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On the Cover

Alone in the unspoiled wilderness. Ciucas Peak, Romania.

Photo by David Marcu on Unsplash.

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Rock arch over pond in Haines Falls, New York. **Photo credit** Todd Torabi on Unsplash

EDITORIAL PERSPECTIVES

Crisis of Use

by ROBERT DVORAK

Robert Dvorak

The substantial increase in the recreational use of natural resources during this global pandemic has been well documented. National parks, cultural heritage sites, and wilderness areas globally are all recording levels of visitation at a scale never previously experienced. For example, Yellowstone National Park recorded 921,844 recreation visits in August 2021, the largest August visitation on record. Further, the park has welcomed 3,590,904 visits through August 2021, representing a 40% increase from the same period last year. At Rocky Mountain National Park, a timed entry permit system was implemented from May through October 2021. Visitors are required to obtain a timed entry permit to be allowed access into the park between the hours of 5 a.m. and 6 p.m. daily. In the Galápagos, increases in cruise travel, guided tours, and land activities have created greater impacts on the important ecological resources. And at the Machu Picchu UNESCO site, managers are grappling with overcrowding, waste disposal, and sanitation issues. Officials of the World Heritage Committee have had to consider whether to add Machu Picchu to the list of World Heritage in Danger.

Is it appropriate and important to recognize that use levels in protected areas have reached a state of crisis? Have individual day visits and tourism reached a level that is beyond social and resource capacities and thus unsustainable? And is this happening at a global scale, representative of the global protected area systems and not simply unique case studies or circumstances?

I certainly recognize the implications that come with calling a situation a crisis. Such a call must be done responsibly to initiate social and political movements. It requires mobilization, investment, education, and collaborative leadership. I also have stated previously that increased demand during the global pandemic has created a great opportunity to engage new constituencies and partners in protection and management. I still believe that is true. I also believe that a holistic view of use and access is critical if our community is going to continue to expand efforts that address the vital issues of diversity, equity, and inclusion across protected area systems.

Regardless of whether our parks, wilderness areas, and heritage sites are experiencing a crisis of use, a guided strategy is needed. As we transition to a post-pandemic society, demand for transformational, restorative, and education experiences in nature will not recede. Nature has demonstrated its diverse benefits to a greater constituency these past months, and we as advocates, scientists, and managers need to embrace the challenge that comes with a larger audience. But that means we must acknowledge we have demand like never before, and that it will take dedicated resources to develop, test, and implement adaptive strategies that manage this demand while still protecting the integrity and quality of our important natural resources. This crisis is an opportunity, but only if we embrace it and have the commitment and courage to act now.

In this issue of IJW, David Cole, Stephen McCool, and David Lime pay tribute to George Stankey. Thomas Lang and Bill Borrie examines wilderness solitude in the 21st century. Mark Anderson provides a synthesis of recent findings on carbon storage in old growth forests. And Rosemary Evans discusses prescribed burning as moorland management in Britain. IJW

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Boundary Waters Canoe Area Wilderness. **Photo credit** Josh Hild on Unsplash.

George Stankey: Mentor, Colleague, Friend

by DAVID N. COLE, STEPHEN F. MCCOOL, & DAVID W. LIME

Just over a half century ago, passage of the Wilderness Act in the United States created a new land designation, codifying the specific meaning for wilderness as something to be protected and experienced. But what exactly was this special experience, what threatened it, and how was this experience, wilderness lands, and visitors to be managed? A few people recognized the importance of bringing science to bear on these issues, and the science of wilderness and its management was born in the 1960s. One of the pioneers of this new wilderness science, George Stankey, died peacefully on August 18, 2021, surrounded by family at his home on the Oregon coast. He was 78. George had been diagnosed with stage 4 pancreatic cancer just months before. For those who knew him, not surprisingly he departed on his own terms with dignity and grace – and maintained his humor to the end.

George Stankey was a critical thinker who saw the big picture and could work across disciplinary boundaries.

The undisputed father figure of the new wilderness science was Bob Lucas, one of the first scientists to study wilderness visitors in detail and the person given responsibility, in 1967, for creating and directing the first wilderness management research program at the Forest Service's Intermountain Forest and Range Experiment Station in Missoula, Montana. Bob went on to hire or provide funding to many of the pioneering wilderness scientists of the 1960s and 1970s: Sid Frissell, Dave Lime, Larry Merriam, Steve McCool, Perry Brown, Joe Roggenbuck, and David Cole. But George Stankey was the scientist Bob chose to join him, in 1968, at the wilderness research unit in Missoula.

George was raised in Oregon, where hiking, camping, and fishing with his folks led to a love of the outdoors. He studied geography, with a special interest in recreation geography, at Oregon State University, where he received BS and MS degrees in 1965 and 1966. His master's thesis was on recreation planning methodologies. In 1967, he started a PhD program in geography at Michigan State University. That year George responded to an outreach letter the department had received from Bob Lucas about potential work opportunities in his Forest Service research unit in St. Paul, Minnesota. By the time Bob and George had a chance to meet, Bob had accepted the wilderness research position in Missoula, Montana, with the authority to hire an additional scientist. He offered that position to George. In 1968, having completed all his graduate work other than a dissertation, George left Michigan State and moved to Missoula.

George's first priority in Missoula was to complete his dissertation. Bob Lucas had broken new ground in his dissertation work on wilderness visitors and carrying capacity in the Quetico-Superior Canoe Country (now the Boundary Waters Canoe Area Wilderness) in northern Minnesota. George decided to extend this work, studying visitors to different wilderness areas and exploring new concepts and approaches to wilderness visitor management. He attempted to better understand the nature of high-quality wilderness experiences, what characteristics of use influence experience quality, and how to help manage for quality experiences. Recognizing that there are many different ideas about what constitutes a wilderness experience, he reasoned that experience quality should be judged – not by the average visitor – but by those he called "purists," those visitors whose personal definitions of what is and is not desirable in wilderness most closely match the legal framework provided by the Wilderness Act. These visitors defined a high-quality wilderness experience as one with few encounters with others, in an environment where human evidence was minimal, and where it was possible to camp far from others (Stankey 1973).

Figure 1 - George Stankey, in 1970, on a wilderness trip during his doctoral research. Courtesy of the US Forest Service.

George asked visitors how they would feel about encountering an increasingly large number of other groups, in this way relating satisfaction with one's experience to level of use. He referred to widely shared preferences as norms – preferences regarding the number of encounters with other groups, appropriate methods of travel, and group size. He found that other characteristics of the groups encountered affected satisfaction more than the number of groups encountered. From the perspective of what we know today, this might seem obvious, but at the time this

finding ran counter to the perception that defining carrying capacity was the key to management, and capacity was all about numbers of visitors. George found that, in addition to amount of use, visitor satisfaction was affected by method of travel, group size, and where encounters occurred (e.g., near access points versus well away from access points in the backcountry). He then described a range of management actions, in addition to restricting the number of users, that might be taken to manage wilderness use within its capacity and provided data on visitor opinions about the desirability of these actions (Stankey 1973).

One important characteristic of George's early work was the time he spent with prominent Forest Service managers engaged in protecting wilderness, people such as Dick Joy, Bill Worf, and Tom Kovalicky. These relationships contributed to George's deep understanding of the issues wilderness managers face, allowing him to draw important management implications from his empirical results. These relationships also contributed to George's ability to write insightfully about wilderness management generally and to contribute to development of frameworks for helping managers think through problems. Prominent examples include the Wilderness Management textbook that George coauthored with Bob Lucas and John Hendee (Hendee et al. 1978), wilderness management classes George taught at the University of Montana and Oregon State University, and visitor use management frameworks such as the Limits of Acceptable Change (Stankey et al. 1985).

Even more than George's empirical work, these contributions inspired and influenced research and land management professionals around the world. Following a recent announcement on Facebook of George's death, there have been numerous testimonials about the personal importance of George's writings and teachings. One comment that captured George's influence and nature came from a retired US National Park Service planner and superintendent. Noting that George had been an important mentor to many at the University of Montana in the mid-1970s, he said "his syllabus was a disorganized mess; but his class was one of my favorites."

As the 1970s came to a close, George's skills at networking, critical thinking, and problem-solving drew him in directions beyond wilderness in the United States. He got involved in discussions and dialogues concerning human dimensions of natural resource issues such as how to obtain and analyze meaningful public involvement. Following his work on the Forest Service Roadless Area Review and Evaluation and the Recreation Opportunity Spectrum, he received numerous requests from foreign countries for guidance concerning their emerging wilderness programs. In 1980 and 1981, he took a leave of absence from the Forest Service, lecturing in the Natural Resource Department of the Canberra College of Advanced Education in Australia and working with the New South Wales National Parks & Wildlife Service. He returned to Missoula in 1982. In 1987, he resigned from the Forest Service and took a position in Sydney, Australia, at the Kuring-gai Chase College of Advanced Education to teach and work with Australian wilderness and park managers on visitor use issues. After two years in Australia, he returned to the United States to work in the College of Forestry at Oregon State University in Corvallis.

At the time he returned, timber management in the Pacific Northwest was becoming increasingly controversial and came under escalating scrutiny, primarily around old-growth harvesting and management of endangered species, such as the

Figure 2 - George Stankey, in 2017, on the deck of his house on the Oregon coast. Photo by Jackie Stankey.

marbled murrelet and the spotted owl. President Clinton, in 1994, established a multiagency Federal Ecosystem Management Assessment Team that was to examine timber and wildlife management policies, make recommendations on public land management, and build public confidence in management. The team was made up of numerous scientists representing various disciplines. George served on that team as a social scientist, along with Roger Clark from the Pacific Northwest Forest Experiment Station and Maggie Shannon from the University of Washington. The three together examined management policy and the community effects of Forest Service and Bureau of Land Management timber management in Oregon, Washington, and Northern California.

The assessment was an enormous and costly effort, both financially and personally. But out of it came discussion of how adaptive management could be applied to national forest lands, at that time principally through Adaptive Management Areas designated on public lands. George rejoined Forest Service research in 1996 in Corvallis at the Pacific Northwest Research Station where he worked in the People and Natural Resources Program. With Forest Service colleagues Bernard Bormann and Roger

Clark, George coauthored a seminal piece on adaptive management (Stankey et al. 2005).

George Stankey was a critical thinker who saw the big picture and could work across disciplinary boundaries. He could see how to integrate scientific data gathering with potential solutions to real world problems of natural resources management and planning. He helped define the new science of wilderness and its management. George was a respected networker, teacher, motivator, mentor, and friend to many in both the research and natural resources management community in the United States and abroad. He touched the hearts and minds of scientists and students alike. For many who knew George well, it has not been easy to lose his presence. He will be thought of often and genuinely missed.

More Information

For those interested in reading or hearing a recent interview with George or exploring his writings, the History of Wilderness Science page on the website of the Aldo Leopold Wilderness Institute has a section on Pioneering Wilderness Scientists, with a page devoted to George Stankey at https://leopold.wilderness.net/history-of-wilderness-science/pioneering-wilderness-scientists/George%20Stankey/default.php. ijw

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View of the Sierra Nevada from the Granite Mountain Wilderness, California. **Photo credit:** Tobias Nickel.

STEWARDSHIP

A Plea for a Standard Definition of "Natural" in Wilderness Stewardship

by TOBIAS NICKEL

Tobias Nickel

"We face the challenge of applying more nuance and thought to the term 'natural,' the meaning of which most of us previously took for granted."

The Wilderness Act of 1964 mandates that an area of wilderness is "protected and managed so as to preserve its natural conditions" (Section 2c). Based on this statutory language, agency guidance documents have recognized natural conditions as one of five qualities of wilderness character (National Park Service 2014; Landres et al. 2015; BLM 2020; Landres et al. 2021). Indeed, every year, wilderness managers approve and implement management interventions inside designated wilderness with the justification that these actions improve (or prevent degradation of) the natural quality of wilderness character (Liebermann et al. 2018).

However, managing for "natural conditions" is increasingly becoming a Sisyphean undertaking in the Age of the Anthropocene, a time characterized by intensifying human domination of biophysical environments and processes (Crutzen 2002; Steffen et al. 2007). Human-caused climate change and the coupling of human and ecological systems render it more and more difficult to sift apart human and natural causes of environmental change. In disrupting the carbon cycle, humans are not only changing the chemical composition of the atmo-

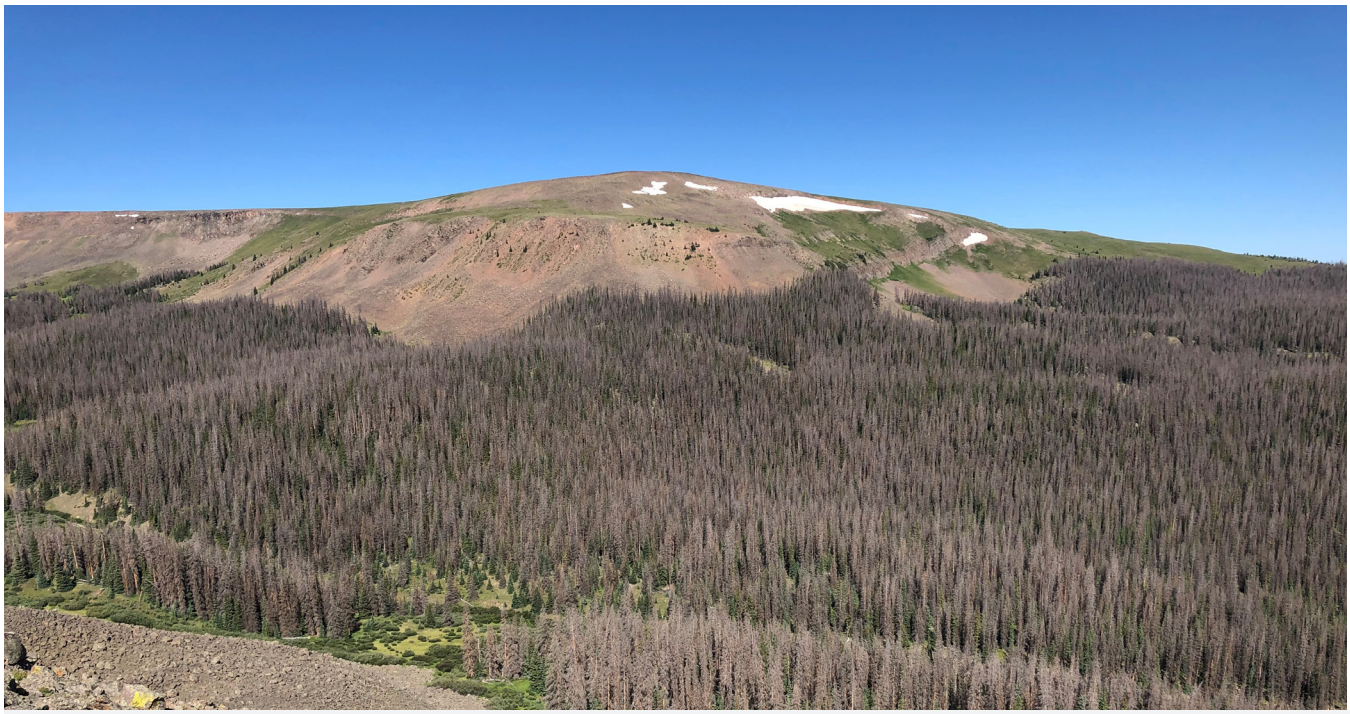

Figure 1 - Large swaths of forests in the Powderhorn Wilderness affected by the ongoing spruce beetle epidemic. What does it mean to manage for "natural conditions" in the Anthropocene? Photo by Tobias Nickel.

sphere, but we are also, at least indirectly, altering Earth's biosphere, hydrosphere, and lithosphere. As Bill McKibben (1989) observes in The End of Nature, "For the first time human beings had become so large that they altered everything around us." He continues: "Our appetites and habits and desires could now be read in every cubic meter of air, in every increment on the thermometer." Human influence is ubiquitous, and everything is modified by us to some degree. Anthropogenic forces have become so intertwined and entangled with natural systems that we have effectively ended nature as an independent force on Earth.

In the face of these shifting environmental conditions, the question then arises whether it is desirable or even feasible to sustain natural conditions, especially when that means expending ever greater amounts of energy and using heavy-handed human control to resist change. In "The Untrammeled Wild and Wilderness Character in the Anthropocene," Roger Kaye (2018) succinctly explains this challenge. He writes, "Wilderness areas will continue to become less and less natural. Attempting to maintain their natural conditions or components will require increasing levels of intervention, manipulation, and ecological restoration."

As a result, land managers charged with the mandate of preserving wilderness character are increasingly confronted with a stewardship dilemma of whether wilderness ecosystems should be left wild and untrammeled or, paradoxically, be manipulated toward a more natural state (Cole 2001). In "Preserving the Wildness of Wilderness in the Anthropocene," published in the last issue of this journal, Kaye (2021) captures this dilemma in the following question: "Should we strive to maintain natural conditions, that is, the products of evolutionary

creativity at our point in time, or should we perpetuate that creative process itself, wildness?"

As human domination of ecological systems and processes intensifies both in extent and magnitude, new pressures to trammel and calls for active ecosystem management to sustain sensitive native species are arising. Under these circumstances, wilderness mangers will increasingly be faced with difficult decisions of whether, when, where, and how to intervene in ecosystem processes. However, in attempting to preserve natural conditions, Kaye and others are concerned that wilderness managers may be sacrificing one of the principal reasons why wilderness areas were protected to begin with: as places where nonhuman nature is self-willed, autonomous, and not subjugated to human designs and purposes. Given these pressures and competing values over what wilderness is and should be, Landres et al. (2020) predict, "The combination of climate change with other landscape stressors is driving ecological restoration to be one of the single most important, challenging, and potentially litigious wilderness stewardship issues."

In light of intensifying anthropogenic pressures and accompanying management dilemmas, I am concerned that the federal land management agencies tasked with the responsibility of stewarding our National Wilderness Preservation System have not developed further guidance or consensus on a definition of "natural conditions." As Cole and Yung (2010) note, "Naturalness is inscribed in most protected area policies but is rarely, if ever, defined with any specificity." Unlike the words "untrammeled" and "wilderness character," which have been discussed and defined at length, the term "natural" remains elusive.

The result of this ambiguity and lack of standard terminology is disagreement and controversy that is fueled by a lack of transparency and defensibility in decision-making. Under current agency guidelines, several different and often conflicting management actions can be justified by invoking the ambiguous natural quality of wilderness character. As Landres et al. (2020) point out, "Decisions allowing or denying restoration in wilderness are currently made on a case-by-case basis in the context of scientific uncertainty, ambiguous law and policy, and competing values." In this context, how should managers manage for "natural conditions" as mandated by the Wilderness Act? How do we define, monitor, and assess natural conditions? How do we know when natural conditions are deteriorating and when management action is needed? How do we know when ecological restoration projects have accomplished their goals?

When the Wilderness Act was passed, the meaning of "natural" likely was obvious and uncontroversial. However, as I have tried to show, this is no longer the case in the Anthropocene. In fact, the very future of how we steward the National Wilderness Preservation System may, at least in part, hinge on how we define "natural."

The fundamental problem is that the term "nature" has several different uses, and confusion can result when it is used without stipulating its precise meaning. The influential Leopold Report of 1963, which set out principles that helped guide park and wilderness stewardship in the United States for decades, stated that "above all other policies, the maintenance of natural-

ness should prevail" (Leopold et al. 1963). The Leopold report largely (and infamously) framed naturalness in terms of historical fidelity: "As a primary goal, we would recommend that the biotic association within each park be maintained, or where necessary recreated, as nearly as possible in the condition that prevailed when the area was first visited by white man. A national park should represent a vignette of primitive America" (Leopold et al. 1963).

In the 21st century, however, this policy direction of preserving historical conditions has become increasingly problematic. Directly rebuking the Leopold Report, Landres et al. (2015) write, "The Natural Quality [of wilderness character] should not be used to recreate historical conditions from an arbitrary point in time (such as pre-European settlement or the date of wilderness designation)." Ecological systems are in a constant state of flux, and it is impossible to to freeze-frame them.

