RESTORING THE GREAT BASIN DESERT, U.S.A.: INTEGRATING SCIENCE, MANAGEMENT, AND PEOPLE

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Abstract. The Great Basin Desert lies between the Sierra Nevada Mountains to the west and the Rocky Mountains to the east. Nearly 60% of the area's deserts and mountains (roughly 30 million ha) are managed by the U. S. Department of Interior's Bureau of Land Management. This area is characterized by low annual precipitation, diverse desert plant communities, and local economies that depend on the products (livestock grazing, recreation, mining, etc.) produced by these lands. The ecological and economic stability of the Great Basin is increasingly at risk due to the expansion of fire-prone invasive species and increase in wildfires. To stem this loss of productivity and diversity in the Great Basin, the BLM initiated the "Great Basin Restoration Initiative" in 1999 after nearly 0.7 million ha of the Great Basin burned in wildfires. The objective of the Great Basin Restoration Initiative is to restore plant community diversity and structure by improving resiliency to disturbance and resistance to invasive species over the long-term. To accomplish this objective, a strategic plan has been developed that emphasizes local participation and reliance on appropriate science to ensure that restoration is accomplished in an economical and ecologically appropriate manner. If restoration in the Great Basin is not successful, desertification and the associated loss of economic stability and ecological integrity will continue to threaten the sustainability of natural resources and people in the Great Basin.

Keywords: Great Basin, invasive species, restoration

1. The Great Basin Desert

The Great Basin can be defined on a hydrographic basis, e.g. only those areas where the water flows internally; or floristically e.g. similar plant communities (Gleason and Chronquist, 1964). The external boundary we used is based on the floristic not the hydrographic boundaries of the Great Basin (BLM, 1999). The Great Basin stretches from the Rocky to the Sierra Mountains from east to west and from the Snake River Plain in the north to the Mojave Desert in the south. It is a land of extremes in temperature, flora and fauna, landscapes, soils and precipitation (West, 1979). The climate is semi-arid with the majority of the precipitation occurring in the spring and winter. Over half of the Great Basin receives less than 305 mm of annual precipitation (BLM, 1999).

The arid portions of this desert are dominated by plants of the *Chenopodaciae* family (e.g. salt desert shrub communities), the more mesic areas are dominated

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Environmental Monitoring and Assessment **99:** 169–179, 2004.

by *Artemisia* spp. (e.g. sagebrush steppe), and the uplands are a mix of *Juniperus* and/or *Pinus* woodlands and mountain shrubs. Two introductions by European settlers significantly changed the structure and function of many of the native plant communities in the Great Basin. First, domestic livestock were introduced in the late 1800s resulting in the loss of herbaceous understory species in the shrublands (Yensen, 1990). Soon thereafter cheatgrass (*Bromus tectorum*) was introduced by the pioneers and expanded to fill the niche left vacant by the loss of native herbaceous plants (Hull, 1965; Young *et al.*, 1972).

2. Cheatgrass and Wildfires

Cheatgrass has many attributes that promote its establishment and dominance on disturbed Great Basin rangelands (Platt and Jackman, 1946; Young *et al.*, 1987). It is a prolific seed producer, can germinate and grow under a wide range of environmental conditions, and is an efficient user of nitrogen and soil water in early spring, prior to native grass growth. It adapts to new environments and is maintained under heavy livestock grazing regimes.

Perhaps the most significant impact of cheatgrass is its role in increasing the frequency and extent of wildfires in the Great Basin (Pechanec and Hull, 1945). Cheatgrass is a wildfire hazard because it matures earlier than native species and provides easily ignited fuels that promote a rapid rate of firespread (Stewart and Hull, 1949). Historically, wildfires occurred at return intervals of 32–70 years in sagebrush vegetation types (Wright *et al.*, 1979), allowing sufficient intervals for the native shrubs, which are generally nonsprouters after a wildfire, to re-establish. Some areas within the Great Basin now experience fire-return intervals under 10 years (Pellant, 1990; Whisenant, 1990) effectively resulting in the loss of sagebrush and other key plant and wildlife species over large areas (Knick, 1999). Whisenant (1990) found a significant correlation between fire frequency and relative frequency of cheatgrass in southern Idaho. The trend of increased wildfire frequency on cheatgrass rangelands observed by Stewart and Hull (1949) is continuing today (Pellant, 1990).

