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Evaluating the Effects and Effectiveness of Post-fire Seeding Treatments in Western Forests

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Joint Fire Science Program

Fire Science Brief

RESEARCH SUPPORTING SOUND DECISIONS

Hillslope seeded with wheatgrass species, a grass commonly used for post-fire seeding treatments. Credit: USDA Forest Service.

Evaluating the Effects and Effectiveness of Post-fire Seeding Treatments in Western Forests

Summary

High-severity wildfires can profoundly affect soils and plant communities, thus requiring emergency rehabilitation treatments such as post-fire seeding. Intended to stabilize soils, reduce erosion, and combat non-native species invasions, post-fire seeding is typically one of the first treatments used by most U.S. natural resource agencies. But despite its widespread use, there is still doubt about the treatment's actual effectiveness and ecological impacts. Therefore, researchers conducted a study to gain more definitive insight on the ecological effects and usefulness of post-fire seeding. The first part of the study involved an evidence-based review of scientific articles, theses, and government publications to address questions on soil erosion, non-native plant invasion, and native plant community recovery. Researchers then analyzed Forest Service Burned Area Reports to assess seeding trends related to species, costs, and area seeded.

Key Findings

- In studies that evaluated soil erosion in seeded versus unseeded controls, 78 percent revealed that seeding did not reduce erosion relative to unseeded controls. Even when seeding significantly increased vegetative cover, there was insufficient plant cover to stabilize soils within the first two years after fire.
- Sixty percent of the studies reported that seeding deterred native plant recovery in the short-term.
- Out of 11 papers that evaluated the ability of seeding to curtail non-native plant species invasions, 54 percent stated that seeding treatments were effective and 45 percent stated they were ineffective.
- Forty papers and 67 Burned Area Reports dated between 1970 and 2006 revealed an increased use of native species and annual cereal grains/hybrids during seeding treatments over time, with native species dominating seed mixes.
- From 2000 to 2007, total Burned Area Emergency Response (BAER) seeding expenditures have increased substantially, reaching an average of $3.3 million per year—a 192 percent increase compared to the average spent over the previous 30 years.

The need for seed

As the number, size, and severity of wildfires escalate across the western U.S., so does the need for post-fire rehabilitative efforts. In fact, U.S. land management agencies such as the Bureau of Land Management (BLM), Forest Service, and National Park Service, are required by federal policy to conduct emergency post-fire rehabilitation measures to stabilize soils and prevent further degradation to the landscape. For this purpose, the most commonly used treatment is broadcast seeding.

Broadcast seeding, which includes aerial or ground-based seeding treatments, is applied to reduce soil erosion and increase vegetative cover, while minimizing the growth and spread of non-native plant species. Non-native perennials or short-lived annuals are often used for these treatments; however, the use of seed from native species is preferred, as there is concern that non-native species will hinder native plant recovery. In addition, contaminated seed mixes can introduce invasive species and stimulate competition with recovering native plant communities. While native species use has increased over time, it is not always possible, due to high costs and inadequate availability.

With the increase in post-fire seeding, it became necessary to examine and quantify the effectiveness and ecological effects of these treatments. To accomplish this objective, researchers conducted a study that included an evidence-based review of post-fire seeding literature and an assessment of Forest Service Burned Area Reports to examine seeding trends.

Assessing post-fire seeding success

Systematic reviews are commonly used in the medical sciences industry but are a relatively new approach for natural resource disciplines. The methodology used is rigorous and includes a predetermined protocol to ensure that the synthesis of available literature is unbiased, thorough, and evidence-based. For this study, researchers began their evidence-based review by conducting an extensive search of theses, scientific articles, agency monitoring reports, and government publications related to post-fire seeding. By targeting appropriate literature, researchers hoped to answer the following questions:

Seeded area (left) versus an unseeded area (right) on the Warm Fire, Kaibab National Forest in Arizona. Seeded annual ryegrass visibly suppresses post-fire native plant recovery. Credit: Melissa McMaster, National Park Service, Grand Canyon.

- Does seeding after severe forest fires reduce soil erosion?
- Is seeding effective at reducing non-native plant invasion in burned areas?
- Does post-fire seeding affect native plant community recovery?

Criterion were used to rate the quality of the evidence—from highest to lowest—based on design and statistical robustness. In addition, researchers evaluated post-wildfire seeding effectiveness based on the treatment's effectiveness in reducing: (1) erosion and sedimentation; (2) non-native species invasion; and (3) effects on native plant community recovery. Each study or individual site within a study was given an effectiveness rating.

