Would Ecological Landscape Restoration Make the ***Bandelier Wilderness*** *More or Less of a Wilderness?*

Jacobs

Is it appropriate to intervene in designated wilderness areas that have been "trammeled by man" and, as a result, no longer retain their "primeval character and influence" as called for in the 1964 Wilderness Act? We explore this wilderness management dilemma—whether we can or should actively manage wilderness conditions to restore and protect wilderness and other values—by asking a series of questions relating to a wilderness area that is no longer "natural."[1] Debate on this issue is not new, but is intensifying, since most wilderness areas in the continental United States are not pristine and ecosystem research has shown that conditions in many are deteriorating. Our case-study

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1. For the purposes of this discussion, "natural" is defined by words and phrases used in the 1964 Wilderness Act: "a community of life untrammeled by man"; "land retaining its primeval character and influence"; or existing in an "unimpaired condition."

piñon and juniper by Serena Supplee

Looking south across the Bandelier Wilderness, New Mexico

Right: Ponderosa pine, Jemez Mountains, Bandelier National Monument, New Mexico

is a proposed large-scale project to restore piñon-juniper woodlands in the Bandelier Wilderness, which comprises more than 23,000 acres in Bandelier National Monument, New Mexico.

Many ecosystems in this wilderness exhibit human-caused damage and unsustainable trends because of a land-use history that includes federally sanctioned overgrazing and fire suppression over the past century. This situation has caused park managers and wilderness advocates to ask several important philosophical and practical questions; questions that—while daunting and requiring extensive public dialogue—have moved us cautiously toward advocating ecological restoration in the Bandelier Wilderness.

Does a park's enabling legislation (or the National Park Service Organic Act) reign supreme and, if so, at what cost to other resource values, including wilderness values, recognized later in a park's history? The answer to this question is contained within the 1964 Wilderness Act (P.L. 88-577). The act simultaneously limits and permits management action to protect both park and wilderness values (which are arguably the same). In addition, the act makes it clear that wilderness designation does not supercede a park's enabling legislation or the National Park Service (NPS) Organic Act, but is supplemental to it. Section 4(a)(3) states that: "Nothing in this Act shall modify the statutory authority under which units of the national park system are created. Further, the designation of any area of any park, monument, or other unit of the national park system as a wilderness area pursuant to this Act shall in no manner lower the standards evolved for the use and preservation of such park.…" The act also makes it clear that the NPS and other agencies have the legal responsibility to meet their mission requirements and other mandates even in *wilderness areas*.

In section 4(b), the act gives the NPS (in this case) responsibility for meeting its mission as well as preserving "wilderness character." Unfortunately, wilderness character is not clearly defined and, thus, a dilemma arises for the wilderness ecosystem manager. To some, "wilderness character" means that wilderness areas should evolve in whatever direction Nature chooses (be free-willed) after the lands have been designated as wilderness, regardless of pre-existing condition or future consequences. This perspective argues that all resource managers (including wilderness/ecosystem restorationists) and researchers should not be permitted to do anything in wilderness using motorized equipment. However, this position is not wholly supported in the act, as in section 2(a), which calls for the preservation, protection, and administration of wilderness areas

photographs: National Park Service (left); by George Wuerthner (right)

"in such a manner as to leave them unimpaired for future use and enjoyment as wilderness.…" While section 4(c) of the act gives the wilderness administrator strong direction to accomplish the preservation and protection task without motorized equipment, it also permits its use if there is justifiable need.

The Organic Act dictates that the National Park Service mission is "to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." Bandelier National Monument, as one of the oldest units in the National Park System, was established in 1916 to preserve and protect "prehistoric aboriginal ruins" on the Pajarito Plateau because of their "unusual ethnologic, scientific, and educational" values.

In October 1976, President Gerald Ford signed legislation creating the 23,267-acre Bandelier Wilderness. The NPS was initially opposed to this wilderness designation, in part because of a general concern that cultural resources research and management in a "traditional cultural resource park" could be severely constrained. The Bandelier Wilderness, like most wilderness areas in the National Wilderness Preservation System, was not pristine when it was designated due to a history of harmful Euro-American land-use practices, yet the public felt strongly that the area should be wilderness (McDonald 1987). Additional wilderness-quality lands were added to the park in 1977, so that today approximately 71% of the park is designated wilderness, while more than 90% (about 30,000 acres) is managed as wilderness.

