland vegetation, and their proximity with one another – are always included (Stewart et al. 2007). We accept the commonly used definition of the WUI as that area where undeveloped wildlands and human developments meet, which making fire management increasingly more costly and difficult (Calkin et al. 2015). WUI fires represent one of the most difficult problems agencies must manage because of the potential for loss of life, livelihoods, health, and property (Curth et al. 2012). In addition, individuals residing within the WUI are from varying socioeconomic backgrounds and their capacity to mitigate risk, protect property, and stimulate recovery differs (Bowker et al. 2008; Gordon et al. 2010). As public lands typically border private property, the need for coordination and cooperation between the two is necessary for policies to be successful (Weible et al. 2005; McCaffrey et al. 2013).

Current cost of wildfires

As the total acres burned has more than doubled in the past fifty years, specifically in more arid western states, the financial burden placed primarily on federal land management agencies is impacting their budgets (USFS 2014). In response, land managers have begun exploring options to reduce hazardous fuel buildups and promote recovery of fire-affected lands (Burns and Cheng

2007; Schnase et al. 2014). Although fuel treatment methods account for a relatively small portion of these agencies' overall budget, the potential short and long term impacts of a more aggressive risk mitigation campaign has the potential to significantly reduce overall wildfire costs.

Estimating a comprehensive cost of wildfires can be a difficult undertaking given the far-reaching impacts of wildfire on the affected ecosystem and regional economy. Attempting to quantify some of these costs – e.g. a decline in air and water quality, soil degradation, loss of recreational or cultural heritage sites, and increased debris-flow probability – is challenging as they represent indirect costs that might not be realized for several years or decades (Western Forestry Leadership Coalition 2010). Still, without a wide-ranging and aggressive fuels treatment policy, the total cost of each subsequent fire season is likely to increase continuously (Thompson et al. 2012).

The controversy of fuel treatment methods

Land managers, in an attempt to be proactive, have several wildfire mitigation methods at their disposal. The most common fuel load reduction techniques are chemical treatments, mechanical thinning, targeted livestock grazing, and prescribed burns. Furthermore, the location of the proposed fuel treatments largely influences the type of methods used, as well as public acceptance of the mitigation technique. Whereas conventional management responses to wildfire (e.g. suppression, mechanical fuels reduction, prescribed fires, and timber salvage) were once unquestioned, they now face increasing public scrutiny (Borchers 2005). Without widespread public support for such treatments, the likelihood of successfully designing and implementing these fuel reduction strategies is low.

Livestock grazing on public lands, whether to reduce hazardous fuel buildups or to forage for economic gain is a controversial issue for many ranching, environmental, and recreational groups (Englin et al. 1996; Diamond et al. 2009; Weber and Gokhale 2011). Environmental and recreational groups point towards the potential for soil, habitat, vegetation, and water degradation from aggressive grazing practices (Holechek 1981; Loomis et al. 1989; Armour et al. 1991; Lacey et al. 1993; Pyne 1996) while others point to the ecological benefits of well-managed grazing practices (Savory 1999; Brunson and Tanaka 2011; Weber and Gokhale 2011). Some of these groups also argue livestock grazing on public lands significantly limits the forage available for big game – elk, moose, mule and whitetail deer – which over time limits the quantity of wildlife in the area (Lacey et al. 1993). Ranching interests, however, claim they are heavily restricted in which public lands they can access and are generally unhappy about the level of involvement federal land agencies have over their land use (Center for Western Priorities 2014). Through the media, the public is typically only exposed to these two competing ideals over livestock grazing and little attention is given to determining the actual effects grazing has in reducing fuel loads in rangelands and forests (Steelman et al. 2014; Crow et al. 2017). In fact, the positive ecological impact livestock grazing can generate through reducing fuel buildups in grass and shrub communities goes largely unnoticed by the public and media (Menke 1992; Diamond et al. 2009; Swanson and Gilgert 2009; Brunson and Tanaka 2011; Weber and Gokhale 2011; Bruegger et al. 2016; Strand et al. 2016).

Concerns over the use of chemical treatments, an herbicidal application, as a land management technique to reduce fuel and litter buildup is not as controversial or well known among the general public as livestock grazing (Paveglio et al. 2016). However, the deployment of chemicals to public lands to halt invasive species' germination and growth is not without its

own controversies. Mainly, many of the public's concerns of chemical treatments relate to issues like cost, effectiveness, and potentially negative outcomes for native flora and fauna (Shindler et al. 2009). The ecological concerns, although still debatable, potentially indicate a deep-seated public anxiety about broad chemical applications to public lands and the potential human-contact factor. As the public knows very little about the chemical treatment process, their concerns over cost and effectiveness could be addressed through outreach and educational campaigns provided by land management agencies (Bell and Oliveras 2006; Gordon et al. 2010; Hamilton et al. 2016; Paveglio et al. 2016).

The public's general perceptions on the use of mechanical thinning to mitigate wildfire risk is somewhat mixed, with a large portion of the WUI population supporting the efforts and an equal sized group rejecting the technique as hazardous and industry driven (McCaffrey et al. 2013). Within the national forests of the West, debates over the management of these fire-prone forests can get quite contentious (Noss et al. 2006). Environmentally oriented organizations suggest mechanical thinning is essentially an excuse by the commercial timber interests to log in areas otherwise restricted (Bell and Oliveras 2006). They argue these private companies are not simply removing the worthless underbrush that creates an unnecessary fire risk in dry regions, but actually harvesting valuable timber. Post-fire (salvage) logging, as Noss et al. (2006) explain, also does not contribute to the ecological recovery process and in fact may have a negative impact. In addition, when mechanical thinning operations entail the use of heavy equipment, the issue of both long and short term ecological damages arise (Weible et al. 2005). Environmentalists suggest the use of heavy equipment can have tremendous impact on already vulnerable ecological systems that may not be able to recover naturally (Stephens et al. 2012; McCaffrey et al. 2013). Loomis et al. (1997) also captured the public's concern over a particular

species, like the Spotted Owl, whose habitat would be directly affected by mechanical thinning. Those residing within the WUI, however, are more likely to support mechanical thinning operations than other methods because of health, risk, and aesthetic perceptions (Weible et al. 2005; McCaffrey et al. 2013; Wibbenmeyer et al. 2013; Engebreston et al. 2016).

Prescribed fire is arguably the most controversial fuel reduction project a land management agency can undertake (Loomis et al. 2001; Bell and Oliveras 2006; Shindler et al. 2009; Gordon et al. 2010; Engebreston et al. 2016; Paveglio et al. 2016). Typically, the public's perception of prescribed fire is presented as negative due to either health or ecological concerns, loss of recreational opportunities, past negative experiences, limited trust of officials implementing the controlled burn, and portrayals of all fires through media and public outreach campaigns as bad (Bell and Oliveras 2006; Brown et al. 2007; Shindler et al. 2009; Gordon et al. 2010; Engebreston et al. 2016; Paveglio et al. 2016; Crow et al. 2017). Poor health, negative past experiences, and powerful narratives or images of wildfire as the enemy are extremely influential public concerns that can dissuade any land manager from attempting the fuels reduction method (Paveglio et al. 2009). In addition, much like the habitat concerns over Spotted Owls in forest settings, prescribed fire is a concern of those interested in promoting the stability of rangeland species like the Sage Grouse (Pyle and Crawford 1996; Nelle et al. 2000; Connelly et al. 2000; Beck et al. 2009). Evidence suggests, however, the public is more tolerant of the smoke from prescribed fires if their wildfire risk perception is high and they were at least somewhat informed or involved in the planning and implementation process (Paveglio et al. 2009;). Equally important to the public's acceptability of prescribed fire relates to the level of trust the land management agency has in that particular area (Shindler et al. 2009; Paveglio et al. 2009; McCaffrey et al. 2013).

Major factors influencing public attitudes towards fuel treatment methods

Extant literature has well established that public opinion influences the public policymaking process (Page and Shapiro 1983; Burstein 2010). Perhaps more importantly, this literature has also demonstrated that public opinion directly influences the actions of land management agencies (Shindler and Cheek 1999; Jacobson et al. 2001; Brunson and Shindler 2004; Maguire and Albright 2005; Blanchard and Ryan 2007; Shindler et al. 2011). Accordingly, understanding the determinants of public support, opposition, or concern is essential for land management agencies to navigate the implementation of these important wildfire management techniques.

There are a number of possible explanations for why an individual would perceive a particular wildfire management technique as harmful or beneficial to a targeted ecosystem. In particular, this project turns to the political science literature for guidance on predicting policy support or opposition. Perhaps not surprisingly, there is a large body of literature that explores public perceptions of policy. In particular, we will focus on the literature regarding personal behaviors, knowledge, trust, and personal demographic characteristics. Political scientists have long recognized the importance of understanding how individual behaviors influence policy preferences (Sears et al. 1980). Personality, genetics, knowledge, attitudes, trust, risk perception and many other factors impact how an individual behaves, especially in times of high stress and uncertainty (Druckman 2001; Jacobson et al. 2001; Mumpower et al. 2013; Smith et al. 2014; Robinson et al. 2017).

The three major factors influencing whether the public supports or opposes a fuel treatment plan are 1) personal experience with, or knowledge of, wildfire, 2) their use of public lands, and 3) trust in land management agencies (Holechek 1981; Englin et al. 1996; Winter et al. 2002; Winter et al. 2004; Bell and Oliveras 2006; Brown et al. 2007; Steelman et al. 2015;

Hamilton et al. 2016). One area often overlooked within these three factors, however, is the public's perceptions of the potential ecological impacts a fuel loads reduction techniques may cause. Nonetheless, these experiences and perceptions can directly affect the probability that a treatment method will be implemented or even successful (Gordon et al. 2010). Due to the importance land managers place on garnering public support for such mitigation techniques, they make serious efforts to consider how various subgroups of the population – e.g. recreationists, the aging and vulnerable, and homeowners –, as well as the local ecosystem, will be impacted by such fuel reduction strategies (Shindler and Cheek 1999; Jacobson et al. 2001; Brunson and Shindler 2004; Maguire and Albright 2005; Blanchard and Ryan 2007; Shindler et al. 2011).

Another key influencing factor on perceptions of ecological impact of a fuel reduction strategy is how individuals interact with public lands. Recreational activities like hunting, hiking, biking, and birding require various ecological conditions be in place for full enjoyment. The destruction (or improvement) from wildfire events can be a significant driving force behind the recreationists' opinions (Lacey et al. 1993; Englin et al. 1996; Loomis et al. 2001; Hesseln et al. 2003; Brown et al. 2007; Brunson and Tanaka 2011). If various activities are restricted or temporarily banned due to a fire event, then those that are directly affected will likely support less invasive fuel reduction treatments that will not negatively influence their recreational activities (Englin et al. 1996). In contrast, those recreationists like big game hunters who could see benefits – e.g. an increase in big game in the area – from certain low- to moderate fire burns would advocate for or support less invasive treatment methods (Brown et al. 2007). However, those that use public lands for profit – like ranching operations – will have different attitudes towards certain fuel reduction techniques as it may impact their ability to utilize the land for their own personal gain (Holechek 1981; Swanson and Gilgert 2009; Strand et al. 2014). In these

cases, how fuel treatments improve or harm these activities or one's profits, through the promotion or degradation of an area's ecological health, will directly influence their attitudes and perceptions towards any wildfire risk mitigation.

Arguably, one of the more influential factors for determining individual perceptions of the ecological impacts of various fuel reduction treatments is their trust of the land management agency in charge of carrying out such plans (Davis 2001; Winter et al. 2002; Winter et al. 2004; Crow et al. 2017). Bowker et al. (2008) highlights certain levels of trust among the public is largely influenced by race and socioeconomic status, with those in lower income brackets and belonging to minority groups having very low levels of trust for federal and state land management agencies. Moreover, those that have negative experiences with land managers or their agencies – e.g. through past perceived mistakes on behalf of these agencies or failure to respond adequately to fire events – also are more skeptical of any aggressive treatment plan that is proposed (Steelman et al. 2015; Paveglio et al. 2016). Land managers can attempt to earn public trust, however, if they are transparent with their mitigation strategies and involve the public in every facet of the planning and implementation process (Winter et al. 2002; Lijeblad et al. 2009). This can be done by notifying the local community about a proposed plan, elicit meaningful feedback, and keep the residents up-to-date about its progress. Without earning or maintaining the public's trust, land managers face an uphill battle in implementing much needed fuels reduction strategies throughout the West.

This study hopes to contribute to the existing literature by providing an examination into the determinants of public perceptions of fuel load reduction techniques by looking at residents of a WUI and their use of public lands, knowledge of wildfire, and trust in state and federal government. Although several studies previously mentioned have looked at issues like behavior,

attitude, trust, and knowledge to help explain why the public opposes or supports fuels treatment, none have, to my knowledge, examined these variables with regards to ecological ramifications or collectively. By examining the more influential behaviors, attitudes, and knowledge of a WUI community, land managers will ideally be able to select a fuel mitigation strategy the meshes with the local populace and receives widespread public support.

