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RESEARCH ARTICLE

Manipulating the wild: a survey of restoration and management interventions in U.S. wilderness

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Landscape scale restoration is a common management intervention used around the world to combat ecological degradation. For wilderness managers in the United States, the decision to intervene is complicated by the Wilderness Act's legal mandate to preserve wilderness character and demonstrate managerial restraint (16 U.S.C. § 1131–1136). We assessed the frequency and type of management interventions, specifically actions to manage ecosystems, that have occurred in the National Wilderness Preservation System between 2011 and 2015, including the specific type of intervention, the methods used, the project proponent, and the factors that influenced the decision to act. We sent an online survey to staff members at 527 wilderness units from four federal agencies that manage wilderness and found that management interventions occurred in 37% of wildernesses sampled ($n = 210$). The greatest frequency of interventions occurred in the National Park Service (75%), and the three most common interventions were vegetation treatments (46%), wildfire (35%), and wildlife restoration projects (18%). Our findings point to a need for greater transparency about information on management interventions. We recommend creating an interagency database to track information on management interventions in wilderness to better understand which actions are occurring and why; such a database could help inform wilderness stewardship decisions while demonstrating best practices for ecological restorations implemented within the constraints of the Wilderness Act.

Key words: ecological interventions, landscape scale restoration, National Wilderness Preservation System, untrammeled, wilderness, wilderness character

Implications for Practice

- Wilderness managers can use site-relevant scientific support to develop restoration proposals and use methods appropriate to working in federally designated wilderness.
- Wilderness managers should understand stakeholder values to help clarify costs and benefits of ecological interventions in wilderness.
- Wilderness managers should monitor and share information about restoration practices and outcomes among all stakeholders to increase consistency in use of appropriate restoration practices in wilderness, and minimize or prevent unintended adverse consequences.

Introduction

Globally, protected areas are critical for resource conservation, and though human activities may be restricted, these areas are not immune from the impacts of trans-boundary ecological drivers, such as invasive species, pollution, and wildfire (Sanderson et al. 2002; DeFries et al. 2007; Hansen et al. 2014). In response to rapidly changing disturbance regimes and environmental conditions, protected area stewards must decide if, when, where, and how to implement management actions such as restoration. There remains considerable uncertainty about restoration, and in many cases, it remains an experimental enterprise as techniques develop and effectiveness is assessed (Katz 1992; Norton 2009). Moreover, uncertainties are likely to increase with rapidly changing environmental conditions that may exceed ecological thresholds (Wiens & Hobbs 2015), which may result in unintended or adverse consequences (Doak et al. 2008). Ecological changes will likely increase the perceived need for actions to enhance ecological resilience and resist or facilitate change (Gonzalez et al. 2010; Stephenson & Millar 2012; Stocker et al. 2013; Stephenson 2014). Balancing the risks, benefits, and uncertainties of ecological restoration in protected areas entails prioritizing resources to achieve desired outcomes, a challenging triage with implications for the economic and social values affected by the interventions.

In the United States, designated wildernesses (IUCN category 1b protected areas) are unique in that they require managerial restraint through the preservation of untrammeled (uncontrolled) wilderness. Given the rarity of these areas, management actions require additional scrutiny. Federally designated wilderness is managed under the 1964 Wilderness Act (16 U.S.C. § 1131–1136) to preserve wilderness character, which is composed of five unique qualities, two of which have relevance

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to this study: natural and untrammeled (Landres et al. 2015). The National Wilderness Preservation System (NWPS) consists of 801 wilderness units managed by four federal agencies: The National Park Service (NPS) manages 61 units, U.S. Fish and Wildlife Service (FWS) 71, Bureau of Land Management (BLM) 224, and the U.S. Forest Service (USFS) manages 445. Some wildernesses are managed by multiple agencies. Ecological restoration may be contentious in wilderness because, although restoration is important for biodiversity and resource conservation, restoration constitutes a purposeful management manipulation, thereby degrading the untrammeled quality of wilderness character (Cole 2000; Hobbs et al. 2009; Long & Biber 2014; Landres et al. 2015).

