Fifty Years of Wilderness Science

An International Perspective

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Science provides knowledge upon which to make informed decisions about the protection and management of wilderness. In addition, wilderness provides opportunities for scientific understanding that is not often available in other, less well-protected areas. Thus, science is important to wilderness and wilderness is important to science. (Parsons 2000, p. 34)

Introduction

The 50th Anniversary of the U.S. Wilderness Act is a cause for celebration, not least of which is the scientific use recognized in Section 4(b) of the act. This year also marks the 20th anniversary of publication of the *International Journal of Wilderness* (*IJW*). *IJW* plays a unique role in wilderness stewardship, science, and advocacy, providing a forum for presentation and discussion of important questions, challenges, and opportunities. But wilderness provides unique opportunities for science, and *IJW* provides an equally useful international venue for scientists interested in establishing a dialogue with managers and interested publics.

In this article, we take an international view and we focus on how science has benefited from wilderness and also how wilderness has benefited from science. We discuss why each is important (some might say essential) for the other, beginning with an overview of science articles published in *IJW*. We then shift our attention to the 10th World Wilderness Congress and review the main wilderness science themes developed in Salamanca in 2013. Finally, we conclude with some thoughts on what wilderness can do for science and science for wilderness and as a result, implications for other dimensions of human life and our natural heritage.

Wilderness science generally involves one of three categories: (1) research in wilderness, (2) research about wilderness, and (3) research for wilderness. In the first category, scientists investigate the more or less natural and untrammeled conditions and processes found in wilderness to better understand how nature works. Wilderness provides us with a natural laboratory in which we can carry out observations and experiments within and about the natural world without having to worry too much about the potential effects of human influences on our work. For example, in many western U.S. wildernesses, naturally ignited fire plays an important role in shaping the vegetative mosaic. Research on fire suggests how ecological processes operate, the role of so-called disturbance variables, and how humans may have impacted those processes and resulting conditions.

In the second category of wilderness science, researchers are focused on the human aspects of use: impacts and consequences such as the effects of management, wilderness law and policy, recreation, commercial use, and so on. The objective of this research is to better understand the role of wilderness in human life, the ecological services it produces, the ways in which people transform those services into benefits, and how stewardship may impact wilderness.

The third category is that of research for wilderness, wherein the focus is more on understanding the wilderness ideal, how it needs to be stewarded, and the equity effects of management actions. For example, scientists may engage in identifying global, regional, and local patterns in wilderness quality; may research the importance

of wilderness in human discourse; and may investigate how policy is developed, formed, and applied.

Twenty Years of Science and Research in *IJW*

IJW has served as an important international venue for publication of articles on all three categories of wilderness science. In the 57 issues published since 1995, scientists have published a variety of peer-reviewed papers or invited contributions on a diverse range of topics and questions. To better understand what seems to be of interest to scientists, we tabulated science articles appearing in *IJW*'s Science and Research section across all 57 issues and categorized their major themes. Table 1 summarizes the main topics or themes developed in all issues of *IJW* between September 1995 and December 2013. In total, 119 papers were published that had a science orientation covering multiple topic/theme categories. We have attempted to distill these into just seven categories, as shown in Table 1. There is nothing particularly scientific in this process, since the classification is necessarily quite subjective because of the applied and often multidisciplinary nature of many of the articles reviewed. We acknowledge that, if a reader were to repeat this exercise, it is highly probable that they would produce somewhat different classes and numbers, although the overall pattern would seemingly remain the same.