Methods

In order to help explain what predicts the likelihood of the public perceiving fuel treatments as ecologically beneficial or harmful, a public opinion survey, using a convenience sample to select respondents, was conducted using undergraduate and graduate students, over the age of eighteen, at ISU in the fall 2017. Ultimately, 338 students agreed to participate in the survey in October of that year.

Table 3.1: Coding and Questions for Primary Independent Variables & Control Variables

IV	Survey Question	Coding
Bike (behavior)	How frequently do you engage in the following activities on public lands?	1= Never 2= Less than once a month 3= Once a month 4= 2-3 times a month 5= Once a week 6= More than once a week
Hike (behavior)	How frequently do you engage in the following activities on public lands?	1= Never 2= Less than once a month 3= Once a month 4= 2-3 times a month 5= Once a week 6= More than once a week
Hunt (behavior)	How frequently do you engage in the following activities on public lands?	1= Never 2= Less than once a month 3= Once a month 4= 2-3 times a month 5= Once a week 6= More than once a week

Regional Concern (knowledge)	Wildland fire is a major concern to Idaho and most other western states.	1= Strongly disagree 2= Disagree 3= Neither agree or disagree 4= Agree 5= Strongly Agree
Frequency (knowledge)	Wildland fires are decreasing in both size and frequency across the western United States every year.	1= Strongly disagree 2= Disagree 3= Neither agree or disagree 4= Agree 5= Strongly Agree
Costs (knowledge)	The cost to suppress wildland fires across the western United States is more than the cost to rehabilitate the land post-fire.	1= Strongly disagree 2= Disagree 3= Neither agree or disagree 4= Agree 5= Strongly agree
Federal Government (trust)	Please indicate your level of trust in the following.	1= Strongly distrust 2= Distrust 3= Neither trust nor distrust 4= Trust 5= Strongly trust
State Government (trust)	Please indicate your level of trust in the following.	1= Strongly distrust 2= Distrust 3= Neither trust nor distrust 4= Trust 5= Strongly trust
Age (demographics)	What is your age?	1= 18 to 30 years of age 2= 31 to 45 years of age 3= 46 and older
Female (demographics)	What is your gender?	1= Male 2= Female 3= Other
Political Ideology (demographics)	Which of the following best describes your political orientation?	1= Very liberal 2= Liberal 3= Moderate 4= Conservative 5= Very conservative
Year in School (demographics)	Which of the following best represents your classification at ISU?	1= Freshman 2= Sophomore 3= Junior 4= Senior 5= Fifth-year Senior or higher 6= Master's student 7= Doctoral student
Student SEC (demographics)	In terms of income, how would you classify yourself?	1= Working class 2= Lower-middle class 3= Middle class 4= Upper-middle class

		5= Upper class

The dependent variables for this analysis assesses the public's likelihood that they will perceive fuel treatments – chemical treatments, mechanical thinning, livestock grazing, and prescribed burns – as ecologically beneficial or harmful. To measure the dependent variables, the study used a question battery to ascertain the levels of ecological concern with each of the fuel treatments. The survey asks – "On a scale from 1 to 5, where 1 represents 'Very Beneficial' what kind of ecological/environmental impact would you expect each of the following land management techniques [chemical treatments, mechanical thinning, livestock grazing, and prescribed burns] to have?" Further, due to the way the dependent variables were coded, an ordered logit is the most appropriate analytical strategy and statistical model.[3]

The primary independent variables used in this study are trust in government, wildfire knowledge, and public land use (Table 3.1). First, this study examined the influence of trust by measuring an individual's trust in federal and state governments. I anticipated that those who have greater trust in both federal and state government will be more likely to perceive greater ecological benefits from fuel reduction strategies.

Second, I examined the influence of wildfire knowledge by measuring the respondents' knowledge of wildfire frequency, regional susceptibility, and total costs of a fire event. I anticipated that individuals who demonstrate a relatively accurate representation of wildfire issues will be more likely to perceive positive ecological impacts from prefire land management techniques.

[3] See the Appendix section for a more comprehensive description.

Finally, I looked at the influence different types of public land use – specifically biking, hiking, and hunting – by individuals played in determining their likelihood to support or oppose fuel reduction methods. Again, I anticipated individuals who frequently use public lands for recreational activities would perceive greater ecological benefits from fuel reduction techniques.

The statistical model used in this study controlled for a variety of additional influences – i.e. basic demographics – that previous research suggests may be important for predicting the likelihood the public will support or oppose fuel reduction strategies (Loomis et al. 2001; Lijeblad et al. 2009; Kooistra 2016; Kolden 2019). For instance, I will examine the influences that age, gender, political ideology, class standing, and a students' socioeconomic condition have on individuals' opinion or perception on land management techniques. Although I will not focus on these variables, they are still significant to the study as they serve as controls and guiding markers for our model.

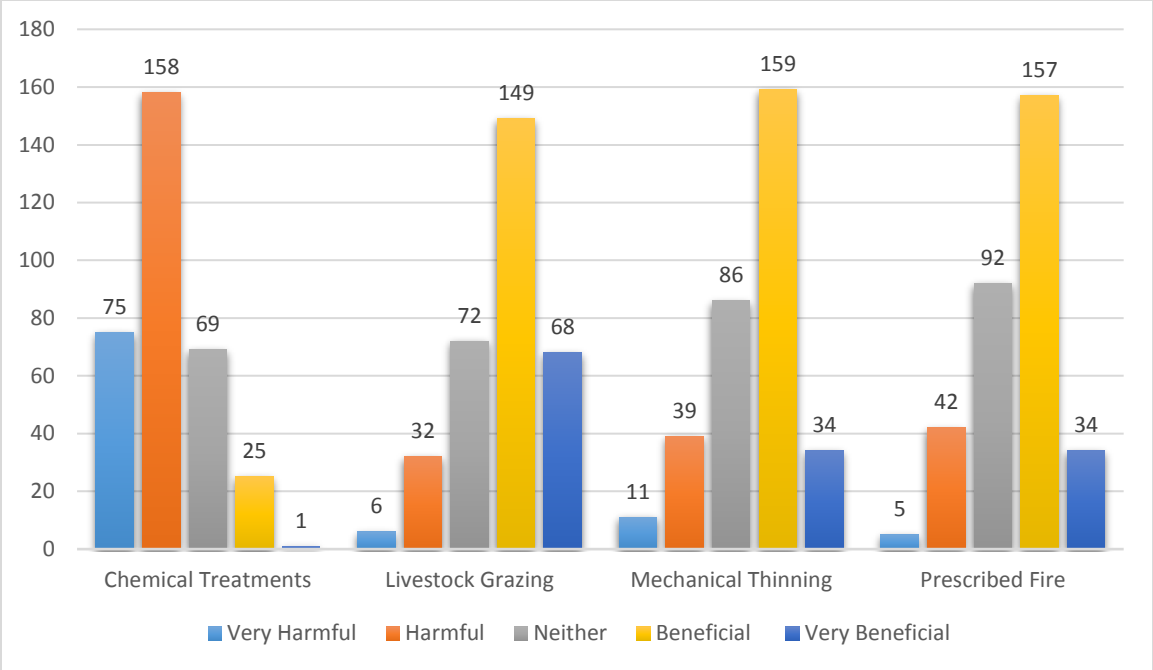
The main goal of this study was to provide a more nuanced understanding of what drives public perceptions of controversial fuel loads reduction methods. Given this, I hypothesized (H1) that individuals who recreate on public lands will perceive greater ecological benefits as a result of fuel reduction treatments, (H2) individuals who demonstrate high levels of knowledge about wildfire issues will perceive greater ecological benefits as a result of fuel reduction treatments, and (H3) individuals who have high levels of trust for federal and state governments will perceive greater ecological benefits as a result of fuel reduction treatments

Results

The results of our statistical model will be divided into four sections – chemical treatments, mechanical thinning, livestock grazing, and prescribed fire – and I will discuss how knowledge, trust, and types of public land use influenced the public's perceptions of the ecological

circumstances behind these treatment methods. The results of all four models will be presented in the same table, Table 3.2, to allow comparisons across models.

Figure 3.1: Public Perceptions of Fuel Treatment Methods on Ecological Health.



Chemical Treatments

This section explains how the independent variables of knowledge, trust, and public land use, influences the dependent variable of perceptions of chemical treatment on ecological health. The model, however, failed and the results are only speculative at best.

Knowledge

First, I will focus on the results for the perceptions of chemical treatment on ecological health. In Table 3.2, the results suggest that knowledge of wildfire was not a predictor on whether an individual perceived chemical treatments as ecologically beneficial or harmful (Table 3.2). However, perception of chemical treatments and knowledge on fire frequency in the West was a

positive predictor. In other words, those respondents who correctly identified an increase in wildfire frequency were more likely to perceive chemical treatments as ecologically beneficial.

Table 3.2: Determinants of Public Perceptions on Ecological Impacts of Hazardous Fuel Treatments

	Chemical		Livestock		Mechanical		Prescribed	
	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
Behavior								
Bike	-.083 (.088)	0.348	-.038 (.094)	0.687	.008 (.097)	0.932	.038 (.092)	0.679
Hike	-.054 (.103)	0.601	-.026 (.091)	0.776	-.008 (.096)	0.926	.110 (.092)	0.232
Hunt	.136 (.115)	0.238	.251 (.137)	0.068	.204 (.163)	0.212	.295 (.131)	0.025
Knowledge of wildfire								
Regional								
Concern	.064 (.182)	0.723	.507 (.174)	0.004	.272 (.160)	0.089	.125 (.166)	0.450
Frequency	.408 (.159)	0.011	-.203 (.132)	0.125	-.190 (.143)	0.183	-.123 (.150)	0.410
Costs	-.032 (.156)	0.834	.171 (.155)	0.271	-.058 (.155)	0.707	-.193 (.151)	0.203
Trust								
Fed. Govt.	-.112 (.132)	0.396	-.080 (.130)	0.536	.020 (.120)	0.864	.230 (.142)	0.106
State Govt.	-.028 (.176)	0.872	.278 (.158)	0.079	.085 (.155)	0.583	-.043 (.168)	0.797
Demographics								
Age	-.000 (.001)	0.912	-.005 (.001)	0.006	-.002 (.002)	0.255	-.008 (.002)	0.001
Female	-.031 (.232)	0.892	.477 (.239)	0.046	.015 (.234)	0.947	-.197 (.232)	0.396
Political Ideology	.104 (.135)	0.440	.304 (.130)	0.020	.021 (.132)	0.873	.146 (.138)	0.293
Year in School	.063 (.066)	0.336	-.060 (.067)	0.542	.025 (.059)	0.661	.180 (.065)	0.006
Stud. SEC	-.004 (.133)	0.973	.180 (.120)	0.371	.019 (.122)	0.872	.012 (.135)	0.926
Cut Point 1	-.635 (.835)		-.700 (.842)		-2.630 (.790)		-2.918 (.885)	
Cut Point 2	1.593 (.831)		1.221 (.829)		-.761 (.730)		-.557 (.830)	
Cut Point 3	3.202 (.790)		2.637 (.856)		.648 (.734)		1.025 (.846)	
Cut Point 4	6.390 (1.203)		4.959 (.920)		3.257 (.771)		3.863 (.889)	
Number of Cases	293		292		294		295	
Wald Chi²	14.050	0.370	40.280	0.000	8.950	0.776	30.180	0.004
Log Pseudolikelihood	-349.629		-361.668		-374.015		-354.581	

Robust standard errors in parentheses. Two-tailed tests.

Trust

Turning our attention to the next variable, I found that respondents' trust in both federal and state governments are not predictors of their perceptions of the ecological impacts of chemical treatments. Therefore, there is likely little relationship, positive or negative, between individuals' use of public land and support for chemical treatments.

Behavior

Perhaps an individual's behaviors and familiarity with this environment will influence their perception of the ecological impact of chemical treatments. Specifically, this analysis examines those who bike, hike, and hunt. The results suggest that individuals' public land use activities is not a predictor of whether an individual will perceive chemical treatments as having an impact, positive or negative, on a targeted ecosystem. Therefore, there is likely little relationship, positive or negative, between individuals' use of public land and perceptions of chemical treatments.

Demographics

Looking at the control variables, I found that demographical influences on perceptions of the ecological impact of chemical treatments were nonexistent. Therefore, there is likely little relationship, positive or negative, between demographical characteristics and perceptions of chemical treatments.

Prescribed Fire

This section will explain how the independent variables of knowledge, trust, and public land use, influences the dependent variable of the public perceptions of prescribed fire on ecological health. The model, however, failed and the results are only speculative at best.