A systematic understanding of the frequency and type of implemented management interventions targeting ecological degradation does not exist across the NWPS. The purpose of this exploratory research survey was to document the frequency and type of specific management interventions addressing ecological degradation occurring in wilderness between 2011 and 2015, including the methods used (conventional or novel, prohibited or not within the legal framework of the Wilderness Act), the level of public participation, and the factors motivating action. The type of intervention, geographic distribution, and rationale for the intervention was of interest because there is currently no assessment of the various types of interventions occurring in wilderness, and this would allow us to evaluate patterns and management response to ecological pressures. Further, this analysis will help us understand if and how wilderness character is being considered and integrated into wilderness management. In addition, wilderness size was analyzed because of the hypothesized influence of edge effects on ecological degradation (Soulé 2001). For instance, smaller areas have a greater proportion of edge and therefore are subject to more threats such as encroachment by invasive species. Finally, documenting whether proposals to intervene were rejected was used to understand managerial restraint regarding the untrammeled quality of wilderness character, where a high proportion of rejected proposals to intervene indicates preservation of the untrammeled quality. Importantly, results from this research document effects to wilderness character, provide a benchmark against which the number and type of future interventions can be assessed, and may inform future policy.

Methods

To collect information on ecological intervention type, amount, and other characteristics, an online survey was disseminated to wilderness managers. The survey was necessary because each of the four U.S. wilderness agencies administers a unique system to track management projects, although generally the range of data is limited and inconsistent among agencies. For example, the three wilderness agencies under the Department of the Interior (NPS, BLM, and FWS) do not document projects in a similar manner to the Department of Agriculture (USFS); therefore, it is difficult to compare management actions across all agencies in the NWPS. The data are not all publically available, and wilderness-specific projects are not clearly identified.

Sampling

In designing our survey, we sought to achieve a 95% confidence interval with a 5% margin of error (Vaske 2008), and assumed a 50% response rate. Thus, we aimed to receive 260 survey responses and distributed surveys to 523 wilderness units. We randomly selected the surveyed wilderness units to reflect the proportion of wilderness units that each agency manages; the USFS received 291 surveys, the BLM 145, the FWS 46, and the NPS 41. We used the NPS geographic regions as the geographic units for our geographic analysis to examine potential regional patterns in the type and frequency of management interventions. For the size analysis, each wilderness was ranked according to its acreage and labeled "small" if they were below the median of 10,710.8 ha, and "large" if they were above this median.

Creating and Analyzing the Online Survey

The survey was developed using Qualtrics Survey Software and pilot tested by two current and two retired wilderness managers, in addition to two ecologists from the Aldo Leopold Wilderness Research Institute (Qualtrics 2016). Subject matter experts were consulted to develop the categories and subcategories of common types of management interventions. The survey focused on four categories of management interventions implemented from 2011 to 2015: actions that were taken to manage vegetation, fire, wildlife, and water. For example, a vegetation action may include applying herbicides to control nonnative invasive plants. The wildfire section asked if any actions were taken to manage wildfire (examples include mechanically reducing fuels, prescribing fire, or suppressing wildfire). Multiple-choice and open-ended questions were used to collect data for 18 subtypes of management interventions within the four main categories (Table 1).

For this study, we use the term "management intervention" to refer to management actions above a minimum threshold of scale and scope that impact wilderness character (e.g., more than simply restoring a campsite; Landres et al. 2015). Management interventions are defined as an intentional manipulation, or trammeling: an action that purposefully alters, hinders, restricts, controls, or manipulates "the earth and its community of life" (16 U.S.C. § 1131–1136). We also use the term intervention to avoid confusion about whether actions meet the standard of ecological restoration versus other restorative activities.

Before the survey was disseminated, an initial email was sent to each wilderness contact informing them of the purpose and confidential nature of the survey, and requesting their voluntary participation. The survey was sent online using Qualtrics in September 2016 and was open for responses for 30 days. Follow-up emails were sent out weekly to participants who had not responded.

Table 1. Ecological intervention categories.

Intervention Category	*Subcategories*
Vegetation	Applying herbicide
	Planting vegetation
	Mechanical removal of vegetation
	Biocontrol
	Other vegetation actions
Wildfire	Fuels management
	Initial attack (full suppression)
	Control lines
	Application of fire retardant
	Post-wildfire restoration
	Planting seeds
	Stabilizing hill slopes
	Application of soil and mulch
	Application of log terraces
	Other wildfire actions
Fish and wildlife	Removal of wildlife
	Introduction or reintroduction of wildlife
	Other wildlife actions
Water	Installation of structures
	Addition of chemicals
	Modification of water flow
	Other water actions

For each specific type of intervention, such as prescribed fire, we asked managers to indicate the primary reason for taking action. The survey also requested information on the project proponent, factors influencing the decision to intervene, and implementation methods. Implementation methods are significant in wilderness because some actions are prohibited by section 4c of the Wilderness Act (16 U.S.C. § 1131–1136): building temporary roads, using motor vehicles, motor boats, motorized equipment, aircraft landing, mechanical transport, and installing permanent structures or installations. Managers may use these prohibited actions, however, if they can demonstrate they are the minimum tool necessary to manage the area as wilderness (16 U.S.C. 1131(c)).

