Strategic Plan for the Coordinated Intermountain Restoration Project

USGS/BRD/ITR—2002–0011
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U.S. Department of the Interior
U.S. Geological Survey

Balsamorhiza hookeri in sagebrush grassland east of Burns, Oregon, courtesy of David A. Pyke, U.S. Geological Survey.

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By David A. Pyke, U.S. Geological Survey, and
Mike Pellant, Bureau of Land Management

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Executive Summary

In 1982, the Bureau of Land Management's (BLM) Idaho State Office began the Intermountain Greenstripping and Rehabilitation Research Project (IGRRP), or the "Greenstripping Program," to investigate plant materials and technologies that can reduce wildfire incidence and improve rehabilitation practices. Rehabilitation is normally applied as a reactive process to wildfires, yet land managers in the Great Basin wish to become proactive by replacing fire-prone invasive annual grasses with native plants. The Coordinated Intermountain Restoration Project (CIRP) evolved from the Greenstripping Program to conduct research studies and provide technical assistance on restoration of native ecosystems on rangelands that are infested with invasive annual grasses or other invasive or noxious weeds. To accomplish this objective, the CIRP will promote the understanding of ecosystem disturbance dynamics as well as evaluate plant materials, site preparation techniques, weed control methods, seeding equipment, management methods, and monitoring techniques for restoration projects.

The CIRP will not address the restoration of forested or woodland (juniper [*Juniperus*]) ecosystems. It will include a component on fuel management to reduce the impacts of wildfires on semiarid rangeland ecosystems where exotic annual grasses provide the fuel. The people who will benefit directly from this research include land managers and users of public and private lands in the northern Great Basin, the Columbia Plateau, and the Snake River Plain. The CIRP will provide an integration framework for a multidisciplinary approach to research with numerous opportunities for input and collaboration.

The U.S. Geological Survey will initially dedicate approximately $1 million over 5 years (about $200,000 per year) to jump-start this effort. U.S. Geological Survey funds will establish a science advisory board to oversee the project. This board will contain members of Federal research and management agencies within the region. U.S. Geological Survey funds will support (1) continued development of VegSpec, a computer program that is a restoration expert system, (2) research to examine changes in ecosystem processes when native plant-dominated communities shift to communities dominated by exotic annual grasses, and (3) research to address mechanisms for establishing native plants in locations dominated by exotic annual grasses. Through these initial funds, USGS hopes to leverage additional research with other agencies (e.g., BLM's Great Basin Restoration Initiative or the Native Plant Materials Development Project, which is an interagency program to supply and manage native plant materials for restoration and rehabilitation on Federal lands) or funding organizations (e.g., the U.S. Department of Agriculture's [USDA] National Research Initiative Competitive Grants Program, or the USDA's and U.S. Department of the Interior's [USDOI] Joint Fire Science Program), and to obtain additional research partners (e.g., university or Federal scientists) willing to expand this effort to address all aspects of this strategic plan.

Project Vision

This project shall increase our understanding of natural and human-caused disturbances (e.g., wildfires, livestock, and recreational impacts, etc.) and invasive plants in the Great Basin, and develop strategies to manage, maintain, and restore above and belowground biodiversity and functional ecosystems.

Project Goals

1. Understand ecological responses to disturbances and invasive plants.
2. Develop strategies and appropriate techniques to maintain or restore functioning ecosystems.
3. Demonstrate and transfer scientific results and applications.

Prioritized Historical Plant Communities for Restoration

- Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*)
- Winterfat (*Krascheninnikovia lanata*)
- Shadscale (*Atriplex confertifolia*)
- Other sagebrush species and subspecies

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Frontispiece. A Wyoming big sagebrush – Thurber's needlegrass site dominated by native shrubs and grasses near Boise, Idaho. Photograph taken by David A. Pyke, USGS.

Strategic Plan for the Coordinated Intermountain Restoration Project

By David A. Pyke[1] and Mike Pellant[2]

Abstract

Since the late 1800s, arid and semiarid rangelands in the Great Basin have changed continually from diverse shrublands and grasslands dominated by native perennial plants to grasslands dominated by invasive annual plants such as *Bromus tectorum*, also known as cheatgrass or downy brome. This conversion has affected or threatens to affect over 30 million ha (74 million acres) of land in the Great Basin region managed by the U.S. Department of the Interior, Bureau of Land Management. This change has led to larger and more frequent wildfires and to an annual plant community that is difficult to eliminate and limits the success of native plant restoration. Led by U.S. Geological Survey research and technical assistance, the Cooperative Intermountain Restoration Project's (CIRP) goal is to increase knowledge of natural and human disturbances and of the impacts caused by invasive plants to ecosystems in the Great Basin. The CIRP will also develop methods to manage, maintain, and restore native biodiversity and functional ecosystems within this region. Information gained from this effort will be demonstrated and transferred to scientists, land managers, and the general public.

Keywords: biodiversity, *Bromus tectorum,* disturbances, ecosystem processes, ecosystem resilience, ecosystem resistance, fire, invasive plants, livestock, nutrient cycling, rangelands, rehabilitation, restoration, soil organisms, technical assistance

Project Vision

This project shall increase our understanding of natural and human-caused disturbances (e.g., wildfires, livestock, and recreational impacts, etc.) and invasive plants in the Great Basin, and develop strategies to manage, maintain, and restore above and belowground biodiversity and functional ecosystems.