The first two topics, accounting for just over half of all papers published, are recreational use of wilderness and ecosystem management issues. Recreation is not only a key value of wilderness, it is also often viewed as a threat through its impact on wilderness ecosystems in terms of disturbance, erosion, pollution, and so on. Within this topic we have lumped a number of articles looking at perceptions of wilderness from recreational visitors, as it is important to understand these as they influence attitudes, or are determined by them, but are nearly always expressed politically. Many articles herein might be considered to fall into the broader category of science about wilderness; in this case *about* use. Ecosystem management is another key area of concern that follows naturally on from the focus on recreation. Here many articles look at issues such as restoration, wildlife, and control of exotic/nonnative species – all of which are influenced in one way or another by human use. In the broader scheme of things, ecosystem management might be considered to be science *for* wilderness but not exclusively. We might have included fire within ecosystem management but decided that this probably warrants its own category given its prominence within the wilderness science literature. Fire is a significant natural process in wilderness and as such is often a needed modifier of habitat and wildlife. Add those general science papers focusing on doing science in wilderness, and you can account for more than three-quarters of all the articles.

A number of key articles stand out, not least of which are a series of pithy "shorts" on wilderness science and research perspectives from the staff at the Aldo Leopold Wilderness Research Institute, covering topics as varied as natural fire regimes, promoting wilderness values, monitoring programs, wilderness-dependent species, managing recreation, and visitor experiences. Reading these provides us with a pastiche or vignette of developments in the wilderness science paradigm and how the field has developed. Recent examples include articles on GIS mapping applications, stewardship, ecosystem services, managing fire, climate change, and recreation impacts.

Within the mainstream scientific literature the picture is a little more difficult to discern, largely because the accumulated scientific literature of the last 100 years or so is vast. Google Scholar is probably too blunt a tool to use, but some basic searches reveal approximately 785,000 returns for the word "wilderness," approximately 287,000 for the Boolean search term "wilderness AND science," and only 1,390 returns for "wilderness science" as a cojoined phrase. A search of the journals *Nature* and *Scientific American* reveals a total of 1,751,837 and 3 articles, respectively. The problem here is that "wilderness and science"

Table 1 – Main wilderness science topics/themes found in the *IJW*.

Topic/theme	Number of articles	Percentage
Recreation	37	35
Ecosystem management	19	18
Fire	13	12
General science	12	11
Monitoring	11	10
Wilderness psychology	9	8
Modeling	6	6

is too vague a search term: it simply is not a good description of the kinds of research going on in, about, and for wilderness. We all know colleagues that are doing good science using what many of us would call wilderness areas as study sites in which to collect their data, or perhaps they are simply working in wilderness-related fields, but they never use the term, probably because they are not from institutions where the focus is on wilderness per se; rather they focus on other subjects wherein wilderness areas are just a great place to carry out their research. Without going into a long debate on the origins and philosophy of the wilderness idea and the use of the word itself, this wider lack of engagement can potentially deflate any argument as to the importance of wilderness to science and/or science to wilderness before we even start.

As regards publishing wilderness science within the pages of *IJW*, we inevitably turn to the issue of *Institute for Scientific Information Impact Factors* (*IF*) used to rate the importance of academic journals based on the number of citations of articles published therein. *IJW* is an applied journal without an *IF* rating and so is not necessarily the best place to publish pure and basic science. Putting it bluntly, scientists and academics get more credit for publishing in high impact factor journals, and while we may consider *IJW* to be the only purely wilderness-focused journal, there are plenty of other avenues open for publishing wilderness science research that generate more credits and more citations than does *IJW*. Taking recreation as an example, if the interest is in promoting and sharing your work primarily within the broader academic community, as opposed to managers and decision makers, then the *Journal of Leisure Research* (IF=0.51) or *Leisure Sciences* (IF=1.07) is where you'd most likely seek to see your paper published. Likewise, many wildlife-related journals and other disciplines such as environmental management, landscape research, forestry, ecology, and so forth, all take and publish material on wilderness science for dissemination to their respective audiences.