Knowledge

I begin with an analysis of the respondents' wildfire knowledge and its influence over the public's perception of the ecological impact of prescribed fire. Focusing on Table 3.2, the results highlight that knowledge of wildfire issues – i.e. regional concern, frequency, and total costs – was not a predictor of whether an individual will perceive prescribed fire as having an ecological impact. Therefore, I can state that there is likely no relationship, positive or negative, between the selected issues on wildland fire knowledge, ecological impacts, and prescribed fires.

Trust

Turning our attention to the next variable, I found that individual's trust in federal and state governments as predictors of their perceptions of the ecological impact of prescribed fire were largely absent.

Behavior

Looking at public land use, or behavior, and its influence over the public's perception of the ecological ramifications of prescribed fire provided mixed results. Turning to Table 3.2, the results illustrate that one of the public land use activities –hunting – is a strong predictor in determining whether an individual will perceive prescribed fire as being ecologically beneficial or harmful. Further, I see a relationship between the independent variable and the dependent variable with a positive correlation, which indicates a "beneficial" belief. Therefore, there is likely a positive relationship between those individuals who recreate on public lands by hunting and their perception that prescribed fires ecologically enhance a targeted area.

Demographics

Turning our attention to the demographical information, I found that age was a predictor of whether an individual will perceive prescribed fire as being ecologically beneficial, with older individuals supporting the technique more so than their younger counterparts do.

Mechanical Thinning

This section will explain how the independent variables of knowledge, trust, and public land use, influences the dependent variable of the public perceptions of mechanical thinning on ecological health.

Knowledge

The results of the influence of wildfire knowledge on public perceptions of mechanical thinning and its ecological impact were mixed. In Table 3.2, the results illustrate that knowledge of regional concerns of wildfire were strong predictors in determining if an individual would perceive mechanical thinning as being ecologically beneficial or harmful (Table 3.2). Further, there is likely a positive relationship between those who identify wildfire as a serious concern for the state of Idaho, as well as the other western states, and their likelihood to perceive mechanical thinning as a measure to benefit the local ecosystem.

Trust

Focusing on trust, I found that individual's trust in both federal and state government are not predictors of their perception of the ecological impact of mechanical thinning. Therefore, there is likely little relationship, positive or negative, between the trust in government and support of chemical treatments.

Behavior

Turning to the next variable, I found that respondents' public land use activities – i.e. biking, hiking, and hunting – and its influence over the public's perception of mechanical thinning are not strong predictors. Therefore, there is likely little relationship, positive or negative, between behavior and perceptions of ecological impacts of mechanical thinning.

Demographics

Looking at the control variables, I found that demographical influences on perceptions of the ecological impact of mechanical thinning were nonexistent. Therefore, there is likely little relationship, positive or negative, between demographical characteristics and perceptions of chemical treatments.

Livestock Grazing

This section will explain how the independent variables of knowledge, trust, and public land use, influences the dependent variable of the public perceptions of livestock grazing on ecological health.

Knowledge

The results of the respondents' wildfire knowledge provided the strongest predictor for perceptions of the ecological impacts of livestock grazing. Although knowledge of wildfire frequency and cost is not an indicator of whether the public perceive livestock grazing as ecologically beneficial or harmful, perceived knowledge on regional concern is a strong predictor. Looking at Table 3.2, the results illustrate that knowledge about regional concerns of wildfire has a positive correlation. Furthermore, I can suggest that individuals who perceive wildfires as being a regional concern will likely also perceive livestock grazing as a method to promote ecological health. In addition, with the model fit statistics indicating that the model performs well, I are rather comfortable suggesting these results are accurate.

Trust

Similar to the prior results on mechanical thinning, the respondents' trust in federal government and its influence over the public's perception of ecological livestock grazing were not strong predictors. Therefore, there is likely little relationship, positive or negative, between trust in federal government and perceptions of ecological impact of livestock grazing. However, as

identified in Table 3.2, trust in state governments is a strong predictor and suggests that those who trust the state agencies are more likely to perceive livestock grazing as being ecologically beneficial.

Behavior

The results of behavior on public land and its influence over the public's perception of the environmental impacts of livestock grazing were mixed. Looking at Table 3.2, specifically at the rows covering biking and hiking on public land, I see no indicators that these recreational activities are influential in determining whether an individual will perceive livestock grazing as ecologically beneficial or harmful. However, the results do highlight that hunting on public lands is a strong predictor of an individual's perceptions of the ecological impacts of livestock grazing. Further, as the relationship is a positive one, I suggest that those individuals who recreate on public lands by hunting will also be more likely to perceive livestock grazing as ecologically beneficial.

Demographics

Looking at the control variables, I found that demographical influences on opinions of livestock grazing were mixed. Political ideology – specifically conservatism – was a strong predictor for whether individuals would be more likely to perceive this treatment method as being ecologically beneficial. In addition, I found that age was a predictor of whether an individual will perceive livestock grazing as being ecologically beneficial, with older individuals supporting the technique more so than their younger counterparts do.

Discussion and Conclusion

This project sought to gauge the public's perception of the ecological impacts of fuel loads reduction strategies. As land managers have become increasingly dependent on the approval of

the public for implementing pre- and post- fire land management projects, inquiring about public perception from those who reside in a fire prone region is important. Moreover, their responses, and the subsequent results, will assist land managers, wildfire researchers, WUI residents, and local stakeholders in determining what influences the public's overall support or opposition of land management techniques.

Our first hypothesis – individuals who recreate on public lands will perceive greater ecological value as a result of fuel reduction treatments – was largely rejected as individuals who recreate on public lands were not necessarily more likely to perceive ecological impacts. The only recreational activity that predicted public perception were by individuals who hunt. These individuals were likely to perceive the positive benefits of prescribed fires and livestock grazing. Perhaps this is because removing the excess growth would make it easier for hunting. One potential explanation as to why our results did not support the findings of previous studies is that there might be little salience among the survey population about how wildfires on public lands could negatively impact recreational activities for several years after the fire is contained and extinguished. Another possible explanation could be that the respondents knew very little about the fuel reduction methods, and therefore were unable to distinguish attitudes regarding the ecological impact of these methods.

The second of our hypotheses – individuals who demonstrate high levels of knowledge about wildfire will perceive full treatment methods as ecologically beneficial – was largely rejected. Although the results of knowledge and the subsequent perceptions of fuel reduction treatments more closely fits with previous research and theory, it too had mixed results. Knowledge on wildfire frequency is suggestive that it might be a predictor of an individuals' perception for chemical treatments, but it had little impact on the perception of other treatment

methods. Similarly, knowledge of the increasing costs of wildfire had little impact on the ecologically-based perceptions of the fuel reduction techniques. However, knowledge of the regional concern of wildfires appears to be a predictor of those believing livestock grazing is generally positive from an ecological perspective. Additionally, the results suggest that this knowledge might also be a predictor of believing mechanical thinning is good for the environment. A possible explanation for the lack of predictability could be the respondents knew very little about fuel reduction methods resulting in the limited belief in their efficacy to reduce fire risk. Indeed, if one knows little about, say, mechanical thinning, it may be difficult to assess the ecological impact of this process. Accordingly, while a respondent might be more knowledgeable about basic concepts related to wildfires, it does not mean that they understand the specifics of any of these land management techniques.

Finally, the last hypothesis – individuals who have high levels of trust for federal and state government will perceive positive ecological impacts from fuel reduction treatments – was widely rejected. Trust in state government only influenced the public's perception of livestock grazing, while trust in the federal government was not an influential factor in any of the models. Arguably, one possible explanation for these results not supporting theory is that the respondents were unfamiliar with the duties of land management agencies and therefore did not see them as being a necessary entity in ensuring successful treatment methods were implemented.

For future research on this or similar topics, I would suggest expanding the battery of questions on all independent variables – trust, knowledge, and public land use – to be as comprehensive as possible. Due largely to space constraints on this particular survey, I were unable to provide more than a handful of questions on each variable, which leaves the possibility that a key element of the public's perception on reducing fuel loads was missing. In addition,

although ISU's student population provides a solid mixture of traditional and nontraditional students, which more closely mirrors the demographics of the region than other universities , perhaps broadening the respondents' pool to include local residents would provide a more accurate depiction of the opinions of the targeted community. Another option would be to conduct the survey during the fire season, or even while a wildfire was burning in the area, to ensure more salience of the topic. This alteration may lead to more variations in the responses and perceptions of the public who would be contemporaneously facing the actual impacts of wildfires rather than possibly thinking hypothetically.

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CHAPTER FOUR

Innovation and Diffusion of Geospatial Tools for Post-Fire Decision Support: A Case Study using the NASA RECOVER Decision Support System (DSS)

Introduction

Public opinion – positive, negative, or indifferent – can have a tremendous impact on decision makers in a natural disaster context (Petak 1985; Pilgrim 1999; Pearce 2002). From policies implemented to resources adopted, decision making in this type of emergency context can be highly scrutinized (Petak 1985; West and Orr 2007). Identifying the actual congruence between public opinion and decision makers' policy adoption and implementation is the key focus of this overall project.

Research on the diffusion of innovations and policy is a major area of emphasis for students of American politics. Diffusion scholars have devoted a significant amount of their focus to state policy adoption and state-to-state diffusion, largely overlooking the separate and similar processes for federal and state agencies (Berry and Berry 2007). Although some studies have examined the diffusion process when facilitated by federal agencies, like Stoutenborough and Beverlin's (2008) examination of net metering and the Environmental Protection Agency, attention is more commonly placed on how the policy or innovation diffused across states and not agencies themselves.

U.S. federal and state land agencies, for instance, despite having similar or cooperative visions, responsibilities, and policies, provide a relatively fair amount of autonomy in management and oversight decisions to their respective local offices (Kaufman 1960; Culhane 1981; May et al. 1996; Ellison 2001). Therefore, the adoption of new technologies, like geospatial tools, to assist and compliment the efforts made by land managers and their staff to

collect and analyze relevant data needed in wildfire emergency response planning, is largely left to the local or regional decision maker. Given the lack of a centralized control mechanism that dictates how land managers can approach their duties, as well as the importance of individual users in GIS adoption research (Nedovic-Budic and Godschalk 1996), interviewing the individuals in leadership positions at these agencies would provide insight into how and why geospatial tools are diffused and adopted. This is not to suggest, however, that these agencies lack a top-down hierarchy without any centralized direction or oversight, but rather to indicate the amount of influence local decision makers can have on the overall adoption and diffusion process.

U.S. land management agencies, both state and federal, provide a suitable case study to examine further the concept of GIS diffusion and innovation within and across government agencies. For example, Li and Sui (2011) identify the diffusion of technological innovation is the most important field in diffusion research and as land managers utilize various geospatial technologies in multiple settings, they are an ideal group to evaluate innovation, adoption, and diffusion. Land management agencies face consistent obstacles managing the public's land, natural resources, and promoting ecosystem health. Added to this list of priorities is the necessity to prepare, respond, and recover from natural and manmade disasters such as wildland fire. As wildfires in the western U.S. continue to increase in size and frequency, without a concomitant increase in the number of personnel managing wildfires, fire managers will likely grow progressively more reliant on geospatial data and satellite imagery to aid in performing their duties. Further, because technological innovation is widely seen as a means for raising productivity levels for state and local entities (Feller 1980), land management agencies who

adopt would likely influence other regions within the same agency, as well as outside agencies with similar responsibilities and capacity, to innovate.

This raises an important question, what influences individual land managers to adopt a new geospatial technology? Using data collected from twenty semi-structured interviews with state and federal users of RECOVER, this chapter examines the internal and external factors that cause an institution or individual to adopt a new technological innovation. In addition, using Roger's (1962) five classes of adopter categorization – i.e. innovators, early adopters, early majority, late majority, and laggards – we compare the adoption rate of RECOVER and the innovativeness of interviewed land managers to illustrate the widespread acceptance and usability of this decision support system. The results reveal RECOVER has a higher than average rate of innovators, as well as highlights the importance of communication channels in the adoption and diffusion process of geospatial tools for land management purposes.

Background

The NASA RECOVER decision support system (DSS) is made up of a RECOVER Server and a RECOVER Client. The RECOVER Server is highly automated using Python scripting within the ArcGIS platform. The RECOVER Client is a full-featured Web Map/GIS analysis environment. When provided a wildfire name and geospatial extent, the RECOVER Server aggregates site-specific data from numerous geospatial datasets residing on the server and exposes a tailored collection of site-specific data to the RECOVER Client through web services. RECOVER is transforming the information-intensive planning process by reducing from days to a matter of minutes the time required to assemble and deliver crucial wildfire-related data (Schnase et al. 2014). The adoption and diffusion rate of RECOVER by land management

agencies and similar users, as well as the internal and external factors that influenced the innovation-diffusion process, is the focus of this study.

