



Does Wilderness Matter in the Anthropocene? Resolving a Fundamental Dilemma About the Role of Wilderness in 21st Century Conservation

Patrick Kelly^{a*} and Peter Landres^b

^aResearch Associate, Aldo Leopold Wilderness Research Institute, Rocky Mountain Research Station, USDA Forest Service, Missoula, MT, USA; ^bEmeritus Scientist, Aldo Leopold Wilderness Research Institute, Rocky Mountain Research Station, USDA Forest Service, Missoula, MT, USA

ABSTRACT

Should wilderness be understood as primarily untrammeled or primarily natural? In this paper, we examine the conceptual and philosophical roots of untrammeled and natural in the context of the 1964 Wilderness Act and show how in some situations tension can arise between them, leading to a stewardship dilemma and subsequent debate over the future conservation role of wilderness. After showing that this debate is ultimately rooted in a false dichotomy, we offer a conceptual framework that presents managers with the tools necessary to shepherd the wilderness idea through the changing environmental realities of the Anthropocene, and continue to allow wilderness to be both a cornerstone and touchstone for conservation in the 21st century.

KEYWORDS

Anthropocene; ecological restoration; naturalness; untrammeled; wilderness

Introduction

The continued viability and importance of wilderness to species and ecosystem conservation efforts worldwide has grown increasingly uncertain amid growing biophysical impacts (Coad et al., 2019; Holsinger et al., 2019; Watson et al., 2016), and conceptual criticism of wilderness from academic scholars (Callicott, 2008; Cronon, 1996; Vogel, 2015) and conservationists (Kareiva et al., 2012; Marris, 2015a). These biophysical and conceptual challenges converge in a debate and ensuing dilemma over ecological restoration, or the broader term we use here, intervention, in wilderness and other areas managed for their natural values. Broadly, this debate is centered on whether wilderness should be devoted primarily to protection of particular species (or biodiversity in general) even if that requires active manipulation of species or the ecosystem, or whether wilderness is devoted primarily to being untrammeled, that is, left alone to change and evolve as an autonomous or self-willed landscape without imposition of human desires for what that landscape should look like or the species that occur there.

This debate is playing out in the face of widespread impacts from climate change and other ecological changes wrought by the Anthropocene. This debate is also forcing

CONTACT Patrick Kelly ✉ patrick.ram.kelly@gmail.com 🏠 Research Associate, Aldo Leopold Wilderness Research Institute, Rocky Mountain Research Station, USDA Forest Service, Missoula, MT

*Present address: P.O. Box 2863, Boise, ID 83701

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wilderness managers, conservationists, advocates, and scholars into an increasingly poignant dilemma: should individual species be preserved in wilderness if such action directly compromises the untrammelled quality of the landscape? Or, stated the other way, should the untrammelled quality of a wilderness landscape be preserved if such deliberate inaction compromises the biodiversity of the area?

Brower (1964) first raised this type of dilemma in discussions about the management of areas that were being considered for potential wilderness designation. Graber (1983; 1995) predicted that the values of untrammelled and natural wilderness potentially would be in conflict within U.S. National Park Service designated wilderness as anthropogenic impacts increase in frequency and severity, propelling managers to take manipulative action to protect and restore natural conditions. Cole (1996) provided the first extensive examination of the issues surrounding this dilemma. Alpert (2004) framed this dilemma as whether 'stewards should be pilots', that is, whether wilderness stewards (i.e. managers) should allow manipulation of wilderness ecological systems to preserve what is considered natural, or whether they should not allow manipulation and accept what happens even if it entails the loss of native species or disruption of natural processes. Cole (2001; 2007) predicted that this dilemma would become a defining issue in wilderness stewardship in the 21st century.

Numerous examples of this dilemma, all in designated wilderness, across a wide range of taxa and resources involving vegetation, fish and wildlife, water, and fire, are presented by Zellmer & Anderies (2014) and Landres et al. (2020). For example, Sydoriak et al. (2001) present the case for removing encroaching native trees to restore natural fire regimes and preserve archeological resources in the Bandelier Wilderness. Vucetich et al. (2012) examine the issues related to introducing wolves to augment a declining population in the Isle Royale Wilderness. Ernest et al. (2002) discuss reducing the size of an indigenous predator population to benefit the population of an indigenous and endangered ungulate in several Californian wildernesses.