Wilderness Science: The View from WILD10

October 2013 year saw many people congregating in Salamanca, Spain, for WILD10 (10th World Wilderness Congress) and, for those who couldn't make it, following live video streams online. In total, around 1,200 people from more than 50 countries attended the congress in person, all of whom received an electronic copy of *IJW* in their delegate packs. A key part of the program was, as usual, the Science and Stewardship Symposium. Sessions within the symposium included themes on spatial science, rewilding, climate science, transboundary/corridor landscapes, ecosystem services, fire, and restoration, while a participatory exercise identifying key questions facing wilderness science (the "WILD Wall") ran throughout the whole congress.

Post-congress, there is now a great opportunity to take stock of wilderness and conservation science as we enter the Wilderness Act's 50th anniversary year and consider how the act and its amendments have influenced developments. Key themes and findings from the symposium can be summarized as follows:

Spatial science. There was something of a special emphasis on spatial science in the symposium, funded by the World Universities Network, from which a new community of interest is emerging to lead future spatial analysis to guide wilderness protection around the world. This community is focused around the Wildland Research Institute at the University of Leeds (see short Leopold Institute article this issue on WRI) and promises to move mapping applications into a new era of hypothesis testing and theoretical development, as well as reconnaissance, data management, planning, and policy development. The basic message here is that we need to know where remaining wilderness is located and the spatial patterns of wilderness quality in order to better develop policy, designate wilderness areas, and protect it for future generations. A multiscale approach is needed as global scale maps, valuable as they are for the overview they provide, are more or less useless at a local scale where the need for accuracy and detail in understanding relative local differences is paramount. A network of local "mapping champions," facilitated by www.wildernessmaps.net, will take the national and regional mapping agendas forward within Europe and elsewhere.

Traditional and scientific knowledge. Due to the interactions between Indigenous people, academics, and stakeholders within the symposium community, there is evidence of movement toward a new focus on research as "resistance": the decolonizing practice of Native people claiming authority to define research questions and better integrate scientific knowledge with traditional knowledge. This will, it is hoped, act to guide traditional wisdom and scientific knowledge

via the applications of the combined knowledge base to protect our relationship with wild nature. Nonetheless, there still seems to be something of a barrier between Western science and traditional knowledge, making this an area for potential future collaboration and a challenge to developing participatory processes that honor different wisdoms.

Climate change. The role of wilderness in climate change research emerged through various sessions and presentations within the symposium and is likely to become a leading issue in future wilderness stewardship decision making. Where previously we focused on the role of wilderness in mitigation of climate change effects, now we are entering a new era of decision making about the use of wilderness areas for research into these effects. This echoes at least two of our categories of wilderness science outlined earlier. There is a much greater awareness about the role of wilderness as a geographical and temporal baseline for climate change research, where other human-caused influences are minimized. This poses new challenges in processing requests for instrumentation, specimen collecting, and installations in wilderness, as these themselves can have their own impacts.

Young scientists. We have seen a new generation of enthusiasts for science and stewardship of wilderness emerge at this symposium. CoalitionWILD and GenWILD were very visible, with these young people now talking about new career paths they didn't previously know existed, inspired by interpersonal interaction with scientists and stewards from all over the world, and learning about using new technologies and methods of communication. They now seriously want to share their ideas and experiences with young people of other countries. The students from the University of Leeds and other volunteers played an important and enjoyable role in the symposium, and maybe we will see them at the next World Wilderness Congress as presenters and moderators.

Wilderness and human well-being. In the future we will see a growing discussion about the role of environmental quality in human well-being. Across the themes of transboundary conservation, ecological networks, rewilding, and threats to ecosystem services and wild nature, there is a need for interdisciplinary collaboration to fully acknowledge and protect the intertwined benefits to humans from wilderness protection. Utilitarian models about the quality of life are being replaced by models with more sustainability foundations, moving us to embrace long-standing recreation interests in wilderness but also moving us to evaluate programs such as Nature Needs Half (nature-needshalf.org/home/), based on the contribution of environmental well-being to human well-being.