In addition to an increased scientific understanding of nature's inherently dynamic processes, alternative and indigenous views of the human-nature relationship critique past notions of "natural." Our increased anthropological understanding of the influence that

Figure 2 - Pile burning in ponderosa forests of Grand Canyon National Park. Fire management represents one of the greatest challenges for wilderness managers in the 21st century and compels us to think deeply about the problem of managing for naturalness. Photo by Michael Quinn/National Park Service.

Native peoples had on previously assumed "pristine" landscapes calls into question the very premise of human separateness. In his essay, "The Trouble with Wilderness, or, Getting Back to the Wrong Nature," William Cronon (1995) traces the intellectual history of "the myth of the wilderness as 'virgin,' uninhabited land." Cronon argues that the ideal of wilderness (i.e., self-willed, pristine, independent nature) originated in Europe with romanticist thinkers and was subsequently projected by European settlers onto the American landscape. However, as Potawatomi scientist and author Robin Wall Kimmerer (2000) explains, "The presettlement landscape was often intensively managed by its original inhabitants, so what we viewed as pristine was the product of human intervention." In other words, the independent, pristine wilderness, the loss of which McKibben (1989) mourns in his book The End of Nature, never really existed in the first place. Wilderness, construed as a domain where nature is fully independent and self-willed, is only a "cultural invention," "the reflection of our own unexamined longings and desires" (Cronon 1995).

Figure 3 - Unnamed alpine lakes in the Fossil Ridge Wilderness, Colorado. How do we manage for naturalness when no place on Earth is left unaffected by human influence? In disrupting the carbon cycle, humans are not only changing the chemical composition of the atmosphere, but we are also, at least indirectly, altering Earth's biosphere, hydrosphere, and lithosphere. Photo by Tobias Nickel.

In brief, we face the challenge of applying more nuance and thought to the term "natural," the meaning of which most of us previously took for granted. In Beyond Naturalness, Cole and Yung (2010) even go as far as to argue that the "the concept of naturalness does not provide sufficient guidance for future park and wilderness stewardship." While Cole and Yung may be correct in suggesting that the term "natural" has outlived its usefulness, the concept of naturalness is not likely to disappear from legislation and federal policy frameworks any time soon. Therefore, I believe that we must make a collective effort to make sense of and define what we mean by natural conditions in the context of wilderness stewardship.

To provide a starting point for this difficult conversation ahead, I would like to offer some preliminary thoughts and approaches on how we might go about defining naturalness. I currently see four principal options for defining "natural" for purposes of managing units of the National Wilderness Preservation System. The first is to collapse the distinction between the natural and undeveloped qualities of wilderness character. There always has been a great emphasis on the apparent naturalness of wilderness in the Wilderness Act. Section 2(c) says wilderness "generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable" (emphases added). In identifying areas suitable for wilderness designation, the federal land management agencies have often interpreted apparent naturalness to refer to whether an area looks natural to the average visitor who is not familiar with the biological composition of natural ecosystems versus human-affected ecosystems. From this perspective, human-made features (i.e., developments) are generally considered to degrade the naturalness of an area. This focus on developments in evaluating natural conditions might lend credibility to an approach that seeks to merge the natural quality with the undeveloped quality of wilderness character.

Another, opposing option would be to stress the ecological integrity of an area as a measure of its naturalness. Under this approach, the science of ecology would be heavily relied upon to assess whether an area is natural according to agreed-upon indices and measurements. Such a definition of natural would go far beyond apparent naturalness as viewed by the average visitor and solicit the expertise of scientists and land managers in evaluating whether an area is natural. This approach would likely support an interventionist approach to wilderness management that emphasizes ecological integrity, resiliency, or ecosystem health as management goals (although this approach still would require balancing those goals with the other qualities of wilderness character).

A third option would be to define naturalness in terms of historical fidelity, as I have already discussed. In a modified and contemporary version of the Leopold Report (1963), such an approach would prioritize the preservation of ecosystem composition and processes within historic ranges of variation. Historical fidelity differs from ecological integrity in that it emphasizes the preservation of specific biological structures, processes, and assemblages that existed at some period in time

(determining the exact dates of that period is, of course, a difficult and value-laden exercise). For example, proponents of ecological integrity may accept extirpation of individual species, as long as the system as a whole maintains its overall resilience and functionality. By contrast, the loss of a species that has "historically" been present in an area would be unacceptable from the viewpoint of historical fidelity. Naturalness defined as historical fidelity would likely result in the highest degree of intervention in wilderness ecosystems to maintain "natural conditions."

A fourth option would define "natural" to mean the opposite of modern human civilization. While we have already established that in the Anthropocene no place on Earth is completely unaffected by human influence, that does not mean that all places are equally dominated by human activity. In this view, naturalness would describe the relative autonomy or independence of wilderness ecosystems from the effects of modern civilization. From this perspective, the further an organism or ecosystem is removed from the chain of human causality, the more "natural" it is. While difficult to measure, this approach would likely merge the untrammeled and natural qualities of wilderness character on some level.

There is always the option of developing a definition that represents a composite of the above approaches. I am confident others will also formulate additional definitions that I have not presented here. In the end, I fully recognize the difficulty and far-reaching consequences of defining "natural conditions" in the context of the Wilderness Act of 1964. However, I believe it is ultimately in our own best interest to develop defensible methods and definitions that will hold up to public scrutiny. Rather than making up makeshift definitions of naturalness when pressed to make management decisions, let us attempt to systematically steward our enduring wilderness with a consistent and thoughtful understanding of what we mean by "natural conditions." Therefore, it is my humble plea that the federal land management agencies and their partners begin an inclusive and deliberate process to develop a definition of the term "natural" for the purpose of stewarding the units included in the National Wilderness Preservation System. To be clear, I am not taking a stance on whether management interventions to protect natural conditions inside wilderness are appropriate or not. Rather, my goal with this plea is to stimulate conversation and exchange of ideas on this important topic that we all deeply care about, hopefully steering us toward a positive evolution of the wilderness ideal. ijw

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Smartphone Forest **Photo credit:** kbk8196 on pexels.

SCIENCE & RESEARCH

Wilderness Solitude in the 21st Century: A Release from Digital Connectivity

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ABSTRACT Recent advances in mobile communication technology have led to decreased opportunities for alone time within daily life. Perhaps as a result, the solitude and independence offered in wilderness landscapes has become even more valuable. This study synthesizes past research and theory to create a quantitative model of wilderness solitude with a particular emphasis on release from digital connectivity. Study participants were visitors to Montana's Bob Marshall Wilderness Complex during the summer and fall of 2017. Exploratory factor analysis reveals four components of wilderness solitude: Societal Release, Introspection, Physical Separation, and De-tethering from Digital Connectivity.

Contemporary understandings of wilderness solitude need an update. As a body of knowledge, most field research concluded toward the end of the 20th century with the focus of indicators primarily relating to visual-social encounter norms and issues of visitor-use density. However, a handful of studies utilized humanistic measures that sought to investigate wilderness solitude in relation to a visitor's motivation and capacity to positively cope with time spent alone. These studies view

solitude as a personal experience, in addition to a response to the environmental conditions and perceived crowdedness of a given wilderness area. This suggests that the ability to experience solitude is not only dependent on the social conditions they encounter but is also influenced by an individual's potential to temporarily detach from societal norms and focus their attention inward. This study sought to begin the process of integrating these research frameworks but also considers the rapid acceleration of digital connectivity that has influenced society since the bulk of solitude research was conducted.

We start by briefly reviewing past wilderness solitude research and then outline some of the more recent changes brought on by mobile technology. We then present and test an enlarged model of wilderness solitude that includes variables related to digital connectivity. It is our hope that researchers and managers might continue to consider a broad range of experiential conditions (both external and internal) that impact visitors seeking opportunities for solitude within units of the National Wilderness Preservation System.

Solitude as a Complex Research Topic

Wilderness solitude has long been an elusive concept. The Wilderness Act of 1964 is relatively terse when it calls for the provision of "outstanding opportunities for solitude or a primitive and unconfined type of recreation." Engebretson and Hall (2019) suggest that "there has been and continues to be a lack of clarity about the meaning of the whole phrase." Nevertheless, wilderness researchers have pursued two frameworks of inquiry into the experience of wilderness solitude and identify a suite of possible indicators or desired conditions. Those frameworks of inquiry are: (1) the physical isolation perspective, which aims to measure threats to solitude with an emphasis on visitor use density, number of encounters, and degree of privacy (Hammitt and Madden 1989); and (2) the psychological detachment perspective, which investigates an individual's solitude experience in terms of personal introspection, sense of self, and a freedom from societal norms and roles (Hollenhorst et al. 1994). Common threads between these two perspectives are the objectives of determining the characteristics that define an individual's direct experience of solitude and of identifying indicators that serve as a proxy to the subjective experience of wilderness solitude. We believe it is important to note:

> *The task of studying solitary experience is intrinsically difficult, [and] in one sense self-contradictory. In order to obtain information on what takes place when people are alone, their privacy must somehow be broken, thus, to a degree, negating the object of study. (Larson 1990, 159)*

Within the physical isolation framework, threats to wilderness solitude have been most closely aligned with the social-spatial conditions within a given wilderness area, utilizing indicators such as visual or social contact, personal autonomy, and physical remoteness (Lee 1977; Hall 2001). Due to the comparative ease of documenting the number of encounters a wilderness visitor experiences across a landscape (during a certain amount of time), the themes of crowding and

visitor use density have traditionally guided the development of models in which "opportunities for solitude" have been measured (Long et al. 2007). The physical isolation perspective "assumes that solitude is a psychological response to social conditions experienced in the wilderness setting. If crowding is low or encounter norms are not exceeded, opportunities for solitude are presumably high" (Hollenhorst and Jones 2001, 56). Subsequently, the concept of wilderness privacy was developed to further articulate this line of inquiry and, as Hammitt and Madden (1989) found, one of the most important aspects of wilderness privacy "was being in a natural, remote environment that offers a sense of tranquility and peacefulness and that involves a freedom of choice in terms of both the information that users must process and the behavior demanded of them by others" (293).

In contrast, the psychological detachment framework shifted the focus away from wilderness conditions relating to isolation potential and, instead, concentrated on aspects of wilderness solitude that foster personal growth and development, specifically relating to self-examination and sense of self (Young and Crandall 1984). Hollenhorst and Jones (2001) developed the following definition for this framework:

> *Solitude is psychological detachment from society for the purpose of cultivating the inner world of the self. It is the act of emotionally isolating oneself for self-discovery, self-realization, meaning, wholeness, and heightened awareness of one's deepest feelings, and impulses. It implies a morality that values the self, at least on occasion, as above the common good (emphasis added, 56).*

Instead of building an operational definition of solitude based around the social and environmental conditions of a wilderness landscape, the psychological detachment perspective suggests that solitude ought to be investigated through the internal conditions that an individual brings with them to the wilderness. In contrast to indicators of physical isolation, and the continued monitoring of trail encounters being the standard by which wilderness solitude is understood, Hollenhorst and Jones (2001) proposed that "there are other important factors related to social disengagement and opportunities for contemplative reflection that demand more managerial and research attention" (60). This suggests that freedom from societal norms and expectations are important conditions within the experience of wilderness solitude.

A New Epoch in the Human Condition

Major technological advancements since the turn of the century have added new considerations for the study of wilderness solitude. The advent of smartphones has dramatically changed the patterns and frequencies of social interaction within contemporary life – creating a higher quantity of relationships to manage (both personal and professional). Which makes it difficult for many individuals to experience moments of uninterrupted alone time. For this reason, face-to-face communication has quickly become a secondary option due to the overwhelming preference, and ease, of digital exchange. Although the ability to remotely communicate and share information with friends, family, and colleagues serves as an incredible tool – cultur-

ally, there has been less dialogue toward determining the appropriate use of our novel communication technologies. As a result of these sociodigital transformations, "Rapidly evolving information and communication technologies are seen as marking a whole new epoch in the human condition" (Wajcman 2014, 2).

As we plug in to our social circles via digital means, we expose ourselves to the norms and attitudes of various groups at all hours of the day. Perpetual access to social networking has amplified the voice and image of a physically distant public, producing an unrelenting sphere of social updates and political opinions that has the potential to drown out opportunities for internal dialogue and personal reflection (Deresiewicz 2009). Instead of increasing the quality of interpersonal relationships, mobile communication technology has increased the quantity of such relationships, which has stretched the individual thin and produced a demand for one's attention that has left many individuals with overwhelming feelings of anxiety and stress (Alter 2017). The transition of social interactions from face to face toward screen to screen has produced a reliance on technological devices that our culture has never experienced before. Unfortunately, this newfound reliance has also evolved into behavioral addictions: to the physical medium of our mobile devices, as well as to the social networks harbored within them (Gao et al. 2018).

Research conducted by the MIT Initiative on Technology and Self has found that younger generations of Americans are becoming more comfortable with certain technologies than they are with one another, with Turkle (2012, 295) concluding that if "the simplification and reduction of relationship[s] is no longer something we complain about… It may become what we expect, [and] even desire." As we relinquish our private time to stay better connected with others, our personalities, and the stories behind them, now exist in both a physical and digital realm. This dualism has led to the development of a tethered-self: one that is always connected and always online (Turkle 2008). The notion of the tethered-self is one of electronic copresence: the individual is physically present in a fixed location while also able to manage social relationships that exist within online platforms. Cyberspace

"…face-to-face communication has quickly become a secondary option due to the overwhelming preference, and ease, of digital exchange. Although the ability to remotely communicate and share information with friends, family, and colleagues serves as an incredible tool – culturally, there has been less dialogue toward determining the appropriate use of our novel communication technologies."

offers the opportunity for a second life, one where an individual can craft an idealized version of themselves – where idiosyncrasies can be filtered and a more polished version of one's identity can be put on display. Because of this, individuals become tethered to the task of grooming their online identity, while also being drawn to these very devices that offer short-term amusement and gratification (Turkle 2008).

The emergent utility of device-based diversions is not without its limitations: "inevitably, the constant flow of communication requires negotiation over the allocation of time and attention in multiple temporal zones, causing communication congestion and conflicts" (Wajcman 2014, 159). And if such conflicts are not identified, or addressed, an individual can face obstructions within their understanding of themselves and their world. It is suggested that to best address these incidences of congestion and conflict, an individual benefits most from allocating their time and attention back to themselves in a more deliberate and personal manner (Buchholz 1997). Wilderness provides outstanding opportunities for such a reallocation of time and attention to take place.

When considering the continuing relevance of wilderness in contemporary society, one needs to look no further than the parallels between the accessibility and connectivity offered by automobiles and roadways in the early half of the 20th century, and the accessibility and connectivity offered by digital devices and high-speed communication networks in our current era. As Paul Sutter pointed out in his 2002 book, Driven Wild: How the Fight against Automobiles Launched the Modern Wilderness Movement, rampant road building and the proliferation of automobile manufacturing not only threated the integrity of wild landscapes to commercial exploitation and habitat fragmentation, but this era also changed the way in which people interacted with such landscapes. As more and more visitors remained on roadways and viewed the outside environment from the comfort of their vehicles, they limited their opportunities to immerse themselves in the experience of wild nature and cultivate a personalized sense of place. Similarly, our mobile technologies in the 21st century are designed to bring the luxuries and attitudes of modern life with us wherever we go and, therefore, have the ability to limit and isolate one's connections to self, community, and the Earth. What makes wilderness environments significant in relation to the digital age is that these landscapes offer an opportunity to experience relief from the multifaceted stresses that such technologies can harbor within the placeless environment of cyberspace. Wilderness offers space and time for individuals to explore the subtle aspects of human life and community that are all too often omitted within the collectivism of digital culture.

This Study: Location, Sample Population, Methods, Results

This study used an on-site, quantitative survey to assess the level of importance wilderness visitors place on various experiential conditions relating to wilderness solitude. The goal of this study was to develop an operational model of wilderness solitude that incorporates the human-

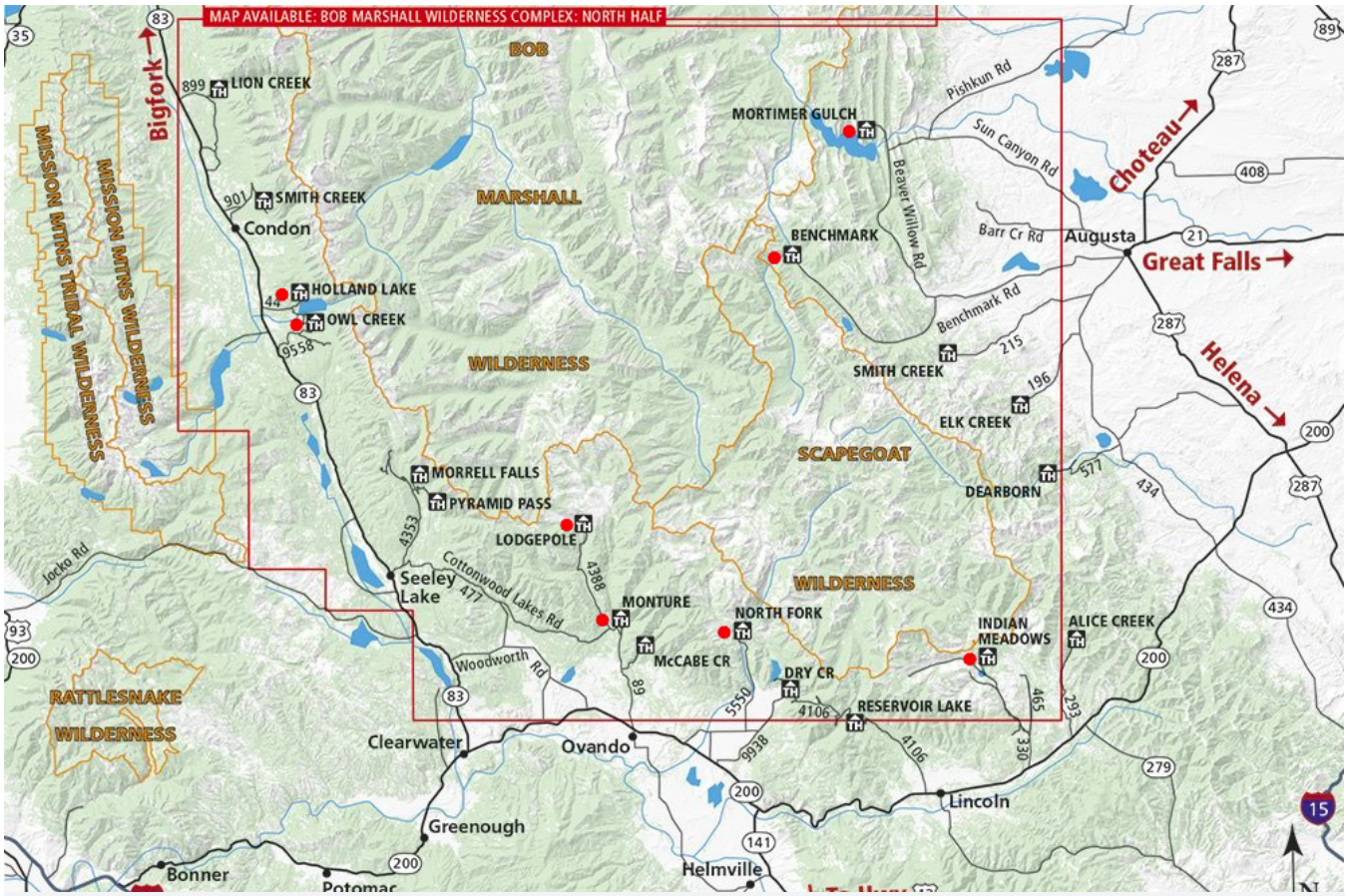

Figure 1 - Map of Trailheads in southern half of BMWC. Courtesy of Cairn Cartographics.

istic indicators of the psychological detachment perspective, with the more objective measures of the physical isolation perspective while also highlighting the conditions of contemporary digital culture that have emerged since those research frameworks were developed.

