



CEE review 08-023

DOES SEEDING AFTER SEVERE FOREST FIRES IN WESTERN USA MITIGATE NEGATIVE IMPACTS ON SOILS AND PLANT COMMUNITIES?

Systematic Review Protocol

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1. BACKGROUND

Rehabilitation efforts following severe forest fires, the largest and mostly damaging of which tend to burn on public lands of the western United States, commonly focus on re-establishment of a growing 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 ecological effects or cost:benefit ratios. The U.S. 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 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 is seeding, primarily with native or non-native grasses, on which there has been considerable 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). 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 burned area assessment teams on tight timelines to recommend stabilization measures.

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 (CO) and Rodeo-Chediski (AZ). Climate projections consistently indicate that trends in increasing size and severity of wildfires will continue (McKenzie et al. 2004).
- Severe burning up to and within urban areas has presented new challenges for post-fire rehabilitation, for instance in the Cerro Grande fire, Los Alamos (NM).
- 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.
- Signing of Executive Order 13112 establishing the National Invasive Species Council to prevent the introduction of invasive species and provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause.
- Burned Area Emergency Rehabilitation (BAER) teams and agency staff have shifted from relying on non-native species to native species, allocating substantial sums 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 striking trends, it is clear that the opening decade of the 21st century has been characterized by a sea change in the scale of severe fires, the scientific information available to support management decisions, and the choices made by managers for post-fire seeding. 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 severe forest fires mitigate negative impacts on soils and plant communities?

2.2 Secondary question (*if applicable*)

Secondary questions include: 1) What are seeding effects on soil stabilization and invasion by non-native species? 2) What are trends in seeding of specific species, especially the use of native species, over time? 3) What are the findings in regions beyond the western USA?

3. METHODS

3.1 Search strategy

- Internet search engines and databases supported by Cline Library, Northern Arizona University: Ingenta, Forest Science Database (Ovid), JSTOR, Google Scholar.
- U.S. government databases (U.S. Department of Agriculture, Forest Service publications and proceedings)
- Libraries at universities with Forestry programs (M.S. and Ph.D. theses).

Search terms to include: seeding AND fire, seeding AND wildfire, seeding AND burn, seeding AND native species, seeding AND erosion.

3.2 Study inclusion criteria

- **Relevant subject(s):** forests of the USA, predominantly coniferous forests of the West but information from any burned forests will be included.
- **Timeframe:** There are multiple timeframes to consider. First, studies since the review by Robichaud et al. (2000) will be exhaustively assessed for inclusion. Second, any relevant studies from 1970-present will be included as appropriate, especially if these studies were not included in previous reviews. References that appear in the literature to relevant earlier research will be tracked down.
- **Types of intervention:**
 - Seeding of herbaceous plants.
 - Seeding of shrubs.
 - Combinations of seeding in conjunction with other post-fire rehabilitation activities such as mulching, water-bars, tree-felling on terrain contours, etc.
 - Methods and timing of seed delivery.
- **Types of comparator:**
 - Replicated randomized experiments
 - Before-after control-impact (BACI) studies
 - Observational studies
 - Expert opinion
- **Types of outcome:**
 - Cover and biomass of herbaceous plants.

- Cover and biomass of shrubs.
- Cover and 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 after severe forest fires.

- **Potential reasons for heterogeneity:**

There is substantial heterogeneity in the forests of the USA, even among the western forests where the greatest amount of information is likely to be found. This heterogeneity is associated with the latitudinal and elevational gradients where these forests occur and ecotones with adjacent ecosystems. 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) and nearby sources. Finally, management interventions vary widely in terms of the species selected for seeding and the timing and methods of seed delivery.

3.3 **Study quality assessment**

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

3.4 **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 spreadsheet, recording qualitative and quantitative aspects of the studies.

3.5 **Data synthesis**

Data 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 Northern Arizona University and the USDA Forest Service who have contributed to the literature on this topic. We will address the possibility of conflict of interest by following the review process through CEBC and additional reviews solicited from scientists who are not on the review panel and not affiliated with the lead institutions.

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