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# The Bureau of Land Management's native plant restoration in arid regions of the United States

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## Introduction

Since the early nineteenth century, lands in the American west have been used as a source of raw materials for economic activity. Mining and livestock ranching were encouraged because the supply of land and natural resources appeared limitless. As a result of this economic development, much of the land in the western United States is degraded. The Bureau of Land Management (BLM) is the largest owner and manager of these lands (BLM 1997a). A 1982 inventory reported 60 percent of the BLM's 168 million acres are in fair to poor condition and nine percent are extremely degraded (Atwood 1990). To return some to these degraded ecosystems to a stable, functional state, the BLM is now participating in over 1200 restoration projects (Van Haveren et al. 1997).

Van Haveren et al. (1997) categorizes BLM restoration activities into five divisions: riparian rehabilitation, native plant restoration, wildlife habitat restoration, southwest pine forest ecosystem restoration, and disturbed land (mine) rehabilitation. Additionally, the Utah State Office (1997) includes revegetation after a wildfire event as a restoration activity. Although a separate goal, the use of native plant species is a deliberate part of all of the above categories. This paper discusses the history, methods, effectiveness, and limitations for native plant restoration in arid ecosystems regions by the Bureau of Land Management. In particular, the paper focuses on the application of native plant restoration within the divergent goals of utilitarian restoration and ecological reclamation.

## Agency history

The BLM is a federal agency within the Department of Interior. It was created from a 1946 merger of the General Land Office and the U.S. Grazing Service (Hess and Holechek 1995). At that time, it primarily continued the cadastral survey and distributed grazing allotment and mining permits. In 1976, however, the U.S. Congress granted the BLM full management authority over remaining unadministered public lands. Its management duties were redefined to encompass multiple-uses, such as recreation, grazing, mineral exploration, and wilderness, at a sustainable level. Although it is a federal agency, many of the BLM's activities and policies are developed in state offices.

Since its creation, the BLM has revegetated areas to manage erosion and improve livestock forage. These early efforts were site-specific and relied heavily on exotic species (Monson and McArthur 1995). Continued habitat destruction and the spread of exotic species have greatly diminished the long-term effectiveness of these early programs (Van Haveren et al. 1997). More recently, the BLM has attempted to increase project success by incorporating landscape considerations, native species, and a community-centered approach.

**Restoration intent**

There is not a direct congressional mandate to rehabilitate and restore BLM land. Long term and multiple-use goals, however, imply the need for restoration since much of the BLM's land is in fair to poor condition. Indeed, the preservation of natural and cultural heritage is one of the BLM's six strategic goals for 1997 (BLM 1997b). Within these goals, the BLM's primary restoration concern is site stabilization and rehabilitating basic ecosystem function (Van Haveren et al. 1997). Native plants can contribute to this goal because they are adapted to site conditions, which may be too harsh for other species. Arid land rehabilitated for utilitarian value retains function but may not have conservation value. Historical characteristics may be permanently lost to a stabilized system because their return is not a purpose for these projects. Continuation of ranching activities maintains cultural value.

Erosion control, keystone species return, and control of the spread of exotic species are part of site stabilization activities. Exotic species, in particular, are a problem for the BLM. Fourteen million acres of public land is dominated by exotic species, such as spotted knapweed (*Centaurea maculosa*), plumeless thistle (*Carduus nutans*), and hydrilla (*Hydrilla verticillata*) (BLM 1998). The removal of exotics contributes to native plant restoration because exotics compete with native species and can contribute to native plant decline. By planting and actively managing native plants, one can aggressively counter exotic plant colonization.

Exotic species can also disrupt the function of native communities by changing disturbance regimes. For example, cheat grass (*Bromus tectorum*) is more flammable than native species and changes the fire cycle of grassland it dominates (Utah State Office 1997). Frequent fires expose the soil surface and increase the rate of wind erosion. This lack of cover also increases the impact of raindrop velocity, which can prevent all plant colonization by creating a surficial crust.

Recreating 'pristine conditions' is difficult because of the expense and personnel required. This goal, therefore, is a secondary interest for the BLM. Restoring to a historical condition in arid regions is referred to as reclamation (Allen 1995). This goal diverges from the utilitarian rehabilitation activities because it has stricter implementation requirements and a higher threshold for success. For example, the use of exotic species would not be permitted in these cases and a greater emphasis is placed on complete return of original ecosystem composition and function.

In the past, preservation of a single, rare or endangered, species initiated reclamation activities. Project success would depend on by the positive reproduction of that particular species (Atwood 1990). The Endangered Species Act directed these activities. More recently, conservation efforts have shifted to the community level because the fulfillment of the needs of one species may not necessarily improve conditions overall. The community approach attempts to return or improve the presence of all ecosystem components. Failure of a particular organism or group of species within the restored system may reflect a deficiency or destructive element in the ecosystem that must be addressed.

