



CENTRE FOR EVIDENCE-BASED CONSERVATION

Protocol CEE 08-022

Does seeding after rangeland fires mitigate negative impacts on soils and plant communities?

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COVER SHEET

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1. BACKGROUND

Post-fire emergency stabilization and rehabilitation (ES&R) efforts following rangeland fires focus primarily on the re-establishment of a desirable plant community to stabilize soils, minimize erosion, and reduce colonization by undesirable non-native species. Substantial resources are invested in these treatments, but relatively little is known about their effectiveness in achieving the stated objectives. The US General Accounting Office (GAO) identified a need for better information on the effectiveness of post-fire emergency stabilization and rehabilitation methods used by the U.S. Department of Agriculture (USDA) Forest Service and Department of the Interior (DOI) agencies (GAO 2003), based in large part on reviews by Robichaud et al. (2000) and Pyke and McArthur (2002). The most widely used post-fire treatment on rangelands is seeding, primarily with native or non-native grasses, on which there has been minimal research and continued debate over effectiveness and ecosystem impacts (Beyers 2004). The success of seeding depends on many factors, including species selection, climate, terrain, competition with other species, seedbed preparation, and post-seeding management (Monsen et al. 2004). Pyke and McArthur (2002) encountered a significant lack of data when investigating the success of native versus non-native species in these projects, and they also found a trend toward larger and more frequent rangeland fires in the Intermountain West. This trend has continued with recent fires such as the 652,000 acre Murphy Complex Fire in southern Idaho and the 363,000 acre Milford Flat fire in Utah. Furthermore, Beyers (2004) pointed out a lack of data on then-emerging seeding practices, especially increased use of native species and sterile cereal grains for erosion control, as well as seeding to prevent spread of invasive non-native plants. The GAO report and the published reviews have sparked an upsurge in research on seeding effectiveness and agency monitoring of post-fire treatments. This new information is scattered and largely unavailable to managers tasked with recommending ES&R measures on short timelines and limited budgets.

Since publication of the recent reviews (2000-2004), several important developments have altered the context of post-wildfire seeding:

- Areas of high-severity forest fires have increased by as much as an order of magnitude in the Intermountain West, including mega-fires such as the Hayman (Colorado), Rodeo-Chediski (Arizona), and Murphy (Idaho). Climate projections consistently indicate that trends in increasing size and severity of wildfires will continue (McKenzie et al. 2004).
- Recent large rangeland fires, such as the Murphy Complex and Milford Flat fires, have resulted in an even greater need for the use of rangeland seeding to prevent future fires by limiting the invasion of exotic annuals that create substantial fine fuels.
- Scientific studies of post-wildfire seeding and plant community interactions have increased dramatically since 2000, with an extensive body of developing knowledge on the use of native seeds as well as the ecological consequences of non-native seeding.
- U.S. Executive Order 13112 was signed, establishing the National Invasive Species Council to prevent the introduction of invasive species, provide for their control, and minimize the economic, ecological, and human health impacts that invasive species cause.
- Burned area emergency response (BAER), ES&R, and agency personnel have shifted from relying on non-native species to using native species, allocating substantial funds for native seed mixes in the hopes of fostering post-fire environments

characterized by native plant communities that are well-adapted to these habitats and resilient to further disturbance (Wolfson and Sieg, in review).

Because of these developments, it is important that the scientific information available to support management decisions be collected and synthesized into a usable document. Our goal in the present review is to develop a practical, complete, and up-to-date synthesis that puts the latest information on burn rehabilitation seeding in the hands of managers and scientists.

2. OBJECTIVE OF THE REVIEW

2.1 Primary question

Does seeding after rangeland fires reduce soil erosion and protect against invasion of undesirable non-native plant species?

2.2 Secondary questions

Secondary questions include:

- 1) Do environmental, geographic factors, and implementation factors (pre-burn vegetation, post-seeding weather patterns, elevation, soils, timing of seeding, and species seeded) change the effectiveness of seeding after rangeland fires?
- 2) Does seeding and transplanting shrub species help to improve plant communities after fire and establish patches of seed sources for future expansion?
- 3) Does livestock enclosure for two years post-fire provide adequate protection to seedlings?