Additional questions focused on project results, including postaction monitoring, intervention efficacy, legal appeals, and level of National Environmental Policy Act (NEPA) review (42 U.S.C. § 4321 et seq.). The level of NEPA review provides a window into the level of public participation that each proposal entailed. For the most recent project within the subcategory of each management intervention category, the survey respondent provided the level of NEPA analysis the project received. An open-ended question at the end of each category allowed respondents to describe additional ecological interventions that were not specifically mentioned in each category.

Statistical analyses were performed in SPSS, with additional wilderness unit information imported such as wilderness size and agency (IBM 2016). To protect respondent confidentiality, the return email address was deleted from the working dataset.

Results

We received 210 completed surveys for a response rate of 40%, yielding a confidence level of 91% with a 5% margin of error. Comparable to the proportion of surveys sent to each agency, the majority of responses were from the USFS (44%), followed by the BLM (35%), the FWS (13%), and the NPS (8%). Survey results indicate that 37% of wilderness units engaged in management interventions from 2011 to 2015. Many of these wildernesses intervened multiple times: 77 wilderness units implemented a total of 111 intervention actions. The NPS had the lowest number of survey responses; however, they had the highest rate of interventions in wilderness, with 75% of NPS wilderness units indicating interventions occurred ($n = 17$ NPS wilderness units). The USFS had the second highest rate of intervention with 37% of the 93 USFS wildernesses that responded. The BLM followed with 35% of the 74 BLM wildernesses that responded, and finally the FWS, with 15% of the 26 FWS wildernesses that responded to the survey.

Types of Interventions

Of the four main intervention categories (vegetation, wildfire, wildlife, and water), vegetation and wildfire interventions were the most common type of intervention documented. Applying herbicide (a vegetation intervention) was the most common type of management intervention, with 28 wilderness units indicating they had completed projects to apply herbicide between 2011 and 2015 ($n = 56$ vegetation interventions; Fig. 1). Thirty-nine wildernesses reported wildfire interventions between 2011 and 2015, with most interventions ($n = 17$) undertaken by the USFS. The most common type of wildfire intervention was establishing control lines with the goal of containing fire, followed by initial attack responses with the intent of extinguishing natural fire ignitions (Fig. 2). Among all agencies there were relatively few postfire restoration projects, with only seven projects documented. Additionally, five projects included planting seeds, two projects to stabilize hill slopes, one to apply soil and mulch, and none that included installing log terraces or straw wattles.

Management interventions focusing on wildlife were the third most common type of intervention in wilderness with 10 projects to supplement wildlife populations, and 10 to remove wildlife (Fig. 3). The FWS intervened in wildlife populations most frequently (50%, $n = 4$), followed by the NPS (46%, $n = 13$). Four projects in the "other" category included efforts to protect threatened species by trapping or excluding small predators with fencing. For example, wire mesh was placed around nests of threatened bird species to protect fledglings and eventually increase breeding pairs. Of the four main intervention categories, water interventions were the least common type, with only one action documented by the NPS to install a water structure.

Reasons for Intervention

Respondents from 95 wilderness units cumulatively selected 213 decision-making factors. The top five factors that influenced the decision to intervene across the four agencies were a desire

