Wilderness Science: An Oxymoron?

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Abstract—Can researchers use the traditional scientific method in studying wilderness without violating the concept and wilderness law concerning "untrammeled" land? This philosophical essay seeks to answer that question through historical review and literature overview, suggesting how science and the study of wilderness can be compatible.

Can one study wilderness scientifically? The modern idea of wilderness, including the statement in the 1964 U.S. Wilderness Act, provides strong limits on human impact. The U.S. 1964 Federal Wilderness Act defines wilderness as a place "untrammeled" by human beings and where people are only visitors. Trammel is itself an interesting word, referring literally to a certain kind of net for catching birds or fish, so that a "trammeled" area would be one in which people had trapped living things, removed them, in this sense had a direct impact. The general idea of an untrammeled area is explained in additional phrases of the Wilderness Act, which goes on to state that a wilderness area "(1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition."

But the scientific method requires direct detailed observations, experimentation with controls and treatments, the development of theory, the search for generality, and the requirement that hypotheses are statements that can be disproved. The conundrum is: Can scientists use this method without violating the idea or the reality of wilderness?

Research Approaches

There are several possible resolutions to this conundrum. One is that studies might be done elsewhere, outside of wilderness, whose results could then be applied to wilderness. But this assumes either that (1) the ecosystem states that exist outside of a wilderness system include all the set of states found within the wilderness; or (2) that there are general rules or laws about ecological systems that will apply directly to *unstudied* wilderness based on studies elsewhere. The first assumption is difficult to meet, although not necessarily impossible. For example, under sponsorship from NASA, I and my colleagues conducted a study of the potentials of remote sensing to observe successional states of the boreal forest. As the study area, we chose the Superior National Forest in Minnesota, which includes the famous Boundary Waters Canoe Area, one of the first legally designated wilderness areas under the Wilderness Act. Because this region of the boreal forest is subject to wildfires, the forest, both inside and outside the wilderness within the national forest, have a similar range of states. Heinselman (1973), in a famous paper about the Boundary Waters Canoe Area, made use of historic records, measurements of forests stands, and fossils to determine that, on average, the entire BWCA burned approximately once a century. Thus the kinds of states of the forest and the range of states found inside the wilderness also occurred outside. Additionally, we were able to use remote sensing to determine the change in successional states of hundreds of thousands of stands both inside and outside the wilderness. In this case, experimental manipulation of stands outside the wilderness but within the national forest would include the range of states found within the wilderness (Hall and others 1991).

The boreal forests offer the potential for such a comparison because this forest type cover a very large geographic range, some of which meets the legal requirements of wilderness. But other ecosystem types no longer have such representation. For example, it would be difficult to find large areas of North American prairie with representation of all successional stages both inside and outside of legally designated wilderness.

Wilderness as Nonsteady-State Systems

The second assumption, that there are general rules or laws about ecological systems that will apply directly to *unstudied* wilderness based on studies elsewhere, is an untested hypothesis, itself requiring research that is likely to require direct intervention in wilderness areas. Ecological systems are so complex, and scientific research about them so new, in relative terms, that we do not know whether that generalization is correct. And since natural ecological systems vary greatly in space as well as in time, many such tests might be required.

Throughout much of the twentieth century, scientists believed that wilderness achieved a steady-state, and that one had only to study this steady-state condition to understand, forecast, and manage wilderness. For example, in the early 1950s, Rutgers University purchased Hutcheson Memorial Forest, a 65 acre stand known never to have been cut—it had been owned by a single family since European settlement in 1701 and family records showed that the stand had remained an unused woodlot. An article in

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Audubon in 1954 described this wood as "a climax forest...a cross-section of nature in equilibrium in which the forest trees have developed over a long period of time. The present oaks and other hardwood trees have succeeded other types of trees that went before them. Now these trees, after reaching old age, die and return their substance to the soil and help their replacements to sturdy growth and ripe old age in turn" (Botkin 1990). *Management* of such an area, if it really were in steady-state, merely required the removal of any human actions. Nature would then take care of itself. Wilderness management policy could merely be "hands off."

But research on ecosystems and populations during the last 30 years of the twentieth century made clear that natural ecological systems are not in steady-state. They change in response to environmental change, and in response to internal dynamics. Many species are adapted to, and require, these changes. What then is the solution? How can there be a wilderness science in nonsteady-state systems?