Although the theoretical concept of diffusion has been around since Herodotus wrote *The Histories* around 440 BC, Gabriel Tarde (1843-1904) arguably elevated diffusion research to a serious academic pursuit in the 19th C. through his work in the fields of criminology and sociology (Rogers 1976; Kinnunen 1996). Significantly ahead of his time in diffusion research, Tarde identified certain rules about the diffusion of innovations which are still relevant today (Rogers 1995). One of Tarde's major contributions to diffusion scholarship was to stress the importance of the actual event of "imitation" – i.e. adoption – or rejection of an innovation and the prominent role of opinion leaders in the process (Rogers 1962; Rogers 1976; Kinnunen 1996). Tarde's work had a particularly significant impact on prominent social scientists in America, especially rural sociologists like Everett Rogers (Rogers 1962; Katz et al. 1963; Kinnunen 1996; Valente and Davis 1999). Although diffusion research went through a period of relative stagnation, a series of independent intellectual enclaves resurrected the field in the 1940s and 1950s (Ryan and Gross 1943; Ryan and Gross 1950; Rogers 1976; Rogers 1995). Around the mid-1960s interest in diffusion studies was apparent among consumer researchers who focused on a particular type of innovation – the act of purchasing a new product – which spurred further development in the field of marketing (Rogers 1976). Rogers, however, often receives the bulk of the credit for increasing the awareness of diffusion studies through his monumental book *Diffusion of Innovations* and its subsequent editions (Kinnunen 1996).

Building upon Tarde's work, Rogers (1962; 1995; 2003) outlined five stages of the adoption process – knowledge, persuasion, decision, implementation, and confirmation – which support the long recognized notion that an individual's decision about an innovation is not an

instantaneous act, but rather a process (Kinnunen 1996; Rogers 2003). With a pro-innovation bias (Rogers 1976), the subjects are evaluated based on their ability to rapidly incorporate new methods, products, and policies. Rogers (1962; 1995; 2003) categorized and ranked those who adopt a new innovation or idea, and the timeliness in which they adopted, as innovators (2.5%), early adopters (13.5%), early majority (34%), late majority (34%), and laggards (16%). Innovators are those willing to take risks and adopt something new within a very short timeframe comparatively (Rogers 1962). Early adopters are those early consumers of something new, but are not the first generation of adopters (Rogers 1962; 1995; 2003). Individuals who are categorized as being a part of the early majority are adopters of a new item significantly after the innovator and early adopters (Rogers 1962; 1995; 2003). Finally, those in the late majority category adopt after the average participant and laggards are typically the last to adopt (Rogers 1962). This breakdown suggests that the bulk of adoption occurs a few years after the innovations' initial introduction to the potential adopter community. The social system in which this potential adopter community functions is also of importance as their hierarchy and types of interactions can influence the adoption rate (Ryan and Gross 1943; Ryan and Gross 1950).

Rogers (1962) defines the diffusion of innovations as the process by which information about an innovation is communicated through certain channels, over time, among the members of a social system. The innovation can be an idea, practice, or object and is perceived as new by an individual or other relevant unit of adoption (Rogers 1976). For fire and land management, continued and effective communication in areas like fire risk information is needed to instill a certain degree of knowledge (McCaffrey 2008). In addition, the quality, duration, and type of communication among the members of a particular social network – i.e. GIS managers for land management agencies – is quite influential in the overall diffusion and adoption process of GIS

technologies (Assimakopoulos 2000). In fact, the individuals who developed the geospatial tool, as well as those who are familiar with and support the innovation, can serve as influential actors among their peers (Rogers 1976). Change agents, who possess a high degree of expertise and experience regarding the innovations that are being diffused, can also provide a direct, and potentially influential, communication link between the technical experts and the potential users, leading to higher adoption rates (Ryan and Gross 1943; Ryan and Gross 1950; Savage 1985; Rogers 2003). Further, the potential for improved communication as a result of adopting a technological innovation can also influence the adoption process for land managers (Toombs et al. 2018). As important to the innovation and diffusion process as communication is, however, it is joined by an array of external and internal factors related to the adopter that jointly determines if an innovation will be adopted and later diffused.

External factors, such as the adoption of a policy or innovation by a neighboring jurisdiction, can drive the individual or entity contemplating adoption, to seek information on the cost-benefits and whether it would be applicable to their jurisdiction and objectives (Haider-Markel 2001; Todtling and Trippl 2005; Berry and Berry 2007). Arguably, the most influential external factors that can predict whether an innovation will be successfully adopted is the amount and quality of interactions among members of the same professional network, the social and political contexts surrounding the adopter and innovation, mass media exposure, and the composition of the GIS tool itself. Among the political contexts surrounding policy adoption or innovation, the most important to this project is public opinion. For GIS technology, communication channels include "a site visit" to a neighboring peer, workshops and conferences, and interactions with vendors or consultants (Budic 1994; Chan and Williamson 1996; Nedovic-Budic and Goldschalk 1996; Johnson 2013). The quality of the communication channels for

both formal and informal professional advice and discussions among professional peers can significantly influence the adoption and diffusion rate of an innovation (Burt 1987). For example, active networking and multilevel interaction among members of a social or professional network generally led to a higher likelihood of adopting GIS technology (Nedovic-Budic and Godschalk 1996; Assimakopoulos 2000; Lynch 2014). Moreover, the amount of mass media attention an innovation receives early in the adoption process, as well as the sociopolitical environment surrounding the adopter or innovation, can also influence potential adopters (Masser et al. 1996; Rogers 2003; Oldenburg and Glanz 2008). However, one factor that can affect the pattern of adoption and diffusion more so than any other is the specific characteristics and features of the technological innovation (Chan and Williamson 1996; Tews et al. 2003). The studies on technological diffusion often ignore the characteristics of the innovation and rarely discuss the technical feasibility – i.e. existing regulatory standards and structures – that can affect both adoption and diffusion rates (Chan and Williamson 1996; Tews et al. 2003).

Policy adoption is a function of both diffusion and internal determinants, and these internal factors help explain that the social, economic, and political circumstances of the potential adopters can drive the overall innovation, adoption, and diffusion process for that entity (Berry and Berry 2007; Stoutenborough and Beverlin 2008). The innovation and diffusion of GIS technology can be slowed by a variety of internal factors with the most common being limited institutional resources, expertise of staff, compatibility issues, and composition of an organization or agency (Feller 1980; Chan and Williamson 1999; Tews et al. 2003; Borchers 2005; Tolbert et al. 2008; Johnson 2013; Jordan and Huitema 2014). For land management organizations, many of these same barriers have been identified as reasons why technological adoption has remained stagnant (Borchers 2005). Funding is a major barrier to innovation, as

well as adoption, and the diffusibility of a technological innovation is largely dependent on the availability of resources for an organization (Tolbert et al. 2008; Johnson 2013). An organization's internal technical compatibility – i.e. GIS vision, mission, incentives, technical expertise of staff, etc. – can also have an influence on whether an innovation will be adopted and implemented successfully (Eyestone 1977; Cooper and Zmud 1990; Chan and Williamson 1999; Tews et al. 2003). Moreover, the characteristics of an organization or individual adopter – i.e. views, values, needs, and responsibilities – can help predict whether that entity will be able to successfully adopt a technological innovation (Feller 1980; Chan and Williamson 1999).

Technological innovations by land management agencies, as well as other entities concerned with natural resource management, represent recent efforts to implement forest and wildland fire management decision support systems (FMDSS) that land and fire managers can use to augment and streamline their work (Martell 2015). Until recently, however, the adoption of technological innovations such as risk assessment, decision analysis, and landscape simulation models by land management agencies were relatively limited (Borchers 2005). Due in large part to limited resources, a lack of communication, and an inadequate innovation-decision process, many land management agencies were slow to adopt geospatial tools (Johnson 2013). Yet, with the latest innovations in science and technology presenting more inexpensive opportunities to improve the organizational performance and effectiveness of land management, these agencies have attempted to utilize geospatial tools to substantially reduce the amount of uncertainty and risk in the decision making process (Ambrosia et al. 1998; Pence and Zimmerman 2011; Thompson and Calkin 2011; Christensen 2015). With a wide array of satellite observational data and geospatial technologies available for land managers, the use of technological innovations to compliment field work and data collection duties will likely increase.

Public opinion and the news media are arguably one of the more influential factors associated with environmental issues and their subsequent policy solutions (McCombs 2004). The media holds a key role and can influence the policy process through its coverage of an issue – i.e. agenda-setting – as well as through shaping and reflecting public opinion and attitudes (Burgess 1990; Iyengar and Kinder 1987; Fan 1988; McCombs 2004; Johnson et al. 2006). As more media focus is given to a specific issue, the public is increasingly exposed to new information which helps formulate deeper opinions (Lane and Sears 1964; Iyengar and Kinder 1987). Further, extant literature has well established that public opinion influences the public policymaking process and that there is a strong tendency for policy to move congruently with public opinion (Page and Shapiro 1983; Page 1994). This reflects an awareness that relationships between bureaucrats and citizens is important to the actual formation and implementation of public policy (Stivers 1990; McCaffrey 2006). In addition, advocates of public influence on policymaking have often endorsed increased reliance on polls as providing a solution to some of the weaknesses of American political institutions (Manza and Cook 2002). Perhaps more importantly, at least to this study, is that this literature has also demonstrated that public opinion can directly influence the actions of land management agencies and thus environmental goals in general (Buttel and Flinn 1976; Jacobson et al. 2001; Buttel and Flinn 2005; Shindler et al. 2009; Frederick 2014; Kooistra 2016).

This chapter hopes to contribute to the existing literature on technological diffusion by providing an examination into the determinants of land management agencies adopting a new geospatial tool to support post-fire planning and rehabilitation efforts. Although several studies previously mentioned have looked at the adoption and diffusion of innovations and policy through a variety of spectrums – mainly looking at the culture of potential adopting agencies or

organizations – this project primarily focuses on the level and quality of communication and networking in the adoption process of geospatial technologies. By examining the influence of communication and social networking on adoption – i.e. between the RECOVER technical experts and the potential adopters, with early adopters and potential adopters, and through participation in one of the training opportunities – we can ascertain whether accessibility to experts and person-to-person contact are significant factors for adoption.

Methods

Utilizing the interview results with twenty adopters of RECOVER, we attempt to outline the primary internal and external factors that likely influenced their decision to adopt, as well as how the geospatial tool diffused within and between other land management agencies. We used the participants' responses to identify these influential factors and use the frequency of that response to illustrate its' significance. Moreover, to demonstrate the high levels of success and above-average adoption rate RECOVER has experienced, we compared our results with Rogers' categorization of adopters based on innovativeness. Our results are juxtaposed with Rogers' (1962) normal frequency distribution, which is divided into five adopter categories – innovators, early adopters, early majority, late majority, and laggards – to highlight the high levels of innovation and early adoption associated with RECOVER.

Interview Process

From the 2013 to 2017 fire seasons, RECOVER has been called upon to provide web maps for 60 wildland fires and has supported and improved the work and decision making of sixteen different state and federal agencies throughout the western United States. From the pool of RECOVER users, Twenty semi-structured interviews were conducted from January 2017 to December 2017 with personnel from these various federal, state, and local agencies, representing

a wide range of job functions and responsibilities, who had used RECOVER as part of their post-fire duties. These twenty participants represent 78% (n=47) of the fires in which RECOVER has provided web maps and an area covering over 715 000 ha[4]. Through the semi-structured interviews we sought to acquire insight into the circumstances in which RECOVER was adopted and diffused, as well as to identify the key influential internal and external factors that affected the adoption-diffusion decision process.

As part of our semi-structured interviews we requested the participants identify the main external and internal factors – specifically the composition and compatibility of the GIS tool, the quality of the communication channels, impacts of public opinion, and the agencies' resources available – that influenced their decision on whether to adopt RECOVER (Table 4.1). To help pinpoint some of the primary external influences, we asked the interviewees to identify the specific components of RECOVER they found most useful, elaborate on the quality of the communication channels between themselves and RECOVER's technical experts or prior adopters, and describe if there was any social or political obstacles that affected the adoption process. For the internal influences, we requested the interviewees discuss the extent of their agencies' resources, describe the compatibility of RECOVER with their agency, and provide a self-assessment of their GIS proficiency. Although attempting to identify all of the potential internal and external factors that could influence the adoption process of geospatial tools proved a difficult task, the participants provided particularly insightful responses we were able to use to assess the context in which RECOVER was adopted.