Scientific study in and adjacent to the Bandelier Wilderness since 1987 strongly supports the notion that historic Euro-American use of the area has triggered unprecedented change in most of the park's ecosystems (Allen 1989, Davenport et al. 1998); similar changes have occurred throughout much of the Southwest (Allen et al. 1998, Bogan et al. 1998). For example, federally sanctioned livestock grazing and fire suppression from 1880 through 1932 catalyzed severe accelerated soil erosion across the park's extensive mesas that are now dominated by piñon-juniper woodlands (Gottfried et al. 1995, Wilcox et al. 1996a). These old, relatively shallow soils are the physical matrix for thousands of "aboriginal ruins" that Bandelier National Monument was established to protect (Head 1992, Bandelier National Monument unpublished data). The Bandelier Wilderness contains significant portions of these altered ecosystems and "aboriginal ruins." Over 90% of the park's 11,730 acres of piñon-juniper woodlands are within designated wilderness—thus, resolution of any resource issues related to this community type necessarily involves wilderness considerations. An estimated 2,500 cultural resource sites located in the Bandelier Wilderness are subject to accelerated erosion-caused damage, or risk of loss, within the next century (Powers and Orcutt 1999).[2]

In sum, the National Park Service, to accomplish its protection and conservation mandate, must respond to known resource threats within the Bandelier Wilderness—and the authority to control unnatural rates of erosion, even using motorized equipment, appears to be permitted under the provisions of the Wilderness Act.

2. Every rain event reduces the information-yielding potential of the "aboriginal ruins." For example, in a single storm on June 29, 1995, 1,040 artifacts were transported off-site and captured in a $1m^3$ sediment trap at the mouth of a 0.1 hectare catchment basin (Bandelier National Monument unpublished data).

Right: Experimental restoration treatments reinvigorate native herbaceous cover. Untreated area in foreground, treated area in background, four years after treatment, Bandelier National Monument, New Mexico. Below: Blue grama grass (Boutelouca gracilis) *damaged by "pedestaling," where soil around the roots is washed away until the plant dies of exposure or is dislodged.*

If one understands wilderness exclusively as the absence of apparent evidence of human management in the short term, then management intervention is not warranted in Bandelier. Unfortunately, the piñon-juniper ecosystems of the Bandelier Wilderness seem unable to heal themselves—which leaves wilderness managers, and the public, with some profoundly difficult choices.

Should federal land managers intervene if wilderness ecosystems are degraded and unsustainable due to the historic activities of motorized societies? Soils in areas now occupied by woodlands likely formed under different vegetation during cooler, moister conditions of the late Pleistocene; in other words, they are over 10,000 years old, and many are over 100,000 years old (McFadden et al. 1996). Changes in climate and vegetation in the early Holocene (8,500–6,000 years ago) led to at least localized episodes of soil erosion on adjoining uplands (Reneau and McDonald 1996, Reneau et al. 1996). During this time, the dominant climatic and associated vegetation patterns of the modern southwestern United States developed, including grasslands, piñon-juniper woodlands, and ponderosa pine savannas (Allen et al. 1998). On the basis of local fire history (Allen 1989, Morino et al. 1998, Touchan et al. 1996), dense piñon-juniper age class (Bandelier National Monument unpublished data, Julius 1999) and soils data (Davenport 1997, Earth Environmental Consultants 1974, McFadden et al. 1996), we believe that many

photographs: by Dorothy Hoard (left); by Warren Lieb (right)

sites within Bandelier now occupied by piñon-juniper woodlands were formerly more open grassland, woodland, and ponderosa pine savanna communities, with well-developed soils and herbaceous understories that: 1) protected the soil from excessive erosion during intense summer thunderstorm events, and 2) provided a largely continuous fuel matrix, which allowed surface fires to spread and maintain these vegetation types.