During the summer and fall of 2017, survey data was collected in the Bob Marshall Wilderness Complex (BMWC) in northwestern Montana. The BMWC comprises three contiguous wilderness areas: Bob Marshall, Great Bear, and the Scapegoat Wilderness, and covers over 1.5 million acres (607,028 ha) of rugged and remote designated wilderness. Field research was extended across three US Forest Service Ranger Districts within the southern half of the BMWC: Seeley Lake, Lincoln, and the Rocky Mountain Ranger District. Visitors were sampled at a total of nine trailheads, shown in red on Figure 1.

The population of interest for this study was wilderness users of the southern half of the BMWC. The sampling method used is considered convenience sampling, with a distinct limitation in its ability to accurately describe a specific population because some, rather than all, of the elements in the population are sampled (Vaske 2008). Therefore, the resulting data from this study is not a representative sample of wilderness users across the BMWC; however, a comparison with past social-science research in the BMWC conducted in 2004 by Whitmore et al. (2017) suggests little sampling bias exists. That is, while the analysis and results of this study do not

make generalized claims about the sample population, the sample does allow for consideration of the content and reliability of a four-dimensional model of wilderness solitude.

Most survey items assembled for this research were selected from statements that had been previously tested within the physical isolation and psychological detachment perspectives. Of the 22 items, two-thirds were taken from Driver's (1983) Master List of Items for Recreational Experience Preference Scales and Domains and Hammitt's 1982 study titled, "Cognitive Dimensions of Wilderness Solitude." This helped ensure content validity with survey items that have already been shown to perform in a consistent and predictable manner and build on past findings within the wilderness solitude research tradition. New items focusing on digital connectivity and accessibility were derived from the themes and findings of recent scholarship on the affects and conditions of contemporary digital culture (Turkle 2008, 2012; Wajcman 2014). These new items have a particular emphasis on the importance of being away from the technologies and devices that demand attention and diminish private time. By synthesizing the two perspectives and incorporating ideas on digital connectivity and accessibility, an updated and comprehensive assessment of visitor preferences for conditions related to the experience of wilderness solitude has been achieved. The resulting scale, the 21st Century Solitude Scale, heeds the themes of self-reflection, isolation potential, and temporary avoidance of societal norms.

The survey was separated into three sections: (1) social demographics, (2) visitor motivations, and (3) preference for components of wilderness solitude. For the 22 questions on wilderness solitude, participants were asked, "How important are the following items to your wilderness solitude experience?" and they responded on a six-point (1–6) scale: Extremely Unimportant / Unimportant / Somewhat Unimportant / Somewhat Important / Important / Extremely Important.

A total of 32 sample days throughout late July to mid-October resulted in a sample of 166 respondents who were either entering or exiting the BMWC. The survey was conducted on-site and was both voluntary and anonymous. Due to extensive wildfire activity across western and central Montana during the 2017 season, visitation levels to the BMWC were lower than usual. However, the respondents were found to mirror the characteristics found in a comprehensive 2004 BMWC visitor study conducted by Whitmore et al. (2017): 77% were male, 78% had visited the BMWC previously (possibly indicating a continued increase in previous experience across the decades), about the same proportion traveled in groups of two to four people (67%), and the average age was very similar at 42 years old. The current sample had higher proportions of day visitors (42%), of anglers (46%), and of those who reported staying overnight in the wilderness, the average length of stay (2.8 nights) was slightly lower than reported in 2004 when it was 3.3 nights.

Analyzing the 21st Century Solitude Scale

One of the primary goals of this study was to determine the underlying structure of the wilderness solitude scale. For this reason, exploratory factor analysis, through the technique of principal components analysis (PCA), was performed on the dataset. PCA works to statistically identify communalities among certain scale items so that a large number of variables can be reduced and explained through grouped items: components (Kyle et al. 2020).

A Kaiser-Meyer Olkin (KMO) value of 0.856 suggests that the sample was a suitable candidate for PCA (Kyle et al. 2020). A Bartlett's test of sphericity with an approximate Chi-square of 1931.417 with 231 degrees of freedom is significant beyond a 0.05 level, also signaling sufficient association to proceed with PCA. To determine the optimal number of components (or factors), the most used approach is the latent root criterion where only those components with eigenvalues greater than one are retained (Hair et al. 2018). This produced a four-factor solution that, combined, explained a satisfactory 60.9% of the variability within the 22-item wilderness solitude scale. A scree test criterion is used to confirm the selection of four components, where plotting the eigenvalues of each component shows a steep downward slope toward an inflexion point between the fourth and a fifth component. Beyond the fourth component, the scree plots flattens out (the "scree") with each subsequent component contributing little additional explanation. Examination of an orthogonal rotation of the component matrix showed conceptual distinction between, and consistency within, four components. As a result, the analyses identifies four core dimensions within the 21st Century Solitude Scale, which we have interpreted as:

1. *De-tethered from Digital Connectivity*
2. *Physical Separation*
3. *Introspection*
4. *Societal Release*

Each of these four components have Cronbach's alpha levels above 0.7, suggesting each grouping of questions is internally consistent and reliable (Kyle et al. 2020). The results of the factor analysis (component structure), as well as the mean and standard deviation for each of the 22 items, is shown in Table 1.

The first component (De-tethering from Digital Connectivity) explained 35% of the overall variation in response to the 22 items, indicating its foremost importance to the wilderness solitude experience. The remaining components (Physical Separation, Introspection, Societal Release) each explained a further 11%, 9% and 7% of overall variation. Factor loadings are high and all inter-item Pearson correlations within each factor were statistically significant above a .01 level. There were relatively few items (5) with cross-loadings across two factors (all of which were below a .50 cutoff, as appropriate for a sample size of 144 (Hair et al. 2018)). This suggests a conceptual distinctiveness and occasional intersection of the orthogonal components. For

example, the item "To be alone" loaded strongly on Factor 2: Physical Separation (0.63) but also on Factor 3: Introspection (0.45). The item "To experience life without everyday technologies" loaded heavily on Factor 1: De-tether from Digital Connectivity (0.61) but also on Factor 4: Societal Release (0.45). We now turn to interpreting each of the four components.

Table 1 - Factor Analysis of 21st Century Solitude Scale (Rotated Component Matrix)

Wilderness Solitude Items	Factor Loading				Mean	Std. Dev.	Cronbach Alpha
	1	2	3	4			
Factor 1: De-tether from Digital Connectivity (7 items)							**0.91**
To be away from emails and instant messaging	.86				4.4	1.3	
To be away from internet connections	.84				4.3	1.4	
To disconnect from social media	.78				4.4	1.5	
To be away from cell phones and other digital devices	.76				4.6	1.3	
To not multitask with digital devices	.73				4.1	1.4	
To experience life without everyday technologies	.61				4.8	1.0	
To get away from the noise back home	.54				4.6	1.3	
Factor 2: Physical Separation (6 items)							**0.79**
To camp free from the sights and sounds of others		.74			4.9	1.1	
To encounter low numbers of people on the trail		.70			4.9	0.9	
To be away from crowds of people		.65			5.1	0.9	
To be alone		.63			4.0	1.3	
To feel isolated		.59			4.3	1.3	
To be free from observation by all other people		.58			3.8	1.3	
Factor 3: Introspection (4 items)							**0.71**
To think about who I am			.84		4.0	1.3	
To think about my personal values			.73		4.4	1.2	
To develop personal and spiritual values			.72		4.2	1.4	
To be on my own			.68		4.2	1.3	
Factor 4: Societal Release (5 items)							**0.71**
To avoid everyday responsibilities for a while				.69	4.5	1.2	
To be relieved from the rules and constraints of society				.68	4.1	1.4	
To give my mind a rest				.58	5.0	1.0	
To get away from the usual demands of life				.51	4.5	1.2	
To be in an environment mostly free of human-made intrusions				.45	5.2	0.9	

Notes:
N = 166, Varimax rotation with Kaiser normalization, factor loadings less than .5 not shown
Lead in question: "How important are the following items to your wilderness solitude experience?"
Responses ranged from 1 [Extremely Unimportant] to 6 [Extremely Important]

Figure 2 - Digital Intimacy by Roman Odintsov on pexels.

Component Interpretations and Implications

De-tethered from Digital Connectivity

The De-tether component suggests that a lack of digital connectivity is an important experiential condition for wilderness visitors seeking solitude. The opportunity to exist without everyday technologies (particularly cell networks), to be away from emails, instant messaging, and social media is of great significance to both overnight and day visitors. By spending time away from the influences of digital culture, wilderness users have the chance to be more fully immersed in their immediate environment and less distracted by digital devices and the networks within them. Given the conditions of hyperconnectivity that encompass contemporary society, individuals who find it important to spend time away from internet and cell service value that wilderness areas allow a temporary release from the sensory overload and social pressures of modern digital life.

The implications for management within this component are complex. First, future pursuit of the installation of cell phone towers into wilderness, perhaps arguably justified based on visitor and administrative safety, could be counter to the definition of wilderness as areas of "undeveloped Federal land retaining its primeval character and influence, without perma-

nent improvements or human habitation" (Wilderness Act of 1964). Wilderness is further defined to be in contrast to areas where humans and their works dominate the landscape, and we suggest the ubiquity of network service would render wilderness less distinct, and certainly less primitive. Further, as Howard Zahniser, the original architect of the act, reminded us in 1953, "We must remember always that the essential quality of the wilderness is its wildness" (1992, 52). Thus, what cell service would take from wilderness is not only an important part of the opportunity to experience wilderness solitude but also potentially its primeval character and influence – its wildness.

The importance of de-tethering has only just begun to be explored, and we encourage further examination in the context of wilderness experiences. The ideas of Sherry Turkle and Judy Wajcman provide one such foundation through their exploration of the shrinking of time and space in the face of modern technology and its impacts upon our sense of self and interpersonal relationships. The development of further indicators for the degree of de-tethering is suggested, as well as an investigation of their relationship to overall wilderness character. Lastly, a comprehensive research agenda focused on the relationship between digital connectivity and the use of mobile devices in wilderness areas is warranted (Dustin et al. 2019).

Physical Separation

The Physical Separation component of wilderness solitude suggests that avoiding crowds and having the opportunity to "camp free from the sights and sounds of others," to "encounter low numbers of people on the trail" and to "be away from crowds" are significant experiential conditions for wilderness visitors seeking the experience of solitude. The items within Physical Separation also indicate the importance of feeling isolation and of being alone. Nevertheless, we note that the findings of this study demonstrate that Physical Separation is only one element within the phenomenon of wilderness solitude and that a relatively equal importance ought to be given to the other three components.

It is common practice to tally the numbers of encounters that visitors or wilderness rangers experience while in a wilderness area, or to count the number of occupied campsites in a particular location – as these are conditions that may threaten opportunities for wilderness solitude. However, these measures may not indicate opportunities for feelings of aloneness and isolation. Hall and Shelby (1996), for example, found that more than 50% of respondents contacted in the Eagle Cap wilderness either reported being unaffected by encounters or could not report a particular threshold beyond which encounters became detrimental to their wilderness experience. The question of how, when, with whom, and where encounters affect solitude deserves more attention, as does the development of indicators that are proxies for the experience of physical separation rather than threats to that experience.

Introspection

The Introspection component of wilderness solitude suggests that wilderness visitors who are seeking to experience solitude value opportunities to examine their personal values

and a stronger sense of self. The establishment of this component helps expand the bank of potential indicators for monitoring wilderness solitude and supports past research as to its relevancy to the wilderness solitude experience. That is, a visitor's internal conditions must be considered when determining if "opportunities for solitude" exist.

It is unclear what conditions most favor such opportunities for introspection (and was beyond the scope of this study), but we would expect that management decisions, particularly regarding rules and regulations, might directly impact these opportunities. Additionally, the implications of a lack of human intrusions (visual, olfactory, and auditory) upon the multisensory enjoyment of wilderness may be one theme that deserves further investigation. Again, potential indicators of introspection should serve as proxies for this experiential quality and be sensitive to potential threats to these opportunities. Part of the challenge presented by the Introspection component is the difficulty of measuring an individual's subjective experience; therefore, qualitative research could be used to identify major themes and build a stronger understanding of the conditions relating to Introspection.

Societal Release

The Societal Release component suggests that wilderness visitors who are seeking to experience solitude find opportunities to spend time away from the usual demands of life to be important. To be relieved of the rules

Figure 3 - Bob Marshall Wilderness by Joceyln Catterson on flickr.

Figure 4 - Scapegoat Wilderness by Tom Lang.

and constraints of society is also associated with this component, thus suggesting it is important wilderness continues to function as a contrast to mainstream society. Wilderness areas not only provide visitors with an opportunity to immerse themselves within a natural environment but also to have the chance to experience life without the norms, limitations, and social expectations of the built environment – one that is free of commercial influence and exploitation. That is, wilderness solitude is more than aloneness, it is a release from the expectations, demands, and pace of modern life. We think of this as somewhat akin to "stepping off stage" and taking a break from the gaze and influence of the physical or digital crowds. Engebretson and Hall (2019) similarly point out that within the crafting of the Wilderness Act, solitude was defined in contrast to the

confusing sensory overload and pressure of modern civilization and mechanized culture.

Reminders of the built environment should be substantially unnoticeable such as the use of only very basic signs, limited manager presence, use of primitive tools and organic materials, and few restrictions on travel once inside wilderness. These conditions would not only provide the opportunity for Societal Release, but also signal deliberate restraint by managers. We believe these to be both important to the wilderness solitude sought by visitors but also to the untrammeled, primitive, and unconfined character of wilderness.

Conclusion

The findings of this study suggest wilderness solitude to be more than avoidance of other people. The four components of wilderness solitude indicate the importance of temporarily freeing oneself from the opinions, requests, and commercial interests that pervade daily life in the 21st century. In wilderness, there are opportunities for refuge, rest, and autonomy. Additionally, the sanctuary that can be discovered by visitors who turn their attention away from mass culture and reflect on the memories and experiences that define their lives is a major social benefit embedded within the original vision for wilderness. The chance to unplug is more important than ever, and this study supports the increasing relevance of wilderness solitude within the 21st century.

It is our belief that the measurement and monitoring of solitude should extend to the inward focus of the experience, which visitors reported to be important to their opportunity to experience solitude in wilderness. The emergence of the De-tethering component suggests that wilderness visitors are motivated toward unscripted and unmediated experiences that allow for self-discovery and reflective thought. Wilderness provides visitors with conditions that allow their personal time to remain personal, largely away from the algorithms, manipulations, and demands of modern, digital life. This study illustrates that solitude is a physical, psychological, and societal phenomenon, and for managers to protect this vital opportunity, the need to update our understanding of wilderness solitude grows more significant throughout each passing moment.

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The Mission Mountains (pictured) and Bob Marshall Wildernesses in northwest Montana were the focus of 10 VUM-focused research items published between 2000 and 2020. **Photo credit** Will Rice.

COMMUNICATION & EDUCATION

Distribution of Visitor Use Management Research in US Wilderness from 2000 to 2020: A Scoping Review

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ABSTRACT Visitor use in wilderness has grown over the past several decades, along with research focused on visitor use management (VUM) in congressionally designated wilderness. This scoping review of research published between 2000 and 2020 explores the distribution and representativeness of wilderness VUM research within the context of (a) the federal land management agencies administering wilderness and (b) the geographic distribution of research. Findings indicate wilderness administered by the Bureau of Land Management and US Fish and Wildlife Service were disproportionately understudied compared to both the total acreage of wilderness and number of wilderness areas administered by the US Forest Service and National Park Service. Additionally, large geographic gaps exist in the research produced during this period, with clusters of VUM-related research occurring in high-profile wilderness areas and the vast majority (89%) of wilderness areas generating no research. As we look toward the next 20 years of wilderness VUM-related research, these findings suggest a need for a more representative narrative and highlight several specific opportunities for future research.

Wilderness visitor use management (VUM) research has evolved and expanded since the creation of the National Wilderness Preservation System (NWPS) in 1964 (Cole and Williams 2012). Initially concerned with exploring fundamental questions about visitor motivations (Cole 2011; Cole and Williams 2012), VUM research in federally designated wilderness has evolved to "more deeply explore [the] visitor experience as the thoughts, emotions, and physical feelings that arise from visitors' activities, their physical and social context, and their focus of attention" (Cole 2011, 68). Beyond evolving explorations of the visitor, wilderness VUM research has also changed with management needs and philosophies, the changing composition of the NWPS, and an increased capability to conduct research. For instance, educating visitors through the Leave No Trace program gained support as a complement to regulating amounts of use under early carrying capacity approaches (Cole 2018). More broadly, social science efforts in wilderness VUM were guided by various policy changes such as the congressional introduction of the Recreation Fee Demonstration Program (Watson et al. 2015). Administratively, the original Wilderness Act only designated US Forest Service areas, mostly in the West, and, over time, designations included other federal land management agencies (e.g., the National Park Service), geographic regions, and ecosystem types (Watson and Armatas 2018). As wilderness designations expanded, research needs did as well, as reflected in the establishment of the Aldo Leopold Wilderness Research Institute (ALWRI) in 1993 (Cole 2019). The ALWRI is a federal interagency science unit based in Montana, which is charged with conducting and sharing research to support all federal land management agencies administering the NWPS. However, the formal interagency focus of wilderness research, led by the ALWRI, emerged after nearly 30 years of research conducted by the Intermountain Research Station's Wilderness Management Research Work unit (a US Forest Service unit established in 1967 in Montana).

"To our knowledge, no study in the past 20 years has empirically assessed VUM research across the NWPS as it relates to geographic focus and administering federal agency."

From 1987 to 2012, numerous reviews were conducted on wilderness VUM research (Cole 2001; Cole 2011; Cole and Williams 2012; Hollenhorst et al. 1992; Freimund and Cole 2001; Leung and Marion 2000; Krumpe 2000; Roggenbuck and Lucas 1987). However, these reviews largely consisted of selective, or nonscoping/systematic, research (see Cole 2011). Roggenbuck and Lucas (1987) provided a unique systematic review of wilderness research related to VUM, which included a descriptive analysis of where research was being conducted; the authors found research focused on a very small fraction of all wilderness areas (e.g., Bob Marshall Wilderness Complex and Boundary Waters

Canoe Area Wilderness) administered almost exclusively by one agency (US Forest Service). As wilderness VUM research continues within the context of a NWPS that is now geographically diverse and managed by all four major federal land management agencies, there is a need to understand the more recent distribution of VUM research to ensure diverse representation of geographies, use patterns, and management in the greater wilderness VUM research narrative.

In general, limited empirical research has examined the NWPS as a whole (Watson and Armatas 2018). To our knowledge, no study in the past 20 years has empirically assessed VUM research across the NWPS as it relates to geographic focus and administering federal agency. Therefore, the purpose of this study is to examine recent spatial and agency disparities in VUM research throughout the NWPS. Importantly, this study is not a "state-of-the-knowledge review" and does not include analysis of research themes, increases in wilderness designation, or VUM research, more broadly. Instead, this study seeks to provide a first step toward a larger review of VUM research within the NWPS by addressing more recent spatial and agency research disparities, exclusively. Through a scoping review and spatial descriptive analysis, we examine these disparities in the wilderness VUM-related research items published from 2000 to 2020. In doing so, we identify agencies, regions, and wilderness areas that have been disproportionately understudied over this period. We define disparities not in relation to visitation volume across wilderness areas or agencies, nor in relation to the national profiles of particular wilderness areas or agencies. Instead, we examine disparities related to (1) distributions across space and (2) in relation to the total area and number of wilderness areas administered by each agency. Previous research clearly illustrates the importance of studying visitor use regardless of use levels (Freimund and Cole 2001; Graefe et al. 2011); as demonstrated by D'Antonio and Monz (2016), low visitation conditions can potentially lead to more resource impacts than high visitation conditions. It is important to identify understudied sites, as they may represent areas where important visitor use phenomena are happening, but are not influencing the larger, national research narrative surrounding wilderness VUM. Further, tracking changes and trends in wilderness character – an important task of wilderness stewards on the ground—is complicated by a lack of a baseline understanding of visitors in the vast majority of wilderness areas. With these realities in mind, management and policy decisions – lacking representative research – may be based on only a subset of geographically and administratively similar wilderness areas. Therefore, the following two research questions guide this study:

R1: What is the recent distribution of wilderness VUM-related research (2000–2020) across administering agencies, and what agencies are disproportionately understudied?