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Background

The Coordinated Intermountain Restoration Project (CIRP) evolved from the Intermountain Greenstripping and Rehabilitation Research Project, or the "Greenstripping Program." The Greenstripping Program was established by the Bureau of Land Management's (BLM) Idaho State Office in 1982 to select plant materials and technologies that can reduce wildfire incidence and improve rehabilitation practices. Implementation of the Greenstripping Program and the research associated with it was stimulated by the realization that the increase in wildfire size and frequency on Idaho's Snake River Plain was not controllable by traditional fire suppression efforts (Pellant, 1990). Nor could BLM's Emergency Fire Rehabilitation (EFR) program replace the native plant communities that were adversely impacted by wildfires and the subsequent increase in flammable annual exotic grasses.

The Greenstripping Program used both short- and long-term proactive approaches to the problems of increasing wildfire frequency and size, and the loss of native vegetation. In the short term, strips of fire-resistant vegetation were planted at strategic locations on the landscape to reduce the frequency and/or size of wildfires. The long-term approach was to reestablish perennial plant communities to return fire frequency and severity to historic levels. A critical element in both the short- and long-term approaches was control of exotic annual grasses through seedbed preparation and establishment of competitive vegetation.

The Greenstripping Program achieved anticipated results with some successes (establishing fire-resistant vegetation that slowed or stopped some wildfires), although some project seedings suffered establishment failures because of drought conditions in the mid-1980s. The research component of the project has also been successful as evidenced by the plant materials selected (four cultivar releases are pending) and planting methods (e.g., row spacing, seeding rates, effectiveness of anchor-chaining) that were developed to improve wildfire rehabilitation success (Anderson and others, 1998, unpub. report to USGS, Forest and Rangeland Ecosystem Science Center; Monsen and others 1999, unpub. report to BLM Idaho State Office).

The program was evaluated in 1991 and 1998 to (1) determine if objectives were being met, (2) determine if current objectives were still appropriate or if modification to future direction of the program was necessary, and (3) assess the scientific value and technology transfer of the research. In 1998, an ad-hoc evaluation team provided a positive review of the program and made several recommendations regarding continued management and direction (see Anderson and others, 1998, unpub. report to USGS, Forest and Rangeland Ecosystem Science Center):

- The program should be expanded with a greater funding base to meet research needs relative to the increasing problem of invasive weeds and fuel management, along with the use of native plants for rangeland restoration.
- A full-time research coordinator should be added to the project to develop the scientific program.
- A scientific oversight committee should be established to assist with the development of scientific goals, help coordinate projects, ensure scientific merit, and increase technical output.
- The project should maintain the dual emphasis of basic research to answer mechanistic questions as well as adaptive management to test and evaluate plant materials used in fuel management and restoration projects.
- The scientific objectives of the Greenstripping Program should expand to include more process-oriented studies and research of larger scale issues, possible interactions of restoration with livestock grazing, and development of improved scientific methods for plant materials evaluation and selection.
- Current direction of the project should emphasize closure on some of the long-term projects and encourage submission of publications to peer-reviewed scientific journals.

Initiatives and Programs Potentially Supported by the Coordinated Intermountain Restoration Project

Great Basin Restoration Initiative

Wildfires burned a record number of acres in the Great Basin during the summer of 1999, resulting in the Great Basin Restoration Initiative (GBRI), which was funded for the Federal fiscal year 2001 at the level of approximately $11 million. The scope of this initiative includes portions of five states and roughly 10 million ha (25 million acres) of public land. Priorities associated with the GBRI include restoring fire-damaged or weed-infested rangelands. The CIRP fits well into the goals of the GBRI by providing more scientific information to conduct successful restoration projects (USDOI, 1999, 2000).

Invasive Species Executive Order

On February 3, 1999, President William Clinton signed Executive Order 13112 establishing the National Invasive Species Council. This Executive order encouraged agencies, including BLM, to research mechanisms of introduction, spread, and control of invasive species, and to procure, use, and maintain native species and healthy plant communities to aid in limiting invasion and spread of exotics. The Executive order also encouraged strong public education and information-sharing programs related to invasive species.

Standards for Rangeland Health

In 1995, BLM grazing regulations were changed to focus public land management on ecosystem health. These regulations spawned the development of standards for rangeland health and guidelines for grazing management for each state (USDOI, BLM Instruction Memorandum No. 2001-079, January 19, 2001). The standards set minimum requirements for proper nutrient and hydrologic cycling and energy flow relative to the ecological potential of a site; the guidelines direct grazing management to promote significant progress towards meeting the standards (e.g., USDOI, 1997). Research funded through CIRP provides managers with information on how to maintain existing, healthy native ecosystems as well as techniques and materials for restoring degraded landscapes. These resources are important for meeting the standards and implementing the guidelines.

Bureau of Land Management Science Strategy

The Bureau of Land Management has identified the role of science in making sound land management decisions and meeting Federal legislative and regulatory requirements for lands administered by the BLM (BLM, 2000a). Specifically, both the 1969 National Environmental Policy Act (NEPA) and 1976 Federal Land Policy and Management Act (FLPMA) prescribe an interdisciplinary approach and integration of scientific data in planning and decisionmaking. The BLM's Strategic Plan for Fiscal Years 2001-05 (BLM 2000b) dictates that the agency will ". . . sustain the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations." The BLM's science strategy also identifies the need to use science proactively to help identify BLM management goals and needs. Examples set forth in the science strategy include addressing invasive species on both regional and national levels.