Rewilding. There was much talk about rewilding at WILD10 with a group of sessions organized by Rewilding Europe. While the general model being followed is based on rewilding of abandoned farmlands, there is much debate as to the best way to do this. Although Rewilding Europe seems wedded to the hypothesis that high densities of large herbivores create grazing pressure that is able to modify vegetation and maintain open and semi-open landscapes (i.e., the Vera Hypothesis), there is an ongoing debate about the scientific evidence supporting this worldview. Certainly large herbivores in the absence of top carnivores create artificially denuded landscapes, such as what was seen in Yellowstone National Park before the reintroduction of the wolf, and so rewilding solely with large herbivores – whether wild or semidomesticated – without a functional carnivore pressure ought to be avoided. This has created a niche for science to exploit in better understanding the patterns and processes involved, and so informing the future role of rewilding in creating new wilderness in former agri-landscapes.

Spain. In the WILD10 host country we expect to see many long-term impacts from the exchanges at the symposium. Rewilding projects are in motion that will focus on Iberian lynx, and the rest of Europe and the world will follow these activities closely. Efforts to establish corridors to reconnect landscapes are under way and promise a bright future. With a mixed history of nature protection in Spain, it is clear now that there is a strong central community that is focused on raising public awareness and making great strides toward a wider acceptance of larger carnivores. Environmentally friendly tourism is likely to be a much more visible trend in the future than it has been in the past.

Doing wilderness science. Finally, Gary Machlis (science advisor to the director of the U.S. National Park Service) instigated a special workshop at the congress entitled Doing Science in Wilderness. This focused on the policies, protocols, and ethics of actually doing science in wilderness. Whereas wilderness stewards and

managers, informed by the results of research on wilderness, are working hard to mitigate against the impacts of wilderness recreation and cope with the effects of climate change, those of us working in wilderness as scientists and managers often don't practice what we preach. The Leave No Trace (LNT) Center for Outdoor Ethics promotes seven basic principles to be followed by people engaged in outdoor recreation. These are:

1. Plan ahead and prepare.
2. Travel and camp on durable surfaces.
3. Dispose of waste properly.
4. Leave what you find.
5. Minimize campsite impacts.
6. Respect wildlife.
7. Be considerate of other visitors.

Often, these are summed up in the wilderness user's mantra: "*Take nothing but photographs, leave nothing but footprints*." Doing science in wilderness often breaks this rule and many of the principles of LNT. We take samples, we leave scientific monitoring equipment, and we often study wildlife and disturb it in the process (taking measurements and biopsy samples, installing cameras, fitting radio/GPS collars, etc.). We may justify such impacts in the name of science and for the good of the wilderness, but policies, checks, and regulations can help minimize these. In some cases, if the impact is deemed too great or the costs outweigh the benefits, it may be better to do the science somewhere else.

The Wilderness Movement in Europe

While much of our attention will focus on the 50th anniversary of the U.S. Wilderness Act this year, let us focus for a moment on Europe. It may be argued that it was Europeans who first "exported" the idea of wilderness to the New World during the Age of Discovery, first as an object of dread, of ungodly places inhabited by wild animals and wild people, but subsequently as something more positive during the Romantic period when wilderness began to take on a more positive tone associated with the state of nature and the sublime. Much has been happening in Europe over the last five years, both in recognizing that wilderness exists in the Old World as much as it does in the New, and in promoting good wilderness science to underpin developing European policy. Indeed, history tells us that Europe has a strong scientific tradition in its approach to nature conservation that is less tempered by the landscape aesthetic that laid the foundations of the U.S. Wilderness Act. Much of this attention has sought the preservation of unique assemblages of species rather than necessarily of landscape values.

The emergence of the Swiss National Park in 1914 with its policy of undisturbed nature as a long-term, open-air laboratory marked a characteristic approach to wild nature that had contemporaries in other protected areas across Europe. U.S. botanist Harvey Hall, who had studied the flora of Yosemite National Park, visited the Swiss National Park in 1928 while investigating protected area approaches in Europe. Hall took a number of messages back to the Carnegie Institution, including the need to have "complete reserves" in the core areas of national parks and national forests, and that a more scientific approach should be taken as soon as an area was brought under protection.