R2: What is the geographic distribution of recent wilderness VUM-related research (2000–2020) across the NWPS, and what geographic areas containing wilderness are disproportionately understudied?

Table 1 - Defined Scoping Review Keywords

VUM Keywords	*Wilderness Keywords*
"visitor use"	"wilderness"
"outdoor recreation"	"solitude" or "unconfined recreation"
"wilderness visitors"	
"use allocation"	
"user capacity" or "social carrying capacity"	
"recreation ecology"	

See an example Boolean search phrase: "Wilderness" AND ("visitor use" OR "outdoor recreation" OR "use allocation" OR "user capacity" OR "social carrying capacity" OR "recreation ecology" OR "solitude" OR "unconfined recreation")

Methods

This study takes the form of a scoping review (see Arksey and O'Malley 2005). Scoping reviews are "commonly undertaken to examine the extent, range, and nature of research activity in a topic area" (Pham et al. 2014, 371). This reviewing approach is unique from a systematic review, as it does not engage in meta-analysis or include an assessment of research quality (Hanneke et al. 2017). Scoping reviews are useful in assessing the general "landscape" of an area of research (Hanneke et al. 2017). This study relies on Arksey and O'Malley's (2005) methodological framework for scoping studies, with additional guidance from Levac et al.'s (2010) update to this framework and its five-step review process: identify the research question, identify relevant studies, select studies, chart the data, and summarize results.

Research items were gathered from four databases: Google Scholar, USDA Treesearch, Aldo Leopold Wilderness Research Institute publication database, and ProQuest Dissertations & Theses database. Additionally, targeted searches were conducted within four outdoor recreation-related journals: International Journal of Wilderness, Journal of Park and Recreation Administration, Journal of Outdoor Recreation and Tourism, and Journal of Leisure Research. Searches of databases and journals used the same Boolean-based keyword inquiries (see table 1). Research items were screened using predetermined inclusion criteria, including: published between January 2000 and September 2020, published in the English language, focused on VUM in US federally designated wilderness, and not published as commentary, editorial, or conference abstract. For the purposes of our review, VUM was defined using the definition established by the Interagency Visitor Use Management Council (2016): "The proactive and adaptive process for managing characteristics of visitor use and the natural and managerial setting using a variety of strategies and tools to achieve and maintain desired resource conditions and visitor experiences" (113). Given the applied nature of wilderness VUM-related research, peer-review was not an inclusion criterion – as many studies are published only in general technical reports, theses, or dissertations.

Table 2 - Distribution of research items across wilderness-administering agencies

Administering Agency	Number of Research Items	Number of wilderness areas Administered or Co-Administered*	Acres of administered wilderness
Bureau of Land Management	3 (1.5%)	260 (32.4%)	9.9 million (8.9%)
National Park Service	70 (35.2%)	61 (7.6%)	44.3 million (39.7%)
U.S. Forest Service	111 (55.8%)	448 (55.8%)	36.7 million (32.9%)
U.S. Fish and Wildlife Service	7 (3.5%)	71 (8.8%)	20.7 million (18.5%)
Multiple Federal Agencies	8 (4.0%)	—	—
Total	199	803*	111.6 million

Note: * Some wilderness areas are administered by multiple federal agencies.

Each research item meeting the inclusion criteria was coded according to the wilderness area that served as its primary research setting. Additionally, the encompassing state/states and administering agency/agencies for each wilderness area were recorded in a common spreadsheet. Counts of research items falling within each wilderness area, state, and agency jurisdiction were then generated. Counts for each wilderness area and state were subsequently geocoded using ArcGIS Pro. Through a final step of analysis, the number of research items per state was divided by the total number of wilderness areas per state to obtain a coefficient, or ratio, of representation.

Results

In total, 259 research items focused on VUM research within the NWPS were identified through the scoping review process that met the inclusion criteria. Of these, 199 items focused on a specific wilderness, or selection of wilderness areas. Sixty items met the inclusion criteria but were not specific to a single wilderness area or a set of wilderness areas (e.g., review papers and conceptual pieces). These items were therefore excluded from this analysis. Of the 199 remaining items, 111 (55.8%) examined 1 or more units of US Forest Service–administered wilderness, and 70 (35.2%) examined National Park Service–administered wilderness (see table 2). Wilderness administered by the US Fish and Wildlife Service and Bureau of Land Management was the focus of just 7 (3.5%) and 3 (1.5%) items, respectively. Per both the number of wilderness areas administered and the total amount of wilderness acreage administered, the US Fish and Wildlife Service and Bureau of Land Management are underrepresented in these research items (see figure 1).

In terms of geographic distribution, of the 44 states containing wilderness, 16 states had no VUM-related research (zero research items) published from 2000 to 2020 (Figure 2). This group of states includes New Mexico, which presently contains 39 wilderness areas. Additionally, Nevada, which contains 70 wilderness areas, produced only 1 research item. On average, states contained 0.33 research items per wilderness area (e.g., 3 total research items across 9 wilderness areas within the state). The states with a ratio of research items to wilderness areas greater or equal to 1 include Indiana, Kentucky, Minnesota, New Hampshire, and Pennsylvania. Of those states containing at least 5 wilderness areas, Alaska, Montana, New Hampshire, and South Carolina have a research item to wilderness ratio greater than or equal to 0.5 (see figure 2).

In figure 3, disparities within states become apparent. For instance, in Michigan and Minnesota, we find all of these states' research items, 7 and 9 respectively, clustered in the Isle Royale and Boundary Waters Canoe Area Wilderness areas – leaving the remainder of the states' wilderness areas with 0 research items. Similarly, in Virginia, all research items focus on the Shenandoah Wilderness – leaving 23 wilderness areas without any VUM research. In Oregon, we find the majority of studies clustered along the wilderness areas within the Cascade Range, with wilderness areas along the Pacific Coast and in the eastern desert disproportionately understudied. The lack of research items focused on coastal wilderness is strikingly illustrated in figure 3. Only one wilderness on the Atlantic Coast, Cumberland Island, generated a research item. Wilderness areas along the Gulf of Mexico include 0 items, while those in California, Oregon, and Washington bordering the Pacific Ocean have but 1 area – King Range Wilderness – that generated research items. A variety of regions containing numerous wilderness areas appear similarly underrepresented, including Vermont's Green Mountains, the Ozarks of

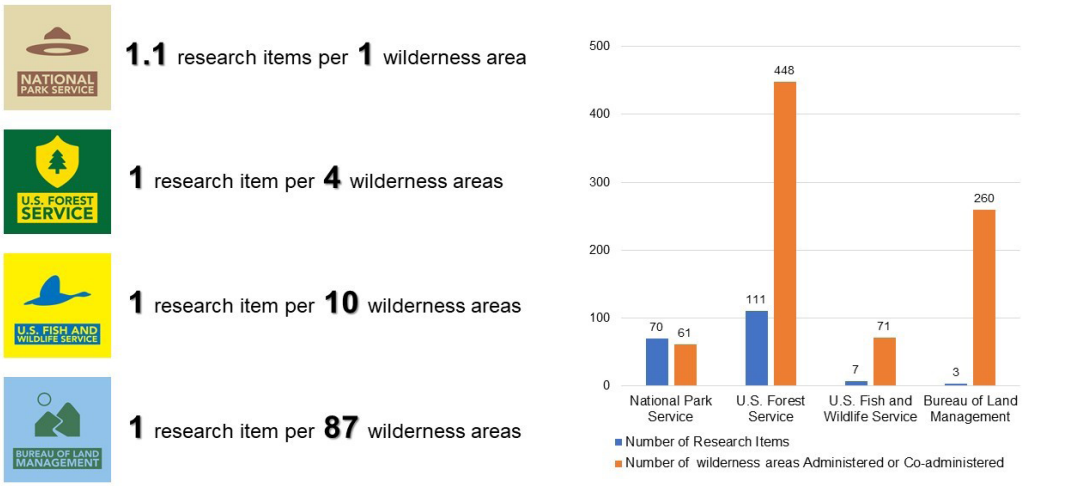

Figure 1 - Ratio of number of research items per wilderness areas administered by the four federal agencies administering wilderness.

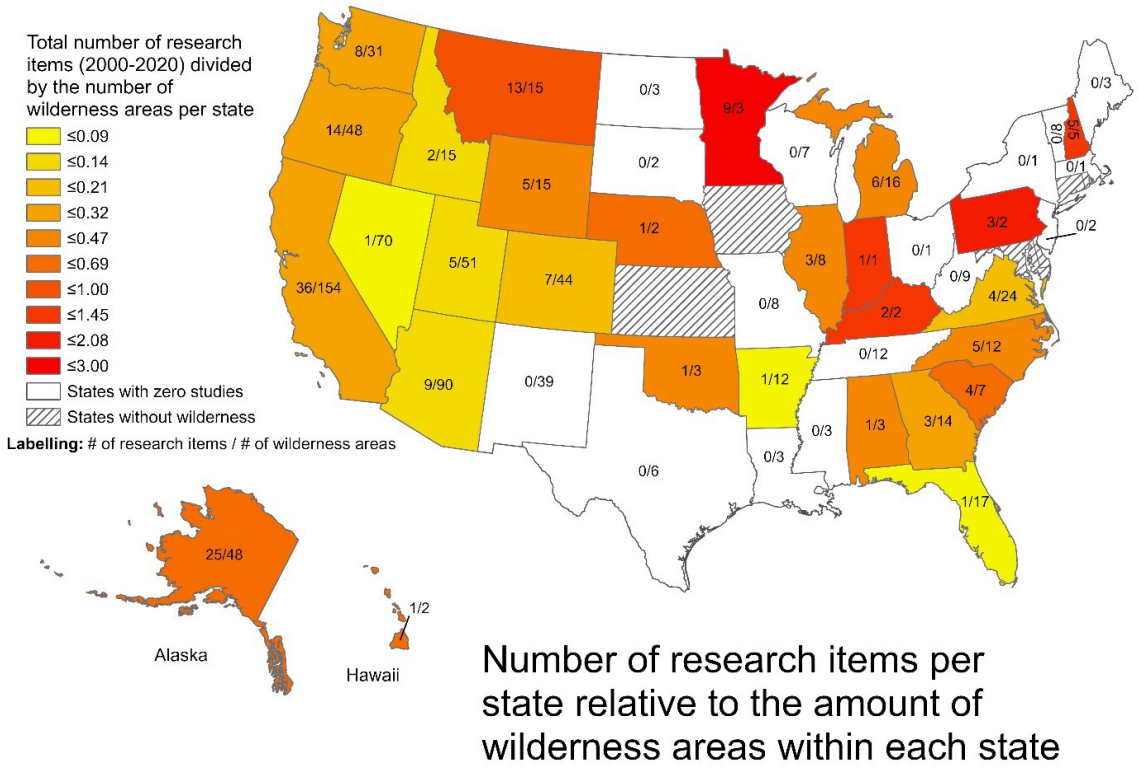

Figure 2 - Number of research items per state relative to the amount of wilderness areas within each state.

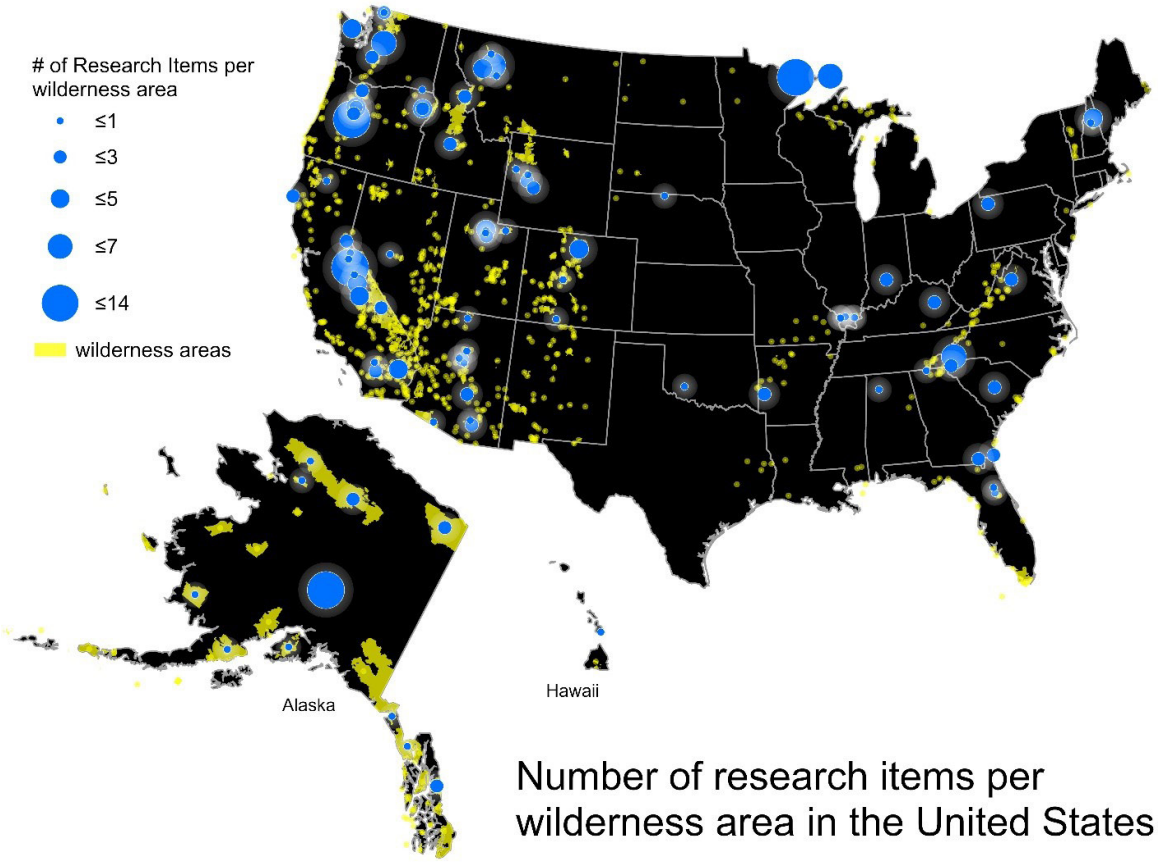

Figure 3 - Number of research items per state relative to the amount of wilderness areas within each state.

Missouri and Arkansas, the Great Basin of Nevada and Utah, the Everglades and Keys of South Florida, and the Great Plains.

Discussion

Agency Distribution

From an agency perspective, the largest disparity revealed through this study is the lack of VUM-related research focused on Bureau of Land Management– and U.S. Fish and Wildlife Service–administered wilderness. The Bureau of Land Management administers 32.4% of all wilderness areas, but accounts for just 1.5% of all recent research items. This represents a continuation of a long-running trend. Roggenbuck and Lucas (1987) note, "Past research on use and users has focused primarily on National Forest wilderness, with limited coverage of National Park areas," and, "There have been virtually no published studies on [US] Fish and Wildlife Service and Bureau of Land Management–managed "wilderness" (237). The authors note just three research items including National Park Service-administered wilderness (Gilbert 1980; Hendee et al. 1978; van Wagtendonk and Benedict 1980). In their nonsystematic review of wilderness recreation ecology research, Leung and Marion (2000) find a similar pattern, reporting that most of the research to date was conducted in US Forest Service–administered wilderness, with some research occurring in National Park Service–administered wilderness, and very limited research occurring in Bureau of Land Management– and US Fish and Wildlife Service–administered wilderness. While National Park Service–administered wilderness has received increased research since the Roggenbuck and Lucas (1987) review – evidenced by being the focus of 35.2% of all research items between 2000 and 2020 – the other agencies remain largely underrepresented.

Agency missions provide one potential reason for the disparity of recent research among agencies. For instance, historically, outdoor recreation was less central to the mission of the Bureau of Land Management (Glicksman 2014). Additionally, the work of the specially designated institutes, centers, and divisions within the US Forest Service and National Park Service likely impact the amount of wilderness VUM research within these two agencies. However, with relatively recent structural changes occurring within recreation management of federal agencies (e.g., the restructuring of the Bureau of Land Management, designation of Urban National Wildlife Refuges, shifting management of cultural resources in wilderness, etc.) this prioritization may shift. For instance, the creation of the Bureau of Land Management's National Landscape Conservation System may well make wilderness VUM a greater priority given the system's focus on offering "unparalleled recreational opportunities" (Jarvis 2003, 110).

The disparity in agency priorities has several important implications related to varying resources, missions, and recreation patterns across agencies. First, the nature of the resources preserved by wilderness tends to vary across agencies (Glicksman 2014). Each agency has a unique mission and history; they manage lands protected for

Figure 4 - North Carolina's Shining Rock Wilderness generated the most VUM-related research items among the wilderness areas of the eastern United States from 2000 to 2020. Photo by Will Rice.

various reasons, and the environments of those protected lands vary by agency. The Bureau of Land Management, for example, is the product of those "leftover" lands of the US federal government's defunct General Land Office (Glicksman 2014). These lands are somewhat distinct in their physical characteristics from those, for example, that are administered by the National Park Service and were largely selected from the public domain for their outstanding qualities. For instance, the National Park Service–administered Joshua Tree Wilderness was the focus of four research items during the study period, while its five adjacent Bureau of Land Management–administered wilderness areas generated zero research items, combined. Second, despite a common wilderness mandate, agencies tend to manage wilderness differently (Zellmer 2014). For example, Glicksman (2014) examines differences in wilderness management between the Bureau of Land Management and the US Forest Service – both "multiple-use" oriented agencies –finding that divergences arise from agency culture, policy, judicial treatment, and varying physical characteristics in the two agencies' lands.

Finally, wilderness users and recreation patterns vary across agencies, largely in response to physical characteristics and agency missions (Zellmer 2014). As Zellmer (2014) notes, wilderness managers in the National Park Service face increased pressure from tourism, while their counterparts in the US Fish and Wildlife Service must navigate unique visitor use impacts

related to wildlife-focused mandates and hunting in wilderness. The latter agency prioritizes wildlife-related activities "such as environmental education, interpretation, wildlife photography, hunting, and fishing" while "nonwildlife-related recreation receives a lower priority ranking" (Zellmer 2014, 523). This is not the case in the National Park Service (Zellmer 2014). Therefore, certain visitors and uses are likely being overlooked through VUM research almost exclusively concentrated on wilderness administered by the US Forest Service and National Park Service.

Geographic Distribution

In their review of the literature in 1987, Roggenbuck and Lucas note, "Relatively few studies have been conducted in the East and California," and, "The Desert Southwest and the South are little studied." (206). Our results show that – more recently – California hosted the most research items per state over the past 20 years, addressing this previous disparity. However, much of the East, including New England and Florida, is still underrepresented in wilderness VUM research (research items to wilderness areas ratios < .33). The same could be said for the southern group of states ranging west to east from New Mexico to Florida. Roggenbuck and Lucas (1987) also note that only 7.4% (33 out of 442) wilderness areas had been studied within the realm of VUM by 1985. Our results show 11.5% (92 out of 803) wilderness areas were the subject of wilderness VUM research from 2000 to 2020. Therefore, while some regions and agencies remain disproportionately understudied, the group of wilderness areas hosting VUM research appears to be diversifying to some degree. It is important to note, however, that much has changed in the wilderness VUM research realm since the review by Roggenbuck and Lucas (1987). The number of units within the NWPS nearly doubled. Additionally, the ALWRI was established in 1993, likely aiding expansion of wilderness VUM research.