Wilderness and Naturalness

One solution lies with the difference between the idea of what is *wilderness* and what is *natural.* According to the old, steady-state idea, these would be identical: a wilderness area would be natural, and a natural area would be a wilderness. But if ecological systems are always in flux, then perhaps what is natural might not fit the classic idea of wilderness. And perhaps a studied and manipulated area might be natural. Part of the resolution of this question lies with an understanding of physical phenomena, but part of it lies with people's attitudes, beliefs, and desires. We must ask: when is it that people are seeking to conserve and understand about *wilderness*, and when is it that they are seeking to conserve and understand a *natural* area?

The difference between wilderness and a natural area is illustrated by a classic example of a problem in the conservation of an endangered species, the Kirtland's warbler. In 1951, a survey was made of this warbler, making it the first songbird in the United States to be subject to a complete census. About 400 nesting males were found. But concern about the species increased in the 1960s when the population declined. Only 201 nesting males were found in 971 (Byelich and others 1985). Conservationists and scientists began to try to understand what was threatening the species with extinction.

They rapidly recognized the problem. Kirtland's warblers breed only in young jack pine woodlands in southern Michigan—between 6 and 21 years old. The warblers build their nests on dead branches near the ground. Young trees, between 5 and 20 feet high, retain these dead low branches. Because of fire suppression and the replacement of jack pine stands with forests of commercially more valuable species, Kirtland's warbler nesting habitat was disappearing (Botkin 1990). Jack-pine, a fire-dependent species, has serotinous cones that open only after they are heated by fire, and the trees are intolerant of shade, able to grow only when their leaves can reach into full sunlight. Even if seeds were to germinate under mature trees, the seedlings could not grow in the shade and would die. Jack pine produces an abundance of dead branches that promote fires, which is interpreted by some as an evolutionary adaptation to promote those conditions most conducive to the survival of the species.

The Kirtland's warbler thus requires change at short intervals—forest fires approximately every 20 to 30 years—which was about the frequency of fires in jack-pine woods in presettlement times (Heinselman 1973). At the time of the first European settlement of North America, jack pine may have covered a large area in what is now Michigan. Even as recently as the 1950s, jack pine was estimated to cover nearly 500,000 acres in the state. Jack pine, a small poorly formed tree, was considered a trash species in the nineteenth century by the commercial loggers and was left alone. But many large fires followed the logging operations when large amounts of slash—branches and twigs and other economically undesirable parts of the trees—were left in the woods. Elsewhere, fires were set in jack-pine areas to clear them and promote the growth of blueberries.

Some experts think that the population of Kirtland's warblers peaked in the late nineteenth century as a result of these fires. After 1927, fire suppression became the practice, and control of forest fires reduced the area burned and the size of individual fires. Where possible, it was the practice to encourage the replacement of jack pine with economically more useful species. These actions reduced the areas conducive to the nesting behavior of the warbler (Mayfield 1969).

Although it may seem obvious today that the warbler requires forest fire, this was not always understood. In 1926, one expert wrote "fire might be the worst enemy of the bird" (Norman A. Wood in Mayfield 1969). Only with the introduction of controlled burning after vigorous advocacy by conservationists and ornithologists was habitat for the warbler maintained. The Kirtland's Warbler Recovery Plan, published by the Department of the Interior and the Fish and Wildlife Service in 1976 and updated in 1985, allocated 38,000 acres of new habitat for the warbler. There, prescribed fire would be "the primary tool used to regenerate nonmerchantable jack-pine stands on poor sites" (Byelich and others 1985).

Those who wanted to save this species acted from observation and made use of the scientific method. They were not working in legally designated wilderness areas, but worked in areas where active experimentation could be done. They were creating a natural area in the sense that it was natural for the warbler. The jack pine stands manipulated to conserve the Kirtland's warbler could be considered "natural" in the sense that they were recreations of the habitat conditions that species had evolved within, adapted to, and required.

This episode indicated a turning point in the modern perception of the character of nature and the requirements to manage and maintain nature. If wilderness areas undergo natural changes, but changes have been suppressed, then management for wilderness requires imposing actions on the wilderness, thus violating the modern concept of wilderness and also perhaps violating the 1964 Federal Wilderness Act. It was possible to create a natural area, although this area might not meet the wording of the Wilderness Act.