Fire in a Wyoming big sagebrush – Thurber's needlegrass community on the U.S. Fish and Wildlife Service, Hart Mountain National Wildlife Refuge, Oregon. Photograph taken by Troy Wirth, Oregon State University.

Coordinated Intermountain Restoration Project Objectives

The main objective of the CIRP is to restore species native to rangelands of the northern Great Basin, Snake River Plain, and Columbia Plateau that are infested with exotic annual grasses (primarily cheatgrass, *Bromus tectorum*, and medusahead wildrye, *Taeniatherum caput-medusae*) and that may be threatened with further introductions of secondary exotic invasive plants (e.g., knapweeds [*Centaurea* spp.] and rush skeletonweed [*Chondrilla juncea*]). To accomplish this objective, the project will promote the following: (1) the understanding of ecosystem dynamics following long-term degradation, particularly with regards to fire; (2) the evaluation and selection of plant materials, and the development of site preparation, weed control techniques, and seeding equipment; and (3) the management and monitoring of projects focused on restoration of functioning ecosystems.

The CIRP will not address restoration of forest- or woodland-dominated (juniper [*Juniperus*]) ecosystems. It will not include a component on fuel management to reduce wildfire impacts on rangeland ecosystems, since this is a major charge of the interagency Joint Fire Science Program, but it may address how fuel management techniques may impact ecosystem processes. The beneficiaries of this research include land managers and users of public and private land in the northern Great Basin, Snake River Plain, and Columbia Plateau. The CIRP will provide an integration framework for a multidisciplinary approach to research with numerous opportunities for input and collaboration.

Regional problem analyses have already defined the research priorities to be addressed by the CIRP (Pyke and Borman, 1993; USDA, 1996). A research strategy for Department of the Interior (DOI) lands within the interior Columbia Basin and Snake River Plateau identified rangeland health (including control of exotic plants), restoration of degraded lands, and development of protocols for adaptive management as three of the top five research priorities (Beever and Pyke, 2002). The CIRP already has in place background research and a network of cooperators, as well as management support within the BLM, to provide a base for continued study.

Science Advisory Committee

The CIRP Science Advisory Committee is an interagency, multidisciplinary committee that is responsible for development, review, and revision of the CIRP strategic plan. The committee members will prioritize research needs based on their knowledge of management research needs and based on current publications or reports. The committee will be co-chaired by representatives of the BLM and USGS or by the project manager. The other members will include two research scientists, a plant materials specialist, and a BLM manager. Duties of the Advisory Committee will include (1) critically reviewing proposed study plans associated with this project;

(2) reviewing the need for a project manager and, if the need is sufficient, assisting in preparing a draft position description and providing recommendations for the appointment to the hiring official(s); (3) establishing guidelines for submission and evaluation of future requests for research proposals should additional money become available; (4) reviewing and advising the project manager regarding current and future projects; (5) reviewing annual research reports to insure that projects are addressing the project goals and that deliverable products are received; and (6) reviewing and recommending future budget items. The Advisory Committee will meet annually in the winter to review the previous year's work, adjust plans for the next year, and recommend future budget modifications. During the annual report phase of these meetings additional managers and resource specialists will be invited. Managers and resource specialists will be given an opportunity to hear current research results and to provide insight into the results or to future work related to the project. The Advisory Committee will provide or conduct peer reviews of all study results in publications that are not peer-reviewed (e.g., compiled proceedings), theses, and all final reports stemming from CIRP funds before publication of material, thus insuring adherence to USGS policy.