The primary outcome of the inconsistent coverage of VUM research across the NWPS is an overall research narrative that remains nonrepresentative of the larger system. Large, well-researched sites such as Yosemite, Denali, Boundary Waters Canoe Area, Three Sisters, and Rocky Mountain National Park Wilderness Areas generate numerous research items, while the vast majority of the system (89%) generates zero VUM research. Therefore, our understandings of wilderness visitors' recreational impacts, motivations, values, encounter norms, and Leave No Trace competencies are derived from only those recreationists who visit the 11% of the system that generates VUM-related research. However, visitor characteristics, travel patterns, and encounter norms vary across wilderness areas (Ewert and Hood 1995). Importantly, Lindley et al. (2018) note that the urban-proximate wilderness experience is somewhat distinct from the nonurban proximate experience (e.g., less sensitivity to crowding). Yet throughout two decades of wilderness management that sought to increase relevance and inclusion, zero VUM research items were produced in wilderness areas immediately adjacent to the New York, Miami, Las Vegas, Portland, or San Francisco metro areas.

Further Implications of Nonrepresentative Distributions of Research

When it comes to VUM-related research allocation, we posit that perhaps an implicit hierarchy exists, as some agencies and areas receive more research. Possibly as a result of the evolution of wilderness research, agency priorities, funding, and missions, lasting research traditions at a unit level, and, perhaps, researcher preferences, many high-use wilderness areas have never or scarcely been studied in the context of VUM (e.g., Gila, La Madre Mountain, Marjory Stoneman Douglas, Otis Pike Fire Island High Dune Wilderness Areas), while others generate research items on a nearly biennial basis (e.g., Yosemite, Three Sisters, Denali, and Boundary Waters Canoe Area Wilderness areas). While the focus of wilderness VUM-related research items between 2000 and 2020 shows relatively greater coverage of the NWPS compared to the review by Roggenbuck and Lucas (1987), the more recent cohort of studies still represents just over 11% of the system. As a result, the knowledge created from wilderness VUM research, which may be influencing managers throughout the NWPS, is based on a small portion of the system. While trends data from well-studied wilderness areas are important, it is also important to recognize the opportunity cost of focusing on such a small portion of the larger NWPS. As noted by Roggenbuck and Lucas (1987), a continued focus on the same set of wilderness areas – the majority being "mountainous and alpine" – comes at a cost, in the form of a knowledge gap concerning the "study [of] wilderness use and users in desert, swamp, and coastal plain wildernesses" (237). It is therefore important to recognize that wilderness areas are not created equal, and that essentially all wilderness areas – despite the primary reasons for their designation – host some level of visitor use (with the exception of very remote areas), and each one has unique visitation patterns and uses and is worthy of study.

An Agenda for Future Research

Given the findings of this study, we highlight opportunities for future wilderness VUM research, which may support addressing geographic and agency disparities. We do not recommend halting the collection of long-term trend data, but instead suggest the pursuit of additional research in those areas, environments, and agencies that have received less attention throughout the previous two decades. It is imperative that underrepresented wilderness areas be studied to generate a more complete understanding of visitor use throughout the NWPS. We acknowledge that visitation volume is not the only justification for VUM research (Freimund and Cole 2001; Graefe et al. 2011). Environments have varying levels of sensitivity to wilderness recreation (Marion et al. 2016), visitors' sensitivity to crowding and other aspects of the social and managerial setting vary across wilderness areas (Cole 2001), and wilderness management varies across agencies (Glicksman 2014; Zellmer 2014). Given previous demonstrations for how the ecological and social settings impact wilderness visitor use, targeted studies must attempt to amend regional disparities in research by focusing on wilderness areas

Figure 5 - Of wilderness areas generating VUM research between 2000 and 2020, California's King Range Wilderness is both the only wilderness area along the US contiguous Pacific Coast and the only wilderness area administered by the Bureau of Land Management. Photo by Bob Wick/Bureau of Land Management.

in the Gulf, Atlantic and Pacific Coasts, Great Plains, Great Basin, and Ozarks. Additionally, we stress the importance of research in oft-overlooked urban-proximate wilderness areas, as future projections suggest continued increase of wilderness day use by urban residents (Cole and Hall 2010). Finally, we highlight the potential value of prioritizing VUM research in Bureau of Land Management and US Fish and Wildlife Service–administered wilderness to examine unique qualities of VUM in these wilderness areas and provide a more comprehensive narrative concerning visitor use throughout the NWPS.

Conclusion

Recent wilderness VUM research occurring between 2000 and 2020 was not representative of the areas within the NWPS or the agencies that administer it. Bureau of Land Management– and US Fish and Wildlife Service–administered wilderness were disproportionately understudied compared to both the total acreage of wilderness and number of wilderness areas administered by the agencies. Additionally, large geographic gaps exist in the research produced during this period, with dense clusters of VUM-related research occurring in high-profile wilderness areas, and the vast majority (89%) of wilderness areas generating no research. As a result, the research narrative concerning VUM in wilderness is derived from only those recreationists who visit the 11% of the system that generates VUM-related research. These findings suggest a need for the

wilderness VUM research community to pursue a more representative narrative concerning spatial and agency distribution. As we look toward the next 20 years of wilderness VUM research, we recognize the agency and geographic disparities of the previous 20 years and note the great value in conducting research that was representative across settings and agencies. With Thoreau in mind, we remember that "the future" of wilderness is perhaps not found in the long-studied alpine gardens "but in the impervious and quaking swamps" (2013, 262).

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Wild Carbon: A Synthesis of Recent Findings on Carbon Storage in Old Forests

by MARK G. ANDERSON, PhD

We find ourselves not at the edge of a precipice, but beyond it. "Climate change" was once a warning bell suggesting a dire future but is now a full-fledged alarm signaling direct and immediate impacts on human and other-than-human communities. With heat waves, droughts, wildfires, melting glaciers, and record-breaking storms making headlines weekly, if not daily, the effects on people and society are unfolding in real time. While our wild relatives make the news less frequently, the consequences of climate chaos on their lives is no less devastating or widespread – and indeed, their well-being is indivisible from our own.

All living beings will experience the hardships of a hotter, more volatile climate no matter how quickly we act to reduce our collective carbon footprint. Yet this fact does not nullify our collective responsibility to do all we can to make the best possible choices, informed by current research, to employ our last best chance of reducing atmospheric carbon dioxide – currently reported at an average of 409.9 parts per million by the National Oceanic and Atmospheric Administration – to safe levels for nature and people. And while technological inventions to capture carbon have been the subject of popular attention

Mark G. Anderson
Photo by DJ Glisson, II/Firefly Imageworks

"...creating wild spaces where unmanaged forests can age and develop should be the centerpiece of our carbon solutions."

and hope of late, it turns out that the most economic and effective systems to sequester and store carbon were "invented" long before humans walked the Earth. They are called ecosystems.

Forests, grasslands, oceans, and wetlands are considered "natural climate solutions." These ecosystems are already doing the work that carbon capture technology hopes to achieve – at a fraction of the cost and with innumerable cobenefits to wildlife and people. With deforestation eating away at the few intact natural places left on Earth, meaningful legal protection – coupled with rewilding and restoring degraded land – is necessary if these wondrous places are to continue doing their important work while also providing refuge to diverse, declining species and supporting the health of human communities. Initiatives such as 30x30 (www.campaignfornature.org), Nature Needs Half (www.natureneedshalf.org), and the UN Decade on Ecosystem Restoration (www.decadeonrestoration.org) are indicative of a global shift in consciousness toward protecting nature as an essential solution to climate change, and a critical ingredient for a thriving, healthy planet.

An emphatic embrace of natural climate solutions to mitigate global overheating does not require an either/or choice between managed and unmanaged forests. However, conserving unmanaged wild forests is a proven, scalable, and cost-effective strategy that is complementary to, not exclusive of, the continued conservation and stewardship of well-managed woodlands.

– Jon Leibowitz, Executive Director of Northeast Wilderness Trust

Wild Carbon

Wild nature has a right to exist simply for its intrinsic value and rich biodiversity, but recent peer-reviewed research is shedding light on an added benefit that old unmanaged forests offer exceptional carbon storage capacity. A long-standing debate over the value of old forests in capturing and storing carbon has prompted a surge of synthesis studies published in top science journals during the past decade. The findings of the studies summarized herein as six well-supported truths resolve this debate and demonstrate the irreplaceable value of older forests.

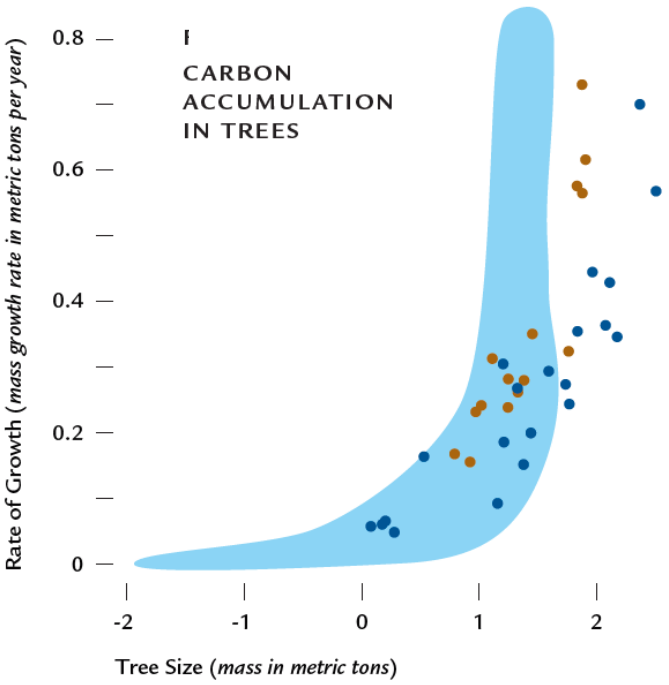
Trees Accumulate Carbon Over Their Entire Lifespan

Plants absorb carbon dioxide from the air and transform it into carbon-rich sugars. These are then converted to cellulose to create biomass (wood, bark, root, and leaves) or are transferred belowground to feed the root-fungal (mycorrhizal) networks. Over the long lifespan of a tree, large amounts of carbon are removed from the air and stored as biomass. Growth efficiency declines as the tree grows, but corresponding increases in the tree's total leaf area are enough to overcome this decline and thus the whole-tree carbon accumulation rate increases with age and size. A study of 673,046 trees across six countries and 403 species found that at the extreme, a large old tree may sequester as much carbon in one year as growing an entire medium-sized tree (Stephenson et al. 2014; figure 1). At one site, large trees made up 6% of the trees but 33% of the annual forest growth. Young trees grow fast, but old trees store a disproportional amount of carbon.

Old Forests Accumulate Carbon and Contain Vast Quantities of It

Old-growth forests have traditionally been considered negligible as carbon sinks. Although individual trees have an increasing rate of carbon sequestration, the forest stands (groups of trees) have an "S-curve" of net sequestration rates. The rate of carbon accumulation in the ecosystem is slow at first, then speeds up for some time, then slows down again after many decades. The expected carbon neutrality of older stands was thought to be due to sequestration during tree growth being balanced out by carbon emissions from respiration and decomposition.

To test this, and determine if old forests are actually carbon neutral, an international team of scientists reviewed 519 published forest carbon-flux estimates from stands 15 to 800 years old. They found that contrary to expectations, 75% of stands more than 180 years old sequestered more carbon than they emitted, and the chance of an old-growth forest being carbon neutral was less than 1 in 10 (Luyssaert et al. 2008). They concluded that old-growth forests act as carbon sinks more often than not, steadily accumulating carbon as well as storing vast quantities of it. They argued that accounting rules for forest carbon markets should give credit for leaving old-growth forest intact. Goldstein et al. (2020) bolstered this argument by showing that old forest carbon is "irrecoverable," meaning it is vulnerable to release upon land use conversion and, once lost, is not recoverable on timescales relevant to avoiding dangerous climate impacts. This is important globally, as old forests in the tropics have acted as long-term carbon sinks but are now vulnerable to edge effects, logging and thinning, or increased mortality from disturbances (Brienen et al. 2015; Qie et al. 2018).



Aboveground mass growth rates for 58 species (shaded area) juxtaposed with two of the most massive tree species on earth: Swamp Gum (*Eucalyptus regnans*—brown dots) and Coast Redwood (*Sequoia sempervirens*—blue dots). Mass growth rate equals the total mass accumulated each year after accounting for respiration. The mass of a tree is primarily carbon, so the figure shows that annual carbon accumulation increases with the size of the tree. (Adapted from Stephenson et al. 2014.)

Figure 1 – Carbon accumulation in trees.

Old Forests Accumulate Carbon in Soils

The soil-carbon balance of old-growth forests has received little attention, although it was generally accepted that soil organic carbon levels in old forests are in a steady state. In 2017, Guoyi Zhou and colleagues measured the 24-year dynamics of the soil carbon in an old-growth forest at China's Dinghushan Biosphere Reserve. They found that the top 20 centimeters of soil accumulated atmospheric carbon at an unexpectedly high rate: over the course of

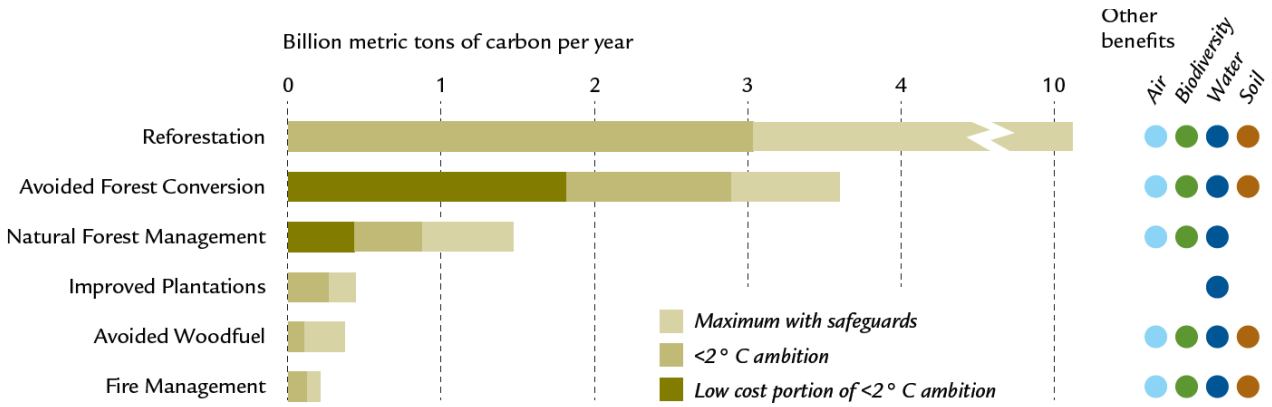
the study, the concentration of organic carbon in the soil increased from about 1.4% to 2.4%, and soil carbon stock increased significantly at an average rate of 0.61 metric tons of carbon per hectare per year (Zhou, G. et al. 2006). Their result directly challenges the prevailing belief in ecosystem ecology regarding soil carbon in old-growth forests and calls for further study.

Forests Share Carbon among Tree Species

Forest trees compete for light and soil resources, and competition for resources is commonly considered the dominant tree-to-tree interaction in forests. However, recent research using stable carbon isotope labeling indicates that trees interact in more complex ways, including substantial exchange and sharing of carbon. In 2016, Tamir Klein and colleagues applied carbon isotope labeling at the canopy scale and found that carbon assimilated by a tall spruce was traded with neighboring beech, larch, and pine trees via overlapping root spheres. Aided by mycorrhizal networks, transfer between species accounted for 40% of the fine-root carbon, totaling roughly 280 kilograms per hectare per year in tree-to-tree transfer (Klein et al. 2016). In a subsequent study, Morrie et al. (2017), found that mycorrhizal soil networks become more connected and take up more carbon as forest succession progresses, even without major changes in dominant species composition.

Forest Carbon Can Help Slow Climate Change

There has been debate about the role of forests in sequestering carbon and the role of land stewardship in achieving the Paris Climate Agreement goal (United Nations 2015). In 2017, Bronson Griscom and colleagues systematically evaluated 20 conservation, restoration, and improved land management actions that increase carbon storage and/or avoid greenhouse gas emissions. They found that the maximum potential of these natural climate solutions would be almost 24 billion metric tons of carbon per year while simultaneously safeguarding food security and biodiversity. About half of this could be delivered as cost-effective contributions to the Paris Agreement, equivalent to about 30% of needed mitigation by 2030, with 63% coming from forest-related actions (figure 2). Avoided forest conversion had the highest carbon potential among the low-cost solution options (Griscom et al. 2017). New research suggests that protecting forests from being converted to other uses is the most cost-feasible option by a large margin (Busch et al. 2019), and it should receive high priority as policy in the United States (McKinley et al. 2011). An analysis of 18,507 forest plots in the Northeast found that old forests (greater than 170 years) supported the largest carbon stocks and the highest simultaneous levels of carbon storage, timber growth, and species richness (Thom et al. 2019). In addition to helping stave off climate change, old forests possess critical cobenefits including building healthy soil, cycling nutrients, mitigating pollution, purifying water, releasing oxygen, and providing habitat for wildlife.



Climate mitigation potential of six forest pathways estimated for reference year 2030. Bars represent maximum possible with safeguards (i.e. constraints applied to safeguard the production of food and fiber and habitat for biological diversity). Darker portions represent cost-effective mitigation levels assuming a global ambition to hold warming to <2° C. Darkest portions indicate low cost portions. Ecosystem service benefits linked with each pathway are indicated by colored dots for biodiversity, water (filtration and flood control), soil (enrichment), and air (filtration). (Adapted from Griscom et al. 2017.)

Figure 2 – Climate mitigation potential

Old Forests Have Higher Net Sequestration Rates of Carbon Than Younger, More Recently Cut Ones

While it is becoming well accepted that old forests store large amounts of carbon, there is controversy over the age at which forests sequester the most carbon annually (e.g., remove carbon from the atmosphere and fix it as biomass). The confusion arises because young trees grow faster than old trees and thus the rate of sequestration in a young forest can be very high. However, in the words of a carbon scientist friend, it is "not the rate we are interested in but the volume" (C. McDonald, personal communication, October 18, 2019). As with a bank account, it is not how fast deposits are made but how large those deposits are, and young forest deposits are limited by leaf area (the total area of leaf surface where carbon exchange takes place).

Net sequestration is the difference between how much carbon the forest absorbs from photosynthesis minus how much it emits through respiration. The former is a function of the leaf area index (LAI), the latter is a function of cell respiration in soils, roots, woody debris, trunk, branches, and leaves. The limitations of young forests in net sequestration was demonstrated in 2001 by a team of researchers at Oregon State. Led by Beverly Law, they implemented a gold-standard, labor-intensive study that measured and compared all the carbon stocks and fluxes occurring in the same forest type at two stages of development (Law et al. 2001). Specifically, they compared an old mixed-age stand (50–250 years) with a recently cut stand (17 years ago) within the same dry ponderosa pine forest in eastern Oregon (figure 3).

The study's results showed clearly that when all fluxes were accounted for, the old forest was sequestering carbon at a rate of 28 g/m2/year, while the young forest was losing carbon at a rate of -32 g/m2/year. The loss was due to the leaf area index being too small to compensate for soil respiration. The authors

All fluxes and stocks shown here were measured in ponderosa pine forests in Oregon by Law et al. 2001. Arrows show carbon fluxes. "Carbon in" (yellow) is sequestration by photosynthesis. "Carbon out" (blue) is carbon loss from respiration. Total carbon stock is shown as a sum of the size of each pool. Carbon stock in the old forest was double the young.