The BLM's Strategic Plan (1997b) outlines the steps to restore to and manage ecosystems to a relatively historical condition. First, management standards must be established and implemented to prevent further degradation. Second, at risk resources, such as priority plant or animal habitats, must be identified. Finally, the appropriate management technique must be implemented to the restored communities to prevent reversion to a degraded state. The BLM plan's highest restoration priority is areas with the "greatest likelihood for recovery and increased [economic and ecological] benefits, especially those lands that are at risk" (BLM 1997b, page 1).

From the goal to restore habitats to historical conditions, came the development of the Native Vegetation Diversity Project, a research directive to explore and improve restoration techniques for native plant species. This program targets two major ecosystem regions: the Columbia Plateau's sagebrush community and the Great Basin's salt-desert scrub (BLM 1998). Of these two systems, the sagebrush community has a higher priority because it has a greater expanse, including parts of Oregon, Idaho, Nevada, Utah, and northeast California (BLM 1998). The sagebrush community is also characterized by extremely low precipitation, which constrains restoration success. Development of successful methods in the Columbia Plateau's sagebrush community may also transfer to the low sage community. The Great Basin's salt-desert scrub is a second priority because it includes only four states and is a shadescale community, which is a rare ecosystem type. More specific criteria for restoration site selection at the local level, but these are not generally available. The BLM is in the process of developing a national standard for targeting degraded communities for restoration (BLM 1997b).

**Restoration methods**

Passive restoration relies on natural or accelerated successional processes, such as removing the immediate stressors or a single seeding event (Whisenant 1995). Active restoration requires management intervention, such as planting, irrigation, and direct removal of exotic species. Restoration in arid areas depends on the use of active techniques because too-frequent human disturbance activities and interactions with the extreme environment alter successional pathways (Allen 1995).

Early federal arid rehabilitation efforts used exotic cover species; such as mountain brome (*Bromus carinatus*) and slender wheatgrass (*Agropyron trachycaulum*), selected for rapid reproduction and spread (Monson and McArthur 1995). Relatively broad or flexible environmental requirements of these plants also encouraged their ubiquitous use for stabilization. The traditional range management and revegetation techniques developed for these exotic species do not easily transfer to native species. Limited knowledge hinders the restoration of native plants in arid ecosystems. Furthermore, the successful use of a particular technique in one arid ecosystem may not be universally successful. For example, the Great Basin salt-desert is a research priority because the BLM anticipates needing new and different techniques to be successful.

One area where native plant restoration techniques have been researched and implemented is wildfire rehabilitation (Utah State Office 1998). These are especially useful when the soil surface has been exposed and nutrients replenished, but these technologies may be useful in other situations, particularly larger areas. The most effective method is seeding with a Standard Rangeland Drill (SRD), which puts seeds at their proper depth to insure correct germinating conditions and prevent seed predation (Utah State Office 1997). A more cost-effective technology is broadcast seeding from aircraft. Aerial broadcast seeding is not as effective as direct planting because the seeds are exposed and have lower germination success (Utah State Office 1997). If the aerial seed broadcast is followed with a covering treatment, such as trampling or use of an anchor chain to move soil over the seeds, effectiveness increases but not to the same level as the SRD. A cover treatment also puts seeds at depth, but does not reach all seeds or put them at a uniform depth.

Topography and financial limits constrain the application of some of these technologies. Steep hillslopes and remote areas are difficult to reseed because of road inaccessibility and potential slope erosion. In these cases, aerial seed broadcast is preferred. Accessible areas that are relatively level are preferable locales for the Standard Rangeland Drill.

In relatively localized restoration efforts, more intensive methods with a strong emphasis on native plants are employed. The California BLM State Office "strongly promotes" the use of native plants and has developed a policy for using them in localized restoration projects (California State Office 1996, page 1). This document appears to be influencing other state's native plant procedures, such as Wyoming and Utah, which reference this policy as a directive.

Within this policy, the use of exotics is allowed in unstable conditions because rapid proliferation and root extension can slow or control erosion. Use of non-native species is uses as a last resort and requires written permission from the central office. Local genetic stocks are stressed as a source of native plant propagules because these populations may be adapted to unique local conditions.