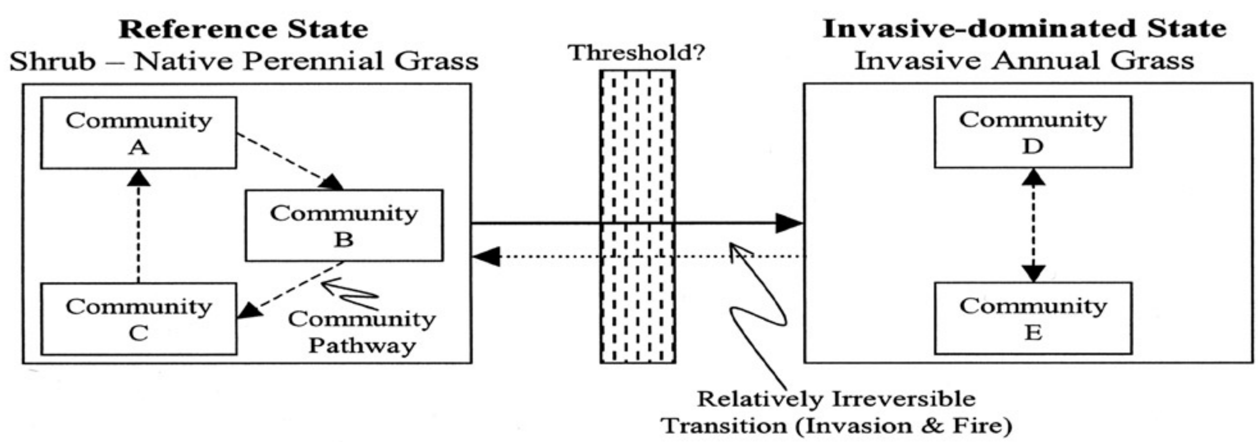
Project Goals

The following section outlines three project goals that are of equal importance. These goals collectively address our need to understand effects of disturbance and invasive plants on ecosystems. To this end, we must understand the structure and function of ecosystems and how to restore these characteristics as well as demonstrate techniques for restoration and monitoring of their recovery. Functional ecosystems are complex and comprise both abiotic (soil, water, air) and biotic components (microorganisms, plants, animals). Loss or modification of either component can have serious effects on the ecosystem as a whole (USDA, 1996). For instance, loss of vegetative cover because of fire or overgrazing can result in accelerated soil loss, which in turn can inhibit reestablishment of vegetation. Therefore, it is critical that the goals integrate a multidisciplinary approach to fully address the intricacies of ecosystem restoration.

1. Understand Ecological Responses to Disturbances and Invasive Plants

Rationale

Restoration research must be built on a foundation of understanding how existing biotic and abiotic systems respond to disturbances (human-induced and natural). Vegetation states, transitions among vegetation states, and unidirectional thresholds leading to alternative vegetation states (Westoby and others, 1989) are thought by many scientists to provide a better explanation of vegetation dynamics in sagebrush grasslands (Laycock, 1991; West, 1988). If thresholds can be identified, then a manager could ascertain if a site will require active restoration (e.g., invasive species control, revegetation, etc.) or passive restoration (e.g., restoration by adjustments in management) to maintain or attain desirable communities. By achieving the objectives of this first goal, subsequent success will be ensured for the second CIRP goal that includes developing both active and passive restoration strategies.



A hypothetical state and transition model for a sagebrush grassland with two ecological states, a reference state and an invasive-dominated state. Each state is connected by a relatively irreversible transition that represents a theoretical threshold between these states. The communities represent the following: Community A – shrubs dominate with perennial grass; Community B – perennial grasses; Community C – equal mix of shrubs and grasses; Community D – annual invasive grasses; Community E – equal mix of shrubs and annual invasive grasses.

Objective 1.1 Define abiotic and biotic thresholds that determine ecosystem recovery potential and the alternative biotic states that may occur once a threshold is crossed.

Discussion: Current ecological theory holds that plant communities can exist in multiple states, and that thresholds exist between states that, once crossed, require active intervention to revert to a former or desired state (Friedel, 1991). One such situation is the conversion of Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) communities in the northern Great Basin and Snake River Plain to annual grasslands dominated by cheatgrass and/or medusahead wildrye (Laycock, 1991). Land managers need to quantify the biotic and abiotic conditions that define the thresholds beyond which restoration of the former native plant community and levels of ecosystem function are improbable (Friedel, 1991). Making management changes prior to crossing this threshold is more economical and timely than implementing expensive, active restoration treatments once the threshold has been crossed.

When rehabilitating plant communities where both cheatgrass and herbaceous native species were present before a fire, it is critical to know what elements contribute to cheatgrass dominance after a fire. Factors that may contribute to cheatgrass dominance and that need further investigation are soil nutrient status, temperature, texture, and other physical properties that influence hydrology and rooting depths; soil microbial populations that affect decomposition and nutrient cycling; and the proportion of native versus exotic species in the prefire community. Resting the recovering native vegetation from grazing is an appropriate response if the "cheatgrass threshold" has not been crossed. However, if the postfire cheatgrass community would suppress recovery of native plants and lead to an increase in future wildfires, then additional site treatment to reduce cheatgrass dominance, followed by reseeding native plants, would be an appropriate course of action. Understanding the threshold between cheatgrass and the native plant community is essential in prescribing post-disturbance treatments.

Objective 1.2 Identify, characterize, and quantify factors and processes that contribute to ecosystem resistance and resilience to invasive plants.

Discussion: Invasion resistance refers to the ability of an ecosystem to retard the entry of invasive plants, while resilience is the ability of the system to recover on its own once disturbance has occurred. If the factors and processes that contribute to resistance and resilience are known, then management can be modified, or active restoration can be implemented to promote these factors or processes.

For example, it has been observed that biological soil crusts in arid and semiarid plant communities on the Snake River Plain impede invasion of cheatgrass by limiting seed-soil contact and appropriate microsites (safe sites) for establishment (Kaltenecker and others, BLM, unpub. data, 1999). Grazing management can be modified to reduce livestock impacts and maintain or increase cover of biological crusts by changing from hot season to cool season grazing (Marble and Harper, 1989; Memmott and others, 1998). Preliminary observations indicate that biological crusts are more resilient during cool, moist periods when they are physiologically active or when the soil surface is frozen than during hot, dry periods (Marble and Harper, 1989). However, level of resilience at various moisture levels depends on soil texture (Belnap and others, 2001). Quantification of these relationships for a broad range of soils would lead to better management prescriptions and might limit cheatgrass invasion and dominance after disturbance on vulnerable sites.

