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Arizona Journal of Environmental Law & Policy
February 22, 2015

Article
Gordon Steinhoff

*302 RESTORING NATURE IN PROTECTED AREAS

In the literature, there is no standard account of ecological restoration. According to the more traditional view, ecological restoration is the attempt to return a damaged ecosystem to some historic state. In this article, I will examine United States federal agency policies concerning restoration within national parks, wilderness, and other protected areas. I will also examine actual restoration projects in these areas. I will argue that ecological restoration within protected areas is not, and should not be, conceived as an attempt to return an ecosystem to the past. Also, restoration in these areas should not be conceived in open-ended ways recently advocated by restoration experts, as "aiming at the repair of damage," for example, or as the creation of "emerging ecosystems." As will be discussed, "ecological restoration" within protected areas should be understood as returning a damaged ecosystem to a close approximation of its natural conditions and processes. A restored ecosystem within these areas must closely mimic natural, not historic, conditions.

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***304 INTRODUCTION**

Although ecological restoration has come to play an essential role in ecosystem management, it is still a contentious issue how "ecological restoration" should be conceived. What exactly are we doing as we "restore" a damaged ecosystem? In the literature, there is no standard account. According to the traditional view, ecological restoration is the attempt to return a damaged ecosystem to some historic state.[1] As I will discuss, this view is problematic for several reasons. Recently, however, ecological restoration has been characterized in a vague fashion that does not require a return to historic or natural conditions. The Society for Ecological Restoration (SER), for example, has defined "ecological restoration" as "the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed."[2] "Recovery" is a vague term. Restoration experts William Jordan and George Lubick state that this definition is purposefully broad, inclusive, even lenient, allowing "a wide range of land management practices to claim the rubric of 'restoration.'"[3] In their popular restoration text, Jelte van Andel and James Aronson accept the SER definition, and they informally characterize "ecological restoration" simply as "aiming at the repair of damage."[4] David Tongway and John Ludwig characterize "ecological restoration" as (essentially) "repairing damaged functions."[5]

As I will discuss, the restoration of damaged ecosystems is vital for maintaining native biodiversity in national parks, wilderness, and other protected areas. I will examine United States federal agency policies concerning restoration within protected areas, as well as actual restoration projects. I will argue that ecological restoration within protected areas is not, and should not be, conceived as an attempt to return an ecosystem to the past. Also, restoration in these areas should not be conceived in the open-ended ways recently advocated by restoration experts, such as "aiming at the repair of damage." Federal protected area policies are properly strict concerning restoration, reflecting their legislative ***305** mandates to conserve natural conditions and native biodiversity. Consistent with federal agency policies and actual practice, "ecological restoration" within protected areas should be understood as returning a damaged ecosystem to a close approximation of its natural conditions and processes. The standard that must be met within protected areas is quite high. A "restored" ecosystem within these areas must closely mimic natural, not historic, conditions.

I. CONCEPTIONS OF RESTORATION

"Ecological restoration" has been characterized in various ways. The U.S. Environmental Protection Agency has recently defined "[ecological] restoration" as "the process of returning a damaged ecosystem to its condition prior to disturbance."[6] This is the traditional understanding, and it is still accepted by restoration experts. Jordan and Lubick claim that ecological restoration ("ecocentric restoration") is "focused on the literal recreation of a previously existing ecosystem, including not just some but all of its parts and processes."[7] Margaret Palmer and others write, "Strictly speaking, ecological restoration is an attempt to return a system to some historical state ...."[8] According to Dave Egan and Evelyn Howell, "A fundamental aspect of ecosystem restoration is learning how to rediscover the past and bring it forward into the present ...."[9] And A.D. Bradshaw writes that ecological restoration is properly understood as "returning [a system] to an original state and to a state that is perfect and healthy."[10] Such an understanding of restoration renders the genuine restoration of an ecosystem either extremely difficult or outright impossible. Jordan and Lubick comment on this "literalist" approach, writing, "[b]y undertaking the re-creation of whole ecosystems in this way ... managers had placed on the ground, if not the real thing exactly, at least a very provocative thing ...."[11] Palmer and others acknowledge that "the difficulty or impossibility" of genuinely restoring an historic state "is widely recognized."[12]

***306** Van Andel and Aronson argue that it is impossible to genuinely restore past ecosystems. They write, "If you play the tape of life back, so to speak, it will never come out the same."[13] These authors accept the current ecological view that an ecosystem does not develop towards a unique equilibrium point or steady state.[14] Also, the trajectory an ecosystem follows may be significantly affected by the timing and severity of past disturbances and a number of other factors.[15] It is impossible to recreate, these authors accept, the exact biotic and abiotic elements that determined the course an ecosystem followed in the past, so a "restored" ecosystem cannot be an exact replica of the historic ecosystem. Stephen Woodley also considers the complexity and dynamism of ecosystems, writing, "In some cases, it may be possible to restore and maintain an ecosystem similar to one in the past but it will never be exactly the same."[16] There is recognition that the best that can reasonably be expected is the creation of an approximation of an historic state.[17]

There has been a tendency in the recent literature to go in a different direction: to conceive ecological restoration in a vague fashion that does not require a return to historic or natural conditions. Following National Park Service and other federal agency policies (see below), "natural conditions" is properly understood as referring not to conditions that held in the past, but to those conditions and processes that would occur within a given area, at the present time, if the area were generally free

of human influence.[18] Again, the Society for Ecological Restoration (SER) has defined "ecological restoration" as "the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed."[19] This definition does not specify returning a damaged ecosystem to its historic or natural ***307** conditions. As mentioned, according to Jordan and Lubick, this definition is purposefully broad and inclusive, allowing a wide range of management practices to count as restoration.[20]

Noting that restoration of a pre-disturbance landscape is "often impossible to achieve," Tongway and Ludwig claim that ecological restoration should be understood as the effort "to achieve self-sustaining systems by repairing dysfunctional processes."[21] These experts emphasize the role of "stakeholders," those groups and individuals who are affected by, or who are interested in, a restoration project.[22] According to Tongway and Ludwig, restorationists should work closely with stakeholders in determining which physical and biological processes are to be repaired within a damaged landscape and the level of functionality that is to be achieved.[23] In consultation with stakeholders, the goals of a project may include better preserving biodiversity, but the goals of each project, and the levels of functionality to be achieved, are left entirely open.[24] In this account of restoration, there is no insistence on returning a damaged landscape or ecosystem to even an approximation of its historic or natural conditions. A landscape is considered functional (that is, successfully repaired) if it has "a high capacity to provide important biophysical and socioeconomic goods and services."[25]

Eric Higgs and Richard Hobbs view ecological restoration as imposing human beliefs onto nature as ecosystems are shaped "to meet human objectives."[26] A "restored" ecosystem, in their view, invariably combines anthropogenic elements and natural features.[27] They write that restorationists "should be faithful, to some degree, to the ecosystem,"[28] ***308** meaning the historic ecosystem, but they do not insist on returning a damaged ecosystem to an approximation of its historic or natural conditions. As Higgs (in his earlier book) writes, "remember that there are social, economic, cultural, political, aesthetic, and moral goals ... to factor in as well."[29] David Cole and a number of other management experts (including Higgs and Hobbs) have argued that, in many cases, "restoration" within protected areas should actually be considered "redirection."[30] They recommend that managers no longer be required to maintain historic or natural conditions within protected areas. Rather, managers should be given the flexibility to reconstruct ecosystems in desired ways, perhaps to anticipate the effects of climate change or to enhance recreational opportunities.[31]

Van Andel and Aronson note that ecological restoration has traditionally been considered a return to pre-disturbance conditions.[32] But it is not possible, they acknowledge, to genuinely restore historic conditions.[33] According to these authors, reference systems from the past should be considered as no more than useful guides in setting restoration targets.[34] Past reference systems should serve as "models to orient and inspire us," they write, but should not be considered "a strict objective to be literally reached."[35] In their view, "ecological restoration" is properly and broadly understood as "aiming at the repair of damage," with the general goal of enhancing a damaged ecosystem's physical and biological resources--its "natural capital."[36] Van Andel and Aronson also emphasize the role of stakeholders in determining the state to be achieved.[37]

These authors propose conceiving "restored" ecosystems as falling in the category of "emerging ecosystems."[38] "Emerging ecosystems" are characterized as ecosystems that ***309** have been substantially altered by humans to the point that their species composition and abundances are entirely new to the biome.[39] These ecosystems do not depend, however, for their existence upon ongoing human manipulation. They are thought to lie between natural ecosystems and those systems that are subjected to substantial and ongoing human manipulation, such as agricultural fields.[40] This category is, of course, quite broad and includes (as has been pointed out) urban industrial sites, toxic mine dumps, drained wetlands, and sewage ponds.[41] Van Andel and Aronson acknowledge that this way of conceiving "restored" ecosystems involves "relax[ing] our concern with historical authenticity."[42] Such a conception allows restorationists to substantially deviate from historic and natural conditions.