Cheatgrass was recognized as an "ecological intruder" as early as 1949 (Stewart and Hull, 1949) and in a more recent survey was found to be dominant on 6.9 million ha of public land in the Great Basin Desert with another 25.1 million ha of public lands at risk of annual grass invasion if disturbed (Pellant and Hall, 1994). More recently, the rangeland dominated by cheatgrass in the Great Basin was estimated at 10.1 million ha (BLM, 2000). The ecological and economical implications of the invasion of cheatgrass and other alien weeds and the concurrent increase in wildfires are enormous (Young *et al.*, 1987; Devine, 1993). Other more harmful weeds, such as rush skeletonweed (*Chrondrilla juncea*) and yellowstar thistle (*Centaurea solstitialis*) are invading cheatgrass areas and may pose more serious resource problems in the future (Piper, 1983). Cheatgrass, wildfires, and the increase in other noxious weeds are reducing biological and economic stability of the Great Basin and the potential of some lands to support a wide variety of wildlife and plant species, provide watershed and recreation values, and support an important livestock industry (BLM, 2000).

3. Is the Great Basin Undergoing Desertification?

Soil and biological degradation in the Great Basin have accelerated the advancement of desertification on millions of hectares of rangelands where invasive species and wildfires control the ecological processes on the land. The United Nations Convention on Desertification in October 1994 defined desertification as "land degradation in arid, semi-arid, and dry sub-humid areas resulting from various factors, including climatic variations and human activities" (United Nations, 1994).

Land degradation consists of reduction in or loss of biological or economic productivity and complexity, as evidenced by accelerated soil erosion, reduced soil quality and long-term loss of natural vegetation. Dregne (1977) characterized desertification by:

1. reduced productivity of desirable plants
2. alteration in biological diversity
3. accelerated soil erosion
4. increased hazards for human occupancy.

Other ecological impacts of the conversion of Great Basin shrublands to annual grass dominated landscapes may include:

1. increased surface soil temperatures
2. reduced availability of soil water to native plants
3. reduced structural and species diversity (flora, wildlife, insect and soil micro-organisms)
4. reduced soil water recharge over winter due to less snow retained on-site
5. disrupted nutrient cycling, especially nitrogen availability
6. reduced potential for reproduction and recruitment of native plants and biological crusts.

Allen and Jackson (1992) linked the invasion of undesirable exotics with desertification and called the Great Basin a "biotic desert" because it is now infested with exotic annual grasses.

The desertification process in the Great Basin is accelerating, given the extent, dominance, and disruption of wildfire cycles, and lack of biological diversity where cheatgrass and other alien species now dominate the landscape. The Nature Conservancy recognized the enormity of the problem when it recently ranked the

Great Basin as the third most imperiled ecosystem in the United States (Stein *et al.*, 2000). This complex interaction of cheatgrass, wildfires and invasive weeds is now the greatest concern of the Basin's largest land manager, the Bureau of Land Management (BLM, 1999). The Great Basin Restoration Initiative (GBRI) was initiated in 1999 to conserve functioning plant communities and restore native plant diversity on priority areas infested with cheatgrass and other weeds (BLM, 2000).

The goals of this initiative are to reduce weeds and wildfires and maintain the long-term ecological and economic viability of this fragile desert. It is clear that science-based management with the involvement of all interested citizens is needed to reverse the trend of degradation and desertification in the Great Basin. This paper describes the current efforts under the auspices of GBRI to reverse desertification in the Great Basin. First the historic linkage between the condition of the land, science and land management will be explored.

4. The Evolution of Research, Management and Public Involvement in the Great Basin

The introduction of domestic livestock to the Great Basin in the early 1800s and subsequent loss of herbaceous native, shrub–steppe vegetation was a significant problem by the mid-1800s (Young *et al.*, 1972; Yensen 1980). Young (2000) and Young and Clements (2001) describes the evolution of research within the Intermountain area, including the Great Basin, from the beginning of the 20th century until the early 1930s, while Monsen and McArthur (1995) and Monsen and Shaw (2001) summarize the development and use of plant materials for rehabilitation of disturbed wildlands in the western United States, going back to 1912. These four papers and their references are utilized to provide a brief synopsis of the evolution and linkage of land management strategies, people and scientific research as they relate to the restoration of public lands in the Great Basin.

The initial focus of the federal government was to describe and report on the condition of the resources in the Great Basin (Young, 2000). Fremont was the first government explorer to enter the area between the Sierra Nevada Mountains to the west and the Rocky Mountains to the east and he named the area the Great Basin (Fremont, 1845). He described the valleys between the mountains as "sterile" and dominated by "the gloomy artemisa (sic) the prevailing shrub." European settlers arrived in the 1850s and introduced large numbers of livestock to the Great Basin without an understanding of the damage that would result from the unregulated and often times abusive grazing of these fragile rangelands. By the end of the 1800s livestock grazing (primarily sheep and cattle) resulted in precipitous declines in forage production and accelerated soil erosion within the Great Basin (Coville, 1898; Griffiths, 1902).