Objective 1.3 Examine the role of temporal and spatial scales of disturbance on the recovery potential of the ecosystem or invasive plant establishment and spread.

Discussion: Sagebrush-steppe landscapes have been modified differently depending on scale. On a landscape scale, continuous stands of vegetation have become increasingly fragmented. Human encroachment on these systems by means such as livestock use and roads have created vectors for exotic plant invasions that contribute to and spread with larger spatial disturbances such as wildfire. At the scale of the community, vegetation has become less patchy and eventually homogenized by invasion of exotic annual grasses. Loss of the local-scale mosaic results in larger, more continuous fires and loss of native plant communities at a landscape level (USDA, 1996).

The areas of concern have arid and semiarid climates where natural plant communities respond to pulses of favorable conditions, primarily with regards to moisture, but also to other resources. Disturbances during dry years have a greater effect than the same disturbances in a normal moisture year. Plant communities impacted (i.e., grazed or burned) during extended drought periods may exceed a threshold for recovery because of the lack of resources for regrowth following disturbance.

Climatic conditions that are favorable to growth and reproduction of native plants can also result in pulses of invasion by exotic species. Information regarding disturbance size and frequency relative to conditions favorable to exotic plants would provide support for adaptive management to minimize impacts when plant communities have low resistance to invasion.

Objective 1.4 Evaluate the effects of disturbances and invasive plants on soil integrity, organisms, and processes.

Discussion: Disturbances such as alterations in natural wildfire patterns and inappropriate livestock grazing may impact soil organic matter, structure, integrity, and stability. These disturbances may also impact soil organisms that enhance both nutrient cycling and nutrient uptake. Short- and long-term effects of both human and natural disturbances are not well known for key groups of soil organisms (e.g., bacterial nitrifiers, bacterial and fungal decomposers, mycorrhizae, nematodes, and microinvertebrates and macroinvertebrates) in arid and semiarid systems. Information is needed regarding whether disturbances change soil organism population structure and dynamics and, if so, also affect decomposition, nutrient cycling, and soil hydrology. This information is pertinent to both the conditions that contribute to the susceptibility of plant communities by invasive nonnative plants, as well as to the success or failure of restoration treatments.

Effects of disturbance could include compaction caused by livestock, human, or vehicular traffic, and removal of aboveground biomass because of fire or grazing. Soil surface compaction reduces water infiltration, as well as activities of soil biota including nitrogen and carbon fixation and decomposition (Belnap, 1995). Removal of aboveground vegetative cover, and, most likely, the biological soil crust, changes litter input as well as soil temperature, which can affect the activity of belowground organisms (Belnap and others, 2001). Mycorrhizal biomass responds to availability of photosynthates that are reduced by vegetative removal, as well as plant community composition (Reeves and others, 1979; Bethlenfalvay and Dakessian, 1984). If subsequent invasion of exotic annual grasses occurs, there is further modification in the spatial quality of the community (Kaltenecker and others, 1999). Current research, funded through the CIRP, indicates that bacterial populations and mycorrhizal potential may not be altered by exotic annual grass invasion (Kaltenecker and others, BLM, unpub. data, 2000). Because there is a lack of understanding how these bacterial populations fit within a functioning, weed-infested community, further research is needed to illuminate mechanisms that contribute to annual exotic grass dominance.

Objective 1.5 Investigate the population biology, life history, and ecophysiological responses of important native and invasive plants to disturbances.

Discussion: Not all native plants respond equally to the same level of disturbance. In natural systems, disturbance drives the dynamic balance in species composition both spatially and temporally. Overall, this information would enable additional understanding of thresholds from a community perspective, assist in selecting native plants for successful restoration, and provide a greater understanding of why invasions occur (even in seemingly intact communities). For

The left side of the photo depicts a cheatgrass-dominated annual grassland, while the right side depicts remnant Wyoming big sagebrush that was not burned in the previous fire. Photograph taken by David A. Pyke, USGS.

example, little is known about the longevity of seeds once they enter the soil and the role of the seed bank as a mechanism for invasion and recovery. Vegetative reproduction is also important for maintenance and survival of perennial plants. Better knowledge of life-history strategies is needed to improve predictions of the response of both native and exotic species to disturbance.

Objective 1.6 Define the relationships between biodiversity and disturbances and/or invasive plants.

Discussion: Progressive conversion of sagebrush ecosystems to exotic annual grasslands is placing numerous sagebrush-dependent species at risk for extinction or at least severe restriction in potential habitat. Recent research in the Snake River Birds of Prey National Conservation Area (NCA) in southwestern Idaho indicates that several species of birds, including sage sparrow (*Amphispiza belli*), Brewer's sparrow (*Spizella breweri*), sage thrasher (*Oreoscoptes montanus*), golden eagle (*Aquila chrysaetos*), and prairie falcon (*Falco mexicanus*) are sensitive to fragmentation of sagebrush habitats. For sage sparrow, Brewer's sparrow, and sage thrasher, their abandonment from the communities appears to be due to loss of nesting habitat and reduction in patch size (Knick and Rotenberry, 1995). For top-level predators, population declines are due to loss of habitat for important prey species, primarily black-tailed jackrabbit (*Lepus californicus*) (USDOI, 1996a). Understanding how species assemblages respond to different levels of disturbance, including less obvious aspects of communities such as the biological crust and soil microbes is needed.