Native American effects on local woodlands are thought to have been insignificant or highly localized until the late twelfth century, when the Ancestral Puebloan (also referred to as the Anasazi) population began to intensively occupy and utilize the Bandelier area (Powers and Orcutt 1999). Cutting and burning of piñon and juniper trees for cooking, heating, building, and agricultural activities likely led to significant deforestation of upland mesas from about 1150–1550 AD. Thus, Ancestral Puebloan land-use practices favored herbaceous vegetation. Intensive soil disturbance certainly occurred in farmed areas and around habitations, but there was probably little net change in landscape-wide erosion rates due to the small size and dispersed locations of "fields" and villages.

Euro-American settlement of the adjoining Rio Grande valley and the introduction of domestic livestock grazing began in 1598. It is unlikely, however, that significant livestock grazing (that is, with substantial widespread effects on the herbaceous understory, fire regime, or erosion rates) took place in much of Bandelier until railroads linked the Southwest to commercial markets in the 1880s. Millions of sheep and cattle were placed in the New Mexico landscape at that time. Livestock grazing—and overgrazing—was allowed in Bandelier until 1932, and feral burros were similarly allowed to cause grazing impacts until about 1980 (Allen 1989). Sharp reductions in the herbaceous ground cover and associated organic litter resulted, effectively suppressing previously widespread surface fires (in concert with institutionalized fire suppression initiated by the federal government in the early 1900s). Severe drought during the 1950s contributed to declines in ground cover (Allen and Breshears 1998). Fire-sensitive piñon and juniper trees became established in densities unprecedented for at least the past 800 years (Bandelier National Monument unpublished data, Julius 1999). As these trees grew, they became increasingly effective competitors for water and nutrients. Thus, a positive feedback cycle was initiated that favors tree invasion and decreased herbaceous ground cover in mesa-top settings.

This land-use history has resulted in degraded and unsustainable ecosystem conditions in today's Bandelier Wilderness. The intercanopy soils of Bandelier's woodlands are apparently eroding at net rates of about one-half inch per decade (Bandelier National Monument unpublished data, Earth Environmental Consultants 1974, Wilcox et al. 1996a,b). Given soil depths averaging only one to two feet in many areas (Davenport 1997, Wilcox et al. 1996a), there will soon be loss of entire soil bodies across extensive areas of the Bandelier Wilderness.

Ecological thresholds have apparently been crossed such that harsh physical processes are now dominant across Bandelier's degraded piñon-juniper woodlands (Davenport et al. 1998). The loss of organic topsoils, decreased plant-available water, extreme soil surface temperatures, and freeze-thaw activity severely impede herbaceous vegetation establishment and productivity (Davenport et al. 1998, Jacobs and Gatewood 1999, Loftin 1999). Reductions in ground cover cause increased runoff from summer thunderstorms (Reid at al. 1999), with associated increases in erosion (Wilcox at al. 1996a,b). Reestablishment of herbaceous ground cover under today's desertified mesa-top conditions may also be difficult due to depleted soil seed banks, highly efficient seed predators, particularly harvester ants (Snyderman and Jacobs 1995), and an unnaturally large elk population (Allen 1996). Herbivore exclosures established in 1975 show that protection from grazing, by itself, fails to promote vegetative recovery in Bandelier's piñon-juniper ecosystems (Chong 1992, Potter 1985). Without management intervention, this human-induced episode of accelerated soil erosion appears to be highly persistent and irreversible (Davenport et al. 1998). To a significant degree, the park's biological productivity and cultural resources are literally washing away.

Do these conditions and their causes justify taking corrective actions? After all: 1) erosion is a ubiquitous geomorphic process; 2) localized, and perhaps regional, episodes of accelerated erosion have occurred naturally in the past (Reneau et al. 1996); and 3) it is impractical to preserve the cultural resource sites at Bandelier in stasis.[3] In addition, some wilderness advocates are understandably concerned about a loss of "wildness" if local land managers have too much latitude to manipulate wilderness resources, even to achieve high-minded and defensible goals.

Given this information, there is no question that we must assess the problem and possible solutions cautiously and responsibly. The decision to implement drastic restoration measures must be made with extreme humility. Yet, it is clear that delays in making this decision in the Bandelier Wilderness come at a high and ongoing cost.

3. Further, some Native Americans do not want the NPS manipulating the landscape or archeological sites for any reason, even to stabilize ancestral sites.