In the literature, "ecological restoration" is typically characterized as either the literal re-creation of some historic state, or in such vague terms as to allow "restored" ecosystems to no longer approximate historic or natural conditions. This dichotomy is easily found in the discussion of restoration by Jordan and Lubick, and in the discussion by Higgs.[43] With recent conceptions of restoration, restorationists are given much leeway (this is the intent) to create ecosystems that are new to the biome and substantially altered to achieve desired ends.

II. SHOULD RESTORATION BE TIED TO HISTORIC CONDITIONS?

We should not insist that "restored" ecosystems within national parks, wilderness, and other protected areas be re-creations of, or even approximations of, historic ecosystems. ***310** Jim Harris and Rudy van Diggelen discuss what they call the "moving-target syndrome."[44] "Time changes an undisturbed ecosystem," they write.[45] They ask: "[S]hould our target prescription be set for where the system was, or where it would be now? What if key species have become extinct?"[46] We must recognize that plants and animals are constantly evolving; ecosystems are constantly changing.[47] Natural changes must be accommodated in restoration. To push an ecosystem back to some past state may be to place at risk native species that should be protected and that managers intended to benefit through restoration. Cole and others write, insightfully, "[I]f we are to allow for the free play of natural processes, including evolutionary change, we cannot expect future park landscapes to look like they did in the past."[48]

An important consideration is that many plants and animals are gradually adjusting to human-induced climate change by shifting their distributions toward higher elevations and toward the poles. Studies have shown, for example, that butterflies in North America and Europe have shifted their ranges northwards by as much as 100 km per decade.[49] Biologists have studied 329 animal species in England, including mammals, birds, butterflies, reptiles, amphibians, fish, spiders, and others.[50] "[M]ost taxonomic groups," they write, "have shown significant distributional shifts northwards and to higher elevations during a period of climate warming."[51] Perhaps it is best to say that such shifts are a natural response to increasingly less natural conditions. A primary goal in most protected areas is the preservation of native biodiversity.[52] Such shifts in species distributions must, therefore, be accommodated within these areas. It would be inconsistent with this goal and a waste of resources to restore an ecosystem to an approximation of some past state, complete with (what is believed to be) the historic species composition, if the restored populations cannot survive the higher temperatures. Indeed, it is mainly considerations of climate change that ***311** have led Cole and other management experts to recommend that protected area managers not seek to maintain historic conditions in many situations.[53]

Yet we should not go in the other direction. Within protected areas, it is inappropriate to apply vague definitions of ecological restoration such as "the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed."[54] Restoration within protected areas should not be characterized as "repairing dysfunctional processes."[55] This also is too vague and open-ended. "Restored" ecosystems should not be conceived as falling within the category of "emerging ecosystems," human-altered systems that are new to the biome. This category is too broad. "Ecological restoration" within protected areas should be conceived more precisely and accurately, as the attempt to return a damaged ecosystem to its natural, not historic, conditions.

III. FEDERAL RESTORATION POLICIES

According to the National Park Service's *Management Policies*,[56] managers are to maintain natural conditions and processes in national parks and monuments. According to these policies, for example, "The National Park Service will maintain as parts of the natural ecosystems of parks all plants and animals native to park ecosystems."[57] Agency policies recognize that plants and animals are constantly changing, and they mandate that evolutionary and other natural processes be maintained. According to these policies, "The Service ... will try to maintain all the components and processes of naturally evolving park ecosystems, including the natural abundance, diversity, and genetic and ecological integrity of the plant and animal species native to those ecosystems."[58] Further, "The Service recognizes that natural processes and species are evolving, and the Service will allow this evolution to continue--minimally influenced by human actions."[59]

Within Park Service policies, "natural conditions" is characterized as "the condition of resources that would occur in the absence of human dominance over the landscape."[60] ***312** Presumably, to speak of natural conditions one is not limited to imagining a landscape. To speak of the natural conditions of an ecosystem (a wetland, for example), one is surely speaking of the condition of resources that would occur in the absence of human dominance over that ecosystem (rather than the entire landscape). The area referred to shifts depending on the area of concern. "Natural conditions" is understood within these policies, then, as the conditions (of resources) that would occur in the absence of human dominance over the given area, or, in other words, the conditions that would be present if the area were generally free of human influence. "Natural processes" is understood similarly, as those processes that would occur if the area were generally free of human influence.[61]

With respect to park landscapes, ecosystems, or other natural areas damaged by human actions, Park Service policies require that managers restore natural conditions and processes. According to the *Management Policies*:

> The Service will seek to return such disturbed areas to the natural conditions and processes characteristic of the

> ecological zone in which the damaged resources are situated. The Service will use the best available technology, within available resources, to restore the biological and physical components of these systems, accelerating both their recovery and the recovery of landscape and biological community structure and function.[62]

These policies do not indicate the meaning of "ecological zone." This expression is understood within the agencies, however, as referring to a relatively large area (larger than a landscape) of generally similar environmental conditions, including geological features, temperature, moisture, soil fertility, and natural disturbances. An ecological zone is associated with characteristic plant and animal species.[63] Park Service policies mandate the ***313** restoration of natural areas damaged by human influence, but managers are not required to return a damaged area to some historic state. Within these policies, it is assumed that conditions and processes that are natural and characteristic of the appropriate ecological zone provide a close approximation of those conditions and processes that are natural for a damaged area--those that would be present in the absence of human-caused degradation. This is the required procedure: return a damaged ecosystem or other area to a close approximation of its natural conditions and processes determined by studying relatively intact natural areas within the appropriate ecological zone. Within these policies, existing, relatively intact natural systems are to serve as models for restoration.

Harris and van Diggelen briefly discuss this method.[64] According to these authors, the use of existing reference systems to set restoration targets has definite advantages over using evidence of historic conditions--for one, this method accounts for natural changes in ecosystems with time.[65] Under this method, restorationists find "modern likely equivalents" to "what would be here in this defined topographic unit if degradation had not taken place."[66] "[W]e may take measurements," these authors write, "aimed at capturing the key attributes of the modern reference system which we aim to achieve in the restored system."[67] They recognize limitations in the use of existing reference systems, for example, these systems may have been damaged to some extent by human actions.[68]

To be sure, Park Service polices allow, and even require, use of historical evidence in restoration. These policies grant managers flexibility to restore historic landscapes that have cultural significance.[69] An example would be famous battlefields. In the restoration of damaged natural areas (as opposed to cultural sites), existing reference systems may be damaged to some extent, making necessary use of historical evidence as managers set restoration targets. For example, natural fires have been suppressed within national parks and other protected areas for decades. Of necessity, managers make use of evidence of past fire frequencies and intensities, including tree-ring data, as they determine an area's natural ***314** fire regime.[70] It can be argued that historical evidence concerning even relatively intact reference systems is necessary to properly understand many natural conditions and processes. Experts emphasize the need to use an appropriate combination of different types of information in setting restoration targets, including measurements of extant reference systems as well as historical evidence.[71] No one type of information is sufficient.

Yet experts have traditionally emphasized use of historical evidence. Again, ecological restoration has traditionally been considered the act of returning a damaged area to some historic state. According to Jordan, what sets ecological restoration apart from other management activities is the effort to "re-create, deliberately, a faithful replica of a historic ecosystem."[72] Michael Morrison emphasizes use of historic ecosystems as models for restoration, as does Higgs.[73] In contrast, Park Service policies require use of existing, relatively intact natural systems as models for restoration. With respect to the restoration of damaged natural areas (as opposed to cultural sites), a "restored" ecosystem or other area is conceived within Park Service policies not as a re-creation of some past state, but as a close approximation of the area's natural conditions and processes--those conditions and processes that would be present if the area were generally free of human influence.

Within these policies, there is recognition that restoration may involve extensive and ongoing management intervention. Interventions in the parks are to be as minimal as possible.[74] But managers are required to intervene to maintain the "closest approximation" of essential natural processes where truly natural processes are "no longer attainable."[75] ***315** These policies provide two helpful examples: management-induced burning to mimic a natural fire regime, and management control of ungulate populations where natural predators have been eliminated.[76] Management-induced burning is becoming increasingly common within protected areas, and such burning represents extensive and ongoing human influence.[77] It is difficult to estimate, for a given area, the natural fire regime for that area. Furthermore, especially in the smaller parks and wilderness areas, it is difficult to put into place a fire regime that closely mimics what is believed to be the natural frequency and intensity of fire.[78] David Graber is concerned with discrepancies between fire regimes that are currently maintained in

wilderness areas and estimates of past fire frequencies. In part due to this discrepancy, he describes wilderness as a "social construct."[79] Within Park Service policies, with respect to the restoration of damaged natural areas, a "restored" ecosystem or other area is conceived as a close approximation of those conditions and processes--natural fire, for example, or natural control of ungulate populations--that would be present if the area were generally free of human influence.