Increasingly in the Anthropocene, wilderness and natural area managers are facing this dilemma in their stewardship decisions, leading to difficult ethical questions. Should we intervene? Under what set of circumstances is intervention more or less likely to be justified and successful? How is success defined if human intervention is continually required to sustain natural conditions? Do the ends (i.e. restoring the indigenous ecological components and processes of an area) justify the means (i.e. intervening to achieve those ends)? Given altered species distribution caused by a changing climate in protected areas (Holsinger et al., 2019), is the goal of restoring species or ecological processes scientifically and ethically feasible or otherwise appropriate for the area?

These ethical questions and the values that underlie them have led to increasingly polarized arguments either for or against ecological intervention in wilderness (Alpert, 2004; Callicott, 2008; Cole, 2004; Cole et al., 2016; Graber, 2003; Kammer, 2013; Landres, 2010; Nickas, 2004). This dilemma has also fostered articles in the popular press questioning the continued relevance of wilderness to 21st century biodiversity conservation (Ferguson, 2014; Solomon, 2014), while Marris (2015a) asserted that this dilemma spells the end of the wilderness idea. While the United States is the only country legally mandated to preserve untrammelled wilderness, of the 11 countries with wilderness legislation, all explicitly include protecting biodiversity or natural conditions (Landres et al., 2008) and international conservationists are struggling with this dilemma and

these same ethical questions (e.g. Deary & Warren, 2019; Murray, 2017; Pettorelli et al., 2018; Root-Bernstein et al., 2017; Schnitzler, 2014).

This paper examines how this dilemma is affecting stewardship decisions in designated wilderness and in other areas protected for their natural values. We focus on the US because the legal mandate to preserve untrammeled wilderness allows a more robust and thorough analysis of the issues and values at risk; our analysis may also apply internationally. We show that this dilemma is a false dichotomy based on a misinterpretation of wilderness values. Interpreting natural and untrammeled as independent and absolute states obscures a third choice: natural and untrammeled are interdependent values that together can guide effective and thoughtful wilderness stewardship, and preserve the important role of wilderness in 21st century conservation. By advocating for this nuanced conceptual framework, our intent is to provide a thoughtful foundation for wilderness managers as they respond to proposed actions in wilderness amid future rapid environmental change.

The Legal Mandate to Preserve Untrammeled and Natural in Wilderness

The U.S. Wilderness Act (U.S. Public Law 88–577, §2c) defines wilderness, in part, as ‘an area where the earth and its community of life are untrammeled’ and as an area ‘which is protected and managed so as to preserve its natural conditions’. Preserving both untrammeled and natural conditions in all areas designated, or by agency policy managed as wilderness, is a legal mandate to federal managers administering the Wilderness Act 1964 (Zellmer, 2014).

Untrammeled is synonymous with unhindered, unmanipulated, or unrestrained by human actions or desires (Webster’s 3rd International Dictionary, 2002), and its ecological and societal meanings and values have been thoroughly described (Dawson and Hendee, 2008; Landres, 2010; Scott, 2001). Untrammeled wilderness has been called the ‘wilderness ideal’ (Saylor, 1963; Scott, 2001), the ‘quintessential flourish’ of the Wilderness Act (Greenberg, 2016), and the ‘unquestionably central’ element of wilderness character (Kammer, 2013). In practical stewardship terms, an interagency team (Landres et al., 2015) defined untrammeled wilderness as ‘essentially unhindered and free from the intentional actions of modern human control or manipulation’.

This practical definition of untrammeled focuses on the actions of wilderness managers, requiring them to exercise the utmost humility and restraint to minimize control, interference, or manipulation of the plants, animals, soils, water bodies, and natural processes within designated wilderness (Landres et al., 2015). This definition focuses only on intentional actions, rather than unintended effects such as those caused by climate change or regional pollutants, and on modern actions thereby recognizing and embracing the actions and effects of Indigenous peoples that occurred prior to the 1964 Wilderness Act as an integral part of the landscape (Landres et al., 2015). Broadly, untrammeled requires managers to focus on the process of *how* the wilderness is currently managed rather than on *what* occurs within the wilderness. Fundamentally, the idea of untrammeled serves as a check on the strong human impulse to manipulate and control (Holling & Meffe, 1996).