To facilitate use and development of native plants in restoration, the California State Office Instruction Memorandum for native plant use (1996) outlines the process for salvaging local plant resources, site preparation, and long-term monitoring of the restoration site. Early planning contributes to success by insuring that ample seeds are collected and stratified. In addition, if the restoration mitigates a future activity, data and plant collection can occur before the disturbance takes place. Data to be collected includes plant and animal community composition, plant cover, and conditions (California State Office 1996). If the site has already been destroyed, a reference system can be used. This information is helpful for determining the restoration goals for a specific system and designing the project's outcome.

Retaining other ecosystem components for plant reintroduction is also stressed. The California State Office Instruction Memorandum for native plant use also outlines methods for salvaging and storing the topsoil from mitigation sites for maintenance of the site's invertebrate, fungal, and seed resources. The instruction memorandum provides specific seed storage protocols, such as retaining seed moisture, maximum length of storage, and a proper temperature range (California State Office 1996). Literature research and personal consultation are encouraged for developing site- and species-specific restoration techniques; some plant lists and potential contacts are listed to direct additional queries.

**Restoration challenges for arid ecosystems**

The climate west of the 100th meridian and east of the Cascades and Sierra Mountains in North America is arid to semiarid. Arid ecosystems are characterized by less than twenty inches of rain each year and thin soils. These climatic conditions are strong limits to plant growth and predominantly support rangelands (arid grasslands) and desert ecosystems. Most BLM land is dominated by these conditions, which pose a significant challenge to their restoration efforts.

Water is the primary restricting resource; both amount and frequency of precipitation events hinder the establishment of plants. Natural plant establishment, therefore, appears to occur in pulses, when precipitation is above normal for a period of one to many years (Allen 1995). Waiting to restore an area until an appropriate weather pattern exists is one way to increase a project's success. Whisenant (1995) suggests restoration endeavor in arid climates should reduce the rate of evapo-transpiration to increase success by increasing litter or shading leaves to lower their temperature. The California State Office Instruction Memorandum for native plant use suggests consideration of seasonal patterns of rainfall when planning and implementing a restoration. They also suggest that experimental plantings of many species near the site before the actual restoration may improve site success (California State Office 1996).

Aronson et al. (1993) outlines several site-specific problems associated with restoration in arid climates. The BLM memoranda addressed many of these problems, including erosion control, decreasing vegetation cover, loss of nutrients, low seed bank diversity, and a dearth in species function and diversity. Propagules from many different individuals and, if possible, different years will increase the genetic diversity (California State Office 1996). Retaining all of the plant components in the reference system is encouraged, even if the managers must resort to nursery stock, which may not be adapted to local conditions. This recommendation clearly illustrates the BLM’s priority of functional return over local genetic adaptation.

Maintaining litter cover, however, was only briefly mentioned and perhaps should receive more attention in the California State Office Instruction Memorandum for native plant use. Litter can increase soil organic matter and the ability to hold nutrients at or near the soil surface (Aronson et al. 1993). Root treatments for maintaining hydration, such as acrylimide copolymers (Terra-sorb), were not discussed the California State Office Instruction Memorandum for native plant use. In addition, the need to reestablish of mycorrhizal relationships and potential inoculation techniques were not contemplated.

Plant patchiness, which results from micro-site distribution, was not addressed by the BLM’s native plant restoration techniques. Natural resource concentrations, called fertility islands, may influence recolonization patterns (Whisenant 1995). Identification of fertility islands may facilitate restoration because these sites contain the resources necessary for germination and growth. In undisturbed habitats, these sites may have supported a congregation of vegetation. Exploitation of these features may help reintroduce spatial heterogeneity to the landscape. Use of these resources may also reduce costs because limiting nutrients are concentrated here and do not need to be applied. Further research, however, is necessary to identify the restoration potential of these fertility islands.

Other resources, such as organic matter and nutrients, are also low in arid environments. Soil loss accelerates these limitations by directly removing the storage medium. In arid regions, soil loss can be extreme, because of rapid erosion or livestock compaction. Colonization of some late successional plants requires a relatively mature soil structure and they cannot be reintroduced without some site preparation. Remnant soil can be augmented with nutrients and organic matter. Unfortunately, some soil structure development, such as displacement of clay particles, requires time (Allen 1995).

Finally, in a review of BLM memoranda and information bulletins, the author found no discussion of irrigation or shading plants to increase the survival of young propagules. Water is a scarce resource in arid regions and wet years can produce a pulse of germination and growth (Allen 1995). Water can also accelerate creation of soil structure. Clay displacement and aggregate accumulation result from water flow through the soil. Unfortunately, irrigation can also increase the upward movement of solutes and promote soil salinity, a condition that leads to desertification. The use and abuse of irrigation in arid regions should be addressed by the BLM. Guidelines for irrigation timing, frequency, and amount may be the next prudent step for research and instruction.