Wilderness as Solitude

A second solution is to focus on the additional statements in the Wilderness Act that I mentioned earlier: that a wilderness area "(1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition." As with the Kirtland's warbler managed habitat, the use of prescribed burning would create an area that "generally appears to have been affected primarily by the forces of nature." It would also be possible to create areas that had "outstanding opportunities for solitude or a primitive and unconfined type of recreation" even if the area were heavily manipulated. Moreover, if the requirement is a general appearance of naturalness, where the activities of scientists are "substantially unnoticeable," then perhaps sufficient research could be done in an unobtrusive manner, leaving the "wilderness" to "appear" completely "untrammeled."

This is the approach that my colleague, Peter Jordan, and I took to the study of Isle Royale National Park, Michigan. This 280 square mile (540 square kilometer) island is one of the best examples of wilderness in the lower forty-eight states in the sense of an "untrammeled" place. Prior to European settlement, Indians visited the island to collect native copper, but did not settle there and had little direct affect. Since European settlement there have been several episodes of attempts to farm small portions of the island, some land was cleared. But in general little human impact occurred. Once the island became a national park, the National Park System established a series of hiking trails and campsites, along with boat access and two lodges, one at each end of the island (only one of which still exists). These alterations, however, affected only a small fraction of the landscape.

Isle Royale is famous for its high population of moose and for its wolves, both of which reached the island independent of human actions. We investigated factors that might limit the moose population of the island, focusing on a search for what nutrient chemical element might provide the ultimate limit on moose abundance. We established a statistically valid, stratified sampling scheme, sampling small plots within which we randomly selected rectangular volumes of less than a meter in diameter and three meters high. Within these, we clipped all leaves and twigs of species eaten by moose.

Few visitors to the island travel away from established trails. In his forty years of work on the island, Peter Jordan has not encountered another person when he has been at least 100 meters from a trail. The sampled areas were sparse and, given the high rate of natural disturbance of the island, especially from storms and the feeding by moose, these would be unnoticed by all but the most observant hikers and only by those that ventured long distances from trails. In short, we were able to conduct studies of the island wilderness in a way that would not leave traces obvious to others. Furthermore, the present condition of Isle Royale is greatly affected by the browsing of moose, which has led changes in the structure of the forests and to the relative abundance of species. Spruce, which moose do not eat, has come to dominate areas where it was once a minor component. Moose have transformed areas of previously dense understory to near savannahs, where mature trees too tall for the moose to fed on remain as relatively scattered individuals, while the saplings and seedlings shorter than three meters—within the reach of the moose—are sparse. Accepting effects of the moose as "a force of nature," visitors would find the island "generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable" meeting the appearances and the real concerns of the Federal Wilderness Act.

Thoreau and Wilderness Science

Such a light touch approach might be possible for many wilderness areas. But some, to be managed well, require more intense intervention. What is the solution for these? Perhaps the answer lies with the idea of wilderness of Henry David Thoreau, often considered one of the fathers of modern environmentalism. His famous statement, "In Wildness is the preservation of the world" is quoted frequently, both as an inspiration to conservationists and as an assertion of the importance of wilderness in the sense of lacking any impact of human beings. But this is not what Thoreau meant by that statement (Botkin 2000). In the essay in which that statement appears, Thoreau explains the why wilderness is essential. He wrote "From the forest and wilderness come the tonics and barks which brace mankind (Sattelmeyer 1980). The focus is on the importance of wildness to people, not wildness for wildness's sake.

Thoreau made three trips to the Maine Woods where he hiked and canoed within areas that he wrote frequently of as "wilderness." However, many of these areas, he readily observed, had been subject to the hand of man. In his book, *The Maine Woods*, he states in one paragraph that white pine had been cut out by loggers from the area where he walked. Yet in the next paragraph or so he referred to the area as a wilderness, or described his reactions to being within a wilderness. The readily visible effects of human actions did not defer Thoreau from an experience of wilderness.