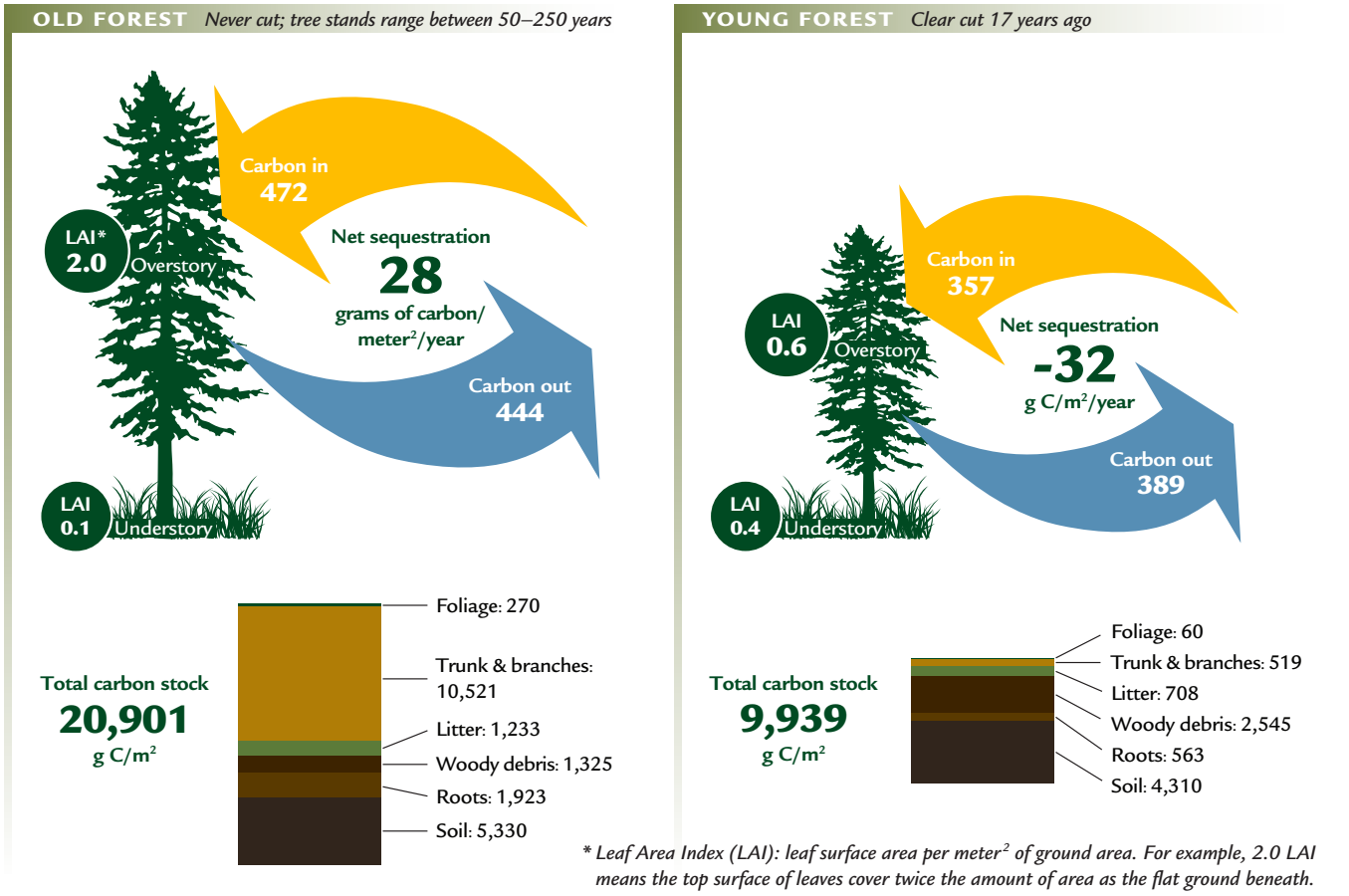


Figure 3 – Adapted from Law et al. 2001. Existing carbon stock shown in proportion to the size of the pool. Old forest carbon stock was double the young. Blue arrows show the carbon fluxes. "IN" refers to sequestration by photosynthesis. "OUT" refers to carbon loss from respiration. The difference is in bold.

concluded that it would take 20–30 years for the young forest to develop sufficient leaf area to offset respiration and become a carbon sink. Until then the forest emits carbon every year.

Similar dynamics occur in eastern forests. A carbon study of an early successional hardwood site in Massachusetts showed that the site became a net emitter of carbon immediately after harvest and was expected to return to being a sink after 10–15 years, assuming no other disturbance (Finzi et al. 2020). Eastern forests, however, show considerably larger carbon stocks and 7–10 times higher rates of carbon sequestrations than the dry forests of eastern Oregon (table 1). This may help them recover quickly where the leaf area index is sufficiently large that net primary productivity surpasses respiration.

The often-touted fast growth and high sequestration rate of young eastern forests (optimized at 30–70 years) helps the forest return to its previous state as quickly as possible, but recovery is a two-step process. First, the forest must regrow its leaf area and return to being a carbon sink (10–30 years). Second, because the forest has been losing carbon, it must make up for those

Table 1 – Comparison of Carbon Stocks and Annual Sequestration. Data sources: Law et al. 2001 (Oregon), Finzi et al. 2020 (Massachusetts), Hollinger et al 2021 (Maine).

State	OR	OR	ME	MA	MA
Forest Type	Ponderosa Pine	Ponderosa Pine	Red Spruce – Eastern Hemlock	Red Oak – Red Maple Hardwood	Eastern Hemlock – White Pine
Stand Age	1–20 yrs.	50–200 yrs.	100–200 yrs.	80–120 yrs.	100–230 yrs.
Total Carbon Stock	8,695	20,602	23,300	29,580	34,573
% Aboveground	7%	52%	45%	40%	40%
% Belowground	56%	35%	48%	53%	54%
% Debris	37%	12%	7%	7%	6%
NPP (net primary productivity)	357	472	629	733	746
Respiration (heterotrophic)	389	444	418	435	281
Mean Annual Carbon Flux (sequestration)	*-32*	*28*	*211*	*298*	*465*

losses before it reaches neutrality. If we assume it takes an equal amount of time to replace the carbon as it did to lose it, then after 20–60 years the forest may just have compensated for the early losses from respiration and will again start to sequester "new" carbon. Comparing this cycle to that of an old forest slowly and steadily sequestering carbon every year over the same time span, the old forest will remove considerably more carbon from the atmosphere despite its slower growth rate (table 1).

Conclusion

Recent peer-reviewed science has established that old forests are highly effective at capturing and storing carbon. It is now clear that trees accumulate carbon over their entire lifespan and that old, wild forests accumulate far more carbon than they lose, thus acting as carbon sinks. This is especially true when considering undisturbed soils only found in unmanaged forests – the role of which is yet to be fully understood. Although young forests sequester carbon at a faster rate, the volume they sequester is relatively small and insufficient to compensate for carbon losses through soil respiration, typically resulting in a net release of carbon. It takes 10–30 years for the leaf area of a young forest to expand to where sequestration offsets ecosystem respiration, and many more years for the forest to offset the losses they accrued in the first 10–30 years. Compounding evidence indicates that avoiding forest conversion is the fastest and cheapest way to sequester carbon over the next few decades and that old forest carbon is irreplaceable on timescales relevant to avoiding climate impacts.

This recent evidence challenges standing assumptions that old forests are carbon neutral (table 2), and that to achieve their maximum carbon potential forests must be managed. However, comprehending the whole story is both messier and more hopeful. It is messier because

Figure 4 – Trees share carbon with one another through belowground fungal networks, and even give extra carbon to their own offspring. © Susan C. Morse.

Figure 5 – This large ash tree is removing carbon from the atmosphere through its leaves and converting it to biomass (branches, wood, bark, roots) through photosynthesis. © Susan C. Morse.

Figure 6 – The amount of carbon that would be lost from old forests is irrecoverable on a timescale relevant to preventing the worst impacts of climate change. © Susan C. Morse.

Table 2 – Glossary of Terms

Carbon neutral	When the amount of carbon a forest takes in equals the amount of carbon it gives off. There is no net loss or gain of carbon in the ecosystem.
Carbon sink	An ecosystem that has capacity to absorb and store more carbon than it currently holds.
Carbon stock	The amount of carbon currently stored in biomass/soil.
Edge effects	The environmental changes that occur in a habitat when the adjacent habitat has been altered or removed. Increased light, wind, and erosion are common environmental edge effects that then change the habitat conditions at the edge and decrease the amount of land that is considered "interior forest."
Natural Climate Solutions	Ecosystems that sequester and store carbon naturally, including forests, grasslands, oceans, and wetlands. These climate change solutions stand in contrast to human-invented carbon capture technology.
Sequestration	The active removal of carbon dioxide from the atmosphere, either by an individual tree, a group of trees, or an entire ecosystem.
Storage	The amount of carbon held in biomass or soil.

forests are subject to natural disturbances such as fires, windstorms, and insect outbreaks that affect carbon storage in ways similar to timber harvest. For example, the hemlock forest data in table 1 were collected just before an outbreak of hemlock wooly adelgid, which caused a steep decline in ecosystem productivity and flipped the forest from a carbon sink to a source (Finzi et al. 2020). But disturbances also offer hope. They rejuvenate wild forests with an influx of abundant coarse woody debris that helps mediate carbon loss, maintain root-mycorrhizal relationships, and increase biodiversity and wildlife abundance. Hope can also be found in the way that foresters are using good science to improve management practices. Retention forestry, longer rotations, and attention to soil carbon pools can promote both carbon and diversity in managed forests. Post-harvest practices that reduce carbon waste during the processing, transportation, and use of wood products is an active area of research with much promise.

Achieving meaningful carbon sequestration by 2050 requires multiple strategies: carbon-neutral forest management, extensive reforestation, and permanent protection. The latter – creating wild spaces where unmanaged forests can age and develop – should be the centerpiece of our carbon solutions. IJW

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NORTHEAST WILDERNESS TRUST conserves forever-wild landscapes for nature and people. Founded in 2002, the Wilderness Trust works across New England and eastern New York. The Wilderness Trust owns Wilderness Preserves and Sanctuaries, and protects land through legal means such as conservation easements. The organization currently safeguards more than 41,000 acres of wildlands in six states. Learn more at www.newildernesstrust.org.

Wild Carbon is the first edition of Northeast Wilderness Trust's "Wild Works" series, which characterizes the values and benefits of wild, unmanaged landscapes.

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SOUTH
AMERICA
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PERU
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VENEZUELA
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PANAMA
MEXICO
LEGEND
SOUTH
PACIFIC
OCEAN

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CoalitionWILD Global Mentorship:
Cracking the Code of the Business Side of Conservation and Preservation

by DONNA MALTZ & VANESSA WYNS

The CoalitionWILD Global Mentorship program pairs rising conservation leaders with veterans from the environmental field for a 12-month virtual and intergenerational exchange. The program provides avenues to build networks, encourages perspective exchange on challenges and celebration of success, and is committed to bridging the gap between generations, cultures, and experience. CoalitionWILD endeavors to go beyond developing the leadership skills in mentees. Rather, this mentorship program is committed to collaborative and equal partnerships between participants built upon foundations of trust, respect, and curiosity. Learn more at www.coalitionwild.org/mentorship/.

Donna Maltz

Vanessa Wyns
Left: age 3, 1995
Right: age 28, 2019

Many of us have common questions and face similar dilemmas while trying to earn a living saving the Earth. How do we earn a decent living as environmental advocates working for the rights of Nature? Why are we not justly financially rewarded for our conservation and preservation practices and careers, and how do we overcome this hurdle to establish ourselves in the environmental field? How can we maintain our hope and passion, and avoid the impulse to "jump ship" and leave the field when the combined emotional burden of hearing constant depressing environmental news and the financial burden of struggling to make a living become too much?

This article addresses these questions and proposes solutions. We suggest that a global, intergenerational, gender-inclusive approach is imperative to solve the inequality crises we are facing. If we act locally and think globally with our careers, the problems are no longer as astronomical. We need the intergenerational power of mentors or guides to share insights and experiences along the way, helping us address the many challenges.

Part of our job is to change our mindsets and the mindset of the masses. By changing our attitudes, language, and how we think about our careers and money, we become more than advocates. We become environmental champions who make the world a habitable place for our children because they deserve to grow up in a world where they can freely breathe.

A Changing World, a Changing Sector

The world is changing quickly, and with it, the career landscape. This both opens the door to many opportunities and undercuts any comforting feelings of career stability, however illusory they may be. Generation Y now holds jobs that did not exist 20 years ago, such as social media manager and data miner (Casserly 2012). A shocking statistic shared by Wagepoint found that the top 10 most in-demand jobs in 2010 didn't even exist just six years prior in 2004. This trend is set to continue for Generation Z and beyond, with another statistic from 2013 claiming that 65% of children entering school today will work in jobs that do not currently exist (Thampan 2013). How do you prepare to enter the workforce to fill jobs that don't even exist yet? The good news for the Gen Y and Gen Z "digital nomads" and "digital natives" is that several newly created careers – and predictions for those not yet created – center on the environment and human health. This provides a clear direction for those pursuing further studies and setting career goals.

Growing consumer demand for ethically sourced and environmentally sustainable products has led to 40% of companies polled in 2020 declaring that they've dedicated efforts to improve their environmental and social impacts (Caldwell 2020). This is up 25% from 2019. The transportation and travel industries are also changing to adapt to new public attitudes. According to Booking.com's 2021 Sustainable Travel Report, 73% of US travelers think that sustainable travel is vital, and 66% of them say that they want to stay in a sustainable accommodation this upcoming year (Booking.com 2021).

More people moving to cities gives impetus to greening our cities for both human and environmental health benefits. To spotlight a specific job, UMass Amherst quips that arborists have a 150% job placement rate due to incredibly high demand (Holloway 2020). Concern about climate change and the global dependence on fossil fuels has shifted cities' priorities to boost urban greening and renewable energy. If current trends continue gaining traction and the necessary government funding and policy support, the renewable energy sector could see growth of up to 20 million new jobs worldwide (Kruse et al. 2017). "Green" jobs – jobs that produce goods or services that benefit the environment and conserve natural resources, or jobs that use more environmentally friendly processes or fewer natural resources – have outpaced jobs in other cat-

egories by almost 250% during the past decade, and their growth doesn't appear to be slowing down anytime soon (Project Learning Tree 2019).

COVID-19 has also done a tremendous job of exposing our world's dysfunction and the need for dramatic change if we are to live on a habitable planet. The virus has brought global attention to the positive environmental changes that take place with reduced human activity and, more broadly, the link between human and environmental health. Hopefully, this will strengthen the trends toward interweaving regenerative solutions and sound environmental practices into the fabric of our lives. Prioritizing our health, family, and careers – in that order – puts us on a path to care for both ourselves and the planet. Finding a job or creating a business that contributes to the betterment of future generations is critical to tackling future health crises. True success is prioritizing the health of people and the planet over greedy profits.

Entering the Environmental Field: Vanessa's Story

It has become the custom in certain fields to take on positions for work experience that cause short-term stress and discomfort as a sacrifice for potential long-term financial stability. But is it right that we ask people to do this?

It was certainly part of my experience entering the environmental field. I was on the not-so-merry-go-round of unpaid internships, volunteer positions, and low-paying seasonal gigs for what seemed like much longer than my friends in other fields, some of whom were able to immediately secure full-time, well-paid jobs post-graduation. I recognize that some of my prolonged entry path is likely because my undergraduate and graduate degrees are in different fields, and that my master's degree is considered quite "niche": I have BAs in Spanish language and studio art and an MS in ethnobotany. However, I worked hard to get excellent grades and supplement my academic work with extracurriculars that gave me work experience, which I thought would translate into job opportunities. Instead, I took on unpaid positions to gain experience before obtaining my master's, while also working full-time and living at home to

"The relationship between habitat destruction, the climate crisis, and the pandemic can no longer be overlooked, making our jobs as environmentalists even more valuable."

save money. I viewed this as a necessary sacrifice, the "cost" of entering the field. Reflecting, I'm disappointed that this is the path to which I and so many others have been subjected.

During my master's, I then worked another unpaid internship tracking the effectiveness of conservation efforts and accepted a low-paid contract position post-graduation as an eco-camp instructor teaching youth the value of plants and natural resources. After struggling to secure a

Figure 1 – Vanessa teaching students how to make recycled water bottle gardens at a youth eco-camp in Espejo, Spain.

full-time job when this position ended, I then led education programs and planned youth environmental service experiences during a six-month internship position with the National Park Service, receiving just $160 a week as a stipend. Although housing was provided, that amount was insufficient to cover my gas, food, medical expenses, car insurance, and other living expenses, which I covered by using personal savings and relying on additional family support. It was a shock to me to realize that at 28 years old I was a low-paid intern who had moved home twice to save money, despite being a triple degree-holding honors program graduate.

I began to see friends who had jobs in business, technology, law, and medicine purchasing homes and meeting other financial goals, while I was still struggling to find some semblance of stability. My current position is full-time and better compensated, although not without its stresses: I had to move away from family to take this job, and I live on a modest nonprofit salary in a location that has a cost of living that is 105% higher than the national average, the San Francisco Bay Area (Areavibes 2021). It is by no means easy.

Environmental justice advocates and activists are among the most compassionate, fiery, and creative people, and we need to know that our time is making a positive impact. We seek excellent jobs: ones in which we are fully valued, and the environment is prioritized. Being passionate people, we can run the risk of sacrificing our health in service of our work, with disastrous consequences. Are the new environmental jobs going to pay enough to keep qualified people employed? Or are they merely another J.O.B. that's going to pay a meager salary, keeping employees "Just Over Broke"? If you're broke and scrambling, how do you have the time and mental energy to protect the environment?

It is alarming to hear the experiences of many recent graduates and other young people in the environmental sciences who are vexed by their exploitation in the workforce. The unfortunate norm for those looking to break into the field includes little to no pay, long hours, overwhelming research tasks, and limited support for mental health. Nobody – in any field – should be faced with choosing between their mental health or following their passion. We need to compensate fairly and establish strong, intergenerational network connections so that people do not see ecological restoration and protection as a path to sacrificial martyrdom of mental health and financial security. To renew ourselves and regenerate the Earth, it is essential to sustain those who do the work to protect the planet.

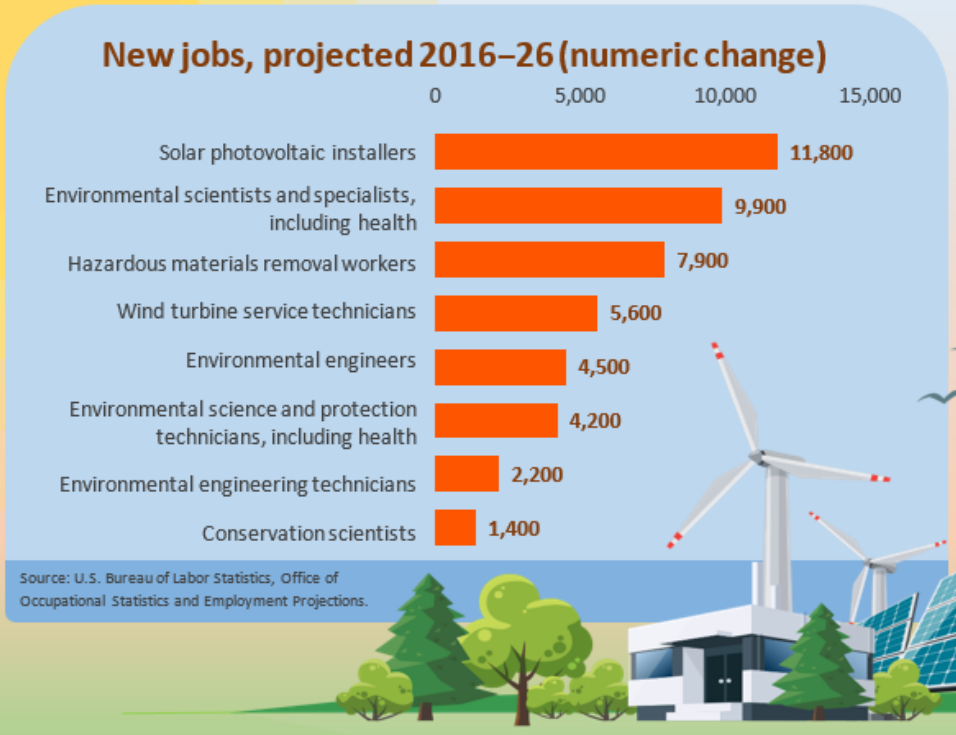
The Challenges for the Physicians of the Earth

While projected trends for green job growth and public interest seem to bode reasonably well for those entering or already in the environmental sector, the associated salaries are often lower than jobs at similar education levels in other sectors (with some notable exceptions). The environmental sector is projected to grow 8% from 2019 to 2029, and we have an opportunity to push for better treatment and fair pay so that green jobs that pay well and respect employees' mental and physical health become the norm and not the exception (EcoCanada 2020). A job will not be a sustainable long-term option for a worker if it doesn't pay adequately. The annual mean salary for all occupations in the United States is $56,310 (US Bureau of Labor Statistics 2020), increasing to $73,892 for college graduates with at least an undergraduate degree (US Bureau of Labor Statistics 2021). With this in mind, the median annual wages for green occupations seem low, mainly ranging from $40,000–$70,000 even for degree holders (Torpey 2018). The top 10 cities for green jobs also correspond with many of US cities with the highest living costs, including the San Francisco Bay Area, New York City, and Washington, D.C (Hoffman 2020). Although the median annual wages for green occupations are adjusted somewhat in these locations to account for the higher living costs (according to searches on Career Explorer and Glassdoor), the adjustments still fall short of making up for the difference in the cost of living.