Other federal agency policies are similar to those of the Park Service. Bureau of Land Management (BLM) policies mandate maintaining natural conditions and processes in agency-managed wilderness areas.[80] According to the *BLM Manual*:

> The Wilderness Act states that wilderness "is protected and managed so as to preserve its natural conditions." ... Management must foster a natural distribution of native wildlife, fish, and plants by ensuring that ecosystems and ecological processes continue to function naturally.[81]
>
> Watersheds, water bodies, water quality, and soils are maintained in a natural condition; associated ecological processes previously altered by human ***316** influences will be allowed to return to their natural condition. Fire, insects, and diseases are allowed to play their natural role in the wilderness ecosystem ....[82] Wilderness areas are living ecosystems in a constant state of evolution. It is not the intent of wilderness stewardship to arrest this evolution ....[83]

Concerning the management of fish and wildlife: "[M]anagement activities should emphasize the protection of natural processes in a wilderness context. It is expected that nature, not human intervention, will play the dominant role."[84] These policies acknowledge legal constraints in the management of wilderness areas. Consistent with the Wilderness Act, for example, BLM policies allow livestock grazing in designated wilderness areas, and mining operations on claims filed before an area was designated wilderness.[85] These policies allow management of herds of wild horses and burros within wilderness areas and the placement of structures and installations for the purpose of such management.[86] Generally, however, these policies are highly protective of natural conditions and processes in wilderness.

BLM policies emphasize allowing damaged ecosystems and other areas to heal naturally. According to these policies, for example, "Natural processes should always be favored to restore disturbed vegetation ...."[87] Also, "Whenever possible, the BLM will rely on natural processes to maintain native vegetation and to influence natural fluctuations in populations within wilderness."[88] Ecological processes that are damaged through human influence *"will be allowed* to return to their natural condition."[89] Active restoration, however, through intervention, is required in cases of human-caused damage with no possibility of natural recovery in a reasonable time. According to these policies, "Management *must foster* a natural distribution of native wildlife, fish, and plants by *ensuring* that ecosystems ... function naturally."[90] "Watersheds, water bodies ... and soils *are maintained* in a natural condition."[91] "[I]n some cases," these policies add, "restoration management activities may be needed to restore vegetation ...."[92] Concerning wildlife: "In some cases, active management of ***317** wildlife or habitat will be necessary to preserve the Natural quality of wilderness character ...."[93] In all management activities, including restoration, managers are required to do only the minimum necessary to accomplish the task.[94]

Concerning restoration and management activities in general, BLM policies provide this mandate: "All management activities must be designed to strive towards natural vegetative composition and processes that reflect what would likely have developed with minimal human influence."[95] This statement indicates the agency's understanding of "natural vegetative composition and processes," and, by extension, "natural conditions and processes."[96] Agency policies mandate as the goal of a vegetation restoration project not historic conditions but natural vegetative composition and processes, understood as the vegetative composition and processes that would be present if the given area were under minimal human influence. These policies go on to specify the procedure to be followed in the restoration of vegetation in damaged landscapes, ecosystems, and other broad areas. "Management actions may be taken to restore vegetation to characteristic conditions of the ecological zone in which the area is situated ...."[97] Managers are required to use existing, relatively intact natural systems within the appropriate ecological zone as models for restoration.

These policies add the requirement that in their proposal for a vegetation restoration project (in an Environmental Assessment or Environmental Impact Statement), managers provide "a description of the natural vegetative community and processes, based on historical and scientific evidence, that would have existed prior to the effects of industrialized humans."[98] This statement is poorly worded. This is not (as it may seem) an indication that managers are to attempt to return a damaged area to some state that existed ***318** prior to industrialization.[99] Such a requirement would not make sense within these policies that emphasize maintaining natural processes and natural changes. Properly interpreted in light of the management goal stated

above, managers are to present a description of the vegetative composition and processes that would currently exist if the damaged area were free from the "effects of industrialized humans"--that is, if the area were under minimal human influence. This description is to be generated using a variety of information-"historical and scientific evidence."[100]

The U.S. Forest Service's *Forest Service Manual* acknowledges that, in accordance with the Wilderness Act, agency managers are required to maintain natural conditions and processes in those wilderness areas under its responsibility.[101] According to these policies, the Wilderness Act "defines wildernesses as areas untrammeled by people ... and directs agencies to manage wilderness to preserve natural ecological conditions."[102] These policies provide the following mandates:

> Manage the wilderness resource to ensure its character and values are dominant and enduring .... Manage wilderness to ensure that human influence does not impede the free play of natural forces or interfere with natural successions in the ecosystems.[103]
>
> Maintain wilderness in such a manner that ecosystems are unaffected by human manipulation and influences so that plants and animals develop and respond to natural forces.[104]
>
> Manage wilderness toward attaining the highest level of purity in wilderness within legal constraints.[105]

According to these policies, a wilderness area has higher purity where there has been less human influence.[106] These policies do not mandate that wilderness ecosystems be managed ***319** to remain entirely unaffected by human influence. Indeed, the *Forest Service Manual* goes on to point out that mining is allowed in designated wilderness areas, in appropriate circumstances, as is livestock grazing and other human activities.[107] According to these policies, the concept of wilderness entirely unaffected by human influence ("absolute wilderness") serves as the ideal that, within legal limits, managers are to strive to maintain.[108] The document also states, "Provide an environment where the forces of natural selection and survival rather than human actions determine which and what numbers of wildlife species will exist."[109] "[I]n wilderness natural processes shall dominate."[110] Within these policies, the agency recognizes that plants and animals are constantly changing through natural selection and other natural processes, and mandates that agency managers maintain natural processes and changes.

Forest Service policies mandate the active restoration of natural areas damaged by human actions, but only where natural healing is not possible in a reasonable time:

> Use watershed improvements to restore watersheds where deteriorated soil and hydrologic conditions caused by humans or their influences create a serious threat or loss of wilderness values .... Promote natural healing where such dangers are not immanent or where natural vegetation would return in a reasonable time.[111]
>
> Use indigenous or appropriate naturalized species to reestablish vegetation where there is no reasonable expectation of natural healing.[112]

Concerning the management of forests:

> Manage forest cover to retain the primeval character of the environment and to allow natural ecological processes to operate freely .... Allow, whenever possible, the natural process of healing in handling disturbed communities. Consider structural or vegetative assistance only as a last resort.[113]
>
> ***320** Allow reforestation only if a loss of the wilderness resource, due to human influence, has occurred and there is no reasonable expectation of natural reforestation.[114]

Managers are required to restore wildlife and fish habitat in cases of human caused damage, again, where there is no possibility of natural recovery in a reasonable time.

> [P]rotect wildlife and fish indigenous to the area from human caused conditions that could lead to Federal listing as threatened or endangered. Provide protection for known populations and aid recovery in areas of previous habitation, of federally listed threatened or endangered species and their habitats.[115]

Habitat improvement projects are allowed only in cases of "abnormal human influence."[116] Fish and wildlife may be introduced if such action is considered necessary to preserve native populations.[117] Generally, managers are required to do

only the "minimum necessary" to conserve fish and wildlife resources.[118]

In their efforts to reestablish native vegetation and wildlife populations, managers are required to maintain natural changes in species distributions and abundances. According to these policies, managers are to maintain "natural successions in the ecosystems."[119] The announced general goal within Forest Service policies is to manage wilderness so that, to the extent possible, "plants and animals develop and respond to natural forces."[120] Human influence is to remain as minimal as possible.[121]

Within Forest Service policies, there is no requirement to impose historic conditions on wilderness areas. The policy emphasis on allowing natural healing fits well with the general goal of allowing plants and animals to "develop and respond to natural forces." These policies do not specify that, in active restoration, managers are to return a damaged area to conditions and processes characteristic of the appropriate ecological zone. These policies do not explicitly require use of existing reference systems in setting restoration ***321** targets. Yet this approach is, as Harris and van Diggelen point out, appropriate for accommodating natural changes.[122]

Forest Service policies concerning restoration in wilderness areas are best interpreted as being similar to those policies adopted by the Park Service and BLM. With respect to natural areas (as opposed to cultural sites), all three agencies place emphasis on restoring natural conditions and processes in cases of human-caused damage. There is much emphasis on maintaining natural changes ("natural successions in the ecosystems"). All three agencies require that human manipulations be as minimal as possible. With respect to the restoration of damaged natural areas (as opposed to cultural sites), a "restored" ecosystem or other area is conceived within these agencies' policies not as a re-creation of some past state, but as a close approximation of the area's natural conditions and processes, those that would occur in the absence of human dominance (as expressed by the Park Service), or those that would be present if the area were generally free of human influence. "Ecological restoration" is conceived as the practice of putting into place a close approximation of a damaged area's natural conditions and processes.