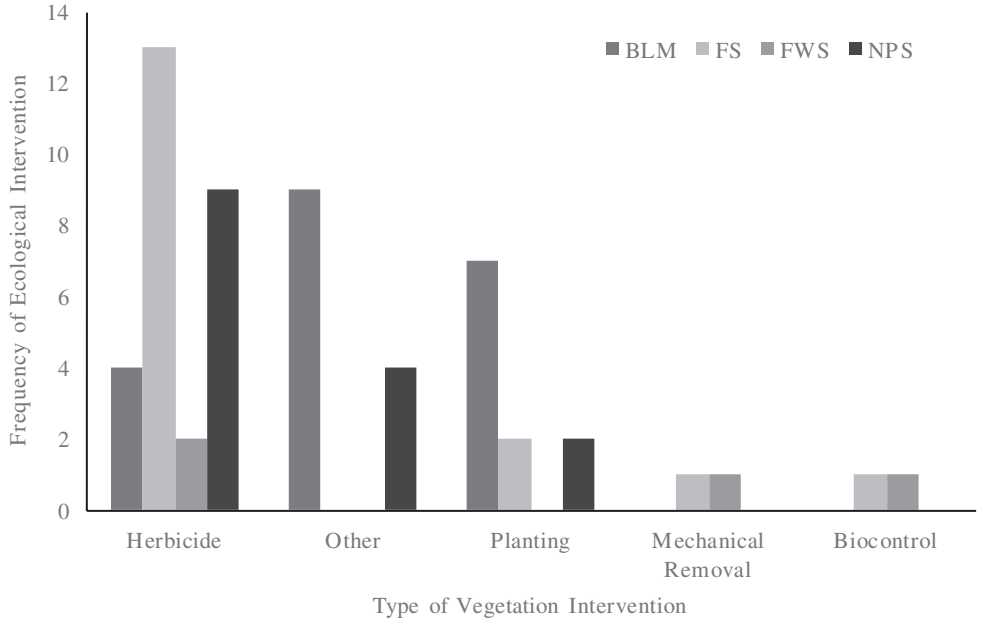

Figure 1. Frequency of vegetation interventions per agency ($n = 56$ vegetation interventions).

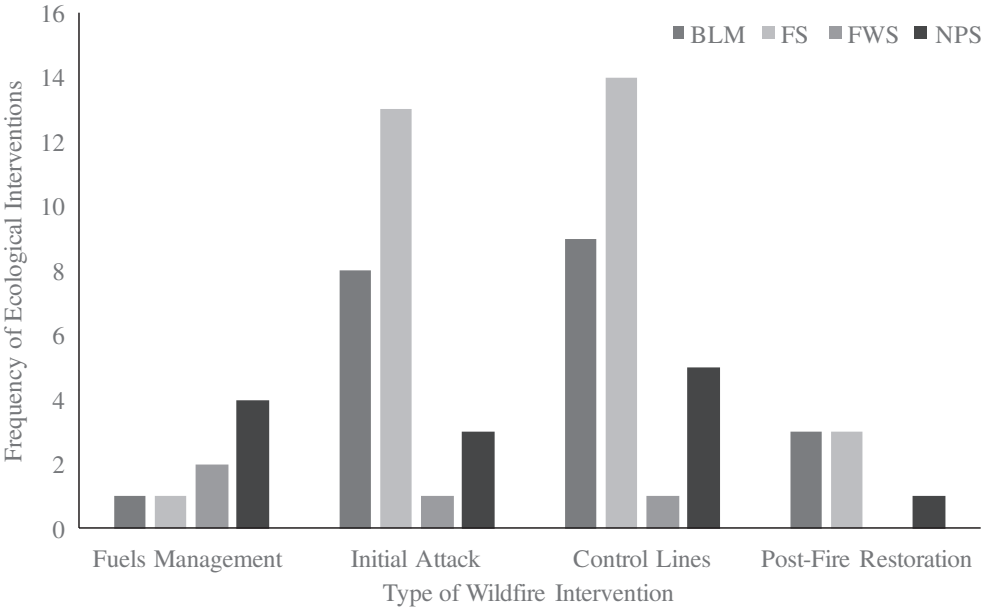

Figure 2. Frequency of the top four wildfire intervention actions per agency ($n = 69$ wildfire interventions).

to improve the natural quality of wilderness character ($n = 56$); a desire to improve the "other features of value" quality of wilderness character ($n = 29$); recommendation from a management plan ($n = 20$); other factors ($n = 18$); and finally, the agency proposing to intervene requested the action ($n = 17$). Of those wilderness units that intervened, most ($n = 36$) selected two factors that influenced the decision to intervene, whereas 25 wilderness units selected one factor. Six wilderness units selected six factors that influenced decision-making, mostly regarding fuel management actions.

Geographic Distribution

The Pacific West Region had the most survey respondents ($n = 82$) and the most surveys indicating interventions had occurred in a particular wilderness ($n = 32$), though the highest rate of intervention occurred in the Intermountain West Region, with 45% of wildernesses in this region intervening ($n = 29$ out of 64) (Fig. 4). Looking at geographic distribution by agency, the BLM units in the Pacific West Region had the most management interventions ($n = 17$), followed by the USFS in the Intermountain West Region ($n = 13$).