During this time of a global crisis, we see the direct correlation between the environment and human health. The physicians of the Earth, those working to save the Earth, deserve comparable pay to medical physicians. A sick Earth is not a healthy place to live. As physicians of the Earth, our work is to educate the masses that Earth is our most important bank, providing the resources that sustain life. We've already taken far too many loans out against the health of the planet, and it is in deep debt. As fires blaze, sea levels rise, and the planet heats up, it is time to expose the truth and recognize the value of the experts responsible for saving the Earth, and humanity.

It is also impossible to have a healthy economy when the Earth is sick. As economies fall into recession, people are led to believe that what we need is consumption to get us out of the mess, when indeed that is what has exacerbated our environmental and health crises. Environmental advocates understand that mass production and overconsumption are responsible for eroding the natural world, and that an economy based on extraction and greed has proven

Selected green occupations with projected employment growth, 2016–26



Occupation	Median annual wage, 2017[1]	Employment, 2016	Employment, projected 2026	Typical entry-level education
Environmental engineers	$86,800	53,800	58,300	Bachelor's degree
Environmental scientists and specialists, including health	69,400	89,500	99,400	Bachelor's degree
Conservation scientists	61,480	22,300	23,700	Bachelor's degree
Wind turbine service technicians[2]	53,880	5,800	11,300	Postsecondary nondegree award
Environmental engineering technicians	50,230	17,000	19,100	Associate's degree
Environmental science and protection technicians, including health	45,490	34,600	38,800	Associate's degree
Hazardous materials removal workers[3]	41,400	46,200	54,100	High school diploma or equivalent
Solar photovoltaic installers[3]	39,490	11,300	23,100	High school diploma or equivalent

[1] Excludes self-employed workers.
[2] This occupation typically requires long-term on-the-job training for a worker to attain competency.
[3] This occupation typically requires moderate-term on-the-job training for a worker to attain competency.
Note: None of the occupations listed typically requires work experience in a related occupation for entry.
Source: U.S. Bureau of Labor Statistics, Office of Occupational Statistics and Employment Projections.

Figure 2 – Salaries of environmental occupations tend to be lower than those that require comparable experience in other fields (with some exceptions).Courtesy of US Bureau of Labor Statistics, https://www.bls.gov/career-outlook/2018/data-on-display/green-growth.htm.

unsustainable, degrading ecosystems, and triggering the development and expansion of mutating viruses and other health issues.

The relationship between habitat destruction, the climate crisis, and the current pandemic can no longer be overlooked, making our jobs as environmentalists even more valuable. Locally and globally, our careers have the opportunity and the responsibility to safeguard the futures of generations to come. Those in the environmental field are taking up this arduous task of being physicians of the Earth. Environmentalists, eco-consultants, outdoor leadership instructors, environmental educators, regenerative farmers, climate scientists, naturalists, biologists, and many other experts are committed to revitalizing habitats, drawing down carbon, and protecting the Earth's biodiversity. Despite dismal projections of accelerating global climate change, our society continues to grossly undervalue these essential professions. The injustice of discriminating against those saving the Earth has gone on for too long.

The physicians of the Earth understand what needs to be done to heal the microbiome of the soil that feeds us and manage the water that sustains us. Like holistic physicians, they understand the value of prevention, preservation, and conservation. Professions that improve the quality of life for all sentient beings are golden careers and deserve equal pay. We must value this good work and the people behind it: the lifesavers, the Earth's physicians.

Educating and Retooling Systems to Align with Ecology and Equality

The digital economy, which is also regulated by the government, is destined to surge in the information age. This is where many people are getting their FREE education. Green technology jobs can assist us in the right direction, as can eco-entrepreneurs who understand how important the online web is to protect the web of life.

One of the greatest appeals of a green career is shaping the future for our children. If we are to live like the future matters, we must educate everyone from preschoolers to PhD holders about how vital the natural world is to our survival and inspire action. We might understand what it takes to have potable water and clean air and how to reduce wildfires, drought, and the effects of polluting factories, but do our children? We might know the value of biodiversity, regenerative agriculture, and the urgency to sequester carbon, but does a chemical engineer? We recognize that our work can decrease medical costs associated with respiratory illnesses by living in harmony with Nature, but do oncologists? The point is, we must educate everyone on how vital the natural world is to our survival. If everyone knew that the healthier the Earth is, the less likely disease is to spread, maybe they would listen.

It will take a concerted effort to shift our mindset to realistic consumption habits and the notion that when the Earth's immune system is healthy, all lives, including yours and mine, are healthier. Education is key to building a new society based on balancing our economy with Nature. We are at the tipping point if we do not educate the masses. We must provide our students with the tools, truth, and wisdom to flip the script from economics to eco-human-nomics. It's our

responsibility to demand our educational institutions teach the importance of a green economy, preservation, and conservation.

Eco-Entrepreneurship: Donna's Story

Since the Ice Age, nothing has changed the world faster than business. It is ethical businesses, led by morally courageous people, that can rapidly transform our world for the better. – Donna Maltz

If you cannot find your dream jobn the environmental field, create one. Many citizens are hungry for a change and searching for what you have to offer. The 21st century has awakened eco-entrepreneurial leaders who produce solution-oriented innovations.

Regardless of occupation, everyone, whether you are an environmentalist, artist, educator, chef, hairdresser, engineer, manufacturer, tech aid, retailer, farmer, business owner, and so on has an environmental impact. You have a responsibility to ensure that this impact is focused on regeneration, not degradation.

Rather than join the job chase, chase your dreams. Yes, taking a calculated risk can be frightening. But remember, you are an educated environmental advocate living in the information age. After a few good business classes, you're on your way to your dream career. By thinking out of the box and embracing a can-do mindset, anything is possible.

Before I started my first business as an organic farmer in 1980, I thought money was the root of all evil. Shifting my mindset took waking up to the notion that money itself was not the

Figure 3 – Donna Maltz at 25 serving healthy food with Peace and Love when milk was around $2.00 a gallon.

Figure 4 – The Bakery and Cafe ran profitable for 37 years, before the owners retired.

problem; the problem was what I thought about it. Once I realized that I could turn that money into something that could help others and the Earth, I had no problem making a lot of it. We must not let money define us but instead enhance who we are and what we do. We must never let our net worth outweigh our self-worth. Money is merely a social and cultural construct. It is the intention we give to the money's purpose that matters. Taking control of our relationship with prosperity and positioning ourselves to thrive while healing the Earth is a mindful choice.

My degree was in social ecology, and until I was 25, I spent most of my early 20s organic farming. Finding a job with my experience and in my field was impossible, so I created one that ensured my passion for preserving Nature was at the forefront of my endeavors. I moved to Homer, Alaska, in 1982 and started the first natural foods bakery and café in the state. With its tagline "Food for People and the Planet," the café made a lasting impression. Our mission was to serve local organic food and make the world a better place, one bite at a time.

It was not always easy, but it made more sense than selling my soul, and I made good money, certainly, more than any J.O.B. ("Just Over Broke") was willing to pay an organic farmer with a degree in social ecology. I used the social part of my education to enhance communication with my staff and customers and taught ecology using my menus and marketing materials. The restaurant succeeded in its mission for 37 years in a state that was extracting oil for the bulk of its revenue. Many viewed me as a nonconformist, hippie, tree lover, and so on, but it all paid off in more ways than one.

I did this while bucking the tide of fast food that was taking over small farms. For years, most people did not care that we were serving local and organic food, but I did not

give up. I worked hard to create a "web of life" culture in the café that was fruitful and served my community. I'm proud that our café earned the recognition of Alaska's Small Business of the Year in 2010 for being a socially and environmentally responsible business. When I got the call, 28 years after starting the business, that we had been selected, I broke down in tears of joy. The award ceremony took place in a fancy hotel conference room. With my devoted husband by my side, I delivered our acceptance speech. The audience, many of whom were once disbelievers in green business, were now respected colleagues. It was a very emotional event and a proud moment for both of us. Perseverance had paid off.

During that time, I created multiple other successful eco-businesses, which I used as a medium to educate people and make a difference with my career. My career has now shifted to teaching and inspiring eco-entrepreneurs. I help them shift from unfulfilling corporate or governmental jobs to fulfilling lives and careers.

When you start making more money than you imagined, you realize it has the power to empower and create or disempower and destroy. It is gratifying to provide a service that people appreciate and to create opportunities for people to work in positive environments. It feels good to donate money to causes you believe in and to lend money to others. To build true wealth means to put our money into helping others and the Earth.

Figure 5 – Donna and her husband, Kevin, serving the Red Hatters of Homer, Alaska in 2005.

Figure 6 – After hours at the café.

The Ecosystem of a Healthy Business

Not everyone has an entrepreneurial drive. If you're convinced you cannot start a green consulting firm, farm-to-table restaurant, edible landscape business, or repurposed clothing company, and want to help run a green enterprise, have no fear. If you are passionate and determined, partner up with an ethical company. Most entrepreneurs will embrace your skills, whether analytical, technical, or manual.

Western society often values individualism and individual accomplishment above collaboration. However, this mindset isolates people and ignores that bringing together people with varied skill sets and talents allows us to achieve more and find greater personal satisfaction. The uniqueness of each individual adds value to any enterprise. Just like in Nature, it takes diversity to function at peak performance.

An employer has a responsibility to create a business culture that encourages team members to lead their healthiest lives, know their worth, and know the worth of the place they live and work. Then, their business is truly successful. People feel more valued when they work with you rather than for you. When people feel appreciated, they are happier and more productive, making the business or organization more successful. This yields higher profits and higher paychecks, benefiting all.

A team leader who cultivates the mindset of a food forest, as opposed to a sterile monoculture, creates a dynamic work environment. Redefining what success and wealth mean is part of the paradigm shift needed to save the Earth.

It is invaluable to work for an employer who understands that dignity has worth.

Ethical Investors and Avoiding Greenwashing

According to the Global Sustainable Investment Alliance 2020 report, at least $35.3 trillion of funds in five regions globally are held in sustainable or green investments, up 15% from 2018 (Global Sustainable Investment Alliance 2020). Imagine what would happen if all billionaires contributed to investing in a just world. Green investments are becoming part of a new way of doing business.

But like clean energy, we must also demand clean money. Greenwashing is the phenomenon in which an organization falsely claims to do environmental good when in fact it may be merely offsetting its other environmental harm. Accepting funding from investors who have earned their wealth through participating in business ventures that cause direct environmental and social harm is one onerous type of greenwashing that we must be extremely careful to avoid. These investors benefit from being linked with environmentally positive endeavors, but many also participate in environmentally destructive practices. Their connection to green investments, therefore, helps them "save face." We need to call out the companies who participate in these practices and force them to be accountable for their actions, or we will continue down this dismal path.

Eco-Entrepreneurs Make Their Own Policies

As an eco-entrepreneur. you can create meaningful employment and set an example for others to stimulate an ethical economy. In addition to improving the antiquated infrastructure and old business models, we desperately need more mental health professionals, Nature therapists, and holistic practitioners to help in these trying times. With ingenuity in every sector of the economy and in every social-economic ecosystem, we can rebuild regenerative communities based on necessities, not gross consumption. With the right nutrients, we can turn this into a fertile world once again. As we are faced with so much adversity, a proud movement is rising and pushing back on injustice. Broadening our sights, we realize we can be happy doing things differently.

If you are ready to jump in and ride the wave of entrepreneurship, first, you must get to know yourself fully, apart from anyone else's vision of you. Who are you? What do you love to do? What is your "purposeful why"? Why are you on this planet, and how can you contribute? Human behavior patterns form during times of crisis and times of good fortune. Now is the time to consider your options.

Conclusion

During the COVID pandemic, many people have been reassessing what is truly "essential" and are reprioritizing health, family, and business – in that order. The authors speak with people all around the world about these issues and sense a common bond that people are ready for this paradigm shift. Many people want to be educated, and given the opportunity, they will strive to

incorporate life-saving measures. We just need to teach the right things and stop the spread of information that is not scientifically or ecologically sound.

When enough of us cherish the Earth and respectfully balance our resources, we will rebuild a healthy economy. It's time for innovation to kick in, in all areas: from congregations to curriculum, the White House to your house, rural communities to urban areas. We can create the world we wish for our children to inherit. It's time to green our economy and demand corporate accountability.

We can create new careers and a new economy that fosters giving back. We can educate the masses that a healthy economy is dependent on a balanced Earth and that to get there, we must value the physicians of the Earth and eco-entrepreneurs who are the practitioners, healers, and are the voices for all life kind. If more people believe and act in humanitarian ways, we can expect fewer global health pandemics and environmental degradation.

By working together, people in the environmental field can rebuild our unsustainable systems and demand higher wages. It's our job to prove this point and demonstrate our worth. These 21st-century crises present us with extraordinary opportunities. We face common problems that will take collective action. When we commune with one another and Nature, we are unstoppable.

> *Never doubt that a small group of thoughtful, committed citizens can change the world; indeed, it's the only thing that ever has. – Margaret Mead*

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Resources and Recommended Reading

- Living Like the Future Matters: The Evolution of a Soil to Soul Entrepreneur by Donna Maltz
- Conscious Cures: Solutions to 21st Century Pandemics by Donna Maltz.
- Project Draw Down – https://www.drawdown.org
- Paul Hawken Books – https://paulhawken.com/
- Plant of the Humans – https://planetofthehumans.com/
- Michael Shuman Books – https://michaelhshuman.com/store/
- Conscious Capitalism – https://www.consciouscapitalism.org/
- Robert Reich – https://robertreich.org/
- Green to Gold: How Smart Companies Use Environmental Strategy to Innovate, Create Value, and Build Competitive Advantage by Daniel C. Esty
- Greening Your Office: From Cupboard to Corporation, An A-Z Guide by Wastebusters Ltd.
- Green Your Work: Boost Your Bottom Line While Reducing Your Carbon Footprint by Kim Carlson
- Smart Green: How to Implement Sustainable Business Practices in Any Industry – and Make Money by Jonathan Estes
- Natural Capitalism: Creating the Next Industrial Revolution by L. Hunter Lovins, Amory Lovins, and Paul Hawken
- 101 Ways to Turn Your Business Green: The Business Guide to Eco-Friendly Profits by Rich Mintzer

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Urra Moor, North Yorkshire, England. **Photo** Rosemary Evans.

Prescribed Burning in Britain as a Moorland Management Technique: Analysis from a Rewilding Perspective

by ROSEMARY EVANS

Rosemary Evans

This author believes the core purpose of rewilding is to let natural processes operate freely. This means moving beyond the idea of 'naturalness' as a human-defined fixed condition, and allowing landscapes to evolve under their own terms, building their own powers of resilience.

The year 2020 saw the introduction of localized bans on the use of prescribed burning as a moorland management technique in Britain and growing calls for a nationwide ban. Opponents to managed burns argue that a ban is an integral part of the country's climate change and flood defense strategy and a way to improve the quality of drinking water. However, vocal supporters of this traditional land management practice provide contradictory evidence. Prescribed burning advocates highlight its economic value for the grouse shooting industry and the benefits of managed fires for maintaining biodiversity and a healthy, functioning peat layer. They also describe the associated benefits for ecosystem services such as water catchment and carbon storage. This article examines both sides of the debate regarding prescribed burning in the moorland of Britain and proposes a new angle for the debate by using the principles of rewilding.

British Moorland

Moorland is an upland ecosystem, found above the limit of enclosed agricultural land. It is typically an open, uncultivated landscape, dominated by low-growing vegetation such as heather, gorse, and juniper. In Britain, the term "moorland" covers a spectrum of conditions including dry and wet heath, blanket bog, and grassland, reflecting the country's North-South temperature gradient and East-West moisture gradient. The archetypal moorland scene would be an underlying layer of peat, formed from dead and decaying plant material under waterlogged conditions, covered by the dwarf shrub species heather. Peatland covers 11% of England's landscape (The Uplands Partnership 2020), and more heather moorland is found in the British Isles and Ireland than anywhere else in the world (Wildlife Trusts 2020).

Moorland provides a range of critical ecosystem services. Peat is widely recognized as the country's largest carbon store, although estimates vary as to how many millions (or billions) of tons of carbon are stored within our peatland. It also has a crucial role in water catchment, with 70% of the UK's drinking water coming from upland areas dominated by peatland (Moors for the Future 2020). Moorland also provides a valuable wildlife habitat, especially for birdlife including skylarks, golden plover, curlew, lapwing, and ring ouzel. Much of Britain's moorland was brought under tillage during the Second World War, while other large swaths of land have been sealed

Figure 1 – Person standing by deep, exposed peat layer, Kinder Scout, Derbyshire, England. Photo by Rosemary Evans.

off for military use, planted with conifers for commercial gain, or impacted by quarrying (Macfarlane 2010, 78–79). Today, British moorland is dominated by two commercial activities: sheep rearing and gamebird shooting.

Prescribed Burning

For hundreds of years, prescribed fire, also known as managed or controlled fire, has been used as a land management technique for the moorland. For example, peat samples taken from Exmoor provide evidence of regular burning dating back to medieval times (Exmoor National Park 2020). Today, the practice is governed by a voluntary code of practice published by the government (Department for Environment, Food and Rural Affairs [DEFRA] 2007a). Prescribed fires rely on a technique known as a "cool burn." This removes surface vegetation without damaging the underlying peat. Controlled fires are scheduled to take place during winter and early spring in the absence of ground-nesting birds and when the soil conditions are generally wetter.

The topic of moorland burning has been heavily scrutinized in recent years. In late 2019, the environment minister announced the government was working on a law to prohibit the repeated burning of heather as a land management practice. The government's position was strengthened in January 2020 with the publication of a Committee on Climate Change report (Committee on Climate Change 2020). This influential report called for a ban on damaging land management practices, including rotational burning on peatland and blanket bogs. According to the report, moorland burning is highly damaging to water quality, biodiversity, and carbon sequestration. Shortly after this report, the country entered lockdown in response to the global Coronavirus pandemic. The Moorland Association asked its members to put any planned burns on hold to reduce pressure on the emergency services. Scotland introduced emergency legislation to ban moorland burning for recreational grouse shooting for the same reasons. And in April 2020, three of the largest landowners in Northern England (Yorkshire Water, United Utilities, and The National Trust) also announced a ban on routine burning of heather to mitigate the risk of out-of-control fires and to minimize the risk of smoke affecting people with respiratory problems. These actions sparked a fresh debate about the impact of controlled moorland burning.

The Case for Prescribed Burning

Grouse Shooting

One of the most cited reasons for prescribed moorland burning is an economic one. Across Britain, an estimated 1.3 million hectares (3,212,369 acres) of moorland are managed for recreational grouse shooting (Rewilding Britain 2020a) – an industry estimated to be worth £67.7 million a year to England's economy alone (The Moorland Association 2020). On grouse shooting estates, burning is scheduled on a rotational basis, occurring on long, narrow strips of land, designed to create a patchwork effect of young and old heather growing near each other, as it goes through cycles of recovery and maturity. The young heather provides a palatable food

source for young birds and the older shrub cover serves as nesting sites and as refuge from predators. An estimated 500,000 wild red grouse are shot per year over the four-month shooting season in England alone (The Moorland Association 2020).