First year's growth of emergency reseeding after the Los Alamos fires in New Mexico. Species planted included prairie junegrass, slender wheatgrass, mountain brome, three awn, gambel's oak, and mountain mahogany. Credit: Jeff Vanuga, USDA Natural Resources Conservation Service.

The second part of the study focused on the overall trends of post-fire seeding costs, area seeded, and use of native seed over time. Researchers reviewed unpublished documents, theses, scientific literature, government publications, and summaries of 1,164 Forest Service Burned Area Reports. Only specific quantitative information on evolving seeding trends was accepted, including area and amounts of seed used, seed sources and species selected, total seeding costs, and cost per hectare seeded.

Types of plant species seeded were characterized as non-native or native, typically based on the author's classifications. Consequently, definitions of "native" differed between papers. To help determine nativity, researchers used the Natural Resource Conservation Service (NRCS) Plants Database. In addition, when available, information on the geographic origin of seed sources was extracted.

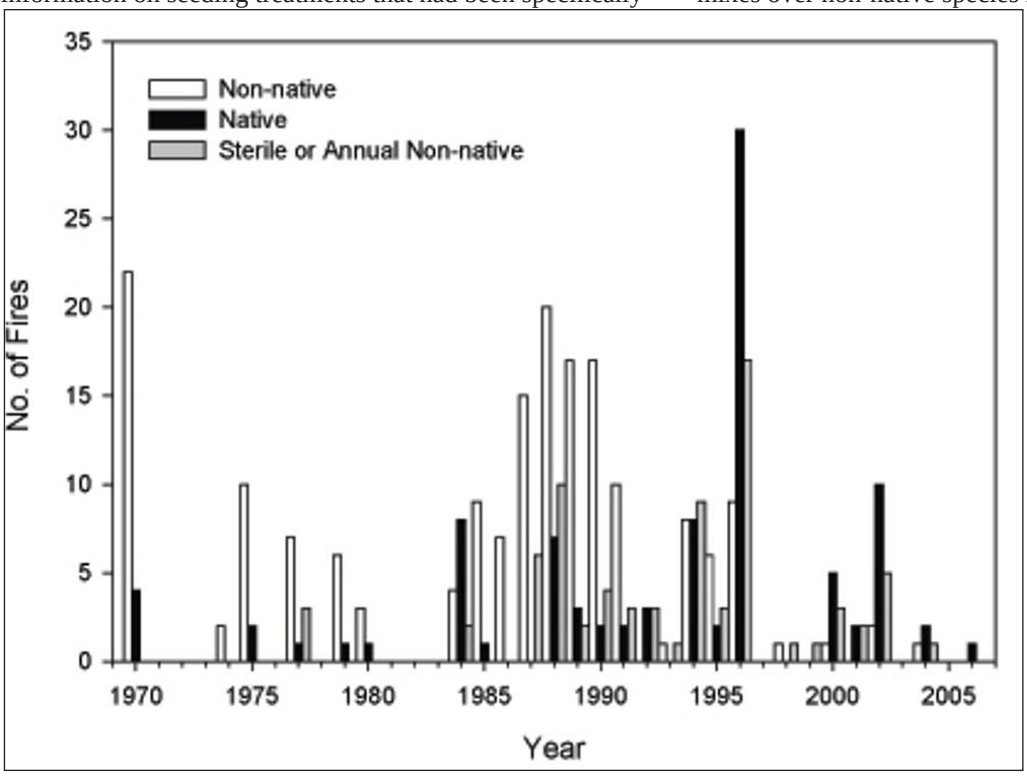
The BLM regional seed warehouse in Boise, Idaho. Most seed procured by the BLM for post-fire seeding is native. Credit: Scott Lambert, Retired BLM.