Although unratified, the London Convention of 1900 had been the first multiparty treaty on wildlife preservation, prohibiting the hunting or destruction of certain listed species, as well as encouraging the creation of wildlife reserves. This intent was eventually realized in the London Convention of 1933, in which definitions of a "national park" and a "strict natural reserve" were penned. U.S. observers were at that conference (Harold Coolidge and John Phillips), and this acted as motivation at the Conference of American States in Lima, Peru, in 1938 to call for a committee of experts to study protection of wildlife in the American republics and prepare a draft convention. The definition of a "strict wilderness area" in the Western Hemisphere Convention (WHC) of 1940 owes much to the "strict natural reserves" of the London Convention, but unfortunately due to world events of the time, the WHC was largely unimplemented. However, efforts to define wilderness in a way usable in land management had been ongoing since Aldo Leopold in the 1920s, continued by Bob Marshall and the Forest Service in the 1930s, and taken on in the 1940s and 1950s by The Wilderness Society and the Sierra Club, culminating in the U.S. Wilderness Act in 1964.

For some time, Finland was the only European country with wilderness legislation. This respects traditional sources of livelihood for the local indigenous Sami people in northern Finland and so has diverse and partly conflicting objectives. Political changes in early 1990s opened large areas of central and eastern Europe for both development by business interests and a hectic exploration of wild nature by conservation organizations intent on preserving wilderness in Europe. The urgent need to protect the last wilderness areas in

Europe was recognized and well documented during the preparation of NATURA 2000, a unique European Union (EU) network of nature protection areas, which aims to maintain European biodiversity. In February 2009, the European Parliament passed a resolution on wilderness in Europe by an overwhelming majority of 538 votes in favor to just 19 votes against. The resolution "emphasizes the importance of protecting Europe's last remaining wilderness areas and that calls on the European Institutions to develop appropriate guidance to EU Member States on the best approaches to ensure the protection of these natural habitats as an important contribution to halting the loss of biodiversity." The resolution and the conference on Wilderness and Large Natural Habitat Areas held in Prague later the same year both called on the European Community and EU member states to define European wilderness, map the remaining wilderness areas, study the value and benefits of wilderness protection, develop management guidelines, and protect wilderness areas. By any yardstick, Europe is now refocusing its attention on recognizing its own wilderness resource. As Europe looks inward to its own remaining wild landscapes, we reimport the wilderness ideal, learning from developments in wilderness protection and legislation in North America, Africa, and former colonies elsewhere in the world including South Africa, Canada, New Zealand, and Australia, many of which have their own wilderness definitions, and all of which owe much to the original wording penned by Howard Zahniser in the 1964 U.S. Wilderness Act. It comes as a surprise to many Europeans, who are long used to living in heavily modified landscapes, that significant wilderness landscapes still remain within their otherwise crowded continent. Nonetheless, in looking to European landscapes we can find many of the ideals and values of wilderness normally recognized elsewhere in the world.

What Can Wilderness Science do for the World?

As already alluded to, we face something of a problem in the lack of visibility of wilderness as a bona fide focus for scientific research, and yet it is clear from our own experiences and the issues raised here that wilderness science (including science in, on, and for wilderness) is incredibly important for the future of not just wilderness but also the planet as a whole. Here we hypothesize about the future and the bigger questions and themes where wilderness is a key part and wilderness science can have a central role.