Coville (1898) was one of the first scientists to suggest the need to manage livestock to prevent abuse of the Great Basin rangelands. Research on the proper management and restoration of Great Basin rangelands was institutionalized in 1905 when the Forest Reserves were established and with them the priorities of protection, management and effective application of science to the lands managed by the Forest Service (Rowley, 1985). The goal of early rehabilitation efforts on these degraded rangelands was to re-establish desirable forage species to support the livestock industry. Cottam (1908) was one of the first scientists to experiment with seeding depleted alpine meadows in Washington with a wide variety of native and introduced plant materials. Seeding trials across the western United States were accelerated to select forage species that could protect the soil and support livestock.

Livestock management practices and grazing systems were developed to maintain the native forage species while providing maximum returns to the livestock industry (Sampson, 1919; Sampson, 1926). During this period, range management was directed primarily towards enhancing meat and wool production on western rangelands (Young and Clements, 2001).

By 1934, when the Taylor Grazing Act was passed, the non-forested public lands in the Great Basin were the scene of many range wars between the sheep and cattle graziers on overstocked and depleted rangelands (Muhn and Stewart, 1988). This act sought "to stop injury to the public grazing lands by preventing overgrazing and soil deterioration; to provide for their orderly use, improvement, and development; (and) to stabilize the livestock industry dependent on the public range." Research done prior to 1934 supported the need to manage and regulate livestock use in the Great Basin. The Taylor Grazing Act set up the regulatory mechanism to accomplish this by establishing a grazing permit system that gave grazing preference to local livestock permittees on grazing units called allotments. The government also set up "Grazing Advisory Boards" made up of local stockmen to assist federal land managers in the management of the public rangelands (Muhn and Stewart, 1988). This was the beginning of the use of public advisory bodies to provide federal land managers with local input into land management decisions. The use of advisory bodies of local citizens to provide management recommendations to the BLM continues to this day via "Resource Advisory Councils."

Revegetation projects and research continued to focus on introduced species through the 1950s because earlier research comparing native and introduced grasses supported the use of the introduced species for the management objectives of that era (livestock forage and soil protection). For example, Hull (1974) evaluated 60 old experimental seedings in southern Idaho and rated only 2 of 248 plots seeded with introduced species as failures. He rated native bunchgrass seedings as failures on half of the 134 plots where they were planted. Crested wheatgrass (*Agropryon cristatum*) became the introduced species of choice for revegetation of large acreages of public lands in the 1950s and early 1960s (Hull and Holmgren, 1964). In addition to having desirable livestock forage and site protection characteristics, crested wheatgrass lessened the cheatgrass fire hazard (Stark *et al.*, 1946; Hull and Stewart, 1948).

The emphasis on the use of introduced species for revegetation continued into the early 1970s, eventually slowing as environmental legislation (e.g. Wilderness Act of 1964, National Environmental Policy Act of 1969, and the Endangered Species Act of 1973) made it more difficult to use non-native plant materials in all situations. With the passage of the Federal Land Policy Management Act of 1976, the BLM had a clear mandate to manage for "multiple uses" and crested wheatgrass monocultures did not support this mandate in many situations. The traditional uses of public lands: livestock grazing, mineral extraction, and timber harvest, were being increasingly challenged by the public, often in a legal setting (Muhn and Stewart, 1988). Conservation groups sued the BLM to stop "range improvements" that they considered environmentally unsound while the commodity interests challenged BLM's authority in movements such as the "Sagebrush Rebellion" of the 1980s.

The contentious nature of public-land management has continued to this day with lawsuits guiding land management in many areas. However, a greater realization is evolving that the long-term stability of the public lands in the Great Basin is dependent on people working together to solve resource problems with the application of appropriate science to land management and restoration. Within the context of science, management and public participation, the Great Basin Restoration Initiative has evolved.

5. The Great Basin Restoration Initiative

Extensive wildfires in 1999 provided the stimulus for the BLM to launch a regional restoration initiative in the Great Basin. Nearly 0.7 million ha of public land were burned in the summer of 1999, negatively affecting natural resources, private property, and local economies on a large scale. This record fire year was followed by another large fire year in 2000 with 0.4 million ha burned. It was obvious to land managers and the public that wildfires and associated invasive species were causing ecological degradation on extensive acreages in the Great Basin. Several teams of federal and state land managers and scientists were brought together to evaluate the issues and develop a consensus on approaches to resolve these issues (BLM, 1999) and then to develop a more detailed strategy to implement an effective restoration program throughout the Great Basin (BLM, 2000). Recently, a progress report on these activities has been published and is available for public review (BLM, 2001).