After the review: Results revealed

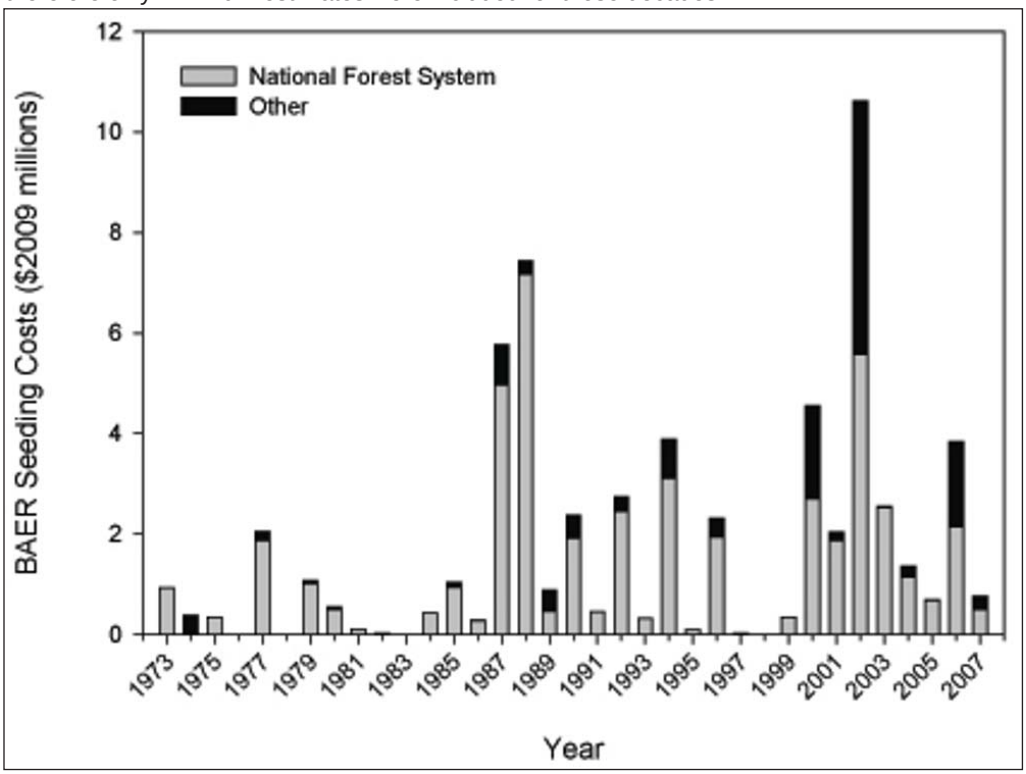
After applying specific inclusion criteria, 94 of approximately 19,455 studies were considered relevant for the evidence-based review portion of this study. Research results related to soil erosion, non-native plant invasions, and native plant community recovery are as follows:

- According to 78 percent of the studies that evaluated soil erosion in both seeded and unseeded areas, seeding did not reduce erosion relative to unseeded controls. Even when seeding significantly increased vegetative cover, there was not enough plant cover to stabilize soils within the first 2 years after fire.
- Out of 11 papers that evaluated the effectiveness of seeding to curtail non-native plant invasions, 54 percent indicated that seeding treatments were effective and 45 percent indicated that the treatments were ineffective. Of those treatments that were regarded as effective, however, 83 percent used non-native species (i.e., grasses and cereal grains).
- Sixty percent of the studies indicated that seeding suppressed native plant recovery. However, long-term impacts were not studied.

To determine trends in post-wildfire seeding, researchers selected 380 Forest Service Burned Area Reports, out of a total of 1,164, because they contained information on seeding treatments that had been specifically conducted in forested ecosystems. From these reports, data indicated an increase in the use of native species and annual cereal grains/hybrids, with native species dominating seed mixes over non-native species in recent years.



Number of fires seeded with non-native, native, and annual cereal grain species between 1970 and 2005. Graph shows only seeded species used on at least three fires for rehabilitation. For the 1970s and 80s values, there was an incomplete collection of Burned Area Reports, therefore only minimum estimates were included for those decades.



BAER seeding costs in forested ecosystems by national forests and other entities that include national forests. Only minimum estimates for the 1970s and 1980s were used.

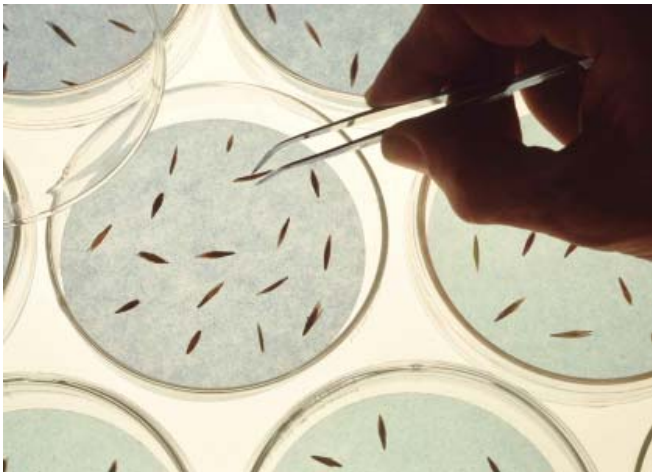
In addition, total Burned Area Emergency Response (BAER) seeding expenditures have increased exponentially, by 192 percent over the past decade (compared to the average spent during the previous 30 years), reaching an average of $3.3 million spent annually. In the 1970s, the percentage of total burned area that was seeded averaged 21 percent compared to only 4 percent between 2000 and 2007, however the cost per acre seeded has risen over time. This inflated cost is likely due to the increased use of more expensive native species.