2. Develop Strategies and Appropriate Techniques to Maintain or Restore Functioning Ecosystems

Rationale

Maintenance of functioning ecosystems requires involving and educating land managers to ensure that the future direction of management does not contribute to degradation. Restoration of degraded systems requires management support for both implementation of treatments and protection of the restored area to enhance probability of success. Fuel management strategies will ensure protection of both intact native areas and restoration projects. Fuel management should be pursued from a landscape, as well as from a site-specific perspective; therefore, coordination with land management specialists is critical to identify priority areas based on resource needs. Because availability of native seed appropriate for a broad scope of ecological sites is critical for implementation of restoration projects, CIRP cooperators and land managers need to work with regional producers to ensure seed availability. Cooperation with local operations staff is also essential to ensure (1) availability of proper equipment either within the agency or through private contractors; (2) design of projects that are both scientifically and logistically sound; and (3) proper application of treatments.

Objective 2.1 Develop management guidelines to maintain or achieve acceptable levels of resistance and resilience in currently functioning or at-risk ecosystems.

Discussion: Establishment of management guidelines requires an understanding of the ecosystem in question from both biological and physical perspectives (USDA, 1996). While patterns and processes that define ecosystems are not entirely predictable, long-term ecological research provides invaluable information for predicting ecosystem responses to disturbance or changes in management from both temporal and spatial perspectives. The CIRP will work with managers to assess the effects of timing and levels of disturbance on biological and physical processes and to adapt management prescriptions based on monitoring outcomes. Monitoring indicators need to be identified so that status and recovery of ecosystems can be quantitatively evaluated. In particular, these monitoring indicators need to be sensitive enough to identify systems that are at risk of crossing a threshold where recovery of a site to a stable condition will require active intervention and application of restoration treatments (e.g., application of herbicides and seeding native species).

Because of economic costs and threats to human life from large, repeated fires, improved fuel management strategies need to be developed to reduce wildfire impacts on functioning or restored ecosystems. The Snake River Plain has become an extremely fragmented system where increased fire frequencies have both precipitated the loss of sagebrush steppe habitats and severely limited the ability to complete restoration before a site burns again. Fuel management has been cited as a high priority to increase defensibility of intact communities and restoration projects (Entwistle and others, 2000). Current techniques include greenstripping and mechanical fuel breaks along roads that can be major ignition sources and the use of herbicides to suppress production of fine fuels. Techniques to reduce fuels on a landscape scale should be investigated, including creation of low-fuel areas within larger stands of continuous vegetation. Studies might include a variety of techniques including livestock management (intensive grazing and exclusion), herbicide use, prescribed fire, and enhancement of natural community elements (such as biological crusts).

Objective 2.2 Identify and select native plant ecotypes and develop plant production techniques that will increase the availability of native plants for restoration.

Discussion: Cooperators and local land managers will help the CIRP identify native plant species priorities and select native seed collection sites. Both propagation and large-scale production techniques (planting, harvesting, seed conditioning, storage, culture, and management) for many native plants are still relatively unknown (Roundy and Call, 1988; Young, 1988). Information is needed regarding potential

Revegetating a sagebrush grassland site using a rangeland drill in the BLM Prineville District, Oregon. Photograph taken by Scott Cook, Bureau of Land Management.

and techniques for successful plant establishment on various ecological sites, as well as the ability of various plant accessions to compete with exotic annual grasses. Common garden studies along elevational and precipitation gradients will provide valuable information regarding the ecological amplitude of locally collected ecotypes.

Cooperators as well as local and regional growers will also work with the CIRP to increase seed for use in large-scale projects. Native seed production will increase as seed growers gain the skill and knowledge to grow native plants and as demand for native plants increases. This knowledge can be increased and thus the time required for adequate seed production reduced if culture techniques (row spacing, watering schedule, fertilization, and harvest timing/equipment) can be identified before the selection is given to the seed producer. Properly designed research can provide this information.

Products on seed production should include manuals that discuss seed conditioning, seed storage, germination testing, seedling establishment, stand management of seed production fields, and harvest techniques.

Objective 2.3 Develop site preparation (including weed control) and native plant establishment techniques associated with specific disturbances and sites.

Discussion: A wide range of site conditions exist on rangelands including, but not limited to, steep slopes, rocky soils, weed infestations, degraded soil surfaces (including loss of the biological crust), and unstable sands. Site preparation equipment is not available for all of these site conditions and comparisons among existing site preparation alternatives is rare, especially on many intermountain sites. Herbicide application technology has improved dramatically for cropland application, but little application of this technology has been done for noncrop rangelands.

Seeding technology has improved greatly on agricultural croplands while most rangeland seed application is still done with 1950s technology. Aerial seeding of native plants (especially shrubs such as sagebrush) is commonly implemented with little information available on the benefits of covering the seed (e.g., using an anchor chain or harrow) compared to no seed coverage or allowing natural recovery without seeding. Native plants have unique seedbed placement and germination requirements. For example, the seed of Thurber's needlegrass (*Achnatherum thurberianum*) has a geniculate awn that serves as a self-burial mechanism; however, the seeds are highly dormant, apparently because they have very specific light requirements for germination (Young, 1988).