These principles are the cornerstones for conducting restoration in the Great Basin (BLM, 2000):

- Apply a landscape-level approach to restoration. The "project by project postage stamp" restoration approach of the past has not been effective in stopping the spread of cheatgrass and other invasive weeds, or the increase in wildfires.
- Emphasize the conservation (protection) of healthy, functioning native plant communities before restoring degraded rangelands, especially those lands with low

precipitation and productivity. Utilize a prioritization process to ensure that conservation and restoration efforts are focused in these critical areas.
- Pool financial resources internally and capitalize on external partnerships to maximize restoration capability and success. Public involvement extends to all phases of the restoration process, not just as a funding source.
- Promote scientific research and studies to cost effectively and successfully implement restoration projects.

The team that developed this strategy addressed the use of native or non-native species for restoration. They decided that the use of native species for restoration should be given preference in seeding projects, pending seed availability, cost and potential for successful establishment. This approach is reflected in the following definition of restoration:

> "Implementation of a set of actions that promotes plant community diversity and structure thereby encouraging plant community resiliency after disturbance and minimizing the increase in invasive species over the long term" (BLM, 2000).

This definition empowers agency restoration teams, in coordination with public partners, to establish seeding strategies based on the "on-the-ground" situation. Monitoring and evaluation of all restoration projects are required to ensure that restoration success stories can be shared and repeated in the future whereas failures can be used to modify future restoration strategies.

Several "guiding principles" for restoration in the Great Basin were developed and are summarized here:

- Restoration must be consistent with current land-use plan decisions and must promote the accomplishment of BLM "Standards for Rangeland Health." These standards were developed in partnership with local Resource Advisory Councils, made up of representatives of various public lands interest groups, and require all public lands to be managed for ecological sustainability.
- Local communities and Native American tribes must be involved in the restoration process. All restoration activities must balance ecological needs with social, political, and economic considerations. There are many opportunities to support local economies by contracting with area businesses and individuals for seed, labor, fence materials, monitoring, etc.
- Restoration work will be based on the best available science. If the science needed to successfully implement restoration is not available, GBRI may assist in funding research to obtain the needed information. Significant funds from the BLM's National Fire Program are devoted to a native plant selection and increased funding for the Great Basin project. This research project has multiple state and federal agency cooperators and includes a component that will fund private seed growers in the Great Basin to assist in developing cultural practices to increase seed availability of key native forbs.

- Public lands in the Great Basin will be managed for no net loss of native shrublands. Emphasizing protection of remaining shrublands with increased fire suppression and fuels management projects will stem the loss of this valuable resource. Greenstripping, the use of strips of fire resistant vegetation established at strategic locations, will reduce fire entry into shrublands and minimize the loss of shrublands if a wildfire starts in a shrub stand (Pellant, 1994). If shrublands are lost due to wildfires, rehabilitation projects will include shrub seed to accelerate re-establishment of the former shrub community and its understory.
- In order to plan restoration projects on a landscape basis, current vegetation communities and areas containing invasive species must be mapped. This inventory and assessment of plant communities within the Great Basin has been initiated using existing inventory information and remotely sensed images. The initial focus of these inventory efforts is to identify properly functioning plant communities for protection and degraded rangelands requiring restoration. A prioritization process has been developed (BLM, 2001) to further delineate priority watersheds for application of protection and restoration treatments.

The strategy and partnerships needed to initiate a much needed restoration effort in the Great Basin are in place. All that is needed now is the funding to implement the GBRI strategy. For the past 2 years, some project work linked to GBRI has been accomplished using funds from other BLM programs (BLM, 2001). However, to fully implement this program, higher levels of funding will be required. Coordination with our partners is continuing to leverage and increase funding to accomplish common restoration objectives. We know that without restoration, the Great Basin as we know it will continue to disappear under the relentless onslaught of weeds and wildfires.

6. Summary

The Great Basin Restoration Initiative offers a proactive solution to the problem of invasive species, wildfires and desertification of the Great Basin. Our current approach to restoration is based on reacting to a disturbance in a patchwork fashion across the Great Basin. If we have a wildfire, we "react" with fire suppression and rehabilitation, if weeds invade an area we "react" and control them. What is needed is an active restoration program that "fixes" small problems before they become big problems at a landscape level. Restoration is expensive (estimated to cost around $40/ha) but the cost to continually suppress fires, rehabilitate the land after a fire or implement noxious weed treatments is even more expensive at $77/ha (BLM, 1999). We cannot afford to wait to save the Great Basin. In 2000, the Acting BLM Director stated, "After all, 75 million acres (30 million ha) of public land in the Great Basin are at stake and the clock is ticking. The time for us to move forward is now" (BLM, 2000).

The Great Basin Restoration Initiative can succeed with the linking of science, proper land management and local people working together to accomplish a common objective of sustaining the ecological and economic integrity. Reversing ecological degradation (e.g. desertification) using local businesses to implement projects and local partnerships to strengthen the support for sustainable ecosystems creates a win-win situation. This partnership of science, management, and people has application anywhere in the world where desertification processes are threatening ecological and economic stability.

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