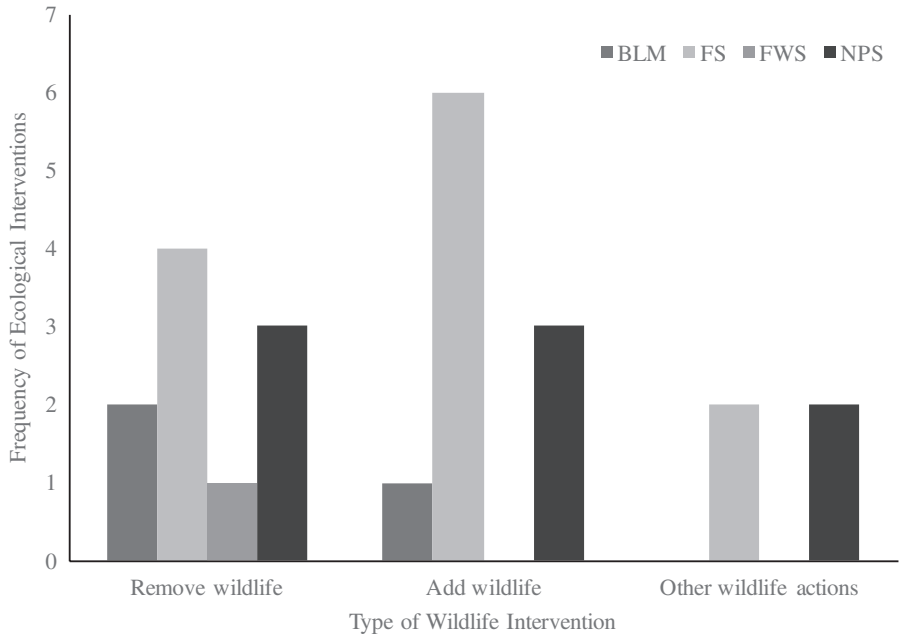

Figure 3. Frequency of wildlife interventions per agency ($n = 24$ wildlife interventions).

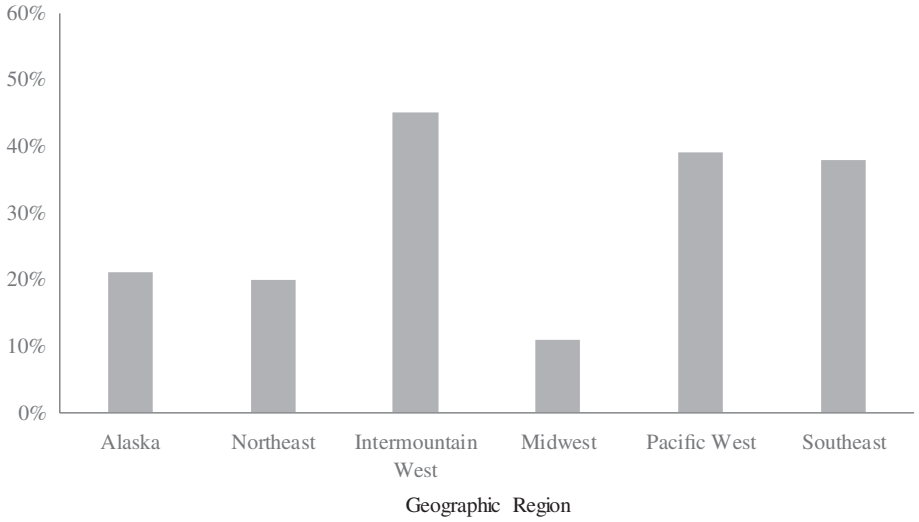

Figure 4. Percentage of wilderness units in each geographic region that experienced intervention ($n = 210$ wilderness units).

Wilderness Size

A total of 30% of wilderness units that intervened were small wildernesses (under 10,710.8 ha), while 70% of wildernesses that intervened were large ($n = 210$ wilderness units). A total of 62% of wilderness units that did not intervene were small, while 38% of wilderness units that did not intervene were large ($n = 210$ wilderness units).

Rejecting Proposals to Intervene in Wilderness

To understand the frequency of proposal rejection rates, we asked if there had been proposals to intervene in wilderness that were rejected. Across all agencies, 14% of wilderness units rejected proposals to intervene: 22% of NPS wildernesses, followed by the FWS with 20%, the USFS with 13%, and the BLM with 9%. We looked at the project proposal rejection rate together with the management intervention rate and found that 28% of wildernesses ($n = 209$) both intervened and never rejected proposals to intervene. A total of 8% of wilderness units intervened and rejected proposals, while 5% never intervened.