While a basic tenet of wilderness is that the "imprint of man's work [is] substantially unnoticeable," human impact on essential ecological patterns and processes is profound in the Bandelier Wilderness. If one understands wilderness exclusively as the absence of apparent evidence of human management in the short term, then management intervention is not warranted in Bandelier. Unfortunately, the piñon-juniper ecosystems of the Bandelier Wilderness seem unable to heal themselves—which leaves wilderness managers, and the public, with some profoundly difficult choices.

Can we restore the "natural range of variability" and will it be sustainable? The answer to this question lies in scientific study to define the natural range of variability, and experimentation to address and test sustainability. Let us look again at the Bandelier woodlands to see what has been discovered.

Since most of the soils of the park's piñon-juniper woodlands are over 100,000 years old (McFadden et al. 1996), we can be sure that the natural range of variability in these ecosystems generally allowed for soil development and stability, rather than the high rates of degradational erosion observed in recent decades. From this fact of long-term soil persistence we can infer that some type of vegetation was protecting the soils from excessive erosion over time, including the last 8000 years of the Holocene during which a modern climatic regime prevailed. We believe that an effective herbaceous ground cover must have been the now-missing glue which held soils in place, given that there is no evidence of formerly closed-canopy woodlands (indeed, the ages of local piñon and juniper trees are largely quite young) (Bandelier National Monument unpublished data, Julius 1999), and since fire-scar studies show a history of recurrent surface fires that could not have occurred without herbaceous vegetation.

Controlled, progressive experiments within and outside of the Bandelier Wilderness since 1992 (Chong 1993, 1994, Jacobs and Gatewood 1999, Snyderman and Jacobs 1995) have shown that undesirable losses of soils, herbaceous vegetation, and cultural resources can be mitigated through active management to thin the smaller trees and leave scattered slash in the form of lopped branches from cut trees. This treatment directly reduces tree competition with herbaceous plants for scarce water and nutrients, and the application of slash residues across the barren interspaces greatly reduces surface water runoff and ameliorates the harsh microclimate at the soil surface, immediately improving water availability for herbaceous plants. This restoration approach has produced a two- to seven-fold increase in total herbaceous cover (at three years post-treatment), relative to both controls and pretreatment conditions (Jacobs and Gatewood 1999), while also increasing the diversity of herbaceous plants. Recent, ongoing research shows striking decreases in sediment movement on treated hillslopes (Bandelier National Monument unpublished data). This tree thinning and scattered slash treatment method is labor intensive and requires extensive use of chainsaws to limb and flushcut the piñon and juniper, given the hard, dense wood of these species (especially juniper) and the large number of trees that require treatment.

Other treatment methods to restore herbaceous ground cover were tested. Seeding in the absence of tree thinning was ineffective, and seeding combined with a thinning and slash treatment conferred little additional benefit. Alternative tree thinning techniques are unlikely to be effective, safe, or practical, as: surface fire cannot currently carry through the barren understory of Bandelier's piñon-juniper woodlands; girdling and herbicide treatment do not generate the on-the-ground slash necessary for the creation of microclimatic conditions that facilitate vegetation recovery, as dead trees would be left standing; and exclusive use of non-motorized tools would take too long, given the urgency of the situation, and also place too many people in the wilderness environment for extended periods, causing other unacceptable wilderness impacts.

In the Bandelier case-study, through scientific investigation, we are confident that a "range of natural variability" (Landres et al. 1999, Swetnam et al. 1999) is reasonably defined. We have also found a seemingly effective restoration technique, but the long-term outcome will only be known as time progresses. The treated areas, though initially dominated by biannual forbs, are becoming increasingly populated by native perennial grasses, which represent conditions that are more natural and sustainable. Will the restored herbaceous cover be able to reduce erosion rates to natural, sustainable levels? Based on initial data from an ongoing study, it appears likely. However, the substantial quantities and distribution of the woody slash used in this restoration approach could support large, unnaturally intense fires. The potential for widespread fire can be eliminated by limiting the size of treatment blocks and dispersing them across the park landscape. In addition, shallow soil sites with rocky substrate which are considered to be relict woodland areas will not receive restoration treatment. The resulting mosaics of fuels and vegetation will provide a margin for error and mitigate aesthetic concerns. Prescribed fire will be introduced to eliminate excessive woody fuel loads and prepare treated areas for naturally occurring fires once adequate herbaceous cover is successfully restored and capable of surviving fire.