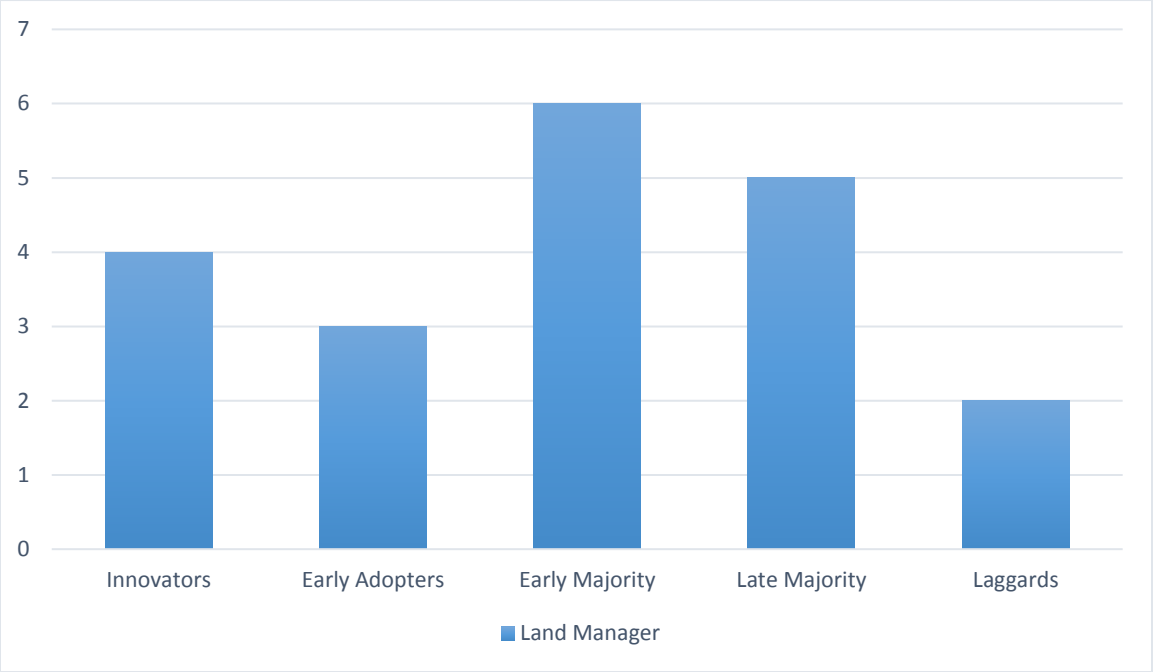
[4] A single hectare (ha) is equivalent to about 2.5 acres (ac).

Table 4.1: Questions from the Interview Instrument used for RECOVER users.

1. How was RECOVER used in your efforts with fire X?
2. What specific data did you find most useful from the RECOVER DSS?
3. Pre-RECOVER, how much time on average did you, or your office, spend collecting and analyzing the relevant data needed to submit an ES&R or BAER plan?
4. Using RECOVER, how much time was spent collecting that same data?
5. How did RECOVER improve BAER or ES&R decision-making?
6. Were communications improved by using RECOVER?
    a. Between team members?
    b. Cooperating agencies?
    c. The public?
7. Roughly how much time was saved using RECOVER for improved communication?
8. Did RECOVER reduce the cost or improve the effectiveness of data assembly? Decision-making for ES&R plan? And post-fire recovery and rehabilitation monitoring?
    a. Approximate dollar amount saved.
    b. Approximate time saved – personal and staff.
9. How did RECOVER assist your team in assessing burn severity?
10. How did RECOVER assist/improve the planning or implementation of emergency watershed rehabilitation measures to help stabilize soils, control water movement and protect property?
11. How did data acquired using RECOVER help circumvent issues related to post-fire hazards such as debris-flows?
12. Was the data acquired using RECOVER helpful in planning reseeding efforts?
    a. Or targeting wildlife habitat areas for rehabilitation efforts?
13. Did RECOVER assist in reseeding efforts that helped place rangeland back into use for grazing in a reasonable timeframe?
14. How do you plan to continue using RECOVER in upcoming fire seasons?
15. Is there anything else you would like to tell us about the value of RECOVER, satellite imagery, and geospatial data for wildfire management? Are you aware of public perceptions and/or attitudes when making decisions about adopting a geospatial tool?
16. Do you consider public perceptions and/or attitudes when making decisions about adopting a geospatial tool?
17. Are you aware of public perceptions and/or attitudes when making decisions about what fuel loads reduction strategy to implement pre-fire?
18. Do you consider public perceptions and/or attitudes when making decisions about what fuel loads reduction strategy to implement pre-fire?
19. Are you aware of public perceptions and/or attitudes when making decisions about what rehabilitation strategy to implement post-fire?
20. Do you consider public perceptions and/or attitudes when making decisions about what rehabilitation strategy to implement post-fire?

Emulating Rogers' adopter typology, the participants for our study were broken down into these categories based off their adoption date. Due to the relative novelty of RECOVER, the first official use of the tool was part of the 2013 fire season, I decided to use the participants' long-term commitment to the geospatial tool as the measure in which we based our categorization. This was done, in part, to rule out the possibility of a trial implementation, where the actor is applying the innovation in a limited manner, being considered a sustained decision to adopt (Gopalakrishnan and Damanpour 1997). Additionally, RECOVER was almost universally new to all of its eventual adopters irrespective of adoption year, which required a more conservative approach when it came to classification. Therefore, the innovators are those who adopted RECOVER from 2013-2014 (n=4), early adopters in 2015 (n=3), early majority in 2016 (n=6), late majority in 2017 (n=5), and the laggards are those who have adopted but have yet to declare the extent of their future use (n=2). As RECOVER matures, however, we would likely cluster the years into larger groups, which could lead to a different distribution within the adopter category.

Figure 4.1: A breakdown of the RECOVER adopter typology by land managers.



Calculations

Due to the relative novelty of RECOVER, especially when compared to other technical innovations that have been the focus of diffusion and adoption studies, we decided to categorize the participants' responses differently than those found within the diffusion literature. For adoption rates, we did not consider the initial use, or implementation, of RECOVER as an indicator of adoption, but instead used the respondents' stated commitment to long-term use as our threshold. In addition, we did not consider whether the potential adopter perceived RECOVER as "new," but rather focused on the date in which they adopted the tool. This was done to show the applicability of RECOVER as well as that the initial use was not a one-time fluke. To estimate the importance and level of influence certain types of communication may have on the adoption and diffusion process of technological innovations, we looked at the

interactions of potential adopters with RECOVER's technical experts, supporters, and prior adopters. Additionally, we inquired as to how the adopter first became aware of RECOVER – i.e. workshops, webinars, or contact with peers and the technical experts of RECOVER – to attempt to identify the level of potential influence of the initial interaction with RECOVER.

Hypotheses

The objectives of this chapter were to provide a more nuanced understanding of the internal and external factors that influence land management agencies to adopt new geospatial tools – i.e. RECOVER – for post fire planning, as well as to highlight the importance of strong communication channels in the adoption and diffusion process. Thus, using Rogers' adopter categorization on the basis of innovativeness, we stressed the importance of timeliness in the adoption decision and commitment to the future use of RECOVER. Moreover, we also concentrated on the frequency and type of communication the potential adopter had with RECOVER's technical experts, previous users, and supporters. Given this, we hypothesized (H1) land managers with open and accessible communication with the change agents or technical experts of RECOVER will have a higher likelihood to adopt, (H2) land managers with open and accessible communication with innovators and early adopters of RECOVER will have a higher likelihood to adopt, (H3) land management agencies who provided the opportunity for their personnel to participate in conferences, webinars, workshops, and other training opportunities to learn about or try RECOVER will have a higher likelihood to adopt, (H4) land management agencies with neighboring districts who have adopted RECOVER will be more likely to follow suit and innovate, (H5) land managers will be influenced by public opinion when considering geospatial tool adoption, and (H6) land managers will be influenced by public opinion when considering fuel load reduction and rehabilitation strategies to implement.

Results

The results of the interviews are categorized into four sections – integrity of communication channels, in-person experimentation and learning, regional diffusion, and comparison of adopters with Rogers' innovativeness classification – and we will further discuss how these internal and external factors influenced RECOVER's adoption and diffusion rates. Some of the major recurring themes derived from the participants' responses is that a frequent and interactive communication channel between themselves and RECOVER's technical experts, as well as with prior adopters, was influential in the adoption process and that peer validation seems more persuasive than regional or neighboring jurisdiction developments. Due largely to the results of our analysis, we will begin by discussing the influence of communication channels, in-person experimentation and learning, regional diffusion, and then proceed to a comparison of adopter classification with Rogers' categorization.

Integrity of Communication Channels

As quality communication channels have been identified as being a critical component of the innovation and adoption process, we expected a large percentage of the interviewees to identify a communicative relationship with the technical experts and prior adopters of RECOVER (Figures 4.2, 4.3, & 4.4). Out of our twenty participants, 40% (n=8) reported having, in some form, one or more open and accessible communication lines to the technical experts of RECOVER. Some of the examples provided by the interviewees, which helped highlight the perceived accessible communication lines, included references to a responsive email correspondence (n=3), frequent teleconferencing (n=3), and the ability to request an in-person interface (n=5) with RECOVER's technical experts. These perspectives are suspected to have positively influenced the adoption process by increasing the confidence and effectiveness of land managers using the new

geospatial tool. In addition, of the twenty interviewees, 45% (n=9) identified working with either an innovator (n=5) or early adopter (n=4) of RECOVER during the early stages of their adoption process. These direct interactions between land managers during a crucial stage of adoption could have served as a form of peer validation for the potential adopters as they were able to learn the new tool with the guidance and instruction of a colleague who has similar post fire duties. Moreover, the results also suggest that innovators and early adopters of geospatial technologies can serve as influential opinion leaders for their professional community.

Figure 4.2: Influence of open and accessible communication channels with prior adopters or technical experts of a geospatial tool.

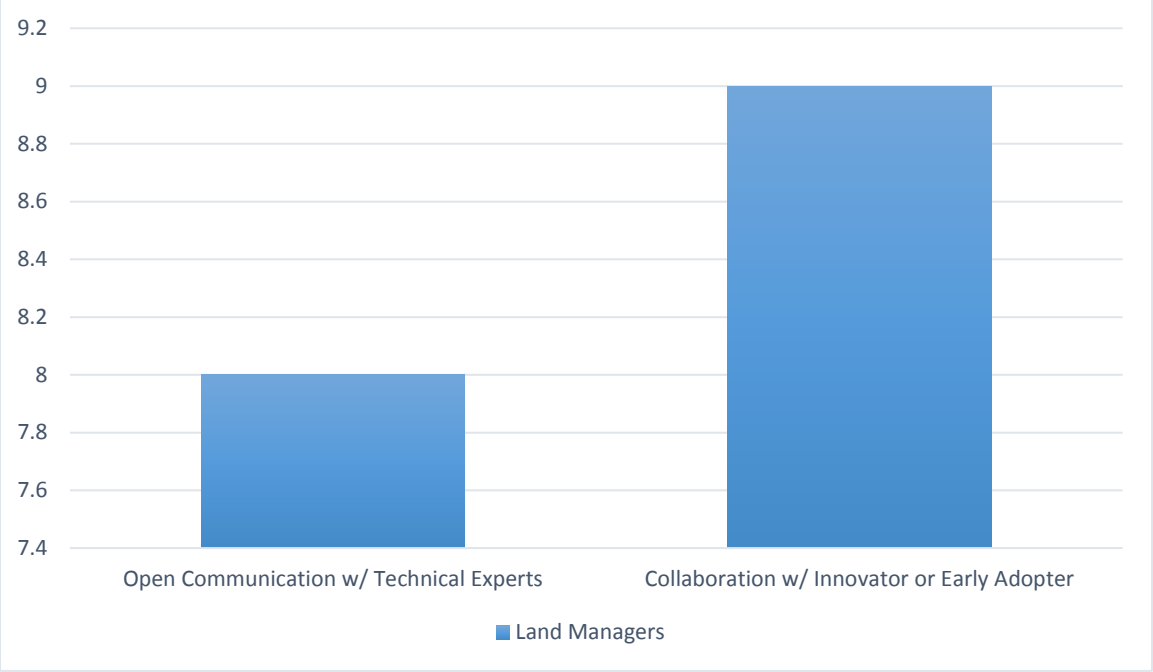


Figure 4.3: Types of communication channels that influenced geospatial tool adoption.