One area of potentially fruitful research is within the wider field of ecosystem services. To many of us working in wilderness science it may seem obvious that wilder landscapes provide a better range and higher quality of ecosystem services than do modified landscapes. It is something of a "no-brainer" that wilderness watersheds provide clean water to downstream communities, a classic example being the protection of the Catskills' watershed in order to secure potable water supplies to the city of New York (Pires 2004). The range of wilderness-dependent services is, however, much larger. DeGroot et al. (2002) classify ecosystem services into four categories: regulating, provisioning, supporting, and cultural services, each of which can be seen within the natural processes, forms, and patterns seen most clearly within wilderness environments. These include clean water, flood protection, erosion control, nutrient cycling, pollution buffering, carbon storage and sequestration, wildlife habitat, recreational environments, landscape aesthetics, human health and well-being, inspiration, and so on. A special issue of *IJW* picked up on the topic in December 2012 (Watson and Venn 2012; Kerkvliet 2012; Douglas et al. 2012).

Of course, not all wilderness ecosystems provide all these services, but it may be that within a particular biogeographical zone, it is the wilderness areas that provide by far the best quality services. Here is a strong and persuasive argument for the preservation of wilderness wherever we find it, as the costs of mitigating against the impacts of reduced quality of ecosystem services, natural disasters, and climate change could well be orders of a magnitude greater than the economic opportunities forgone by maintaining protection for wilderness areas. It is also a strong argument for more research into using soft engineering principles and natural processes wherever possible to secure the services we need to live our lives. Much attention has been given to river flow regimes and the effect flooding has on human activities. A recent series of large and devastating floods around the world, occurring with increasing regularity, has led us to question our approach to river engineering and catchment management. No longer can we rely on pouring yet more concrete and building ever-higher defenses to protect homes and businesses; rather, we need to look upstream to the root causes of flooding and reduce grazing pressure, block or backfill drainage ditches, reforest bare hillsides, give the river back its floodplain, and reintroduce beavers. In short, we

need to rewild watersheds to help restore flow regimes, attenuate flood events, and return base flows to their natural levels.

This is ever more important in a world where climate and weather patterns are becoming more uncertain due to climate change. Herein lies a further area of potentially fruitful research: looking at how wilderness landscapes and ecosystems add resilience to the wider landscape matrix by giving nature space in which to adjust its own patterns and internal rhythms. It is essential that connectivity is maintained or enhanced between core areas, thus allowing species and ecosystems to migrate and evolve as climate changes. This is a burgeoning area for wilderness science research informing strategic decision making about protected area networks, connecting corridors, and nature "infrastructure" such as eco-bridges across highways, nature-friendly farming practices, and creation of stepping-stones or refugia for migrating wildlife. The "cores, corridors, and carnivores" model has become something of a cause célèbre among conservation planners across the world, with examples linking protected areas across the six continents (Worboys et al. 2010).

Wilderness provides us with "reference plots" (or control plots in sensu experiment design), which are essential for monitoring and better understanding our activities in managed forests, meadows, catchments, landscapes, or managed parts of protected areas. There are also other outputs or "deliverables" where wilderness science can improve our knowledge and understanding of human-nature interactions during the evolutionary process. Here, wilderness science can be "a bridge" for better integration of scientific knowledge with traditional knowledge wherein it can help to find a lost key for a safe with our old knowledge about human-nature coexistence, which is to some extent the reasoning behind the focus on Indigenous and traditional ecological knowledge. Wilderness science is also about crossing borders, not just the transboundary/international cooperation kind (although that is important, as wilderness and natural processes do not recognize political divisions) but also about crossing methodological borders. For this reason wilderness science is intensely multidisciplinary and because of this it is always an adventure.

Finally, wilderness science is determined by a dynamic and ever-changing set of issues, threats, opportunities, and events, and could easily go places in the future we can't even anticipate at this point in time. We are certain that wilderness science has been crucial in the past, and will remain crucial in the future for guiding managers and policies to maintain human well-being through protecting and restoring environmental well-being associated, not just within wilderness, but within all other human-modified systems. The challenge to us as wilderness scientists, stewards, and managers is to follow the trends, stay informed, and keep doing good science, whether it is in, about, or for wilderness.

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