Project Proponent

A total of 85% of intervention projects originated from internal agency proponents. For 43% of intervention actions, the project proponent was the natural resources manager ($n = 117$;

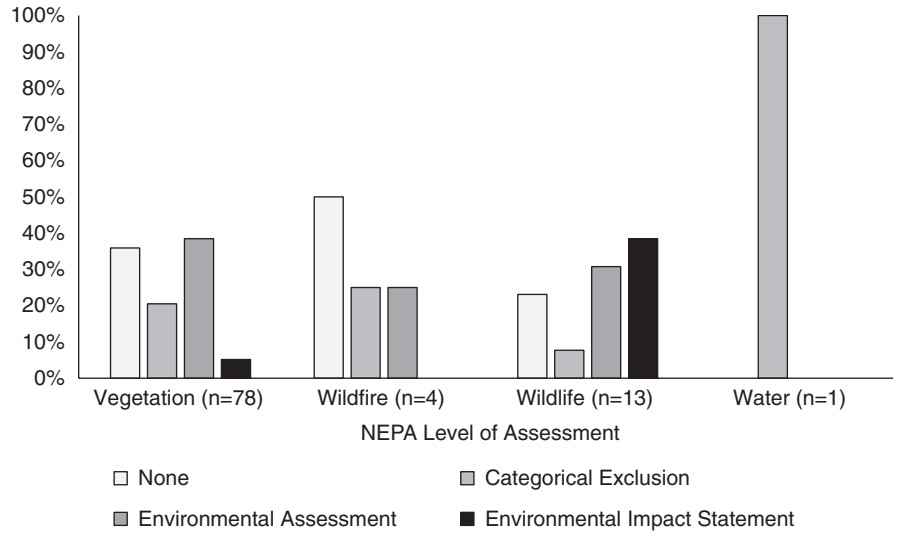

Figure 5. Level of NEPA analysis by type of ecological intervention ($n = 96$ ecological interventions).

respondents could select more than one per project), followed by the wilderness manager (25%), "other staff" (17%), a state agency (9%), other federal agencies (3%), a NGO (1%), and "other" (1%).

Intervention Methods

Survey data show that 54% of wilderness units that intervened did not use Wilderness Act section 4c (16 U.S.C. § 1131–1136) prohibited uses ($n = 90$ interventions). For the interventions that did involve 4c prohibited uses, the most common use was motorized equipment (19%), followed by motor boats (11%) and aircraft landing (10%). Two vegetation projects (applying herbicide used 11 section 4c prohibited uses and mechanically removing vegetation used 8 section 4c prohibited uses), one wildfire (fuels management used 8 section 4c prohibited uses), and one wildlife intervention (wildlife removal used 8 section 4c prohibited uses) required the most 4c prohibited uses (respondents could select more than one prohibited use per project).

Level of Legal Environmental Review

A total of 34% of intervention projects did not complete a NEPA (42 U.S.C. § 4321 et seq.) analysis ($n = 96$), while 20% used a categorical exclusion, meaning these actions were found to have no significant effect on the environment (Fig. 5). Agencies completed an environmental assessment for 37% of management interventions and environmental impact statements were completed for 9% of management interventions. There were no legal appeals filed in response to vegetation interventions, fire interventions, or water interventions; however, an intervention to add wildlife to a wilderness did result in a legal appeal.

Postaction Review

The 77 wilderness units that intervened indicated a total of 111 intervention actions. Data from 79 of these 111 intervention actions was collected on postaction monitoring; 77% of these actions reported that postaction monitoring occurred. Respondents also indicated the effectiveness of ecological restoration projects in completing project goals and objectives. A total of 85% of respondents ($n = 61$) reported that the action was effective in completing project goals, while 2% reported that the action was ineffective in completing project goals and 13% were unsure.

Discussion

Ecological degradation is occurring across the globe, and extends to protected areas, and even affects remote areas such as designated wilderness in the United States. This exploratory research survey is the first to document the frequency, type, and distribution of ecological interventions implemented in the NWPS. The frequency and type of interventions reported here constitutes an initial statistically robust account of management interventions that can serve as a reference for tracking future interventions and trends, including motives. We found that interventions are occurring within all four agencies, across all geographic areas, and within small and large wildernesses. These results run counter to some expectations. For example, a common assumption is that interventions would be more common in the BLM and USFS, due to their multiple-use mandates to serve recreation, commercial, and conservation interests, but our results show that interventions occurred in all four agencies. Another common assumption is that smaller wildernesses in the Eastern United States would be subject to more interventions due to boundary effects (Soulé 2001), but we found that interventions are occurring across all geographic areas within both small and large wildernesses.