Untrammeled is closely associated with the terms ‘wild’ and ‘wildness’ although these terms have been mired in different definitions and uses, and neither term, as discussed here, occurs in the 1964 Wilderness Act (see review in Aplet, 1999). Woods (2017) provides

a cogent and compelling analysis of recent definitions and uses, concluding that wild, and by extension wildness (as the state of being wild), is 'a capacity for authentic, autonomous, and spontaneous expression' (Woods, 2017, p. 255). Further explaining the importance of wildness, Woods (2017, p. 256) asserts that, 'Much of the significance of wildness stems from its characteristic of denoting the autonomy of the other-than-human world. We can recognize and value that autonomy precisely because it arises spontaneously in nature and is beyond our cultural control and domination; the fact that wild nature can exist and act by itself is an important characteristic of wildness as a value adding property'. The direct connection between untrammelled and wild is clear; trammeling actions hinder, tame, reduce, compromise, or destroy wildness. In other words, an untrammelled wildness results in a wilderness that is wild.

The ecological and social meanings and values of 'natural' and 'naturalness' have also been thoroughly examined in the context of designated wilderness (reviewed in Landres et al., 1998 and in Woods, 2017) and has been a topic of extensive discussion in relation to wilderness stewardship in the Anthropocene (e.g. Cole & Yung, 2010; Hobbs et al., 2010). An interagency team of ecologists, for the purpose of establishing consistent monitoring guidance throughout the National Wilderness Preservation System, defined natural as 'wilderness ecological systems are substantially free from the effects of modern civilization' (Landres et al., 2015, p. 11). This definition acknowledges that every wilderness is embedded within a larger landscape (Landres et al., 1998) that may have profound and unintended effects on the biological and physical conditions inside a wilderness (e.g. on indigenous species, communities, soil, air, water, and the processes resulting from their biotic and abiotic interactions).

In terms of wilderness and protected area management, some have advocated that the term natural typically means that an area is 'pristine' (Aplet & Cole, 2010, p.13) or adheres to some sense of historical fidelity in its species compositions and ecological processes (Stephenson & Millar, 2012). However, the word 'pristine' does not occur within the 1964 Wilderness Act. Furthermore, the statutory reason for wilderness designation is to protect the area's natural conditions from 'increasing population ... expanding settlement ... and growing mechanization' (Wilderness Act, §2a), not to freeze those conditions or a particular set of species at a certain point in time. Despite conceptual problems with all definitions of natural and naturalness (see Hobbs et al., 2010; Ridder, 2007), wilderness managers are bound by statutory language and policy to preserve the area's 'natural conditions'.

An Outdated Assumption: An Untrammelled Wilderness Results in a Natural Wilderness

The language of the 1964 Wilderness Act likely reflects an underlying assumption that an area kept untrammelled would necessarily preserve and protect its natural conditions (Cole, 2001; Aplet & Cole, 2010). Stephenson and Millar (2012) also note that natural and untrammelled were usually conflated at the time of the Act's passage, and Zellmer (2014) speculates that sponsors of the Act may have seen the two as synonymous. Given the understanding of biological systems in the mid-1960s, untrammelled wilderness simply allowed a natural wilderness (Cole 2001). (Additional assumptions influencing commonly held views on untrammelled and natural in wilderness are discussed in Friskics, 2008, and Landres et al., 2020).

Given the rapidity, scale, and scope of human impacts in the Anthropocene, however, untrammelled and natural are no longer unquestionably complementary. Wilderness is now subject to ecological impacts originating largely outside and beyond the control of managers charged with preserving and protecting the natural conditions in these areas (Cole & Landres, 1996; Landres et al., 1998; Long & Biber, 2014). Anthropogenic environmental impacts outside wilderness boundaries like climate change, air pollution, widespread occurrence of nonindigenous species, alteration of disturbance regimes, and fragmentation of wildlife migration corridors, all adversely affect biophysical systems – and diminish naturalness – inside the protected area. These effects mean that stewardship inside the wilderness focused on keeping it untrammelled will not be sufficient to keep it natural and, in some cases, human intervention will be required to preserve naturalness (Cole & Yung, 2010; Stephenson & Millar, 2012). For example, intervention may be required to remove nonindigenous species, reintroduce extirpated species, and restore natural disturbance regimes (Long & Biber, 2014; Sydoriak et al., 2001). These impacts led Cole (2001, p. 6) to state, ‘The ubiquity of ecosystem change and human disturbance forces us to confront the fact that we cannot have wilderness that is truly wild or natural – let alone wilderness that is simultaneously wild and natural. We must choose between desirable wilderness attributes, at least to some degree’.