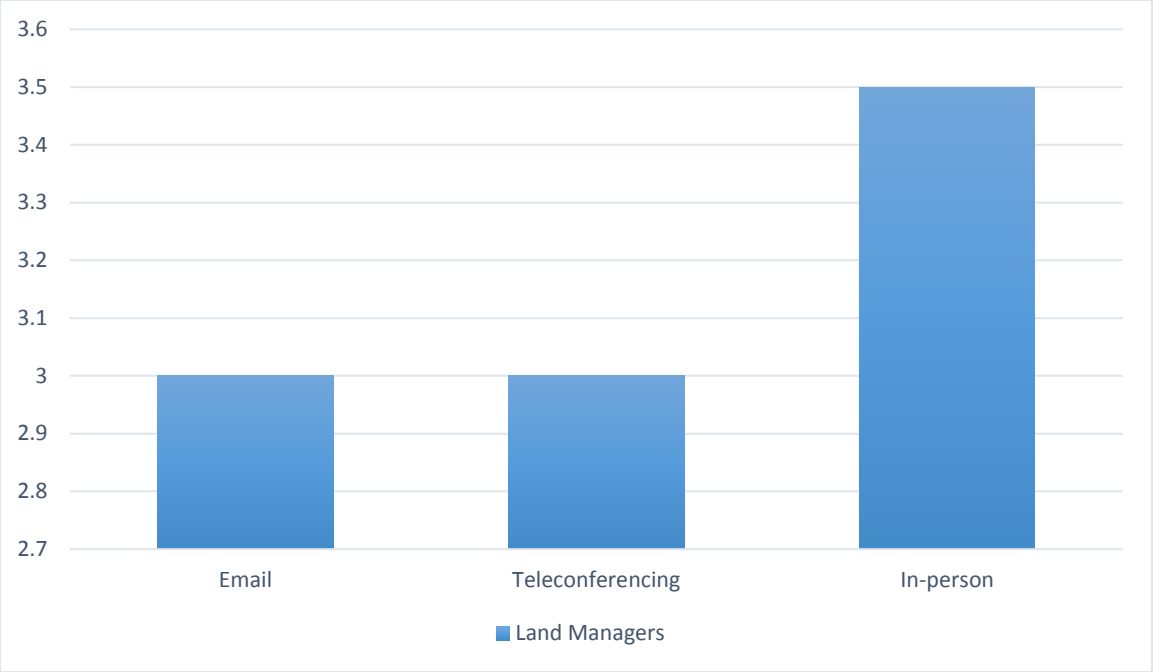
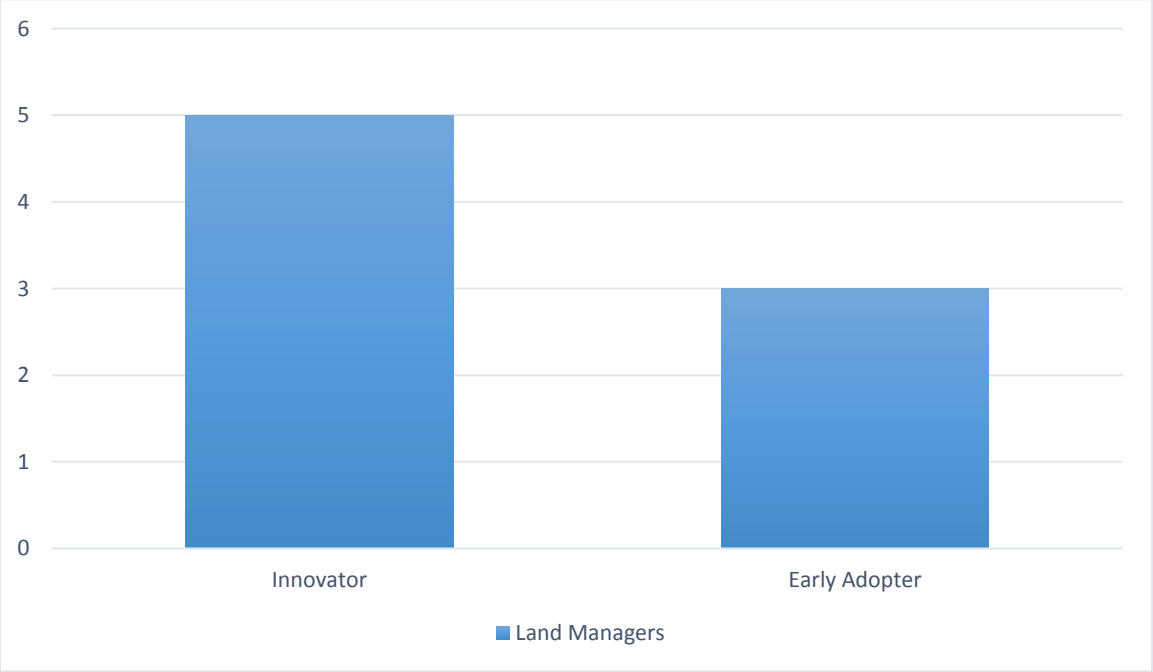


Figure 4.4: Influence of innovators and early adopters for geospatial tool adoption.



In-Person Experimentation and Learning

In order to boost the general exposure of RECOVER to the land management community, its technical experts held numerous informational and educational opportunities for those interested in learning more about or using the post fire DSS (Figure 4.5). The main objectives of these learning opportunities were not only to allow the land manager the chance to familiarize themselves with RECOVER's features, but also to test the compatibility and feasibility of the tool with their own agencies' capabilities and mission. Out of the twenty interviewees, 65% (n=13) confirmed or had been identified as attending one or more of the RECOVER workshops or webinars offered by the technical experts of the tool. Just 35% (n=7) of RECOVER adopters, however, chose to utilize the geospatial technology without participating in one of the structured learning exercises. This is not to propose that these land managers adopted RECOVER without first experimenting or testing the feasibility of the tool first, but merely to indicate that these users did so without participating in a more formal, technical expert led, setting. Nonetheless, although these results are not definitive, they do suggest that the opportunity for land managers to participate in webinars, workshops, as well as other learning and knowledge building experiences is linked to higher rates of technological innovation.

Figure 4.5: Influence of prior exposure to a geospatial tool for eventual adoption.

Regional Diffusion

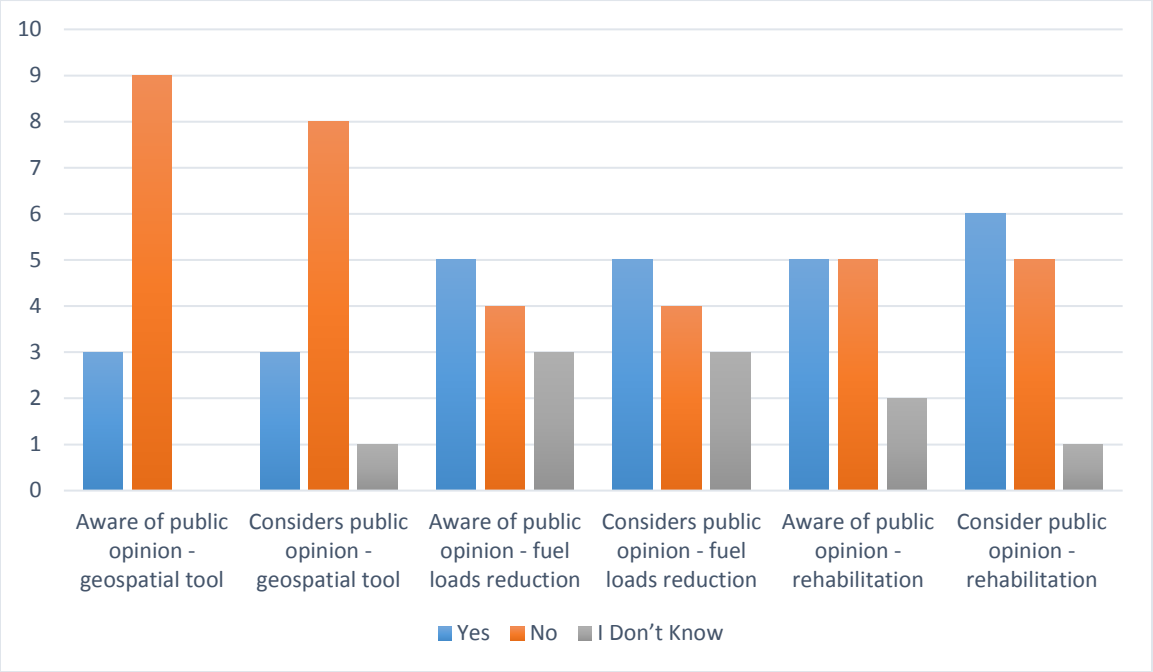
Despite the perceived influence peer validation had on whether a land manager adopted RECOVER for long term use, there did not seem to be the same impact for neighboring adopters. Zero interviewees identified the innovative actions of a neighboring office, operating within the same agency, as influencing their decision to adopt RECOVER or not. In some instances (n=3), the interviewees stated they were aware of RECOVER's adoption by neighboring field or regional offices within the same land management agency, but that these actions did not influence whether their office would adopt the geospatial tool. One interviewee stated, however, they were aware that a neighboring land manager, from a different agency, had adopted RECOVER but shared this did not influence his decision to not commit to a long term adoption. Irrespective of the focus and importance of neighbor or regional influences found in many policy

diffusion studies, our results indicate that geographic proximity to prior adopters of geospatial technologies, like RECOVER, may not be an influential factor for land managers in determining whether to innovate or not.

Influence of Public Opinion

The actual influence of public opinion and perceptions on the land managers' decision making is difficult to capture via survey, but a lot can be gleaned from their responses as far as their own attitude towards the public's desires and beliefs (Figure 4.6). For instance, out of twenty interviewees only 60% (n=12) responded to questions regarding the role public opinion plays in their decision making related to tool or policy adoption. Out of those individuals (n=12), 75% (n=9) were not aware of public opinion about a specific tool adoption while 67% (n=8) did not consider public opinion when making decisions about tool adoption. When it came to fuel loads reduction strategies, 42% (n=5) of land managers were both aware and considered public opinion during their decision making process, while 58% (n=7) paid little attention to public attitudes in this regard. Similarly, 42% (n=5) of managers were aware of public opinion related to rehabilitation strategies and 50% (n=6) considered these perceptions when deciding which approach to implement. Although the sample size is small and the results are not conclusive, they potentially identify a significant gap between the public and the land management agency in relation to the selection and execution of policy solutions.

Figure 4.6: Influence of public opinion on land managers.



Comparison of Adopters

Using Rogers' adopter-innovator typology, we sought to compare RECOVER's adoption rate with the five categories previously identified. Largely because we did not categorize adopters' innovativeness based off their perception of RECOVER being new, we expected similar results as those identified by Rogers' classification. However, utilizing RECOVER's implementation date, the results highlighted an increase of 17.5% in the innovator class and of 1.5% in the early adopter category. Consequently, the laggards group saw a decrease of 6.0% while the early and late majority categories saw a 4.0% and 9.0% decrease respectively. In comparison with Rogers' categories of innovativeness, the adoption results from RECOVER's users illustrates a higher than average percentage of adopters falling into the innovator class, despite using a more conservative estimation. We suspect the increases in the innovator and early adopter groups, as

well as the decrease in the laggard class, is largely due to the compatibility of RECOVER with the land management agencies and their post fire objectives.

Discussion and Conclusion

This project identified the most influential external and internal factors that led to the adoption of a new geospatial tool (i.e., RECOVER) by interviewed land managers. As larger context of my project is to look at the congruence of public opinion and decision making, these results will be a central focus. The study of these factors is important as it assists in developing a working typology of individuals, or agencies, who possess the personal traits or are in the right professional environment that seems to directly or indirectly encourage technological innovation. Further, as uncertainty in wildland fire management stretches well beyond the unpredictability of fire behavior and into the realm of inaccurate or missing data (Thompson and Calkin 2011), improved decision support technology could significantly reduce ambiguity in the post-fire planning environment. Moreover, as wildfires in the western U.S. continue to increase in both size and frequency, fire and land managers will likely grow progressively more reliant on geospatial data and satellite imagery to aid in performing their duties. Therefore, it becomes increasingly more important for the developers of geospatial technologies to understand some of the more influential factors that either increases or decreases the likelihood that a land manager will innovate a new tool or policy to enhance their performance.

Our first hypothesis – land managers with open and accessible communication with the change agents or technical experts of RECOVER will have a higher likelihood to adopt – was strongly supported as nearly half of the interviewees shared they had established an accessible communication line with the developers of RECOVER. The perceived openness during the adoption process of the communication lines between the technical experts of RECOVER and

the potential adopter likely allowed the land manager to fully test the technical feasibility of the tool under the guidance of the expert. Further, the ability to contact the technical experts during the initial learning process probably provided the opportunity to the potential adopter to explore the tools and its features more intimately than if they had attempted to explore RECOVER without communicating with its experts. In all, we posit that the experts of a technological innovation can play an influential role in the adoption process by making themselves available via email, telephone, or in-person meetings to respond to inquiries, in a timely manner, from the potential adopters.

The second hypothesis – land managers with open and accessible communication with innovators and early adopters of RECOVER will have a higher likelihood to adopt – was also widely supported as almost half of the interviewees identified either an innovator or early adopter as providing information or instruction during the early stages of the adoption process. We speculate that the innovators and early adopters of RECOVER served as peer validators for the tool and their early acceptance created an opportunity for these individuals to serve as opinion leaders in the land management community. Additionally, as the potential and prior adopters had similar land management duties and concerns, we suspect the direct learning experiences led by a professional peer influenced the new user to commit to long term adoption. Utilizing the relevant literature, we contend that an innovations' earliest of supporters and adopters – i.e. innovators and early adopters – can serve as pivotal influential actors within their own professional community and the experts or originators of an innovation would be well served to include these actors in further outreach activities (Rogers 1976; Balla 2001; Shipan and Volden 2008; Maske and Volden 2011).