During his last trip to the Maine Woods, Thoreau became lost in Umbazooksus swamp, a large wetlands. He found that he was "soon confused by numerous logging-paths" made by lumbermen who had converted this area from "what was called, twenty years ago, the best timber land in the state" and "covered with the greatest abundance of pine." At the time of that visit, Thoreau found pine "an uncommon tree." He was well aware of the human impact on the woods. Yet a few paragraphs later he wrote that he went through a "wilderness of the grimmest character" occupied by dense cedar trees. The proximity of a selectively logged area to a dense stand of cedar did not affect Thoreau's sense that the latter *was* a wilderness. The effects of people or their occasional presence did not destroy his *sense of being within the wilderness*. (Thoreau 1973). Nor did the existence of many dams, put there, as Thoreau notes, to make the transport of logs easier.

Thoreau distinguished between "wildness" and "wilderness." For him, *wildness was a spiritual state existing between a person and nature, while wilderness was land or*

water unused at present by people, thus it was a state of nature. Contrary to the modern idea that wilderness must be a place untrammeled by human beings, Thoreau believed that human beings were "part and parcel" of wilderness, and that a wilderness lacking human records was a wilderness not of interest to him. In his book, *Cape Cod* Thoreau referred to the ocean as a wilderness of little interest because he could see no effect of Indians or other human culture, no touch of human history on this watery scape. For Thoreau, *a wilderness without the touch of humanity and its history and effects were timeless and distant and therefore not of direct interest to him*.

Wilderness, for Thoreau, was the physical entity, was a place where a person could experience wildness or, if it was destroyed for this use, Thoreau believed that it should be converted to other humanly productive uses.

The resolution suggested by Thoreau's interpretation of wilderness and wildness is that it is possible to experience the sense of wildness within an area heavily affected by human activities. Thoreau distinguished between what was natural in its effects on him and other people (a place to experience wildness), and physical wilderness. If our society were to make the goal for wilderness the opportunity to experience a Thoreauvian sense of wildness, then experimental scientific research of a traditional kind would be compatible within wilderness, even if this research led to occasional, quite visible human effects on the landscape.

Resolutions

The resolutions to the conundrum: can there be a wilderness science? Lie with an acceptance of the naturalness of change and the lack of steady-state of ecological systems. Once this is recognized, the solutions that I have suggested follow. But as long as it was believed that a wilderness existed in steady-state, then the appropriate policy was no action. Nature knew best. Leave nature alone.

However, once that it is clear that natural ecosystems are always changing, then there is no single, simple answer to the question: what is *the* state of wilderness. There is not one wilderness state, but many. And therefore one has to ask: what is the *goal* for wilderness management for a specific wilderness area?

The requirement that we be active participants in the conservation and management of wilderness is all the more apparent today because human induced environmental change is global, and there are few areas untouched by artificial chemicals or a human-induced change in concentration of naturally occurring chemicals. Even at Isle Royale, artificial chemicals are detected in the waters. If global warming were to occur, massive changes would take place in wilderness areas, making some no longer suitable for the purpose for which they were designed.

I believe that there are several goals for wilderness and, therefore, for wilderness science because different people desire different kinds of wilderness. These include: (1) wilderness that offers a sense of relief from the everyday cares of the world, that opens an opportunity to achieve a spiritual, religious, or creative and uplifting experience from nature; (2) a place within which one can test one's survival skills and ability to cope with mountain climbing, the possible contact with dangerous animals and with isolation, relying on few modern pieces of technology; (3) the opportunity to appreciate scenic beauty of a particular kind; a valuation of a kind of rare and threatened ecosystem or a specific threatened or endangered species that appears to depend on states that one attributes to "wilderness"; (4) an area that represents an ecosystem as it was at a particular past time, such as prior to European exploration of North America. This idea of wilderness can be important to a person's imagination of the area as unaffected by human beings in specific ways—either preindustrial, or preagricultural, or prior to any human impacts, such as the use of fire and the proposed extinction of large mammals or the introduction of exotic species. Finally, (5) another idea of wilderness the "existence" rational—the belief that some or many people want a particular kind of wilderness to exist whether or not they may visit it. Its mere existence satisfies either a moral or aesthetic need.

There can be a role, and therefore a location, for each of these five kinds of wilderness. But in the modern world, like it or not, given the modern understanding that nature changes *naturally* and also that human effects are worldwide, if indirect, then we must make choices, we must understand the dynamics of wilderness, and therefore we need a wilderness science. Leaving nature only alone will not work. And, as Henry David Thoreau understood, it is not likely to meet the needs and desires of human beings.

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