Considerable research is needed regarding site preparation to enhance native plant establishment on sites with harsh environmental conditions (e.g., salt-desert shrub) and heavy weed competition (Monsen, 1994; Roundy and others, 1997).

Objective 2.4 Develop criteria and monitoring protocols for evaluating restoration and rehabilitation success.

Discussion: There is no well-defined guidance in terms of techniques or protocols for monitoring restoration or rehabilitation projects. Several technical references describe a variety of sampling techniques and plot-selection protocols (e.g., USDOI, 1996b; Elzinga and others, 1998); however, no guidance has been developed specifically to monitor the establishment of seeded species during the first two growing seasons nor the long-term persistence of seeded species beyond the establishment period. In addition, little information is available to go beyond site-level to landscape-level evaluations of restoration and rehabilitation project success. Remote sensing and geographic information system technology needs to be investigated to see if these tools can provide larger-scale information on locations for restoration as well as information about rehabilitation success.

Objective 2.5 Develop postrestoration management guidelines.

Discussion: Bureau of Land Management policy currently dictates that a rest of two growing seasons from livestock grazing should be implemented following fire and/or seeding to allow recovery of burned endemic vegetation or successful establishment of seeded species. This rest period for seeded plants was based on the average time required for crested wheatgrass (*Agropyron cristatum*) to establish (Sonnemann and others, 1981). Native plants were not generally seeded when these guidelines were developed, and the time required for a native seeding to successfully establish has still not been documented well. Shrubs take longer to become reproductive than herbaceous species, and establishment of young plants can be inhibited by trampling disturbance (Meyer, 1994). In addition, the length of time required for biological soil crusts to recover after disturbance has only recently been investigated and is highly dependent on site characteristics (e.g., soil texture and chemistry, aspect, slope) and climatic patterns (Belnap and others, 2001). While it appears that biological soil crusts recover more slowly than the vascular plant community, some development of both appears to be synchronous (Danin, 1978; Danin and Barbour, 1982; Danin and others, 1989; Kaltenecker, Boise State University, unpub. data, 1997). Therefore, nutrient inputs and soil stability imparted by the crust may be important in successional dynamics of the vascular plant community. Further research is needed to understand biological crust recovery and interactions among seeded species, microbial organisms, and vascular plants.

Livestock management strategies that will successfully result in long-term maintenance of restored areas can be inferred from previous management experience and studies. However, earlier studies focused more on increasing or maintaining “key species” (i.e., palatable forage plants) and not on the health and stability of the landscape (i.e., maintenance of properly functioning ecological processes and plant diversity). Management strategies should also include consideration of invasive species and how to increase the resiliency and resistance of intact and restored native plant communities to minimize impacts from these unwanted plants.

Objective 2.6 Evaluate social and economic impacts of alternatives.

Discussion: In recent years, wildfires have burned extensive areas in the western United States, a number of which have affected urban areas. As a result of the public’s heightened awareness of wildfires in urban areas, there has been more opportunity for land managers to educate the public regarding the ecological issues surrounding wildfire, invasive species, and restoration. One such effort was the 1999 workshop on restoration of the Snake River Birds of Prey National Conservation Area (see Entwistle and others, 2000, for results of this workshop), which included members of the ranching and conservation communities as well as researchers and land management specialists.

Regional-scale restorations need to be designed from the perspective of sound science and ecological theory, but they should also integrate aspects of practicality and sustainability from a land-use perspective. Understanding of the complex issues surrounding restoration could be critical for restoration projects that are subject to public review. Surveys addressing issues such as prescribed burning and herbicide use would be helpful in identifying issues that require attention from an educational perspective. Involvement of interested citizen groups might also be helpful for support of controversial issues, for example, securing the assistance of local ranchers in studies regarding livestock grazing and fuel management, or to determine the tolerance of native and restored communities to grazing pressure.

3. Demonstrate and Transfer Scientific Results and Applications

Rationale

Research and demonstration projects funded by the CIRP will provide critical information to public land managers and other clients regarding invasive species control and native community restoration on a regional scale. However, if the program is to be effective, it is critical that project results be disseminated to clients as well as a broader scientific audience. Dissemination will be accomplished through a combination of progress reports and scientifically reviewed, published papers. In addition, practical applications of materials and methods will be illustrated via management-scale research and demonstration projects.

Participants learning rangeland assessment techniques at a monitoring workshop near Warm Springs, Oregon. Photograph taken by David A. Pyke, USGS.

Objective 3.1 Establish management-scale research and management demonstration projects.

Discussion: Regional large-scale, long-term projects will be established to investigate the success of restoration techniques for a range of plant communities, soils, and climates. The first “demonstration research area” will be established near Boise, Idaho, to conduct integrated, management-scale research and demonstration projects on ecology of sagebrush-steppe and salt-desert shrub communities, restoration technologies, ecotype species performance and adaptation, and management techniques necessary to maintain and/or restore native ecosystems in the Great Basin. This area will include disturbed and relatively undisturbed areas within dominant range sites and soil mapping units along an elevational gradient and will be chosen to represent conditions on a regional scale within the Snake River Plain and the Great Basin.

Objective 3.2 Publish research results in scientifically peer-reviewed journals, USGS fact sheets, application-oriented and popular literature.