If keeping wilderness untrammelled no longer automatically results in the area being natural, and intervention to protect naturalness degrades the untrammelled quality of wilderness, managers are faced with a stark dilemma about which quality of wilderness to prioritize: should wilderness be untrammelled or natural?

Prioritizing An Untrammelled Wilderness

In response to proposed ecological interventions in wilderness, some have advocated the absolute primacy of untrammelled and nonintervention. Cole et al. (2016) assert that the legal definition of wilderness is ‘fundamentally about wildness’ and that any actions that degrade this aspect of wilderness, even to restore naturalness, unacceptably violate this fundamental principle. Kammer (2013, p. 124) asserts that threats posed to ecosystems and their constituent species do not provide justification for interventions into wilderness, that instead wilderness must be kept beyond our ‘manipulative reach altogether’. Zellmer (2014, p. 189) states that ‘intrusions and manipulations’ will make the land into ‘something other than wilderness’. Phillips (2015, pp. 160–161) calls intervention the ‘opposite of humility’, equating it to a ‘gentler’ and ‘more enlightened means of conquest’, concluding that we must ‘humbly let the wilderness be wild’ and ‘favor its freedom over its naturalness’.

In advocating for the primacy of untrammelled wilderness, these authors state that they understand the potential consequences of species loss and that while such loss is not desirable, it is more important to allow wilderness to be unfettered by human will. This idea was expressed early on by Lucas (1973, p. 151): ‘If ecological processes operate essentially uncontrolled within the wilderness frame of reference, the results, whatever they might be, are desirable by definition. The object is not to stop change, nor to recreate conditions as of some arbitrary historical date. The object is to let nature “roll the dice” and accept what results with interest and scientific curiosity’. More recently, Kaye (2014) concluded that we will ‘need to accept’ that in wilderness ‘some species will decline or be replaced’ and that we must resist the ‘temptation to garden’.

We concur that untrammeled is an important and deeply moral imperative at the heart of wilderness stewardship, appropriately placing a strong emphasis on the intangible and symbolic values of humility and restraint. However, granting absolute primacy to the value of untrammeled fosters a limited and incomplete perspective when it comes to wilderness values. The word wilderness implies not just freedom and autonomy in abstract isolation, but also the biophysical elements of a wilderness that express this self-willed character (Nash, 2001). It is the combination of symbolic (untrammeled) and biophysical (naturalness) values that constitute wilderness as an idea and a place (Foreman, 2000). We fully agree that sustaining untrammeled wilderness is an important stewardship principle. However, we likewise assert that the moral imperative for preserving and, where feasible, restoring the tangible biophysical elements of wilderness ecosystems, including native species and ecological processes, is equally important.

Reducing wilderness to symbolic status to serve merely as a vehicle through which we realize our higher moral aspirations of humility and restraint risks demoting the equally important value of natural conditions and abdicates our moral responsibility to protect and preserve species and their habitats (Cafaro & Primack, 2014; Soule, 2001; Wilson, 2017; Woods, 2017). Wilderness plays a crucial role in wildlife conservation, with recent studies showing that these protected wild areas are important for the long-term well-being of species (Gray et al., 2016; Miraldo et al., 2016). For species occurring in wilderness that are listed as threatened or endangered, demoting natural conditions may increase the risk of extirpation or extinction and degrade wilderness character (Landres et al., 2015). Additionally, several authors have noted that more wilderness is needed to buffer the effects of climate change on species extinction (see Heller & Zavaleta, 2009; Wilson, 2017; Wuerthner et al., 2015).