The Wilderness Context

U.S. wildernesses are classified as IUCN 1b protected areas. On a global level, the IUCN acknowledges that category I

protected areas may require a process of restoration, though they state it should be through natural processes or time-limited interventions, "if continual intervention is required the area would be more suitable in some other category, such as IV or V" (Keenleyside et al. 2012). The mandate for U.S. wilderness managers to restrain from engaging in actions that purposefully manipulate or control wilderness is a unique directive within the Wilderness Act. Though agency policy allows for restoring degraded ecosystems in specific circumstances, constraints for restoration typically arise from the practices and methods used (Kammer 2013; Appel 2015).

When wilderness managers are confronted with ecological degradation, they first determine if action is warranted, and if so, then determine the minimum tool necessary to implement the action while preserving wilderness character. As stated above, in U.S. wilderness, the tools used to conduct restoration are scrutinized, and several methods are prohibited in wilderness, which may limit the type of restoration tool and practice, such as not using a helicopter to spray herbicides in remote locations. We found that 46% of intervention projects employed prohibited methods from section 4c of the Wilderness Act (16 U.S.C. § 1131–1136; $n = 90$). Though technology has greatly improved the efficacy and ability to reach remote locations, management interventions to restore ecosystems in wilderness require creative tactics that refrain from using these prohibited methods, even if they are common practice outside wilderness.

Another concern with management interventions is the loss of a hands-off management approach in wilderness, which is of value because it can preserve options for future management and hedge risk. Additionally, a hands-off approach may sustain nonfocal species, thereby removing any bias for selecting certain species to focus restoration, and allow unfettered evolution to occur. These measures demonstrate respect for nature's autonomy and foster scientific and management humility (Zahniser 1956; Turner 1996; Cole 2005; Landres 2010; Sarrazin & Lecomte 2016). Intangible social values of untrammeled wilderness include preserving places of spiritual significance, "sanctuaries of freedom," and areas that "provide spiritual sustenance" (Zellmer 2014). Collectively, these benefits reduce the unintended adverse consequences and risks associated with interventions while providing ecological benchmarks in unmanipulated areas. Given the unique legal mandate of wilderness as a protected area preserved to be untrammeled, a higher level of scrutiny is required for management interventions, including for ecological restoration.

Though interventions may prevent the spread of nonnative invasive species or reintroduce previously extirpated species, a noted benefit, Long and Biber (2014) contend that passive management in wilderness (i.e. restraint from active management to allow the environment to adapt to change autonomously) could improve adaptation to climate change and protect biodiversity. If intervention must occur, they argue that resources may be better spent focusing efforts in severely altered landscapes outside of wilderness, such as protecting habitat from development, improving corridors, and creating buffer zones around wilderness (Rouget et al. 2006). However, Long and Biber (2014) also conclude that the Wilderness Act does not prohibit climate change adaptation actions, stating "[t]he vast majority of management options are available to agencies that manage wilderness areas, though the agency must jump through a variety of procedural and substantive hoops to justify active management for climate change adaptation" (Long & Biber 2014, p. 623).

Action Bias in Management Interventions?

Iftekhar and Pannell (2015) suggest that an action bias, a propensity to act even when risks are high and the outcome is uncertain, is increased by uncertainty. This is an inevitable state in protected areas globally given the dynamic nature of ecosystems, combined with limited monitoring data. Additionally, climate change is testing traditional assumptions for managing within the historic range of variability, and uncertainty about future conditions creates challenges for decision-making. A 37% intervention rate from our survey may suggest that an action bias could be a factor encouraging interventions in wilderness; repeated sampling over time and across multiple countries would help to confirm the influence of climate change on intervention decisions in protected areas more broadly. The impact of climate change on intervention decision-making in U.S. wildernesses is supported by research from Nelson (2013), whose census of NPS climate change adaptation actions found that of the 61 NPS wildernesses, 68% had taken management actions (including monitoring) to address climate change and its effects in wilderness. Comparatively, our study showed that 75% of NPS wildernesses took intervention actions. Nelson's findings also demonstrated that invasive species and wildfire actions were the most common management actions in wilderness, similar to our results.