Our third hypothesis – land management agencies who provided the opportunity for their personnel to participate in conferences, webinars, workshops, and other training opportunities to learn about or try RECOVER will have a higher likelihood to adopt – was the most supported of our six hypotheses as almost two-thirds of interviewees participated in one or more of the RECOVER events offered before adopting. We suggest that the in-person learning and experimentation exercises allowed the potential adopter to not only test the technical feasibility of RECOVER, but also to gauge its capabilities and potential to assist them with their post fire decision making. Moreover, the potential adopters were able to learn about and use RECOVER with the instruction and guidance of the tools' technical experts, which could have reduced some of the uncertainty about the innovation as well as increased the likelihood that the participants would adopt. Derived from the literature on marketing and diffusion, I speculate that the opportunity to participate in an in-person learning or experimentation exercise allowed the potential adopter to become more comfortable with RECOVER and proficient in its capabilities, which led to higher adoption rates among the participants (Mahajan and Muller 1979; Mahajan et al. 1990; Hughes et al. 2007; Gong 2009).

The fourth of our hypotheses – land management agencies with neighboring districts who have adopted RECOVER will be more likely to follow suit and innovate – was rejected as none of the interviewees (0) told us that their knowledge of a neighboring land manager or agency adopting RECOVER actually influenced their adoption decision. These results were somewhat unexpected as not only does the bulk of the literature on innovation and diffusion stress the significance of proximity for regional adoption, but also our own results pointed to the influential power of peer adopters (Lowi 1964; Walker 1969; Boehmke and Witmer 2004; Berry and Baybeck 2005). However, I postulate that the perceived lack of influence neighboring adopters

had on the adoption process is more related to the internal circumstances of the potential adopters – i.e. current fire threat and workload, personnel demographics, resource availability, etc. – than on the working relationship between adjacent agencies or managers. Due largely to the significant amount of control and responsibility the chief land manager exercises at their land agency, time spent conferencing with their agency and non-agency peers may be scarce.

The fifth hypothesis – land managers will be influenced by public opinion when considering geospatial tool adoption – was largely rejected as only 25% (n=3) of participating interviewees were aware of and considered public opinion when making adoption decisions. These results are not at all surprising as significant knowledge of geospatial tools are confined to a relatively small group of experts or specialists and the general public could not be expected to have this intimate knowledge. In certain instances, however, the public has demonstrated a relatively high level of knowledge when it came to the usability of geospatial technologies and tools (Kaminski 2012; Schlag 2013; Culver 2014; Hoenig 2014; Smith 2015) Further, land managers would be prudent to rely on expert opinion when it comes to sophisticated technological innovations, for both cost and usability purposes, and should include the public in more of an informational setting. Overall, I speculate that these results could be safely extrapolated across the broad land management apparatus in the western US as the issue has low salience among the public and will likely continue with that status for the foreseeable future.

Finally, the sixth hypothesis – land managers will be influenced by public opinion when considering fuel load reduction and rehabilitation strategies to implement – had mixed to negative results. In only one instance – consideration of public opinion for rehabilitation strategies – did at least 50% (n=6) of responding land managers consider the public's perception during their decision making process. In all other cases, land managers relatively ignored or

were not aware of public opinion. This undoubtedly presents a fundamental issue when it comes to public opinion and policy implementation as the public seems to have a rather insignificant voice in a very important and communal matter. Further, as the results were mixed and inconclusive extrapolation across broader land management issues would be problematic.

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CHAPTER FIVE

Conclusion

Introduction

As wildfires in the western U.S. continue to increase in size, frequency, and area burned, as well as exceed annual budget projections which are in the billions of dollars, a well-informed public should play a significant role in shaping and implementing land management policy. Yet, wildfire issues have very little salience among the public and land managers have demonstrated they are rather reluctant to include unknowledgeable opinions in serious policy decisions. Understanding how the general public perceives a particular land management technique is crucial for communication and implementation purposes but arriving upon a strategy to educate and inform the public adequately can present an ongoing problem. This is where social science research largely hopes to fill the gap and support the formulation of natural resource management decisions with accurate and timely information (Allen et al. 2009; Czaja and Cottrell 2014). Attempting to demonstrate how social science research can support the development of management recommendations and policy actions in disaster prevention, this project sought to bring together the nuances of public opinion on a variety of wildfire issues and their ultimate impact on land management decision makers.

Overview

The preceding chapters attempted to shed more light on the current relationship and influences of public opinion on various aspects of wildland fire management and policy that have been eluding policy solutions. The timeliness of this study and others could not come at a more needed time as the threat of fire is not just a serious regional risk but a major global crisis (Kodas 2017). Exploring survey data collected in the wildland-urban interface as well as interviews with active

federal, state, and local land managers, this project sought to identify trends in public opinion and adoption, or consideration, of land management policy. The results were somewhat mixed and inconclusive, however there were areas that produced promise for either policy development or future research. These areas of promise for policy development, along with instances where the study can be improved upon, will be the main focus of this chapter. Thus, to bring everything together I will next discuss the potential importance of this study, address the research question, and provide a summary of each chapter's major contributions.

Importance.

The importance of this study is not only tied to the theme of a functioning participatory democracy, but also to the necessity of addressing an exponential increase in wildfire frequency, area burned, longer fire seasons, human settlements in the wildland, and an artificial buildup of hazardous fuels in many areas. This study offers a unique opportunity to examine the ideals of participatory democracy in an environment that is fraught with complexity and substantial risk. As the recent catastrophic fire seasons have demonstrated, the perpetual occurrence and threat that wildfire poses, especially in the West, is a problem that needs a collaborative solution. However, without a well-informed community the public agency faces a difficult task communicating effectively and implementing land management policies successfully. This is precisely why understanding public attitudes and predicting social behavior is necessary for land and natural resource management, planning, and decision-making (Ajzen and Fishbein 1980; Allen et al. 2009). Examining issues like perceived risk and benefits, as well as social behavior, trust, and knowledge, will likely provide the land manager with a clearer perspective of their given community and a broader path to policy implementation. Irrespective of the insights

gained about their community, however, there will still be barriers to certain policy implementations that land managers must face and skillfully address.

Answering the Research Question.

In relation to wildfire and natural resource management, a key question I attempted to answer is "are policy or decision makers acting in accordance with public opinion?" As it was the primary objective of this project to explore public opinion and knowledge of wildfire issues, as well as to evaluate the ultimate level of influence the public exerts over the decision-making process, I sought to identify overall trends that pointed in this direction. Chapter 2 and Chapter 3 examined public opinion of hazardous fuel reduction techniques, and they provide insights into public perceptions and attitudes. Therefore, these chapters' results provided half of the equation, as they identified what the public's general attitudes toward chemical treatments, mechanical thinning, livestock grazing, and prescribed fire were while cross-checking for trends in demographics, behavior, and knowledge. Chapter 4 attempted to identify the key factors influencing land managers' decisions on geospatial tool and land management policy adoption in a post-fire context. In all, the results suggest that the policy or decision makers are not acting in accordance with public opinion in these instances and at times are willfully ignorant of the public's attitudes and perceptions. Additionally, the results identify a clear knowledge gap between the public and the land managers, with the public demonstrating a relatively low amount of basic wildfire awareness. This can arguably be attributed to the reasons why land managers are hesitant to include or consider public opinion when it comes to natural disaster prevention or resource management. Nonetheless, in the realm of pre-fire fuel load reduction techniques and post-fire geospatial tool adoption, the public seems to carry very little influence with key decision makers.

The potential big picture implications of this project on American democracy are worth discussing further here. First, democracy, as a theoretical concept, implies discussion and collaboration, collective deliberation, and rule-governed decision-making procedures that highlights the linkage between public choice and political responsiveness (Lafferty and Meadowcroft 1996). In fact, America's version of democracy provides ample opportunity for many of its citizens to actively influence policy as well as effectively participate in politics, maintain equality in voting, receive and share information, and exercise final control over their government (Dahl 1998). These opportunities expand nearly every policy field, including all aspects of land management, and provide varying levels of options in which to meaningfully engage with fellow stakeholders and decision makers (Lafferty and Meadowcroft 1996; Rehfeld 2009). The results of the project, however, illustrate a different reality as land managers may be becoming increasingly indifferent about the opinions of the public in certain pre- and post- fire contexts. To be clear, the general public has demonstrated a relatively low level of knowledge on basic wildfire issues, which might explain the reluctance on the part of the land manager to consider public opinion during their decision making process. Further, wildfire issues remain of low salience to the general public and will likely not experience an increase in interest without some sort of focusing event. Still, democratic governance assumes that the preferences of average citizens are reflected in policy outputs, regardless of the policy field, and the impacts of excluding the general population from policy decisions will likely have negative outcomes for American democracy (Page and Shapiro 1983; Manza and Cook 2002).

If the results of this study are indicative of a trend across all public agencies and policy domains then American governance, similar to a majority of US interest groups, will likely continue to be influenced and largely led by the elites (Schattschneider 1960; Olson 1965). This

outcome may not be wholly catastrophic, but it will likely discourage more citizen participation, collaboration, and cooperation when it comes to controversial policy implementation. Further, a government geared towards the interests and desires of the elites will likely see an increase in special interests vying for more influence in key policy making processes. In the realm of natural resource and land management, a rush of special interests to influence land agencies will likely at best result in a stalemate and at worst an auctioned degradation of public lands. Additionally, excluding the average citizen's opinion from policy outputs will likely exacerbate problems like low voter turnout, low trust in government, and overall declining political participation among the electorate. Though not all bad, a shift like the one the results suggest will unalterably change the current relationship between the public, their collective land, and the stewards who manage them.

Turning to the practical implications of this project, a few lessons can be gleaned from the results for both the general public and land managers. First, the land management agencies and their chief decision makers should attempt to improve communication channels with both their peers as well as the public. Improving communication among one's peers will likely assist in gaining and disseminating new information, resources, and management expertise, which may lead to improved job performance. Similarly, land managers would be well served to develop and implement new educational campaigns geared towards improving the public's knowledge and collaborative capabilities. These types of campaigns will likely buoy public support when the time comes to implement controversial policies (Jacobson et al. 2001; Halvorsen 2003; Lorimer 2015). Second, land managers should consider increasing opportunities for members of the public to meaningfully participate in key aspects of broad decision making. For instance, an increase in at-large positions for advisory committees and councils, community and

informational meetings, and programs targeted at community youth will likely not only increase the salience of the issue but also the public's aptitude to addressing subsequent problems.

Finally, the practical implications for the general public outlined in the results could not be clearer. As discussed in Chapter One, to have a functioning democracy citizens of the country must bear a certain responsibility for maintaining the quality of its governance (Fishkin 1995; Dalton et al. 2001; Zakaras 2007). This includes, but is not limited to, voting, running for office, actively participating in a political party or interest group, as well as staying informed of key policy issues. As for wildfire issues, this latter sentiment should apply tenfold and especially for those tens of millions of individuals that live in the fire prone regions of the US. Living in the wildland-urban interface requires a similar bearing of responsibility as living in a democracy, because one unkempt area could wreak disaster across even the most well-managed territory. To meet this challenge, average citizens should embrace their responsibility and improve their overall knowledge of environmental and natural disaster policies. This would not only increase their preventive capabilities but also the opportunities to increase collaboration in a difficult policy arena.

Chapter Two.

The first of the three substantive chapters provided valuable insights into how a community located within the wildland-urban interface perceives hazardous fuels reduction strategies, while simultaneously analyzing a variety of wildfire issues related to knowledge, risk, behavior, and trust for potential trends. As discussed in the results sections of Chapter 2, all three hypotheses were rejected and the takeaway message was that the public demonstrated a relative ignorance when it came to these key wildfire issues. Certain behavior on public lands potentially had a slight influence on attitudes for treatment methods, but these results were far from conclusive. In

addition, the public also demonstrated their preferences of fuel treatment methods, with an almost universal distaste for chemical treatments. The ultimate contribution of this chapter to the overall study is that it identified significant knowledge gaps within the general public as well as demonstrated that certain types of behavior on public land can have an influence on treatment method preferences.

Chapter Three.

The second of the three main chapters also provided similar valuable insights to Chapter 2 in regards to perceptions of hazardous fuels reduction strategies and the potential influence a variety of wildfire issues related to knowledge, risk, behavior, and trust has on their opinion and attitudes. The results of Chapter 3, however, added another element to the public's perception of pre-fire land management strategies by incorporating the perceived impact of these techniques on ecological health. As discussed in the results sections of Chapter 3, the hypotheses were nearly all rejected with the take home message again being that wildfire issues have relatively very low salience and that the public almost universally is opposed to chemical treatments. The central contribution of this chapter to the overall study is that it identified significant knowledge gaps within the general public as well as demonstrated that perceptions of ecological health could influence whether an individual supports or opposes a particular treatment.