Demoting naturalness, and thus the related species and wildlife values that inform much of environmentalism, would undermine one of the primary motivations for wilderness designation. Ghimire et al. (2015) note that in recent surveys of the general public, more than 80% of respondents indicated that ‘protecting wildlife habitat’ and ‘preserving unique wild plants and animals’ were ‘very’ to ‘extremely important’ wilderness values. If the Wilderness Act is perceived as an inflexible barrier to species conservation in the Anthropocene, then less protective designations will likely end up filling the role of species and habitat preservation. When well-meaning wilderness advocates preclude the possibility of restitutive interventions on behalf of species, they risk reducing the relevance and appeal of future wilderness designations – designations that require strong and sustained grass roots support and activism (Turner, 2012). With belief in the species protection power of wilderness designation undermined, conservation in the Anthropocene loses a powerful and effective tool at a time when it is most needed.

Prioritizing a Natural Wilderness

In contrast to those who maintain the centrality of untrammeled wilderness, others advocate a new paradigm of human control and ecosystem engineering. Citing the ubiquity and scope of human influence on the planet, some authors assert that ‘nature could be a garden’ (Kareiva et al., 2012) in which humans ‘shoulder the responsibility of planetary management’ (Thompson, 2009, p. 97) and increase their ability to ‘consciously control’ the Earth (Marris, 2015b, p. 48). In this reimagining of conservation, wilderness

and other protected area concepts are called out for being ‘no less human constructions than Disneyland’ (Kareiva et al., 2012). Further, conservationists are told to ‘jettison’ idealized notions of wilderness (Kareiva et al., 2012) to make room for a new ‘environmental goodness’ that is ‘distinct from the value of nature’s autonomy’ (Thompson, 2010, p. 56). In place of wilderness, parks, and other protected areas, Janzen (1998, p. 1313) advocates for what he calls ‘wildland gardens’ that ‘grow’ biodiversity and ecosystem services.

Abandoning untrammeled as an environmental value allows these authors to take a more permissible stance on intervention in designated wilderness. Marris (2015a), for example, asserts that we must ‘give up our beloved wilderness and wildness’ and adopt a ‘gardening’ approach to get on with the business of saving those species that we have pushed to the edge of oblivion. This environmentalism of the future holds a significantly diminished place for valuing the ‘good of autonomy in nature’ (Thompson, 2010, p. 56). In the debate over wilderness intervention, this position holds that saving species or degraded ecosystems, i.e. preserving naturalness, overrides the value of preserving untrammeled wildness. To this end, Marris (2015a) sets up a simple either/or dichotomy that contrasts conservation ‘in thrall to wildness’ to one focused on the survival of species – either we abandon wilderness ethics and values (particularly untrammeled wilderness), or we shirk our moral duty to species.

We concur that a rigid adherence to nonintervention may allow unacceptable large-scale impacts and that climate change is having regional and planetary effects. However, adopting the corresponding extreme of gardening, controlling, or managing wilderness ecosystems allows something equally undesirable – managerial caprice and human arrogance unchecked by any serious valuation of restraint or precaution. Valuing untrammeled wilderness with its attendant values of humility and restraint is not simply a ‘dignity trip’ based in arrogant ‘human exceptionalism’, as Marris (2015a) asserts, but instead embeds a precautionary principle meant to inform rather than dictate managerial decision-making. This allows the value of untrammeled wilderness to be taken seriously without hastily precluding the possibility of intervention in situations where it may be necessary. Rather than being dismissed outright, intervention in wilderness is simply held to a higher standard of justification (Landres, 2004).

In addition, discarding or diminishing untrammeled as a key wilderness value and replacing it with the mind-set of a gardener risks entrenching an ‘action bias’ that the Wilderness Act was intended to mitigate. Describing the prevalence of this action bias in environmental management, Iftekhhar and Pannell (2015, p.390) found that decision makers often ‘choose to take actions even when a “rational” decision maker would prefer to delay actions to allow further information collection, or take no action’. The urge to act or intervene when facing a potential ecological problem may be strong, especially when the harm can be directly attributed to human action (Moore & Nelson, 2010). In these situations, the humility and restraint counseled by an untrammeled approach is both moral and rational, addressing our obligation to other species in a way that acknowledges our limited understanding and the real potential for causing rather than preventing further environmental damage.