If restoration is possible, what should our goal or target conditions be in wilderness? Achieving agreement on target conditions is the crux of the wilderness restoration dilemma. Ideally, a naturally functioning ecosystem exists when a wilderness area is set aside. However, established wildernesses are generally far from pristine—that is, they do not fully retain their "primeval character and influence.…" In the Bandelier Wilderness our vision of target conditions for piñon-juniper woodlands is functional (as opposed to structural or compositional): to reestablish biotic dominance over rates of erosion and enable natural fires to move across the landscape unimpeded.

We do not focus on what the Bandelier Wilderness will *look like* in our description of target conditions. The type of experience a person may have in the wilderness is also not defined. Although wilderness involves scenery and "human experience" management, it is not necessarily or solely defined by them.

Is it appropriate to conduct large-scale ecosystem restoration work in wilderness? The Organic Act and other federal laws mandate protection of park and wilderness resources and values when we know they are threatened. In response to these laws, resource management activities such as exotic plant control, application of prescribed fire, and wildlife reintroduction are routinely and legally accomplished in federal wilderness areas. None of these laws, including the Wilderness Act, specify that a "no action" decision is justifiable based solely on the magnitude or scale of the possible mitigation alternatives. Therefore, National Park Service resource managers are obligated to: 1) consciously decide on a course of action when we detect a threat no matter how large or significant, and 2) make responsible decisions about the type and scale of our response to all kinds of resource threats.

Although the Bandelier Wilderness piñon-juniper woodlands restoration project is considered relatively large-scale (affecting up to 8,000 acres of wilderness), evidence of management intervention (in the form of cut marks on small stumps and scattered slash mulch) superficially disappears within roughly ten years depending on site conditions. Further, we hypothesize that if fire is reintroduced to accelerate woody material decomposition and degrade the flush-cut stumps, the evidence of management intervention will be substantially undetectable in 20 years. (To deal effectively with the threat of a wildfire consuming the woody materials too soon after treatment, we must treat the woodlands in patches, thus creating a mosaic of conditions and appearances.) Perhaps the relatively short duration of the evidence of management intervention matters more than the spatial extent or appearance of that evidence.

If we start manipulating designated wilderness to reach an "unimpaired condition" goal, when and where will management intervention end? This question must be answered if management intervention is to be seriously contemplated. There is justifiable public concern that federal wilderness managers could abuse the wilderness resource in the name of ecosystem health restoration. Management intervention should not be a license to control Nature, harvest resources, or create stasis; it should be a means of facilitating natural healing of motorized societies' impacts to wilderness ecosystems.

We believe this question can only be addressed through extensive scientific research both to diagnose the sustainability of wilderness ecosystems and to understand the causes and effects of unnatural change. As a starting principle, we suggest that management intervention should end when the natural processes present before industrial-age humans are once again working in formerly dysfunctional or "impaired" ecosystems. In the Bandelier case-study, based on over ten years of on-site research, this end point would be achieved when there is sufficient herbaceous cover to carry naturally occurring fires. The herbaceous cover will reduce soil erosion (and associated cultural resource loss) to natural rates, and fire should maintain the restored herbaceous cover and prevent recurrence of the erosion problem. After restoration, the piñon-juniper wilderness ecosystem will be left alone to evolve, driven by natural processes. We submit that this level of restoration would restore important aspects of wildness or "free-will" to the Bandelier Wilderness, consistent with the definition of wilderness established in the 1964 Wilderness Act.

CONCLUSION

Although there are no simple answers to the wilderness questions presented here, we suggest that a research-based management approach, including identification of a process-oriented goal to achieve an ecologically functional endpoint, sets the stage for making rational decisions about whether and how to intervene when unnatural conditions exist in wilderness areas. We have a choice when we know that the land is "sick." We can "make believe" (Leopold 1953) that everything will turn out right if Nature is left to take its course in our unhealthy wildernesses, or we can intervene—adaptively and with humility—to facilitate the healing process. ☾

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