Wildfire Risk

Another argument for the use of controlled fire is that it modulates subsequent wildfire behavior. This has become increasingly important because of climate change. Warmer temperatures and increased precipitation create more vegetation, thereby increasing fuel loads. A prolonged fire season and more combustible material exacerbate the risk of wildfire, and numbers have surged in recent years. In 2018 and the first half of 2019, more damage was caused by wildfires in England than in the entire previous decade (The Moorland Association 2019). Wildfires burn with more intensity than a controlled, cool burn. They produce more greenhouse gas emissions and burn into the underlying peat, damaging the soil and moorland habitat. The availability of biomass on the surface is a key factor contributing to the severity of wildfire. Doubling the quantity of ground biomass can quadruple the intensity of a fire (The Moorland Association 2016). Research shows many wildfires in 2016 started on land without a policy of prescribed burning (The Moorland Association 2016).

Conservation

Fire is a natural process that plays a vital role in facilitating plant regeneration, improving forage quality and productivity, defining vegetation composition, and controlling landscape-scale variation in habitat structure. Used appropriately, it is possible to have a positive relationship between flora, fauna, and fire. For example, research shows the breeding success of moorland birds improves on managed moorland. One study concluded that the population of upland nesting birds (including golden plover, curlew, and lapwing) could be up to five times greater on managed moorland compared to unmanaged moorland (The Moorland Association 2020). In another project, controlled burning was used successfully to create niche habitats for rare butterflies on Exmoor and Dartmoor (DEFRA 2007b). Other research has indicated regular burning improves the resilience of dwarf-shrub species in the face of disease and pest species (Werritty et al. 2015), and another report showed that burning can be especially beneficial for open-ground species, such as ground beetles and surface-active spiders (Natural England 2013).

Ecosystem Services

There is also an argument that prescribed fires support vital ecosystem services, namely water catchment and carbon storage. Once a controlled, cool burn has removed the dense heather canopy, the underlying Sphagnum moss has enhanced access to sunlight and rainfall. The moss has a role to play in protecting the peat layer and when the peat is in a good condition, it holds more water. Sphagnum moss can also hold up to 20 times its own weight in water and slows the water flow across the surface to mitigate against flash floods downstream (The Moorland Association 2019). It has also been argued that heather burning can have a positive effect

on carbon capture. The postfire recovery process, including vegetation regrowth and charcoal production, could potentially improve carbon sequestration (The Uplands Partnership 2020). It has been argued that any greenhouse gas emissions from controlled burns are relatively insignificant compared to emissions from wildfires, and that any loss of carbon through smoke could potentially be canceled out by the vegetation regrowth (The Uplands Partnership 2020).

Figure 2 – Lough Shaw, Northumberland, England. Photo by Rosemary Evans.

The Case against Prescribed Burning

Climate Change

Up to 60% of peat can be carbon – a higher proportion than any other type of soil (DEFRA 2007b). Keeping carbon locked in organic soil is a crucial part of the government's climate change strategy. Research shows degraded peat bogs release more carbon dioxide than they absorb. In the UK, it is estimated that 80% of peat is in poor condition and is responsible for releasing the same carbon emissions as 660,000 households every year (Rewilding Britain 2020a). Up to three-quarters of carbon loss from peat is estimated to be the result of rotational burning of vegetation (Royal Society for the Protection of Birds 2018). The 2017 Natural Environment Research Council's report on the Effects of Moorland Burning on the Ecohydrology of River Basins (EMBER) (Natural Environment Research Council 2017) concluded that controlled fires

dried out peat and deepened the water table, resulting in carbon loss into the atmosphere through oxidation. The report also associated burning with a reduction in the organic matter content of peat and the loss of chemicals important for plant growth and buffering acidic rainfall. Two other studies came to the same conclusion. The 2013 Natural England report (Natural England 2013) concluded that burning reduced the chances of maintaining healthy functioning peatland, reduced carbon storage, and resulted in carbon loss through fuel consumption. And the 2015 Scottish Natural Heritage report (Werritty et al. 2015) also found growing evidence that burning is associated with degradation of the peat-forming processes.

Flood Defenses

In the summer of 2020, the local council for the Calderdale valley in Yorkshire was preparing to ban moorland burning as part of their flood defense strategy (Greenwood 2020). The area had suffered three major floods in eight years, and previous attempts to rely on landowners voluntarily reducing the extent of burning had proven unsuccessful. There is evidence to suggest controlled burns could be linked to an increased flood risk, as found by the EMBER report (Natural Environment Research Council 2017). This is largely attributed to the fact that burning lowers the water table, reducing the potential for water catchment within the peat. In addition, burning reduces surface vegetation, exposing more topsoil, which can be vulnerable to erosion. This can lead to more water runoff, arguably making local places downstream more susceptible to flooding.

Biodiversity

Several ecological studies and conservation groups have raised concerns about the impact of burning on moorland biodiversity. Their argument is that burning changes the vegetation composition in a way that favors fire-tolerant species and reduces the range of habitats that would otherwise be present. The practice perpetuates the domination of fire-adapted heather at the expense of other moorland vegetation, such as grasses and mosses (DEFRA 2007b). Evidence suggests changes in vegetation composition occurring after burning can still be present up to 80 years after the last prescribed burn (Natural England 2013). Studies have also noted changes in soil water chemistry, lower soil pH levels, and reduced nutrient availability after prolonged periods of prescribed burning (Davies et al. 2016). We also know exposed topsoil is more prone to erosion. The risk of this is increased when the protective litter or moss layer is removed through fire (Uplands Management Group 2007).

Water and Air Pollution

There is also evidence of possible links between the use of controlled burns and discoloration of water supplies, which is a cosmetic concern for consumers. This is attributed to an increase in dissolved carbon entering peatland watercourses after burning. The EMBER report found deposits of particulate organic matter were four times greater in riverbed sediments within burned catchment areas (Natural Environment Research Council 2017). The discoloration is expensive for water companies to treat, and the cost is passed to the consumer. Other studies have also identi-

fied alterations in stream water chemistry after burning (Davies et al. 2016) and attributed water discoloration and a buildup of dissolved organic carbon to moorland burning (Natural England 2013).

In addition to water pollution, there may also be concerns from local residents about air quality. One of the country's largest ever moorland fires was on Saddleworth moor in 2018. An investigation into the impact on air quality in Northern England (Graham et al. 2020) concluded the fire had produced large quantities of air pollutants including trioxygen (also known as ozone) and carbon monoxide. The fire primarily burned across heather-dominated moorland with an underlying area of dry peat. Concentrations of certain particulate matter in the air were found to be up to double the World Health Organization recommended guideline limit and therefore likely to have caused negative health impacts for individuals exposed, particularly for those with underlying health conditions.

Wildfire Risk

Another common concern is the risk of a managed fire getting out of control and turning into a wildfire. It is estimated that 50% of wildfires with known causes may themselves be caused by the loss of control of prescribed burns (Werritty et al. 2015). In early 2020, the Moorland Association, an industry body for landowners, instructed landowners to stop the practice of prescribed burning after a fire on Marsden moor in Yorkshire spread out of control. Firefighters tackled a mile-long front for several days, at a time when they were trying to focus resources on supporting the national response to the coronavirus pandemic (Laville 2020). The risk is greatest when a managed burn fails to comply with the best practice guidance; for example, if it occurs in the wrong conditions, with inadequate firebreaks, staff, or equipment. Wildfires burn with more intensity than a controlled "cool" burn and often result in more widespread damage to vegetation and can burn into the underlying peat. There is also a risk to people and property and increased pressure on emergency services to bring the wildfire under control.

The Need for a New Perspective

There are many divergent opinions over the effects of moorland burning. Research so far has focused predominantly on trying to establish the effects on carbon capture, biodiversity, and other ecosystem services, but there is a lack of consensus. Whereas some studies have decisively criticized the practice of prescribed moorland burning, others have opted for a more nuanced approach, stating that trying to categorize the effects of fire as simply "positive" or "negative" is difficult (Davies et al. 2016). Nutrient dynamics are complex, evidence of vegetation succession pathways in response to burning remains in part hypothetical, and it is difficult to untangle complex interacting disturbances.

A rewilding movement is gaining momentum across Britain. From the Knepp Estate in Sussex to landscape-scale projects such as Wild Ennerdale in Cumbria and countrywide projects such as Wild East across East Anglia, rewilding is entering the mainstream of British consciousness.

Rewilding is commonly described as the large-scale restoration of ecosystems to reinstate natural processes and species. It is not geared toward reaching a human-defined optimal point but rather is about allowing an ecosystem to evolve as nature chooses. It is seen as a key part of the nation's defense against climate change and biodiversity loss.

Moorland is intrinsically linked with wilderness in the British psyche. From the fearsome beasts in The Hound of the Baskervilles to the ghostly apparitions of Wuthering Heights and the dangerous smugglers of Jamaica Inn, moorland is often used as a hostile backdrop for daring adventures and as a literary trope for mystery and menace. It is a wilderness of vast, trackless land, leaving you at the mercy of the elements and with a sense of timelessness and loneliness. In a densely populated country, the unbroken horizons and absence of enclosures creates a sense of unparalleled freedom and openness. For many people, the moors of Britain do indeed represent wild places (Macfarlane 2010, 80). With this in mind, new areas of research need to be addressed in order to explore what rewilding could mean for moorland management.

Defining the Desired Condition

The term "rewilding" is used to mean returning to conditions that would have prevailed in the absence of humans, often described as the "natural" condition. This idea is supported by the "pure" wilderness philosophy, which states that the most important value of wilderness is an unmodified ecological environment, where nature has free rein (Worf 1980). This is what makes wilderness distinctive from other areas. This idea is expanded on in the manifesto of the Rewilding Britain organization, where rewilding is defined as letting nature lead and reinstating natural processes (Rewilding Britain 2020b). However, the challenge is determining what an environment, such as a moorland landscape, would look like in the absence of people.

On the one hand, it is possible to argue that the current moorland condition is a human-made landscape, substantially altered by sustained practices of deforestation, grazing, and fire (Werritty et al. 2015) and that without some degree of continual grazing and/or burning, moorland would revert to a "natural" woodland state. Woodland currently covers 13% of Britain, compared to a European average of 37% (Rewilding Britain 2020c). Expanding woodland cover not only tackles climate change by removing carbon dioxide from the atmosphere but protects against flooding, enriches soil, improves river health, and provides shelter and food for a range of plants and animals. This could make the case for allowing shrubs and trees to cover the open moors.

On the other hand, there are those who dispute the notion that closed canopy woodland is the natural state of the British landscape (Tree 2018, 61–64). The "closed canopy theory" says that before human impact, any land with the climate, soil, and hydrology for trees to grow was covered with closed-canopy forest. But this theory does not consider the animal disturbance of megafauna (large herbivorous mammals such as wild ox, bison, elk, boar, and beaver) who worked in opposition to vegetation succession. Fossil bones and

pollen records show many deciduous trees arrived in Britain at least 3,000 years after the large herbivores, who were hunted to extinction or driven out as wildlands were converted to fields. Following this theory, open expanses of land without woodland cover could in fact be the desirable "natural" condition to preserve.

The key to resolving this conundrum lies in how one chooses to define "natural" or indeed if one declares "naturalness" to be the overriding objective. Improved knowledge of ecosystem dynamics has led to a new realization that there may be no single, definable ecological baseline to aim for. The "natural" state may be a moving target. And with novel stressors such as climate change driving changes outside an ecosystem's normal historical range of variability, the recovery of past conditions may not always be desirable or even possible. One could rely on paleoecology to build a longer temporal perspective, reconstruct past environmental dynamics, and investigate the biotic response to change. Or one could choose to be more specific about how one defines the desired conditions. Instead of "naturalness," the objective could be to maintain ecological integrity. This incorporates a functioning structure; healthy, unimpaired processes related to the flow and storage of energy and materials; and a full complement of native species. Alternatively, the objective could be to build an ecosystem's resilience, referring to its ability to recover from stressors, and to persist and maintain its characteristics in changing environmental conditions. Thinking in terms of ecological integrity or resilience could therefore be a more workable and helpful objective than "naturalness," and new research would need to define what that looked like in the moorland context.

Establishing Acceptable Levels of Intervention

Once the desired landscape conditions have been defined, the second question is the extent to which human intervention is justifiable in achieving and maintaining those conditions. In this context, the key challenge is determining whether prescribed burning is a permissible form of management intervention.

On the one hand, there is the argument that a wild ecosystem is distinct from other areas when it is free from human control and natural forces can dominate. This way of thinking would favour a "hands-off" approach that exercises restraint in respect of nature's autonomy (Landres 2010). This acknowledges the limits of our understanding in the context of rapidly changing conditions and allows evolutionary change and adaptation to occur. By evolving and adapting under its own terms, an ecosystem may develop more resilience against future stressors. This line of argument could therefore be used to make the case that managed fires are unacceptable in a wilderness setting.

On the other hand, there is the argument that intervention, such as prescribed burning, can be a necessary part of wilderness stewardship. It can be a way to prevent an ecosystem from drifting into neglect. Heather moorland can be described as a transition habitat along the succession cycle (British Association for Shooting and Conservation 2020). Thousands of years ago, small

Figure 3 – Flowering purple heather in Tarn Moor, Cumbria, England. Photo by Rosemary Evans.

areas of moorland would have existed where native animals had grazed or where flood and fire had removed the trees. To keep moorland at this stage of succession today, we need to implement some form of management, including controlled fire. The argument in favor of prescribed burns can be strengthened when one considers the novel stressors of climate change. With the increased risk of wildfire, there is now greater need to reduce the fuel load by routinely removing surface-level vegetation.

One way to resolve this dilemma is to shift the stewardship focus away from the means to the outcome. In other words, managing for desired conditions regardless of whether the changes are human-influenced or not. The idealized notion of minimal human impact in the wilderness has been challenged by a growing awareness of the impact of people on landscapes throughout millennia. Whilst accepting that humans have and will always exert an influence on the landscape, it is possible to draw a distinction between human influences that have been present in the long-term evolution of ecosystems and our influences that are the result of modern, transformative technology. Whilst the modern practices based on new technology may be judged out of place in a wilderness ecosystem, the older, traditional land-management practices may still serve a role today in

Figure 4 – Glaisdale Moor, North Yorkshire, England. Photo by Rosemary Evans.

maintaining the conditions we strive for. Establishing to what extent managed fire qualifies as a traditional practice and whether it is the least invasive means to achieve the desired outcome would need to be the subject of new research into moorland management.

Consensus on the Values of Wilderness

An additional concern would be the impact of prescribed moorland burning on opportunities for recreational enjoyment. Without anyone to enjoy wilderness environments, they lose part of their purpose. One could argue that prescribed burning has a positive impact on recreation opportunities, because heather regeneration supports the grouse shooting industry. This line of argument relies on anthropocentric values, which view wilderness from a sociological or human-oriented perspective. It is a convenience-oriented approach, designed to maximize direct human use and recreational enjoyment. In other words, management is guided more by societal demands than natural conditions. According to this system of values, it is acceptable to change the character of wilderness to reflect human desires and contemporary standards.

Alternatively, there is a biocentric perspective, which places human use secondary to maintaining natural settings and processes. The goal is to allow ecological processes to operate as freely as possible, so the landscape reflects natural perturbations and the historical patterns of

ecological succession. Following these values, one could argue that it is unacceptable to alter the landscape for the purposes of grouse shooting, as this is neither a primitive form of recreation, nor a wilderness-dependent sport.

This debate can be resolved by reaching a stewardship consensus on whether a utilitarian or ecological philosophy should be followed. The utilitarian philosophy is concerned with the values associated with human use of wilderness. It is a people-oriented approach, devoted to servicing the user and getting the maximum value out of the land. This could lend weight to the use of prescribed fire for the grouse shooting industry. The ecological philosophy is the belief that wilderness preservation is ecosystem preservation. The primary management goal is to minimize human impact on the biophysical resources and to allow nature to take its course. This could lend weight to the argument of those who want to cease the practice of prescribed burning. Gaining consensus on acceptable recreational use and which wilderness philosophy to follow will be important for future decisions.

Conclusions

This article examines the value of bringing a new perspective to the debate on prescribed moorland burning, by analyzing it as a rewilding opportunity. Scientific studies so far have centered mainly on the challenging research questions of comparing the impact of wildfire burns to controlled cool burns, or analyzing the effect of burning on carbon storage, water catchment, and water quality. There is a complex web of disturbance regimes to untangle and there are numerous variables to consider. By analyzing moorland as a rewilding opportunity, the focus of the debate shifts toward identifying the desired conditions we want to achieve, the means we are prepared to use to achieve that end, and the amount and type of human recreational enjoyment we want to facilitate.

This author believes the core purpose of rewilding is to let natural processes operate freely. This means moving beyond the idea of "naturalness" as a human-defined fixed condition, and allowing landscapes to evolve under their own terms, building their own powers of resilience. It means minimizing human intervention and allowing nature to drive the changes, acknowledging that they will be neither "good" nor "bad." And it means practising a biocentric stewardship philosophy, designed to meet ecological objectives rather than satisfy human desires. Integrating these principles into moorland management would be an exciting opportunity to see a genuinely landscape-scale rewilding project in action. ijw

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WILDERNESS PODCAST

Hosted by Adam Bronstein. Available on Apple Podcasts, Spotify, and Google Podcasts. https://wildernesspodcast.buzzsprout.com/.

The world of podcasting has exploded in the last 15 years, and today there are shows on nearly any topic imaginable. Podcasts are convenient, often free, and offer a great way to learn more about something of interest to listeners. So, as a relative newcomer to the world of podcasts, it was disappointing to find a shockingly small amount of shows explicitly devoted to wilderness or wilderness-related issues. Fortunately, despite a lack in the overall number of choices available, the wilderness-themed shows that do exist are of good quality.

First up is the straightforwardly named *Wilderness Podcast*, an interview show hosted, written, produced, and created by Adam Bronstein. This one man "conservation-based passion project," as Bronstein refers to it, seeks to spread and facilitate more in-depth appreciation of wilderness through "long-form interviews with subject area experts." This interview style allows Bronstein to delve deeply into topics with his guests, giving the listener excellent background and context on a given issue. Of specific interest for this reviewer is the wealth of historical knowledge possessed by many of his guests. Bronstein's episode on the commercialization of public lands with Scott Silver, a longtime activist from Oregon, was particularly illuminating. Silver's recounting of efforts, largely successful, by the fossil fuel, off-road vehicle, and outdoor recreation industries to infiltrate and influence public lands policy starting in the 1980s was especially powerful. Silver also shares his extensive knowledge of the fee demo scheme that aimed to shift public lands to a "pay-to-play" system in the 1990s. While much of this history may be common knowledge among older generations, providing this background to younger public lands users and wilderness advocates is especially important.

Bronstein's guests are often representatives from various environmental nonprofits working on wilderness-related issues. Drawn mostly from small- to medium-sized, regionally focused organizations, Bronstein largely avoids guests from the bigger green groups. Organizations featured include the Southern Utah Wilderness Alliance, Center for Biological Diversity, Oregon Wild, Friends of the Clearwater, and Western Watersheds Project, among others. Sprinkled along the way are a few scientists such as bear biologist Dave Mattson, as well as authors and journalists including Christopher Ketcham and philosophers such as J. Baird Callicott.

Throughout the 50-plus episodes of *Wilderness Podcast*, Bronstein's interview style is thoughtful and well researched. He excels in his ability to create an atmosphere of relaxed conversation, and he largely stays out of the guest's way, allowing them the space to explain and educate. Bronstein's unabashed position as an advocate and activist may turn some away, but he does not allow his passion to distort basic reality, as is so often the case these days. Whether or not one agrees with him or his guests, the conversations provide the kind of thought-provoking material anyone concerned with the disappearing wild world would do well to pay attention to.

Search your podcast app for these other worthwhile podcasts with a wilderness component: *Rewilding Earth Podcast*, *Wild Utah*, *The Landscape*, and *The Wild with Chris Morgan*. IJW

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