Wilderness Act limitations on managerial action are neither outdated nor superfluous, but are even more important in an age of rapidly changing climatic conditions and accompanying environmental uncertainty. Directly attacking and undermining the

value of untrammeled wilderness is unnecessary and counterproductive, especially if driven solely by concern for species. Species conservation requires the adoption of the careful, cautious, thoughtful management approach that wilderness values demand, along with the strict habitat protections afforded by wilderness designation.

Moving Beyond a False Dichotomy: Untrammeled and Natural as Process and Product in Wilderness

The two polar positions discussed above are offered as the only possible conservation path forward: either reject untrammeled wilderness and embrace intervention (Kareiva et al., 2012; Marris 2015a; Thompson, 2010), or reject intervention and embrace untrammeled wilderness (Cole et al., 2016; Kammer, 2013). Both of these positions, however, threaten the continued relevance of wilderness and the viability of the 1964 Wilderness Act – the former by directly attacking and undermining its foundational values, the latter by elevating the principle of restraint over the value of species and other biophysical elements of wilderness. We have shown above how neither position alone is acceptable on ethical and pragmatic grounds, how both forego the possibility of reconciliation in their adoption of absolutist stances, and that both do a disservice to wilderness and other areas preserved for their natural values at a time when such areas are most needed.

Lost in this polarized debate is the possibility that these positions present a false dichotomy and that there is a third option that places equal value on the untrammeled and natural qualities of wilderness. This third option embraces the primary legal mandate of the Wilderness Act to the federal agencies administering the Act: preserve wilderness character (Appel, 2010; Landres et al., 2015; McCloskey, 1999; Ochs, 1999; Rohlf and Honnold, 1988). Moreover, this third option is based on the understanding that untrammeled and natural share a common root in the autonomy of wilderness ecosystems. That is, each is dependent on the other, and each is simply a different way of viewing and valuing the same thing: the autonomy of the non-human natural world. Specifically, valuing untrammeled focuses on unfettered ecological and evolutionary *processes*, while valuing naturalness focuses on the biophysical *products* of these processes. A full appreciation of wilderness and fulfilling the legal mandate of preserving wilderness character, if it is to be robust and consistent, demands valuing process and product together.

As core wilderness values stipulated in the 1964 Wilderness Act, untrammeled and natural together create a legal structure for protecting the environmental and moral value of non-human autonomy (Zellmer, 2014). Preserving untrammeled as a principle of wilderness stewardship is the most direct means for fostering humility and restraint as stewardship touchstones. These touchstones in turn perpetuate ecological and evolutionary processes that are unhindered and unmanipulated without focusing on any specific or desired biophysical outcome.

Naturalness as a wilderness value focuses on and protects the products of these untrammeled processes, i.e. over time an untrammeled landscape produces what we see as natural conditions. Species, communities, and ecosystems are valued for what they are in themselves and for what they implicate by their existence. Poetically expressing this idea, Leopold (1949, p. 90) heard no ‘mere bird’ in the call of a crane, but ‘wildness incarnate’, a ‘trumpet in the orchestra of evolution’, heralding the ‘incredible sweep of millennia which underlies and conditions the daily affairs of birds and men’. Similarly,

Mark (2015, p. 178) states that species offer us a ‘portal into wildness’, a portal that embodies and expresses millennia of evolutionary, climatic, and ecological processes operating largely beyond human control. To fully appreciate and value a species – whether crane or crane fly – demands acknowledging and appreciating its origin in the autonomy of ecological and evolutionary processes.