**Effectiveness and evaluation**

Restoration in arid environments is risky, expensive, and short-lived (Allen 1995). Most rehabilitation techniques have been developed in environments that are more hospitable and do not easily transfer to arid regions (Whisenant 1995). Therefore, evaluation and monitoring are important for increasing the knowledge base for managers to draw upon for site preparation and design. Site managers must also evaluate their own projects so that others can learn from their successes and mistakes.

A review of BLM memoranda found no specific reviews of success or failure, but many documents outlined criteria for evaluating a restoration project. These criteria are:

- Species recolonization --the number of native species that have colonized a restored area
- Community structure – the number of vegetation layers
- Diversity of plant age classes and recruitment of new individuals
- Presence of special status species
- Number and abundance of exotic species
- Insect herbivory and pollination
- Wildlife presence and use

The author feels that project monitoring and evaluation should include the measurement of presence and richness of plant guilds, such as legumes, annual forbs, and C4 grasses. The local combination of species can give insight into project conditions or a lack of a disturbance regime. For example, the over-abundance of woody species often indicates a need for more frequent fires.

Other authors have suggested additional means of restoration assessment, such as the rate of nutrient cycling, microbial activity, but these may be more time and economic resource intensive for practical use (Aronson et al. 1993). Whisenant (1995) suggests that synergy on the landscape/ecosystem scale should be monitored for positive and negative feedbacks to the restored site. Nutrient and water flow, pollination services, seed sources, and erosion overburden can move through the landscape and can significantly affect a site.

One criticism of the BLM evaluation methods is that they rely too heavily on a single (often rare) species recovery. Monson and McArthur (1995) caution that this may only demonstrate short-term success, and over time the species population may erode. This method of assessment in the BLM, however, is shifting to favor community composition (Atwood 1990). Community composition is a more accurate and resilient measure of ecosystem health because a single (rare) species may be more sensitive to climatic, herbivorous, or other stochastic pressures. Changes or loss in whole community structure and composition represent more profound and chronic pressures acting on the ecosystem.

The BLM's restoration agenda appears on the surface to be based in sound scientific practices. Although project monitoring and assessment are encouraged, the results are not easily available for examination and deeper analysis. There also does not seem to be any central database to collect relevant data. The author, therefore, cannot comment on the adherence to promoted practices, or the effectiveness of their application. The agency also appears to be responding to criticism in a positive manner. For example, the use of exotic species to stabilize sites was criticized and the BLM now favors native species. The use of community parameters, instead of the single species approach, was also a response to criticism.

Finally, the BLM is addressing institutionalized forms of ecosystem degradation, such as grazing, and attempting to reform land-use practices. Prevention of ecosystem decline is a more economical means of maintaining ecological integrity than site restoration. Unfortunately, the BLM currently lacks an effective means to monitor restored areas and high-quality sites under protection from trespassers, illegal grazing, or other infractions. The BLM employs only 206 enforcement personnel to patrol their millions of hectares (BLM 1997a). Success with project protection and continuation will increase as the agency seeks partnerships with other federal agencies and local groups (Van Haveren et al. 1997).

**Conclusion**

The BLM is the single largest land manager in the United States. The agency must serve a large public with many interests and divergent values, both economic and ecological. The struggle between these two publics is realized in the BLM's restoration goals. Site stabilization is the primary purpose of restoration and most land rehabilitated for this goal will be returned to use. Erosion control and reducing the number of exotic species are particularly important characteristics that contribute to site degradation. Exotic species compete with native plants and can alter disturbance regimes.

Reclaiming an area to a 'pristine' historical condition is secondary because of the financial and staff limitations. This approach originally focused on habitat creation for endangered species, but this single species approach has shifted to entire communities. The 1997 Native Vegetation

Diversity research directive targets the Columbia Plateau's sagebrush and the Great Basin's salt scrub communities. These types of restoration have conservation value.

To achieve the site stabilization and ecosystem reclamation goals, the California State Office developed a policy for the use of native plants. This policy outlines critical needs, such as propagule source, seed preservation, top soil conservation, but does not mention litter depth, mycorrhizal inoculation, or irrigation. The adherence to the use of local genetic stock to restore community structure demonstrates the greater emphasis placed on the stabilization goal, rather than the requirement of local sources.

The BLM promotes the measurement of factors, such as species diversity and community structure, as a means to monitor and evaluate restoration projects. The author feels that measuring the presence and richness of plant guilds may reveal critical ecosystem properties. The BLM appears to be addressing policies to promote scientific restoration actions by emphasizing monitoring. Unfortunately, results were not readily available for analysis.

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