U.S. Fish and Wildlife Service (USFWS) wilderness policies should be interpreted similarly. Briefly, these policies provide this mandate: "Secure an 'enduring resource of wilderness' by maintaining and, where appropriate, restoring, a wilderness area's biological integrity, diversity, environmental health, and wilderness character."[123] "Wilderness character" includes the "natural, scenic condition of the land."[124] Agency policies direct managers to not interfere with natural processes, including predator/prey fluctuations, wildfire, drought, flooding, windstorms, etc.[125] There is no hint within agency policies that managers are to return an area damaged by human actions to some historic state.

There are also dissimilarities in the wilderness management policies adopted by the agencies. The BLM, Forest Service, and USFWS have complex missions, and are subject to legal constraints on maintaining natural conditions that the Park Service does not face. For example, BLM and Forest Service policies allow structures and installations (fences, watering facilities, etc.) considered necessary for livestock grazing, which (as mentioned) is allowed in ***322** wilderness areas managed by these agencies. Forest Service policies allow non-structural "range improvements" (artificial seeding, etc.) for the sake of continued livestock grazing.[126] It is important, however, to recognize the similarities in these agencies' policies--for example, the emphasis on maintaining and restoring natural conditions and processes, and the requirement to minimize management interventions.

IV. RESTORATION PROJECTS WITHIN PROTECTED AREAS

In actual restoration projects within protected areas, damaged ecosystems are restored to close approximations of their natural conditions and processes. There is no attempt to return these areas to historic states, or to create novel or "emerging" ecosystems.

Let us consider, as an example, the proposed restoration of fishless lakes within Sequoia and Kings Canyon National Parks, in the Sierra Nevada Mountains of California.[127] The purpose of the project is to preserve native biodiversity, with special emphasis on mountain yellow-legged frogs (*Rana muscosa* and *Rana sierra*).[128] According to Park Service documents, these frogs have disappeared from ninety-two percent of their historic range in the Sierra Nevada.[129] They have been proposed for

listing under the federal Endangered Species Act.[130] Studies have shown that introduced, predatory trout are a primary cause of the disappearance of these frogs.[131] Most of the high lakes in these mountains were historically fishless. Beginning in the late 1800s these lakes were stocked with fish, in later years using aircraft. Stocking in the national parks ended after 1988, but self-sustaining populations of non-native, predatory trout now occupy the majority of high lakes in the parks.[132] According to biologists, mountain yellow-legged frogs have been pushed into marginal habitats, exist only in small populations, and are slowly going extinct.[133]

***323** Park Service documents discuss the ecological and social importance of mountain yellow-legged frogs. According to these documents, the frogs provide an important link in the food chain. Their loss could significantly affect the abundances of other species, such as western garter snakes (*Thamnophis elegans*).[134] These frogs greatly add to a wilderness experience. According to agency documents, with the restoration of these lakes, visitors will again see tens to hundreds of frogs leaping into the water and hear their "plops" and splashes.[135] Visitors will again see thousands of tadpoles swimming in the shallows.[136] "The experience one finds in waters that have lost their frogs is far more sterile and far less natural."[137] Within agency documents, these frogs have elevated status. They are now charismatic and worth protecting. The Park Service has proposed to completely eliminate fish in up to 87 (16%) of the parks' approximately 549 high lakes, ponds, and marshes through use of gill nets and, in some proposed alternatives, through use of poison (rotenone).[138]

The Park Service will not attempt to restore historic conditions within the parks. The agency is not proposing to restore all or most historically fishless lakes to their original, fishless conditions. The objective of the project is more minimal: to "restore clusters of ***324** waterbodies to their naturally fishless state in strategic locations."[139] The proposal reflects agency desires to preserve mountain yellow-legged frogs and other native species, yet (as disclosed in project documents) the agency desires to provide an appropriate balance of fishless lakes and excellent angling opportunities. The lakes selected for treatment will be determined by beliefs concerning the locations of frog populations, as well as beliefs concerning the recreational value of the lakes.[140] Each lake selected for treatment must be assessed as having only low or medium recreational fishing value.[141] Feasibility of restoration will also be considered. Each lake to be restored must be reasonably accessible by field crews, for example.[142] It is reasonable to say, following Higgs and Hobbs, that the "restored" lakes will be the product of human desires and beliefs as they are shaped "to meet human objectives."[143] The "restored" lakes will be the product of human desires for a balance of preservation and recreational fishing, and beliefs concerning the locations of frog populations, the recreational value and accessibility of each lake, and the potential for success. All these beliefs could be in error. As Higgs and Hobbs claim, every "restored" ecosystem consists of both anthropogenic elements and natural features.[144]

The standard for success is not how well the "restored" lakes approximate past conditions, but how well they approximate, in their species composition and abundances, nearby naturally fishless lakes. According to agency reports, past restoration projects in the parks, conducted on a smaller scale, have resulted in significant increases in numbers of mountain yellow-legged frogs and tadpoles.[145] Biologists have found that, in a short time, species composition and abundances at restored lakes closely approximate those at nearby, fishless control lakes.[146] The lakes "restored" in the proposed project will presumably be close approximations of natural conditions and processes, understood as those conditions and processes that would be present if these lakes were generally free of human influence.

***325** As another example, let us consider the restoration of vernal pools in the legally protected Del Sol Open Space and Vernal Pool Reserve, near Santa Barbara, California. As Wayne Ferren and others write, this restoration project was essential for the preservation of these rapidly disappearing wetlands and the native plant and animal species that depend upon them.[147] Approximately ninety percent of the natural vernal pools in the Santa Barbara area have been lost due to habitat alteration.[148] The restored pools were patterned after existing, relatively intact vernal pools in the area. Ferren writes, "We used the least-damaged extant examples of vernal pools as reference sites for new pool design .... Extant pools were evaluated for topographic structure, hydrologic periodicity, vegetation zonation, and plant and animal species richness."[149] By studying relatively intact vernal pools in the Santa Barbara area, biologists formulated beliefs concerning the appropriate dimensions of these pools, the proper slopes, proper soils, proper fluctuations in water levels, proper distances between pools, appropriate vegetation, species of animals that will be supported, etc. All these beliefs could have been in error. The reference pools are damaged to some extent, hence beliefs based on observations of these pools could be faulty. Ferren writes, "There are no pristine vernal pools available as natural reference sites to guide restoration."[150]

It is reasonable to say that the "restored" vernal pools are products of human desires and beliefs. Their location, structure, and functions have been determined by desires to preserve this type of wetland, and many of their features such as pool dimensions, slopes, distances between pools, vegetative composition, etc. are the result of beliefs concerning how these

wetlands should be restored. The "restored" vernal pools consist of both anthropogenic elements and natural features, and should not be confused with natural vernal pools.

The standard used in evaluating success is not how well the restored pools approximate past conditions, but how well the restored pools mimic the structure and functions of the existing reference pools. According to Ferren, some of the restored vernal ***326** pools are "similar statistically" in their plant and animal communities to the reference pools.[151] They provide "a broad array" of functions, Ferren also writes, that are similar to those provided by the reference pools.[152] Ferren and others justifiably conclude that this is an example of successful restoration. The "restored" vernal pools are appropriately considered close approximations of natural conditions and processes, those that would be present if these pools were generally free of human influence.

V. RESTORING APPROXIMATELY NATURAL CONDITIONS

The restoration of damaged natural ecosystems is essential for maintaining native biodiversity in national parks, wilderness, and other protected areas. Amphibians, rare and endemic plants, and many other species have fairly specific habitat requirements, and are highly sensitive to habitat alterations.[153] Amphibian populations are in steep decline across the United States and around the world, and biologists have clearly identified habitat degradation--including the introduction of predatory fish--as the primary cause of these declines.[154] For the sake of preserving amphibians and other sensitive species, managers must maintain and restore at least close approximations of those conditions to which these species are adapted. Raymond Semlitsch emphasizes this point with respect to amphibians.[155] The proposal to restore fishless lakes in national parks in the Sierra Nevada Mountains has been justified by the need to preserve mountain yellow-legged frogs as well as other aquatic species.[156] Mountain yellow-legged frogs are not adapted for coexistence with introduced, predaceous fish.[157] Again, this species of frog has been lost in ninety-two percent of its ***327** historic range, and has been proposed for federal listing.[158] The vernal pools restoration project near Santa Barbara was justified by the need to preserve these rapidly disappearing wetlands and the species that depend upon them.[159]

As another example (briefly), many butterfly species have strict habitat requirements and are "particularly sensitive to environmental changes."[160] For many butterfly species across the country, only small populations exist in small, remnant habitats.[161] The Karner blue butterfly (*Lycaeides melissa samuelis*) is dependent upon wild lupine (*Lupinus perennis*)--the only plant the caterpillar feeds on.[162] Biologists estimate that the number of Karner blue butterflies has declined throughout its historic range in New England and the Midwest by at least ninety-nine percent due to habitat loss.[163] This species is federally listed as endangered.[164] In an extensive recovery effort, the U.S. Fish and Wildlife Service (USFWS) and others are gradually restoring oak barrens/savanna habitat within wildlife refuges, national forests, and other protected areas by clearing trees and setting fires.[165] The goal of the project is to recover Karner blue butterflies and a number of other native species.[166] Restorationists are not attempting to restore historic conditions. They will not attempt, for example, to recover Karner blue butterfly populations in certain areas where it is believed (based on historical evidence) that these butterflies once existed. Recovery sites were selected ***328** based on contemporary records of butterfly occurrences.[167] Restorationists are relying upon detailed information concerning existing, remnant natural habitats.[168]

In these and other restoration projects within protected areas, managers attempt to return a damaged ecosystem or other area not to its historic conditions, but to a close approximation of its natural conditions and processes, those that would be present if the area were generally free of human influence. Managers make use of historical evidence, such as evidence concerning historic fire frequencies, as they set restoration targets. Restoration is guided, however, by existing, relatively intact systems that serve as models--for example naturally fishless high lakes in the Sierra Nevada, relatively intact vernal pools in the Santa Barbara area, or remnant oak barrens/savanna habitat in New England and the Midwest. This approach accommodates natural changes in species distributions and abundances, which most effectively preserves native biodiversity.