When wilderness values are narrowed into mutually exclusive categories that preclude a comprehensive understanding of wilderness as a whole, wilderness loses. What value is there in a strict process-oriented view of a given wilderness if it has been shorn of its native species and intact ecosystems? For example, Aplet and Cole (2010, p. 22) describe how ‘the C & O Canal, an artificially constructed waterway parallel to the Potomac River, overgrown with exotic species, might reasonably be called ahistorical, highly altered, yet self-willed and untrammelled’ but this hardly qualifies as a natural area or wilderness because it lacks native species. Likewise, a strict product-oriented view of wilderness takes species and ecosystems out of their original context – their origin in the autonomy of ecological and evolutionary processes. Wilderness is not merely a ‘wildland garden’ (Janzen, 1998, p.1313) that is consciously controlled (Marris, 2015b) to protect biodiversity (Callicott, 2008). In contrast to these latter views, Keeling (2007) asserts that ‘We value the wildness of our wilderness areas not only because restraint is a human virtue, but because that restraint results in unique conditions that cannot be gotten any other way. Untrammelled conditions are necessary for preserving both the process of wildness and its products’. Together, untrammelled and natural are integral to wilderness character, and are two ways of valuing the autonomy of the natural world.

Muddling Through: Stewardship of Untrammelled and Natural

In many situations, management to preserve untrammelled wilderness complements naturalness, just as management to preserve naturalness complements untrammelled wilderness. For example, when wilderness managers forbid the trammeling action of stocking non-native fish for recreational fishing, they support naturalness via protection of native lake fauna. And when wilderness managers decide to support naturalness by removing non-native fish that were stocked in wilderness lakes, they intend for the lake to be untrammelled thereafter. In some situations, however, there is tension between untrammelled and natural, and wilderness stewardship requires an informed and transparent decision process that, while striving to maximize both, allows the diminishment of one. Because there is no law or policy guiding this complex decision, muddling through is an appropriate course, as acknowledged in some wildlife management decisions (Bailey, 1982), rather than declaring that a single approach (whether untrammelled or natural) is necessary.

Two different decision frameworks have recently been developed to help agency managers make this complex decision in a transparent and informed process. The first was developed by an interagency team of wilderness managers along with agency and academic scientists, and was designed to integrate science, law, and ethics in evaluating proposals for ecological restoration in wilderness to ensure that all the proposed benefits and likely impacts are fully and fairly considered (Landres et al., 2020). The other decision framework was developed by a National Park Service team of wilderness managers, natural resource managers, and planners, and was designed to provide site-specific guidance about the factors that would lead to a decision on whether to permit, or not,

a proposed trammeling (National Park Service, 2019). Both decision frameworks are neutral and unbiased regarding whether wilderness should be untrammeled or natural, and both frameworks strive to ensure that decisions are based on a rigorous, thoughtful, and transparent analysis of the purported benefits and impacts. In addition, these frameworks could be used within the National Park Service's new planning tool (Schuurman et al., 2020) to help natural resource managers determine the most appropriate course of action in wilderness when confronting environmental changes of the Anthropocene.

Both decision frameworks were designed to be used on a case-by-case basis, potentially leading to understandable concern about 'death by a thousand cuts' to the National Wilderness Preservation System (Cole 2000; 2001; 2007). However, until agency policy guiding such decisions is developed, use of these frameworks at least ensures an informed and transparent decision. Moreover, these frameworks would allow each agency to formally monitor their internal performance regarding these decisions. Such monitoring would enable the agency to understand what is happening when, where, and why, and to take appropriate action to prevent systemic degradation of wilderness character within the agency. In addition, this monitoring could include evaluation of these individual decisions across the four wilderness managing agencies to help forestall degradation across the National Wilderness Preservation System as a whole.

Litigation over agency decisions on wilderness intervention shows that the courts require serious consideration of managerial restraint to minimize impacts to wilderness character (Appel, 2010; Long & Biber, 2014; Steinhoff, 2011). This restraint does not entail absolute prohibition, but a serious consideration of precaution and a conservative approach to the impacts, methods, timing, duration, and spatial extent of proposed actions. For example, agency proposals to protect an endangered fresh water fish by using chemical treatments to eliminate nonindigenous fish were rejected by the courts because the proposed actions failed to consider the effects of these treatments on non-target native insects, thereby falling short of the high bar needed to justify this type of intervention in wilderness and preserve wilderness character (Californians for Alternatives to Toxics et al. v. U.S. Fish & Wildlife Service, 2011).

