Precision Restoration

Research collaboration between The Nature Conservancy and USDA-Agricultural Research Service

What is the problem?

Management of sagebrush habitats in the western US is at a crossroads. In upper elevation habitats, substantial progress has been made in identifying and implementing effective conservation practices to reduce threats like conifer encroachment to maintain and restore plant communities. However, lower elevation habitats face different stressors, primarily exotic annual grass invasion and large-scale wildfire, and little progress has been made in developing a successful response to these threats. Low elevation habitats make up the majority of the sagebrush steppe, and restoring these areas will be critical for maintaining populations of sagebrush-obligate species. Exotic annual grasses dominate or otherwise impair over 60 million acres in the western U.S., can establish and out-compete native perennial species in the post-fire environment, and persist due to their tolerance of repeated fire. Wildfire frequency and size have increased dramatically in recent years (see map below), in part due to the continuous fuel bed associated with annual grass plant communities. In 2012 in southeast Oregon alone, over one million acres of sage-grouse habitat (nearly 10% of the core habitat in the state) was lost in three large wildfires.

Post-fire rehabilitation efforts, such as seeding, require tremendous resources and often fail, yet the amount of seeding being applied is increasing as a result of accelerated habitat loss to fire. Generous analysis of rangeland restoration projects indicates maybe a 20% success rate on the 10’s of millions of dollars spent annually by federal agencies on these efforts.

What have we been doing to solve the problem?

USDA-Agricultural Research Service scientists working at the Eastern Oregon Agricultural Research Center (EOARC) are engaged in a long-term effort to determine ecological barriers to establishing perennial vegetation in low elevation sagebrush habitats. This approach is very different from previous efforts that emphasized refining field restoration practices in the absence of a definite understanding of the ecology underlying past failures.

To date, this research has resulted in a series of important breakthroughs including:

- Determined the integral role of large perennial bunchgrasses in preventing annual grass invasion.
- Determined that seedling emergence, not germination (as previously assumed) is most often the limiting demographic stage for seeded perennial grasses.
- Determined the role of a host of environmental factors (e.g., freezing soils, soil crusting, fungal attack) in limiting establishment of seeded perennial species.
The current focus of EOARC is to combine knowledge of seedling ecology with seed amendment technology to create what we term as “Precision Restoration”. Cumulatively, these efforts have resulted in scores of peer review journal publications, patent applications, and cooperative agreements with private industry partners to market emerging technologies (search EOARC publication database: http://oregonstate.edu/dept/EOARC/publication).

What is Precision Restoration and what has it accomplished?

Precision Restoration is the ability to: a) define ecological barriers to seedling establishment at a given ecological site, and b) apply the appropriate seed amendment(s) to overcome said barriers and increase seedling establishment. Scientists from The Nature Conservancy (TNC) and the EOARC are working cooperatively to demonstrate the efficacy of our Precision Restoration approach. With funding from The Collins Foundation and industry partners, we are in the final stages of testing six specific seed amendment technologies. In small plot trials, these technologies have shown substantial improvement in seeding success (3 to 15-fold increase) for both grasses and sagebrush (see attached graphics for some examples of technologies tested). This approach of blending ecologically-based knowledge with seed-coating technology, combined with our unique collaboration between a leading federal research agency, a major conservation organization and private industry, has positioned TNC and EOARC to offer an arsenal of potential solutions to restore low elevation sagebrush habitats.

What are we proposing to do and what are the expected outcomes?

We are confident that our Precision Restoration approach has the potential to dramatically improve rangeland reseeding success and subsequently transform how rangelands are restored. While the groundwork has been laid for achieving this goal, further research and development is required before commercially available products and restoration guidelines are available for large-scale application. Expected outcomes of this work include:

- Continued development of innovative seed enhancement technologies specifically designed to overcome ecological barriers constraining successful restoration of sage-steppe habitat.
- Determination of where and when specific seed enhancement technologies should be applied across heterogeneous landscapes.
- Expanded manufacturing capacity to mass produce seed enhancements demonstrated to be successful in small- and mid-sized field trials for large-scale evaluation, demonstration, and implementation.
- Added science capacity to effectively evaluate Precision Restoration across a broader spectrum of climatic variation, soils, and management scenarios. Additionally, added science capacity would enable evaluation of a greater number of species for treatment with seed enhancement technologies.
Examples of Precision Restoration Technologies

A. Illustration of a seed coated with a soil surfactant to overcome hydrophobic soil conditions. B. Precipitation releases the surfactant into the soil overcoming the water repellent layer, resulting in a hydrophilic conduit within the microsite of the seed. C. Enhanced soil moisture promotes seed germination and seedling survival.

A. Illustration of seedling emergence being impeded by a physical soil crust layer, and B. multiple seeds in an extruded pellet are able to push through the soil crust.

A. Illustration of seeds attached to a seed pillow. B. Precipitation melts the pillow material over the seeds and enhances seed/soil contact and seedling growth. Photos showing (C) a single seedling grown from non-treated seed and (D) seedlings growing from a seed pillow.

Photo showing three pots planted with cheatgrass and bluebunch wheatgrass seed. A) No treatment was applied and cheatgrass dominated the growing space. B) Soil was treated at 8 oz/acre with the pre-emergent herbicide imazapic, both cheatgrass and bluebunch wheatgrass growth was arrested. C) Bluebunch wheatgrass seed was incorporated into a seed pillow of activated carbon (to deactivate herbicide in the immediate vicinity of planted bluebunch wheatgrass) prior to applying imazapic at 8 oz/acre, and bluebunch wheatgrass grew while cheatgrass was suppressed.
Habitat and economic benefits of increasing native reseeding success via Precision Restoration