In ecological restoration, managers construct a conceptual and (to some extent) quantitative representation of natural conditions and processes, using imagination and (at best) diverse types of information.[169] They can only estimate the frequency and intensity of natural fire, for example, or natural species composition and abundances. Error in such estimates is always possible. A "restored" ecosystem is invariably (as described by Higgs and Hobbs) a combination of anthropogenic elements and natural features.[170] Yet, for the sake of preserving native biodiversity, a "restored" ecosystem must closely mimic nature in relevant ways. Morrison strongly recommends that restorationists let their designs be guided by knowledge of the habitat requirements of those animal species of special concern.[171] He stresses the need many species have for dispersal

and recolonization of sites of local extinction.[172] Indeed, according to National Park Service policies, managers are required to maintain conditions and processes that allow natural population fluctuations in native plants and animals, the recolonization of suitable habitat by amphibians, butterflies, and other species, and the natural migrations of songbirds, caribou, and other animals.[173] Again, Park Service policies require that managers enter into ecosystems to mimic, as closely as possible, ***329** essential processes such as natural fire and natural ungulate control.[174] "Approximately natural conditions" is essential and also required in the restoration of damaged natural systems in national parks and other protected areas.

Management experts argue that natural conditions, or approximations of these, will likely be too difficult to maintain within protected areas in the face of climate change.[175] "Failures could be catastrophic," they warn, as we lose the very species and functions we wish to preserve.[176] There is good reason to believe, however, that maintaining natural conditions and processes (as natural as possible) within protected areas is the best strategy for preserving native biodiversity. Again, studies have shown that a large number and diversity of species are adjusting on their own to the rising temperatures.[177] Reed Noss argues, persuasively, that the best strategy for protecting biodiversity in the context of climate change is to maintain wild, intact landscapes, connected together, with minimal human intrusion.[178]

This approach to ecological restoration may seem problematic since, according to dictionaries, a basic meaning of "restoration" is that something is returned to a previous condition. Authors have claimed that "ecological restoration" involves, strictly speaking, an attempt to return a damaged ecosystem or other area to some past state.[179] According to Kurt Kipfmueller and Thomas Swetnam, "[R]estoration directly implies the return of degraded ecosystems to some desired condition or state that existed in the past."[180] Bradshaw writes: "The relevant definition of *restoration* is 'the act of restoring to a former state or position ... or to an unimpaired or perfect condition.'"[181] And Higgs writes, "If we allow the meaning of restoration to determine the shape of its practice, restoration must depend on historical fidelity."[182]

***330** Let us consider another kind of restoration. A doctor "restores" a patient to good health, we say. Good health is a general state, that of being free from disease or pain.[183] "Good health" signifies certain ranges of values of body weight, heart rate, blood pressure, body fat, etc. that naturally vary with a person's age and (for women) whether one is pregnant or not. A doctor "restores" or "returns" a patient to good health, we say, understanding that what constitutes "good health" is relative to a person's age and other factors. Restoring good health does not involve returning a person to some precisely specified past state, that person as he or she was twenty years ago, for example. Restoring good health is different in this way than restoring a car.

With ecological restoration, similarly, managers return an ecosystem to the general state of natural conditions and processes, more specifically, a close approximation of this. "Natural conditions" signifies biotic and abiotic conditions (temperature, moisture, species composition, etc.) that, for each ecosystem, vary with time. For each ecosystem, there is no unique equilibrium point or steady state.[184] Natural ecosystem processes (photosynthesis, succession, dispersal, erosion, etc.) vary across space and time. Managers "restore" an ecosystem by bringing it to a close approximation of those conditions and processes that are constitutive of natural conditions and processes for that ecosystem at that time. This is literally a returning, but to a general state (a close approximation) that is constituted differently from ecosystem to ecosystem and, within each ecosystem, from moment to moment. Following agency language, a "restored" ecosystem is once again a close approximation of those conditions and processes that would be present in the absence of human dominance (as expressed by the Park Service), or those that would be present if the area were generally free of human influence. The meaning of "restoration" does not require that "ecological restoration" be conceived as returning a damaged area to some precisely specified past state.

CONCLUSION

In the literature, authors have proposed that "ecological restoration" be understood as literally re-creating some historic state. In certain contexts, this is an appropriate conception. National Park Service policies allow managers to restore historic landscapes that ***331** have cultural significance.[185] Such an understanding is generally inappropriate for national parks, wilderness, and other protected areas, however, since natural ecosystems, and their native plants and animals, are constantly changing.[186] There has also been a tendency in the literature to go in the other direction, characterizing ecological restoration in such a vague fashion that a "restored" ecosystem or other area may substantially deviate from historic and natural conditions. Although they surely play useful roles in contexts in which the goals of restoration are more open, recent characterizations of "ecological restoration" in the literature are too vague and inclusive to be applicable within protected

areas. Such characterizations include "the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed,"[187] "to achieve self-sustaining systems by repairing dysfunctional processes,"[188] and "aiming at the repair of damage."[189]

In accordance with federal legislation and policy, national parks, wilderness, and other protected areas have been set aside for the purpose of preserving natural conditions and processes, including native biodiversity.[190] Consistent with legislative mandates, "restored" ecosystems within these areas must closely mimic nature in relevant ways. ***332** Managers must meet a strict standard. Within protected areas, existing, relatively intact natural systems are to serve as models for restoration. This is required procedure within Park Service, BLM, and (as interpreted here) Forest Service and USFWS policies. As discussed, this is the method used in actual restoration projects in these areas. As experts emphasize, various types of information--including measurements of extant reference systems, historical evidence, as well as extensive knowledge of ecology and natural history--should be used in setting restoration targets.[191] But within protected areas, in the restoration of damaged natural areas (as opposed to cultural sites), a "restored" ecosystem or other area is appropriately conceived not as a replica of some past state, but as a close approximation of the area's natural conditions and processes, those that would be present if the area were generally free of human influence. "Ecological restoration" within protected areas is appropriately conceived as the practice of putting into place a close approximation of a damaged area's natural conditions and processes.

Footnotes

1 *See, e.g.*, U.S. Envtl. Prot. Agency, *Restoration Defined*, EPA.gov (Mar. 6, 2012), http://water.epa.gov/type/watersheds/archives/chap1.cfm [hereinafter *Restoration Defined*].

2 SOC'Y FOR ECOLOGICAL RESTORATION, SER INTERNATIONAL PRIMER ON ECOLOGICAL RESTORATION (2004), *available at* http:// www.ser.org/resources/resources-detailview/ser-international-primer-on-ecological-restoration#3.

3 WILLIAM R. JORDAN III & GEORGE M. LUBICK, MAKING NATURE WHOLE: A HISTORY OF ECOLOGICAL RESTORATION 215 (2011).

4 JELTE VAN ANDEL & JAMES ARONSON, RESTORATION ECOLOGY: THE NEW FRONTIER 7 (2nd ed. 2012) [hereinafter RESTORATION ECOLOGY 2012]; *see also id.* at 10 and 307.

5 DAVID J. TONGWAY & JOHN A. LUDWIG, RESTORING DISTURBED LANDSCAPES 1 (2011).

6 *Restoration Defined*, *supra* note 1.

7 JORDAN & LUBICK, *supra* note 3, at 2.

8 Margaret A. Palmer et al., *Ecological Theory and Restoration Ecology*, *in* FOUNDATIONS OF RESTORATION ECOLOGY 1, 1 (Donald A. Falk et al. eds., 2006).

9 DAVE EGAN & EVELYN A. HOWELL, THE HISTORICAL ECOLOGY HANDBOOK: A RESTORATIONIST'S GUIDE TO REFERENCE ECOSYSTEMS 1 (2001).