Restraint is also the appropriate baseline strategy when faced with climate change and scientific uncertainty (Long & Biber, 2014). For example, in assessing whether species and ecosystems require intervention to facilitate adaptation to climate change, often the best option is to leave the area alone (Stephenson & Millar, 2012). Given the compounding effects that climate change will have on scientific uncertainty, assessing the scientific assumptions that underpin wilderness intervention proposals is crucial in minimizing the potential for surprise and undesirable ecological consequences (Doak et al., 2008; Naficy et al., 2015; Noss, 1994). If these assumptions lack scientific rigor and clarity, then restraint is the appropriate action.

In making this decision about intervention, a related but ancillary as well as pragmatic question for wilderness managers is whether the action temporarily trammels a wilderness (i.e. trammeling occurs only during the intervening action), or if that action instead permanently trammels the wilderness. The answer is complex and depends on the viewpoint adopted – we consider two approaches here: ecological and philosophical. Ecologically, all interventions have lasting consequences that affect a myriad of ecological processes into the future. For example, releasing biocontrol agents to control a nonindigenous invasive plant is a transitory trammeling action but may have indirect,

non-target, and long-lasting ecological consequences (Louda & Stiling, 2004; Pearson & Callaway, 2005). If intervention is approved, ecological monitoring should be required to try to document these cascading effects.

Philosophically, several academic scholars have asserted that intervention is permissible so long as it is short-term with the explicit goal of allowing natural processes to resume without hindrance after the intervention. For example, Hettinger (2014, p. 179) posits that human influence and intention can eventually ‘flush out’ of natural systems, returning them to an untrammelled state, resulting in what Woods (2005, p. 180) calls a ‘diachronic wildness’ that changes from one state to another over time (i.e. trammelled to untrammelled). Similarly, Doremus (1999, p. 91) concluded that ‘short-term human control or dependence on humans is not necessarily objectionable’ in restoring populations of endangered species in wilderness, as long as ‘long-term wildness’ remains the ultimate goal. For example, wilderness managers may choose to use herbicide on a small, recently established nonindigenous invasive plant as a one-time trammeling action to forestall the need for continual herbicide treatments if the plant is allowed to spread. Regardless of viewpoint, if an ecological intervention is permitted, untrammelled wilderness is and ought to remain both starting position and end goal. Perpetual trammeling through sustained intervention is anathema to both the letter and spirit of the Wilderness Act and its focus on humility and restraint, as well as simply infeasible from a practical perspective.

Conclusions

When we move away from the false dichotomy of untrammelled *or* natural to a more nuanced goal of untrammelled *and* natural, as advocated early on by Worf (1997) and Landres et al. (2001), considering ecological intervention in wilderness becomes more manageable. This does not mean that the tension entailed by managing for an untrammelled and natural wilderness is eliminated, as some situations may still require thoughtful and measured intervention. Instead, it frees up time and energy for managers to grapple with climate change and a host of other looming ecological problems in wilderness, and to have compassion and concern for species and ecosystems that have been pushed to the brink of extinction (Ceballos et al., 2015). The uniqueness and importance of untrammelled wilderness is never rejected or abandoned – it serves as a crucial touchstone of humility and restraint, as recognition of our limited knowledge, and as a check on our potential for overconfidence and hubris in managing wilderness. Supporting this idea that wilderness serves an important societal role of anchoring human respect for nature, Cafaro (2001) states that, ‘respect for nonhuman nature and an understanding of the threats facing it strongly support wilderness preservation’.

Within the Anthropocene, the 1964 Wilderness Act presents the opportunity for the right kind of ecological intervention precisely because it is limiting without being prohibitive (Long & Biber, 2014; Steinhoff, 2011). Examining the role of wilderness in preserving ecological integrity and how this framing affects the dilemma discussed above, Stephenson (2014) states that, ‘Intervention remains a last resort that should be approached with great caution and forethought. But good reasons to intervene seem sure to increase in the current era of rapid and unprecedented global changes’. And in a similar vein, Keeling (2007) asserts that, ‘Even in an era when anthropogenic global change may cause

wilderness to become less natural, wilderness may still serve as inviolate areas where wilderness has its highest expression'. With no place untouched by the effects of human actions in the Anthropocene, the value of wilderness is that it stands alone in striving to preserve landscapes that are untrammelled and natural. Far from being irrelevant and outdated, the 1964 Wilderness Act and wilderness have a significant and important role to play worldwide in 21st century conservation.

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