"Our results are well in-line with previous reviews but the big difference versus the last major review, published in 2000, is that there has been a wealth of new, well-documented studies. These studies used statistically sound experimental designs to provide more rigorously tested information about post-fire seeding. Incorporating all the new data in our review, we found that earlier reviews describing the lack of efficacy of seeding were supported, but now with much more solid evidence," stated Donna Peppin, Co-Principal Investigator.

Careful considerations

According to the literature review and monitoring data, seeding is not a reliably effective post-fire treatment for short-term soil protection

or native plant recovery. Therefore, it is critical for land managers to carefully consider the tradeoffs associated with these treatments. For example, seeding with non-native species, sterile hybrids, or cereal grains may provide quick vegetative cover, however, the species may persist longer than desired and therefore suppress native plant community recovery. In addition, non-local genotypes of native species are available and still used, but these types of species can compromise the diversity and composition of local gene pools. And, even though use of native seed has increased, costs remain high and supplies are limited.



Continued investigation of seed types is imperative. Here, grass seeds are undergoing germination testing at the NRCS National Plant Materials Center in Maryland. Credit: Tim McCabe, USDA Natural Resources Conservation Service.

When considering post-fire seeding treatments, researchers recommend:

- Weighing treatment costs/benefits and using alternative rehabilitation methods that have been proven to be more effective, such as various types of mulch that are free of non-native seed.
- Monitoring post-fire environments closely to detect the invasion of non-native species and using rapid response methods to contain, deny reproduction of, and eliminate these invasions.
- Using locally-adapted, genetically appropriate plant materials whenever and wherever possible.

To be continued…

The collaboration between researchers and land managers helped provide this study with a solid blend of scientific and on-the-ground experience. Yet, research on post-fire seeding treatments is far from over. Specifically, a greater understanding of long-term effects is needed. Peppin stated, "Our findings underscore the importance of further research in this arena. Of critical importance is the need for well-designed studies addressing long-term effects and effectiveness of seeding, in particular the use of native species and cereal grains or cereal/grass hybrids on burned landscapes." Research on the genetic implications of using non-local genotypes of native species for post-fire seeding is also critical.

"Our findings underscore the importance of further research in this arena."

Management Implications

- Weigh the costs/benefits of seeding treatments and consider using alternative rehabilitation methods shown to be more effective, such as mulching (using mulch that is free of non-native seed).
- Encourage the development of locally-adapted, genetically-appropriate seed sources and limit use of non-local, or unknown, genotypes until seed transfer zones of species used during post-fire seeding are defined.
- Monitor post-fire environments closely and use rapid response methods to help detect, contain, and potentially eliminate invasions of non-native species.

Further Information: Publications and Web Resources

Peppin, D.L., P.Z. Fule, C.H. Sieg, J.L. Beyers, and M.E. Hunter. 2010. Post-wildfire seeding in forests of the western United States: An evidence-based review. Forest Ecology and Management 260:573-586.

Peppin, D.L.,P.Z. Fulé, C.H. Sieg, M.E. Hunter, J.L. Beyers, and P.R. Robichaud. Recent trends in post-wildfire seeding: Analysis of costs and use of native seed. *International Journal of Wildland Fire*. In press.

Project Website: http://www.eri.nau.edu/en/intermountain-west/jfsp-post-wildfire-seeding-review

USDA Natural Resource Conservation Service Plants Database: http://plants.usda.gov/

Scientist Profiles

Pete Fulé is a Professor with the School of Forestry at Northern Arizona University. His research interests include ecological restoration, fire ecology, and Cordilleran forest ecology, specifically in the southwestern United States and northern Mexico. Dr. Fulé earned a BA from Vassar College and an MS and PhD from Northern Arizona University.

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Donna Peppin is currently the Native Plant Nursery Manager at Glacier National Park. Her background focuses on botany and ecological restoration and she is specifically interested in the use of locally-adapted native plant materials for use in restoration activities. Donna earned a BS in Environmental Science from Northern Michigan University and a MS in Forestry from Northern Arizona University.

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Results presented in JFSP Final Reports may not have been peer-reviewed and should be interpreted as tentative until published in a peer-reviewed source.

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