10 A.D. Bradshaw, *Underlying Principles of Restoration*, 53(Supp. 1) CAN. J. OF FISHERIES AND AQUATIC SCI. 3, 3 (1996), *available at* www.cnr.usu.edu/streamrestoration/files/uploads/Bradshaw,%20A.D.pdf.

11 JORDAN & LUBICK, *supra* note 3, at 3.

[12] Palmer et al., *supra* note 8, at 1.

[13] *See* JAMES ARONSON & JELTE VAN ANDEL, RESTORATION ECOLOGY: THE NEW FRONTIER 229 (James Aronson & Jelte van Andel eds., 1st ed. 2006) [hereinafter RESTORATION ECOLOGY 2006].

[14] *Id.* at 226.

[15] *Id. See also* Richard J. Hobbs et al., *Evolving Ecological Understandings: The Implications of Ecosystem Dynamics, in* BEYOND NATURALNESS: RETHINKING PARK AND WILDERNESS STEWARDSHIP IN AN ERA OF RAPID CHANGE 34, 37-39 (David N. Cole & Laurie Yung eds., 2010).

[16] Stephen Woodley, *Ecological Integrity: A Framework for Ecosystem-Based Management, in* BEYOND NATURALNESS: RETHINKING PARK AND WILDERNESS STEWARDSHIP IN AN ERA OF RAPID CHANGE 106, 120 (David N. Cole & Laurie Yung eds., 2010).

[17] *See id. See also* Jelte van Andel & Ab P. Grootjans, *Concepts in Restoration Ecology, in* RESTORATION ECOLOGY: THE NEW FRONTIER 16, 18 (Jelte van Andel & James Aronson eds., 2006).

[18] *See* NAT'L PARK SERV., U.S. DEP'T OF THE INTERIOR, MANAGEMENT POLICIES 2006 36 (2006), *available at* http://www.nps.gov/policy/mp2006.pdf [hereinafter NAT'L PARK SERV., MANAGEMENT POLICIES 2006].

[19] SOC'Y FOR ECOLOGICAL RESTORATION, *supra* note 2.

[20] JORDAN & LUBICK, *supra* note 3, at 215.

[21] David J. Tongway & John A. Ludwig, *Planning and Implementing Successful Landscape-Scale Restoration, in* RESTORATION ECOLOGY: THE NEW FRONTIER 30, 32 (Jelte van Andel & James Aronson eds., 2nd ed. 2012). *See also* TONGWAY & LUDWIG, RESTORING DISTURBED LANDSCAPES, *supra* note 5, at 1.

[22] *See* TONGWAY & LUDWIG, RESTORING DISTURBED LANDSCAPES, *supra* note 5, at 178.

[23] *Id.* at xix, 3-5.

[24] *Id.*

[25] *Id.* at 1.

[26] Eric S. Higgs & Richard J. Hobbs, *Wild Design: Principles to Guide Interventions in Protected Areas, in* BEYOND NATURALNESS: RETHINKING PARK AND WILDERNESS STEWARDSHIP IN AN ERA OF RAPID CHANGE 234, 237 (David N. Cole & Laurie Yung eds., 2010).

[27] *See id.* at 235, 237, 246.

[28] *Id.* at 240.

[29] ERIC HIGGS, NATURE BY DESIGN: PEOPLE, NATURAL PROCESS, AND ECOLOGICAL RESTORATION 127 (2003).

[30] David N. Cole et al., *Naturalness and Beyond: Protected Area Stewardship in an Era of Global Environmental Change*, 25 GEORGE WRIGHT F. 36, 40 fig.1 (2008), *available at* http:// labs.bio.unc.edu/White/Reprints/251cole.pdf.

[31] *See id.* at 39-47. *See also* DAVID N. COLE & LAURIE YUNG, BEYOND NATURALNESS: RETHINKING PARK AND WILDERNESS STEWARDSHIP IN AN ERA OF RAPID CHANGE xi-xiii, 1-10, 252-67 (2010).

[32] RESTORATION ECOLOGY 2012, *supra* note 4, at 7, 13, 307.

[33] *Id.* at 7.

[34] *Id.* at 7, 13.

[35] *Id.* at 13.

[36] *Id.* at 7, 11-12.

[37] *Id.* at 12.

[38] RESTORATION ECOLOGY 2006, *supra* note 13, at 229. *See also* RESTORATION ECOLOGY 2012, *supra* note 4, at 294-95.

[39] RESTORATION ECOLOGY 2006, *supra* note 13, at 229. *See also* RESTORATION ECOLOGY 2012, *supra* note 4, at 294.

[40] Richard J. Hobbs et al., *Novel Ecosystems: Theoretical and Management Aspects of the New Ecological World Order*, 15 GLOBAL ECOLOGY & BIOGEOGRAPHY 1, 1-2 (2006), *available at* http://www.reginozamora.es/wp-content/uploads/2010/04/GEB2006_15_1-71.pdf.

[41] *See* S.J. Milton, *"Emerging Ecosystems"--a Washing Stone for Ecologists, Economists and Sociologists?* 99 S. AFR. J. OF SCI. 404, 405 (2003).

[42] RESTORATION ECOLOGY 2006, *supra* note 13, at 230.

[43] *See generally* JORDAN & LUBICK, *supra* note 3, at 201-04; HIGGS, *supra* note 29, at 93-177. Van Andel and Grootjans express this dichotomy quite well, writing, "The goal of a particular restoration project may involve the return of an ecosystem to an approximation of its structural and functional condition before damage occurred, but it can also include the creation of a new ecosystem that had never existed before on the site selected for restoration." Van Andel & Grootjans, *supra* note 17, at 18.

[44] Jim A. Harris & Rudy van Diggelen, *Ecological Restoration as a Project for Global Society*, *in* RESTORATION ECOLOGY: THE NEW FRONTIER 3, 13 (Jelte van Andel & James Aronson eds., 2006).

[45] *Id.*

[46] *Id.*

[47] *See, e.g.*, Hobbs et al., *supra* note 15, at 37-39.

[48] Cole et al., *supra* note 30, at 39.

[49] Camille Parmesan & John Matthews, *Biological Impacts of Climate Change, in* PRINCIPLES OF CONSERVATION BIOLOGY 333, 348-49 (Martha J. Groom et al. eds., 3d ed. 2006).

[50] Rachael Hickling et al., *The Distributions of a Wide Range of Taxonomic Groups are Expanding Polewards*, 12 GLOBAL CHANGE BIOLOGY 450 (2006).

[51] *Id.* at 452.

[52] *See* COLE & YUNG, *supra* note 31, at 26, 36-37, 110.

[53] *See id.* at 23-24, 50-51, 58-59, 62-63, 133-34, 136-38.

[54] SOC'Y FOR ECOLOGICAL RESTORATION, *supra* note 2.

[55] Tongway & Ludwig, *Planning and Implementing Successful Landscape-Scale Restoration, in* RESTORATION ECOLOGY: THE NEW FRONTIER, *supra* note 21, at 32.

[56] *See* NAT'L PARK SERV., MANAGEMENT POLICIES 2006, *supra* note 18.

[57] *Id.* at 42.

[58] *Id.* at 36.

[59] *Id.*

[60] *Id.*

[61] The characterizations presented here are intuitively correct, and they fit well with the meaning of "natural conditions" offered by Dawson and Hendee in their classic wilderness management text. "Natural conditions," they write, means "substantially unaltered by people and their influence." CHAD P. DAWSON & JOHN C. HENDEE, WILDERNESS MANAGEMENT: STEWARDSHIP AND PROTECTION OF RESOURCES AND VALUES 327 (4th ed. 2009). The agency makes use of the subjunctive mood ("would occur in the absence of human dominance"), referring to conditions that are not actually present but are wished or hoped for. This seems quite appropriate in discussions of restoring damaged natural areas.

[62] NAT'L PARK SERV., MANAGEMENT POLICIES 2006, *supra* note 18, at 39.

[63] *See* STEVE A. SIMON ET AL., ECOLOGICAL ZONES IN THE SOUTHERN APPALACHIANS: FIRST APPROXIMATION B, 4 (2005), *available at* http:// www.srs.fs.usda.gov/pubs/rp/rp_srs041.pdf. Hawaii Volcanoes National Park, for example, is reported to consist of five ecological zones, including rain forest, desert scrub, coastal lowland, and alpine regions. U.N. Envtl. Programme-World Conservation Monitoring Ctr., HAWAII VOLCANOES NATIONAL PARK, UNITED SATES (2009), http://www.eoearth.org/view/article/153262.

[64] *See* Harris & van Diggelen, *supra* note 44.

[65] *See id.* at 13.

[66] *Id.*

[67] *Id.*

[68] *Id.*

[69] NAT'L PARK SERV., MANAGEMENT POLICIES 2006, *supra* note 18, at 69.