Chapter Four.

Finally, the last of the three core chapters tackled the other half of the research question equation by identifying insights into the chief external and internal factors that potentially influences the land mangers' decision making process regarding geospatial tool and policy adoption. As discussed in the results sections of Chapter 4, the hypotheses were nearly all accepted with the take home message being that land managers are more influenced by their peers and a perceived

open communication channel with a technical experts when it comes to geospatial tool adoption than public opinion. Similarly, the land managers interviewed also demonstrated a relative indifference to public opinion when it came to the consideration of what pre- and post- fire land management strategies to implement. The main contribution of this chapter to the overall study is that it identified the key factors influencing a land mangers' decision to adopt a specific geospatial tool, as well as provided insights into why the tool diffused, or not, to other users. Likewise, the chapter also put forth an answer to the project's research question by identifying the low amount of influence public opinion has in regards to land managers' decisions about pre- and post- fire treatment selection.

Implications

Some of the implications of this study have the potential to advise and improve current strategies for land managers in the realm of adopting geospatial technologies as well as educating and informing the public on a variety of wildfire issues. I will next discuss some of these potential implications of each chapter, highlighting some of their more important takeaways.

Chapter Two.

The second chapter's potential implications surround suggestions that land management agencies could employ to help close the knowledge gap among the general public and increase collaboration between the two. First, as chemical treatments face an uphill battle winning public support, land management agencies may wish to develop informational materials and campaigns geared at introducing the public to some of these types of land management techniques. This may increase familiarity and knowledge of a technique and reduce conflict during implementation. Similarly, agencies should increase and enhance public educational campaigns targeting public land users and attempt to bring in this section of the population to help

collaboration efforts. As frequent users of public land have an added personal investment in the health and longevity of their public spaces, this group makes an ideal target for potential partnerships. Lastly, land management agencies should invest in further development of general public educational and informational campaigns that essentially focuses on wildfire risk and knowledge. There is no better way to increase public and agency collaboration than ensuring each group is operating from a similar level of knowledge.

Chapter Three.

Chapter three's potential implications again surround suggestions that land management agencies could employ to help close the knowledge gap among the general public and increase collaboration between the two. First, like chapter two, chemical treatments face an uphill battle winning public support and land management agencies may wish to develop informational materials and campaigns geared at introducing the public to some of these types of land management techniques. This may increase familiarity and knowledge of a technique and reduce conflict during implementation. Similarly, agencies should increase and enhance public educational campaigns geared towards identifying some of the impacts of these techniques on the ecological health of a territory. If the public could see some of the benefits, as well as the risks, of these strategies they may be able to form a more comprehensive and fact-based opinion. Lastly, land management agencies should invest in further development of general public educational and informational campaigns that essentially focuses on wildfire risk and knowledge.

Chapter Four.

The implications derived from chapter four are comprised of suggestions largely for land managers. First, land managers, especially in the West, need to make meaningful strides to include public opinion more in their decision making regarding the implementation of pre- and

post- fire land management strategies. Even if public opinion is relatively unqualified and inconsistent, being cognizant of this status will likely keep the land managers within the margin of error as far as public outcry goes. In addition, land managers seem to be running the risk of becoming more isolated within their own respective field and specialization. This development could help stabilize some aspects of land management by universalizing and standardizing certain areas, but this could also make the field impenetrable to new ideas, methodologies, strategies, and further improvement. Finally, future developers of geospatial technology for land management usage would be well served to follow the successful steps of RECOVER's introduction and adoption by working very closely in the early stages of development with the projected community of primary users.

Future Research and Improvements

The next challenge in relation to connecting public opinion with various aspects of wildland fire management and policy would be to help future scholars in their quest to conduct meaningful research with the real potential to have prodigious outcomes. Building off some of the successes, as well as failures, of previous work, future researchers should be cognizant of what worked and what did not while designing their own project. To aid in this endeavor, I will discuss some of these successes and failures for each of the three substantive chapters previously covered.

Chapter Two.

Attempting to shed light on why the general public may support or oppose certain fuel load reduction strategies is a difficult undertaking. Many factors including knowledge, trust, behavior, and countless other variables can have a significant, yet at times unidentifiable, influence on one's opinion. Although the current survey results do provide unique insights into

some of these influential factors, there is certainly room for improvements. Therefore, future research should consider adopting a longitudinal assessment of public beliefs and perceptions toward fuel load reduction strategies by incorporating participant distance to the nearest wildland-urban interface as well as public lands. This incorporation could identify a geographic bias or issue based on the results, which would inevitably assist land managers develop appropriate strategies for their most volatile territories. Additionally, as the current survey covered enrolled university students exclusively, a more comprehensive participant list should be the goal of future researchers seeking to gain a broader understanding of the public's attitudes. By incorporating more home-owners and widening the age spectrum of participants past predominantly college-aged respondents, future survey results may be more representative of not only the local community but also similar areas across much of the West. Other improvements could also be made through expanding the survey as well as the battery of questions seeking to garner public knowledge or opinions on key wildfire issues and their usage of public lands.

Chapter Three.

As chapter two attempted to identify some of the factors that may influence an individual's opinion on fuel load reduction techniques, this chapter sought to identify their perceptions of these strategies on the ecological health of a targeted area. As previously discussed, the results from this survey provided interesting insights into potential factors influencing an individual's preference of fuel load reduction techniques. However, there is still room for improving this study for future use. Similar to the recommendations given for chapter two, future research for this chapter should adopt a longitudinal assessment of public beliefs and perceptions toward fuel load reduction strategies by incorporating participant distance to the wildland-urban interface as well as public lands. Again, this incorporation could identify a geographic bias or issue based on

the results, which would inevitably assist land managers develop appropriate strategies for their most volatile territories. Also like chapter two, as the current survey covered enrolled university students exclusively, a more comprehensive participant list should be the goal of future researchers seeking to gain a broader understanding of the public's attitudes. By incorporating more home-owners and widening the age spectrum of participants past predominantly college-aged respondents, future survey results may be more representative of not only the local community but also similar areas across much of the West. Additionally, this survey could be drastically improved by juxtaposing a variety of images of public lands before and after a particular treatment method. This type of exercise could provide a look into the influence images have on the formation of land management opinion and could give land managers a more comprehensive view on how public opinion can be influenced by certain types of educational campaigns.

Chapter Four.

The final substantive chapter addressed the external and internal influences on the policy and diffusion of a geospatial tool from the perspective of federal, state, and local land managers. As this chapter was essentially a case study using NASA's RECOVER decision support system (DSS), the results may not be as applicable to other fields. Nevertheless, the results derived from this survey provided valuable insights into the main variables influencing a land managers' decision making process about tool adoption and land management techniques, in both a pre- and post- fire context. Still, there are areas that can be improved which could enhance the study and provide more plausible results. Future research should incorporate a much larger sample size of land managers from federal, state, and local agencies, as well as explore the adoption processes of other geospatial tools in a similar policy arena. By expanding the interviewee list, the results

garnered will have more validity and could do more to help predict the likelihood that a particular geospatial tool would receive widespread adoption and diffusion. In addition, analyzing and comparing the adoption and diffusion process for more mature geospatial tools would provide more context into the same processes of RECOVER. Finally, future diffusion scholars could return to this study several years later and trace the evolution of RECOVER's adoption, diffusion, and status to further analyze the influence of some of the internal and external factors previously documented.

Conclusion

This project aimed at contributing to the current literature by applying certain democratic principles and practices directly to an administrative case study like pre- and post-fire land management decisions. The results were mixed and largely inconclusive, but provided substantive observations that could be utilized by land managers from all backgrounds. For instance, the results indicate that the public is not currently knowledgeable enough to meaningfully participate in land management decision making. This is not to say, however, that the public should not be included throughout the process, as the ideal of democracy warrants direct citizen participation and action, but that there is a dire need for adequate educational and informational campaigns to bring the public up to speed. Moreover, although wildfire issues, management, policy, and science are complex, extensive, and without consensus at times, looking at the level of influence the public has on specific pre- and post- fire management decisions could provide valuable insights that have the potential to be extrapolated to produce broader policy analyses and solutions.

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APPENDIX

Appendix A Table 1: Survey and Coding Information

Variables	Survey Question	Coding
Bike (behavior)	How frequently do you engage in the following activities on public lands?	1= Never 2= Less than once a month 3= Once a month 4= 2-3 times a month 5= Once a week 6= More than once a week
Hike (behavior)	How frequently do you engage in the following activities on public lands?	1= Never 2= Less than once a month 3= Once a month 4= 2-3 times a month 5= Once a week 6= More than once a week
Hunt (behavior)	How frequently do you engage in the following activities on public lands?	1= Never 2= Less than once a month 3= Once a month 4= 2-3 times a month 5= Once a week 6= More than once a week
Regional Concern (knowledge)	Wildland fire is a major concern to Idaho and most other western states.	1= Strongly disagree 2= Disagree 3= Neither agree or disagree 4= Agree 5= Strongly Agree
Frequency (knowledge)	Wildland fires are decreasing in both size and frequency across the western United States every year.	1= Strongly disagree 2= Disagree 3= Neither agree or disagree 4= Agree 5= Strongly Agree
Costs (knowledge)	The cost to suppress wildland fires across the western United States is more than the cost to rehabilitate the land post-fire.	1= Strongly disagree 2= Disagree 3= Neither agree or disagree 4= Agree 5= Strongly agree
Federal Government (trust)	Please indicate your level of trust in the following.	1= Strongly distrust 2= Distrust 3= Neither trust nor distrust 4= Trust 5= Strongly trust
State Government (trust)	Please indicate your level of trust in the following.	1= Strongly distrust 2= Distrust 3= Neither trust nor distrust 4= Trust 5= Strongly trust

Age (demographics)	What is your age?	18-62
Female (demographics)	What is your gender?	1= Female 0= Male/Other
Political Ideology (demographics)	Which of the following best describes your political orientation?	1= Very liberal 2= Liberal 3= Moderate 4= Conservative 5= Very conservative
Year in School (demographics)	Which of the following best represents your classification at ISU?	1= Freshman 2= Sophomore 3= Junior 4= Senior 5= Fifth-year Senior or higher 6= Master's student 7= Doctoral student
Student SEC (demographics)	In terms of income, how would you classify yourself?	1= Working class 2= Lower-middle class 3= Middle class 4= Upper-middle class 5= Upper class
Prescribed Fire	Land managers should use prescribed fire as a technique to mitigate wildland fire risk.	1= Strongly disagree 2= Disagree 3= Neither agree or disagree 4= Agree 5= Strongly agree
Chemical Treatments	Land managers should use chemical treatments as a technique to mitigate wildland fire risk.	1= Strongly disagree 2= Disagree 3= Neither agree or disagree 4= Agree 5= Strongly agree
Mechanical Thinning	Land managers should use mechanical thinning as a technique to mitigate wildland fire risk.	1= Strongly disagree 2= Disagree 3= Neither agree or disagree 4= Agree 5= Strongly agree
Livestock Grazing	Land managers should use livestock grazing as a technique to mitigate wildland fire risk.	1= Strongly disagree 2= Disagree 3= Neither agree or disagree 4= Agree 5= Strongly agree

Appendix B Table 2: Descriptive Statistics of Survey Respondents

Variables	Mean	Median	Std. Dev.	Min./Max. Value
Bike (behavior)	2.054	2	1.426	0 (min.) 5 (max.)
Hike (behavior)	1.267	1	1.416	0 (min.) 5 (max.)
Hunt (behavior)	.631	0	1.158	0 (min.) 5 (max.)
Regional Concern (knowledge)	4.161	4	.794	1 (min.) 5 (max.)
Frequency (knowledge)	2.030	2	.942	1 (min.) 5 (max.)
Costs (knowledge)	3.103	3	.928	1 (min.) 5 (max.)
Federal Government (trust)	2.249	3	.992	1 (min.) 5 (max.)
State Government (trust)	3.362	3	.913	1 (min.) 5 (max.)
Age (demographics)	24.350	21	1.189	18 (min.) 62 (max.)
Female (demographics)	.387	0	.488	0 (min.) 1 (max.)
Political Ideology (demographics)	2.865	3	.989	1 (min.) 5 (max.)
Year in School (demographics)	3.193	3	1.768	1 (min.) 7 (max.)
Student SEC (demographics)	1.797	2	.926	1 (min.) 5 (max.)
Prescribed Fire	3.559	4	.879	1 (min.) 5 (max.)
Chemical Treatments	2.426	2	.926	1 (min.) 5 (max.)
Mechanical Thinning	3.522	4	.911	1 (min.) 5 (max.)
Livestock Grazing	3.641	4	.890	1 (min.) 5 (max.)