Discussion: At least one publication will be required of cooperators for each funded project. The audience and target journals will be determined jointly by the CIRP director and project lead. Periodic USGS fact sheets will be developed to highlight research results and management implications of those results.

Objective 3.3 Present results in symposia, workshops, scientific meetings, and Web pages.

Discussion: Regional symposia and workshops are often more locally focused, management oriented, and accessible to field office resource staff and managers. Participation in these events by cooperators helps to assist in dissemination of information to a local audience and provide opportunity for discussion of research results, as well as the availability of materials and methods. Attendance by cooperators at national and international scientific and professional meetings will provide interaction and input from a broader, scientific and professional community. Creation of a CIRP Web page would make current information accessible to a broad audience. The focus here would need to be tiered from the broad goals of the CIRP to specific research projects.

Objective 3.4 Develop, maintain, and enhance decision support tools (e.g., expert systems) for assisting land managers in rehabilitation and restoration of disturbed lands.

Discussion: Decision support systems, such as VegSpec, provide basic information on potential plants to consider when implementing a rehabilitation and/or restoration project. Enhancements that would improve VegSpec might include wildfire rehabilitation treatments, coordination between VegSpec and seed producers who have the seed available, or creation of a GIS-based structure to the data layers.

Objective 3.5 Conduct annual field tours and research and/or management meetings.

Discussion: Annual meetings will be organized to promote information exchange between cooperators and clients. Tours of project or demonstration areas will help promote use of plant materials and methods and increase understanding of CIRP goals by the clients.

Objective 3.6 Promote information exchange, including technical assistance, between research cooperators and land managers, both nationally and internationally.

Discussion: Submission of annual reports from research cooperators to pertinent land management agencies will be required. An annual synthesis report compiled by the CIRP director will be distributed and available to a larger audience to promote program achievements.

Objective 3.7 Provide research and management data and metadata to a project databank.

Discussion: A standardized procedure and format for data reporting will be established by using readily available software (such as MS Access), with a central repository and person dedicated to insuring database maintenance and quality.

Summary and Future Direction

The CIRP is intended to be an interagency, interdisciplinary program that focuses on issues surrounding the restoration of degraded rangelands in parts of the Great Basin. Research funded by the CIRP is intended to focus on both local- and regional-scale studies that integrate a variety of disciplines within a single project. The USGS will, when possible, attempt to leverage its funds devoted toward this project by participating in cooperative research and demonstration efforts that match the CIRP goals. Because of the potentially long duration of restoration studies, funding by CIRP is intended for both the establishment of restoration projects and the initiation of long-term monitoring.

Mechanisms are in place for both short-term review of individual studies to long-term review of the program. The Scientific Advisory Committee will meet annually and review the progress of projects, including mid-course corrections and completion of reports and publications. The Science Advisory Committee (see page 7) will be responsible for soliciting outside assistance for 5- and 10-year national-level reviews (2006 and 2011) of CIRP as well as continued funding for the program.

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Appendix. Prioritized Communities and Species for Management

Prioritized Historical Plant Communities for Restoration (generally in 6-14 inch [15-36 cm] annual precipitation zones)	
Wyoming big sagebrush	*Artemisia tridentata* ssp. *wyomingensis*
Winterfat	*Krascheninnikovia lanata*
Shadscale	*Atriplex confertifolia*
Low sagebrush	*Artemisia arbuscula*
Basin big sagebrush	*Artemisia tridentata* ssp. *tridentata*

Prioritized Invasive Plants for Control	
Exotic Annual Grasses	
Cheatgrass	*Bromus tectorum*
Medusahead wildrye	*Taeniatherum caput-medusae*
Perennial Herbs (secondary to annual grass invasion)	
Russian knapweed	*Acroptilon repens*
Diffuse knapweed	*Centaurea diffusa*
Rush skeletonweed	*Chondrilla juncea*

Prioritized Life Forms and Native Plants for Restoration

Common Name	Taxa	Priority
Native Forbs (need basic germination and establishment information)		
Mountain-dandelion	*Agoseris*	High
Milkvetch	*Astragalus*	High
Hawksbeard	*Crepis*	High
Biscuit-root	*Lomatium*	High
Lupine	*Lupinus*	High
Buckwheat	*Eriogonum*	Medium
Globemallow	*Sphaeralcea*	Medium
Penstemon	*Penstemon*	Low
Balsamroot	*Balsamorhiza*	Low
Native Grasses (local ecotype identification and selection)		
Thurber's needlegrass	*Achnatherum thurberianum*	High
Great Basin wildrye	*Elymus cinereus*	High
Bottlebrush squirreltail	*Elymus elymoides*	High
Needle-and-thread	*Hesperostipa comata*	High
Bluebunch wheatgrass	*Pseudoroegneria spicata*	High
Native Shrubs (enhancing seed production in wildland locations and developing strategies for managing wildland areas for seed production and collection)		
Wyoming big sagebrush	*Artemisia tridentata* ssp. *wyomingensis*	High
Shadscale	*Atriplex confertifolia*	High
Rabbitbrush	*Chrysothamnus nauseosus, C. viscidiflorus*	High
Winterfat	*Krascheninnikovia lanata*	High
Basin big sagebrush	*Artemisia tridentata* ssp. *tridentata*	Medium
Low sagebrush	*Artemisia arbuscula*	Low

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