[70] *See* Kurt F. Kipfmueller & Thomas W. Swetnam, *Using Dendrochronology to Reconstruct the History of Forest and Woodland Ecosystems, in* THE HISTORICAL ECOLOGY HANDBOOK: A RESTORATIONIST'S GUIDE TO REFERENCE ECOSYSTEMS 199, 215-19 (Dave Egan & Evelyn A. Howell eds., 2001). *See also* DAWSON & HENDEE, *supra* note 61, at 276, 298-99.

[71] *See* EGAN & HOWELL, *supra* note 9, at 11-13. *See also* MICHAEL L. MORRISON, RESTORING WILDLIFE: ECOLOGICAL CONCEPTS AND PRACTICAL APPLICATIONS 10-11 (2nd ed. 2009).

[72] William R. Jordan III, *"Sunflower Forest": Ecological Restoration as the Basis for a New Environmental Paradigm, in* BEYOND PRESERVATION: RESTORING AND INVENTING LANDSCAPES 17, 32 (A. Dwight Baldwin Jr. et al. eds., 1994). Speaking to the Society for Ecological Restoration, Don Falk, former director of the Society, is reported to have said that "adoption of a historic 'reference system' is what distinguishes restoration from other forms of land management ...." JORDAN & LUBICK, *supra* note 3, at 202-03.

[73] MORRISON, *supra* note 71, at 6-7, 10-11, 96-104; HIGGS, *supra* note 29, at 131-77. *See also* EGAN & HOWELL, *supra* note 9, at 1.

[74] NAT'L PARK SERV., MANAGEMENT POLICIES 2006, *supra* note 18, at 37.

[75] *Id.*

[76] *Id.*

[77] Kipfmueller & Swetnam, *supra* note 70, at 215-16; DAWSON & HENDEE, *supra* note 61, at 280-83, 290-91, 296-97.

[78] *See* DAWSON & HENDEE, *supra* note 61, at 287-94.

[79] David M. Graber, *Resolute Biocentrism: the Dilemma of Wilderness in National Parks, in* REINVENTING NATURE?: RESPONSES TO POSTMODERN DECONSTRUCTION 123, 125-27 (Michael E. Soule & Gary Lease eds., 1995), *available at* http:// www.nps.gov/seki/naturescience/upload/reinventing_nature_graber_1994.pdf.

[80] BUREAU OF LAND MGMT., U.S. DEP'T OF THE INTERIOR, BLM MANUAL 6340: MANAGEMENT OF DESIGNATED WILDERNESS AREAS (2012), *available at* http:// www.blm.gov/pgdata/etc/medialib/blm/wo/Information_Resources_Management/policy/blm_manual.Par.22269.File.dat/6340.pdf [hereinafter BLM MANUAL 6340].

[81] *Id.* at 1-5.

[82] *Id.*

[83] *Id.* at 1-10.

[84] *Id.* at 1-57.

[85] *Id.* at 1-27 to 1-29, 1-34 to 1-37.

[86] *Id.* at 1-55 to 1-56.

[87] *Id.* at 1-45.

[88] *Id.* at 1-46.

[89] *Id.* at 1-5 (emphasis added).

[90] *Id.* (emphasis added).

[91] *Id.* (emphasis added).

[92] *Id.* at 1-45.

[93] *Id.* at 1-57.

[94] *Id.*; *see also* ASS'N OF FISH & WILDLIFE AGENCIES, BUREAU OF LAND MGMT & U.S. FOREST SERV., POLICIES AND GUIDELINES FOR FISH AND WILDLIFE MANAGEMENT IN NATIONAL FOREST AND BUREAU OF LAND MANAGEMENT WILDERNESS 4 (2006), *available at* http://fwp.mt.gov/fwpDoc.html?id=24366.

[95] BLM MANUAL 6340, *supra* note 80, at 1-46.

[96] Within these policies, "natural" is defined as "[f]ree from the effects of modern civilization." *Id.* at Glossary-2. This is too strong, however. Intuitively, an ecosystem or other area may have been affected to some minimal extent by modern humans and yet be considered natural. "Natural conditions and processes" is understood, plausibly, as those that would be present under minimal human influence.

[97] *Id.* at 1-47.

[98] *Id.* at 1-48.

[99] *See id*. Note that the policy statement does not require that managers provide a description of the vegetative community and processes that *existed* prior to the effects of industrialized humans.

[100] *Id.* at 1-48.

[101] U.S. FOREST SERV., DEP'T OF AGRICULTURE, FOREST SERVICE MANUAL 2320: WILDERNESS MANAGEMENT (2007), *available at* http:// www.wilderness.net/NWPS/documents/FS/FS_wilderness_policy.pdf.

[102] *Id.* at 6.

[103] *Id.*

[104] *Id.* at 7.

[105] *Id.* at 11.

[106] *Id.*

[107] *See id.*

[108] *See id.*

[109] *Id.* at 30.

[110] *Id.* at 35.

[111] *Id.*

[112] *Id.*

[113] *Id.* at 38.

[114] *Id.* at 39.

[115] *Id.* at 30.

[116] *Id.* at 33.

[117] *See* ASS'N. OF FISH & WILDLIFE AGENCIES ET AL., *supra* note 94, at 10-12.

[118] *Id.* at 4.

[119] U.S. FOREST SERV., *supra* note 101, at 6.

[120] *Id.* at 7.

[121] *Id.* at 6, 7, 11, 30.

[122] Harris & van Diggelen, *supra* note 44, at 12-13.

[123] U.S. FISH & WILDLIFE SERV., DEP'T OF THE INTERIOR [hereinafter USFWS], 610 FW1 GENERAL OVERVIEW OF WILDERNESS STEWARDSHIP POLICY 1.14B (2008), *available at* http://www.fws.gov/policy/610fw1.html.

[124] *Id.* at 1.13B(1).

[125] USFWS, 610 FW2 WILDERNESS ADMINISTRATION AND RESOURCE STEWARDSHIP 2.16B, 2.16B(1) (2008), *available at* http://www.fws.gov/policy/610fw2.html.

[126] U.S. FOREST SERV., *supra* note 101, at 29.

[127] NAT'L PARK SERV., U.S. DEP'T OF THE INTERIOR, RESTORATION OF NATIVE SPECIES IN HIGH ELEVATION AQUATIC ECOSYSTEMS PLAN AND DRAFT ENVIRONMENTAL IMPACT STATEMENT (2013), *available at* http://parkplanning.nps.gov/document.cfm? parkID=342&ProjectID=17157&DocumentID=55701 [hereinafter NATIVE SPECIES IN HIGH ELEVATION AQUATIC ECOSYSTEMS PLAN].

[128] *Id.* at ii-iii.

[129] *Id.* at iii, 3-4.

[130] *Id.* at iii, vi, 6, 92.

[131] *Id.* at vi.

[132] *Id.*; *see also* NAT'L PARK SERV., U.S. DEP'T OF THE INTERIOR, PRELIMINARY RESTORATION OF MOUNTAIN YELLOW-LEGGED FROGS, ENVIRONMENTAL ASSESSMENT 7-8 (2001), *available at* http:// www.nps.gov/seki/parkmgmt/upload/frogea1.pdf [hereinafter PRELIMINARY RESTORATION OF MOUNTAIN YELLOW-LEGGED FROGS, ENVIRONMENTAL ASSESSMENT].

[133] Roland A. Knapp & Kathleen R. Matthews, *Non-Native Fish Introductions and the Decline of the Mountain Yellow-legged Frog from Within Protected Areas*, 14 Conservation Biology 428, 436 (2000), *available at* http:// www.fs.fed.us/psw/publications/matthews/KM_ConsBio_00.pdf.

[134] NATIVE SPECIES IN HIGH ELEVATION AQUATIC ECOSYSTEMS PLAN, *supra* note 127, at 13; PRELIMINARY RESTORATION OF MOUNTAIN YELLOW-LEGGED FROGS, ENVIRONMENTAL ASSESSMENT, *supra* note 132, at 2-3. *See also* Nat'l Park Serv., GIVING MOUNTAIN YELLOW-LEGGED FROGS A FIGHTING CHANCE (2013), www.nps.gov/seki/naturescience/mountain-yellow-leggedfrogs.htm [hereinafter GIVING MOUNTAIN YELLOW-LEGGED FROGS A FIGHTING CHANCE].

[135] *See id.*; PRELIMINARY RESTORATION OF MOUNTAIN YELLOW-LEGGED FROGS, ENVIRONMENTAL ASSESSMENT, *supra* note 132, at 3.

[136] *See* GIVING MOUNTAIN YELLOW-LEGGED FROGS A FIGHTING CHANCE, *supra* note 134; PRELIMINARY RESTORATION OF MOUNTAIN YELLOW-LEGGED FROGS, ENVIRONMENTAL ASSESSMENT, *supra* note 132, at 3.