3. METHODS

3.1 Search strategy

The following sources will be searched;

- Internet search engines and databases supported by the Valley Library, Oregon State University, USGS, including but not limited to Web of Science, Forest Science Database (Ovid), JSTOR, Scopus, Scirus, Google Scholar, and Google (first 50 results).
- U.S. government databases (U.S. Department of Agriculture, Forest Service publications and proceedings)
- Libraries at universities with rangeland and natural resources programs (M.S. and Ph.D. theses).
- Agency reports, specifically BLM ES&R monitoring reports from 2002-2006 and Forest Service BAER monitoring reports since 1998.

Search terms:

All combinations of the following search terms will be used:

- Fire OR wildfire OR burned AND:
- Seeding, rehabilitation, stabilization, revegetation, erosion, invasives, weeds, cheatgrass, *Bromus tectorum*, medusahead, *Taeniatherum*

caput-medusae, chaining, spraying, herbicide, disking, drilling, reseeding, grazing.

- Additional search terms may also be included using various combinations of those already mentioned. This may include using wildcard characters to search for alternative suffixes for each of the search terms.

3.2 Study inclusion criteria

- **Relevant subject(s):** Rangeland ecosystems of the western USA. The synthesis will include rangelands (grasslands through pinyon-juniper and chaparral) in the 12 western states (South Dakota through the West Coast). Information from studies conducted outside of the USA will also be considered for inclusion.
- **Timeframe:** All relevant studies.
- **Types of intervention:**
 - Seeding of herbaceous plants.
 - Seeding and transplanting of shrubs.
 - Combinations of seeding in conjunction with other post-fire rehabilitation activities such as herbicides.
 - Methods and timing of seed delivery (planned and actual) including aerial, ground-based broadcast, and seed drills.
- **Types of comparator:**
 - Rangeland seeding versus not seeding
 - Rangeland transplanting versus not transplanting
 - Livestock exclusion versus no exclusion after seeding
- **Types of outcome:**
 - Cover, density, or biomass of herbaceous plants.
 - Cover, density, or biomass of shrubs.
 - Cover, density, or biomass of invasive non-native plants.
 - Plant community composition: nativity, richness, diversity.
 - Species selected for seeding (non-native and native).
 - Soil stabilization variables.
 - Costs of seeding.
- **Types of study:**
Studies investigating effects of seeding and/or transplanting after rangeland fires (non-forest).

3.3 Potential effect modifiers and reasons for heterogeneity:

There is substantial heterogeneity in the rangelands of the USA. This heterogeneity is associated with the latitudinal and elevational gradients, climate, complex topography, and soil types where these rangelands occur. Wildfires burn heterogeneously as well, and important post-fire effects can have a stochastic component (e.g., erosion is not a simple function of terrain and fire severity, but also of the chance of a strong rainstorm occurring soon after the fire). There is heterogeneity in pre-existing propagule sources (seed bank), vegetation resilience, and nearby sources. Finally, management interventions vary widely in terms of the species selected for seeding and the

timing and methods of seed delivery. Where available from included studies, data will be collected on these potential effect modifiers and their effects explored at the data synthesis stage.

3.4 Study quality assessment

Studies will be evaluated based on the types of methodological design employed, with the greatest weight given to replicated randomized experiments and less to observational and opinion studies.

- Replicated randomized experiments
- Before-after control-impact (BACI) studies
- Multiple location case studies
- Single location case studies
- Observational studies
- Expert opinion
- Monitoring report with quantitative data
- Monitoring report with qualitative data
- Other categories as appropriate

3.5 Data extraction strategy

All studies included at full text will be read by two members of the review panel. We will assemble review information in a master database, recording qualitative and quantitative aspects of the studies.

3.6 Data synthesis

Narrative synthesis will be done by the review panel after reading the studies. We will assemble basic data about the studies reviewed (e.g., number of studies identified in the search, number and percent deemed relevant for review, distribution of geographic locations and information type). We will focus on evidence from literature regarding the specific outcome variables. These will probably be grouped into a few categories: success of seeded plant establishment (cover, biomass, community dominance), ecological effects (soil stabilization, non-native plants), and management trends (costs, species selected). We will draw inferences about the similar and different effects of treatments and highlight areas where further research is needed.

4. POTENTIAL CONFLICTS OF INTEREST AND SOURCES OF SUPPORT

The review is led by researchers from the USGS, Forest and Rangeland Ecosystem Science Center and the USDA Forest Service, Pacific Southwest Research Station who have contributed to the literature on this topic. We will address the possibility of conflict of interest by following the review process through CEE and additional reviews solicited from scientists who are not on the review panel and not affiliated with the lead institutions.

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