Of the 37% of wilderness units engaging in management interventions in the last 5 years, 28% never rejected proposals to intervene, suggesting a potential action bias, or possibly an exorbitant degree of ecological degradation ($n = 209$, one respondent omitted this question). Among wilderness units engaging in intervention actions, only 8% rejected proposed interventions. Having more data over a longer period of time, and tracking individual decision-maker responses to intervention proposals, would provide a fuller understanding of action bias at the level of agencies and individuals.

All agencies had an intervention proposal rejection rate of below 23%; therefore, most proposals to intervene were approved in wilderness. Interpretation of this result is tempered, though, because it is not clear if those wildernesses that did not intervene actually desired to do so but were limited by resources such as staff, funding, and technology, or if they were not intervening specifically to preserve the untrammeled quality of wilderness character. Furthermore, rejected proposals are likely underreported, and this survey was not designed to examine whether ideas to intervene were rejected before being formally developed into proposals. The survey also did not address whether proposals were modified to reduce conflict with wilderness mandates.

Several survey respondents stated that the intervention purpose was to restore "ecosystem function," "protect the habitat from damage from invasive species," or "restore historical

or natural conditions." These statements run the risk of being overly broad, and lack specific contexts for application (Naficy et al. 2016). Similarly, Davis and Slobodkin (2004) emphasize that restoration proposals should refrain from using anthropomorphized conditions such as "ecosystem health" or "ecosystem integrity," which are value-laden. Proposals to intervene in wilderness should be transparent and specific about the rationale for taking action. Further, intervention proposals should explicitly clarify how the natural quality of wilderness character would be improved, as well as what the minimum necessary action would be to maximize the preservation of wilderness character.

Opportunities for Public Participation

Our survey data demonstrate that 28% of interventions received no legal review per the NEPA (42 U.S.C. § 4321 et seq.) guidelines. Studies show that engaging with stakeholders early in the restoration process may build or increase trust, and is important for restoration success in the United States (Hobbs et al. 2009; Metcalf et al. 2015), and globally (Spink et al. 2010). As Lachapelle et al. (2003) note, plans for publically managed natural resources act as social contracts between governments and those affected by government decisions. Ideally, project plans are a collaboration between stakeholders and other public interests. A lack of NEPA review for major ecological interventions not only excludes a public voice from significant projects that impact wilderness character, it may lead to distrust and prevent alternatives from being integrated into project proposals that reflect public values and therefore have a better chance of succeeding long term (Balint 2011).

Conventional Forms of Restoration

Contrary to predictions cited by Schwartz et al. (2012) that climate change will increase proposals for managed relocation, assisted migration, and translocation as conservation strategies, none of these types of interventions were documented in this survey. These results are consistent with Hagerman and Satterfield's (2014) findings that conservation experts in the United States and Canada prefer conventional strategies for conservation such as expanding protected areas, reducing climate stressors, and using tools already integrated into institutions. Nelson (2013) found similar results: climate change is prompting greater monitoring and management actions, and this has led to conventional actions such as nonnative species removal or wildfire treatments. Repeated surveys over time might better test this result, as novel restoration practices may be emerging, but are not yet being implemented, or are too controversial entirely (Stone 2010). Our survey revealed 10 cases of reintroducing wildlife; however, these were reintroductions of native species that were previously extirpated due to human causes, such as habitat destruction and trapping of *Martes pennanti* (fishers) in the Olympic Wilderness prior to designation.

Management Options

In response to increasing anthropogenic ecological threats, protected area managers have two main options: act to restore lands that have been ecologically degraded, or refrain from acting and risk negative ecological consequences. Both options are fraught with uncertainty and unintended consequences. This dilemma poses a wicked problem for protected area managers, a problem which is characterized by a high degree of scientific uncertainty and deep disagreement on values (Balint 2011).

As a starting point for developing policy that could aid decision-makers facing intervention proposals, this survey aimed to provide evidence as to what types of resource management decisions have already been implemented in a subset of protected areas: U.S.-designated wilderness. As the first study to document the number, type, and reasons for management interventions occurring throughout the NWPS, this research demonstrates that landscape-scale actions in wilderness are happening across all agencies, for diverse reasons, across all geographic regions within the United States, and in both large and small wildernesses. Given changing climate patterns and documented ecological changes, more proposals to intervene are likely inevitable. An interagency database that tracks future interventions across the NWPS would improve transparency and has the potential to inform and improve agency policy by bringing restoration actions into the light.

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