[137] *See* GIVING MOUNTAIN YELLOW-LEGGED FROGS A FIGHTING CHANCE, *supra* note 134; PRELIMINARY RESTORATION OF MOUNTAIN YELLOW-LEGGED FROGS, ENVIRONMENTAL ASSESSMENT, *supra* note 132, at 3.

[138] NATIVE SPECIES IN HIGH ELEVATION AQUATIC ECOSYSTEMS PLAN, *supra* note 127, at v, x-xi.

[139] *Id.* at ii.

[140] *Id.* at ix.

[141] *Id.*

[142] *Id.*

[143] *See* Higgs & Hobbs, *supra* note 26, at 237.

[144] *Id.* at 235, 237, 246.

[145] NATIVE SPECIES IN HIGH ELEVATION AQUATIC ECOSYSTEMS PLAN, *supra* note 127, at vi-vii. *See also* GIVING MOUNTAIN YELLOW-LEGGED FROGS A FIGHTING CHANCE, *supra* note 134.

[146] *See* Knapp & Matthews, *supra* note 133, at 437. *See also* Roland A. Knapp et al., *Removal of Nonnative Fish Results in Population Expansion of a Declining Amphibian (Mountain Yellow-legged Frog,* Rana muscosa), 135 BIOLOGICAL CONSERVATION 11 (2007), *available at* http://vesr.ucnrs.org/PDFs/Knapp_BiolCons_ 07.pdf.

[147] Wayne R. Ferren Jr. et al., *Review of Ten Years of Vernal Pool Restoration and Creation in Santa Barbara, California, in* ECOLOGY, CONSERVATION, AND MANAGEMENT OF VERNAL POOL ECOSYSTEMS--PROCEEDINGS FROM A 1996 CONFERENCE 206, 206-07 (Carol W. Witham et al. eds., 1998), *available at* http://www.moremesa.org/VernalPools/ferren.pdf.

[148] *Id.* at 207.

[149] Wayne R. Ferren Jr., *Vernal Pool Enhancement, Restoration, and Creation in Santa Barbara, California, in* A COMPANION TO PRINCIPLES OF CONSERVATION BIOLOGY article 13 para. 4, http:// sites.sinauer.com/groom/article.php?id=13 (last visited Feb. 3, 2015).

[150] *Id.* at para. 1.

[151] *Id.* at fig. A.

[152] *Id.* at para. 6.

[153] *See* THOMAS M. SMITH & ROBERT L. SMITH, ELEMENTS OF ECOLOGY 571 (8th ed. 2012).

[154] Raymond D. Semlitsch, *Critical Elements for Biologically Based Recovery Plans of Aquatic-Breeding Amphibians*, 16 CONSERVATION BIOLOGY 619, 620, 624, 627 (2002). *See also* BRYCE A. MAXELL, MANAGEMENT OF MONTANA'S AMPHIBIANS 10-11 (USDA Forest Serv., N. Reg'l Office, 2000), *available at* http://www.isu.edu/~petechar/iparc/Maxell_Mgmnt.pdf.

[155] *See* Semlitsch, *supra* note 154, at 620-23. Concerning the management of rare plants, Powell stresses the need to assess a species' ecological requirements. *See generally* Bradley E. Powell, *Rare Plant Program: Rare Plant Management on the National Forests and Grasslands in California*, CALIFORNIA NATIVE PLANT SOCIETY (2013), http://www.cnps.org/cnps/rareplants/usfs.php.

[156] *See* NATIVE SPECIES IN HIGH ELEVATION AQUATIC ECOSYSTEMS PLAN, *supra* note 127, at ii-iii.

[157] *See* Knapp & Matthews, *supra* note 133, at 435-37.

[158] *Id.* at iii, vi, 3-4, 6, 92.

[159] Ferren et al., *supra* note 147, at 206-07.

[160] Stuart B. Weiss & Dennis D. Murphy, *Thermal Microenvironments and the Restoration of Rare Butterfly Habitat*, *in* ENVIRONMENTAL RESTORATION: SCIENCE AND STRATEGIES FOR RESTORING THE EARTH 50, 50 (John J. Berger ed., 1990).

[161] *Id.* at 50-51.

[162] USFWS, KARNER BLUE BUTTERFLY RECOVERY PLAN (*LYCAEIDES MELISSA SAMUELIS*) vi, 1 (2003), *available at* http:// www.fws.gov/midwest/endangered/insects/kbb/pdf/kbbfinalrp2.pdf [hereinafter BUTTERFLY RECOVERY PLAN].

[163] *Id. See also* USFWS, ENDANGERED SPECIES: KARNER BLUE BUTTERFLY (*LYCAEIDES MELISSA SAMUELIS*S) (2013), http:// www.fws.gov/midwest/endangered/insects/kbb/karnerbl.html.

[164] BUTTERFLY RECOVERY PLAN, *supra* note 162, at vi.

[165] *See id.* at 52-54, 66-87.

[166] *Id.* at vi; *see also* USFWS, *The Beauty and Benefits of Savannas: Necedah National Wildlife Refuge* (2013), http:// www.fws.gov/midwest/endangered/insects/kbb/savanna.html (last updated July 16, 2014).

[167] BUTTERFLY RECOVERY PLAN, *supra* note 162, at Appendix B.

[168] *Id.* at 28-32.

[169] Peter S. White & Joan L. Walker, *Approximating Nature's Variation: Selecting and Using Reference Information in Restoration Ecology*, 5 RESTORATION ECOLOGY 338, 346-47 (1997).

[170] Higgs & Hobbs, *supra* note 26, at 235-37, 246.

[171] MORRISON, *supra* note 71, at 1-2, 17, 18-20, 26, 30-32, 68-69, 104-05.

[172] *Id.* at 18-20, 30-32.

[173] NAT'L PARK SERV., MANAGEMENT POLICIES 2006, *supra* note 18, at 43.

[174] *Id.* at 37.

[175] COLE & YUNG, *supra* note 31, at 63.

[176] *Id.*

[177] *See* Parmesan & Matthews, *supra* note 49; *see also* Hickling et al., *supra* note 50.

[178] Reed Noss, *Climate Change and Conservation: Land Conservation is Even More Essential and Urgent in a Time of Rapidly Changing Climate*, CONSERVATION NORTHWEST QUARTERLY 4 (Fall 2007), *available at* http:// www.conservationnw.org/what-we-do/wildlife-habitat/climate-change.

[179] Palmer et al., *supra* note 8, at 1.

[180] Kipfmueller & Swetnam, *supra* note 70, at 203.

[181] Bradshaw, *supra* note 10, at 3.

[182] HIGGS, *supra* note 29, at 157.

[183] Definition of Health, MERRIAM-WEBSTER ONLINE (2015), http:// www.merriamwebster.com/dictionary/health (last visited Feb. 2, 2015).

[184] *See, e.g.*, ROBERT L. SMITH, ECOLOGY AND FIELD BIOLOGY 664-68, 686 (5th ed. 1996); DOUGLAS J. SPIELES, PROTECTED LAND: DISTURBANCE, STRESS, AND AMERICAN ECOSYSTEM MANAGEMENT 37-39, 42-44 (2010); Hobbs et al., *supra* note 15, at 37-39.

[185] NAT'L PARK SERV., MANAGEMENT POLICIES 2006, *supra* note 18, at 69.

[186] *See, e.g.*, SMITH, *supra* note 184, at 664-68, 686; SPIELES, *supra* note 184, at 37-39, 42-44; Hobbs et al., *supra* note 15, at 37-39.

[187] SOC'Y FOR ECOLOGICAL RESTORATION, *supra* note 2.

[188] TONGWAY & LUDWIG, *supra* note 21, at 32.

[189] RESTORATION ECOLOGY 2012, *supra* note 4, at 7.

[190] According to the Wilderness Act, designated wilderness areas "shall be administered for the use and enjoyment of the American

people in such manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for ... the preservation of their wilderness character." 16 U.S.C. § 1131(a) (2006). Note that wilderness areas are to remain "unimpaired" or undamaged. "Wilderness character" is properly interpreted as including natural conditions and processes. Within the Act, "Wilderness" is defined (in part) as "an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions ...." 16 U.S.C. § 1131(c). *See* Jerry F. Franklin & Gregory H. Aplet, *Wilderness Ecosystems, in* WILDERNESS MANAGEMENT: STEWARDSHIP AND PROTECTION OF RESOURCES AND VALUES 251, 257-58 (Chad P. Dawson & John C. Hendee eds., 2009). According to the National Park Service Organic Act of 1916, "[The Service] shall promote and regulate the use of the Federal areas known as national parks, monuments, and reservations hereinafter specified ... to conserve the scenery and the natural and historic objects and the wild life 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." 16 U.S.C. § 1 (2006).

191 MORRISON, *supra* note 71, at 10-11; EGAN & HOWELL, *supra* note 9, at 11-13; White & Walker, *supra* note 169, at 346-47.