WASHINGTON STATE UNIVERSITY EXTENSION

SEEDING AFTER FIRE

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Abstract

Soil stabilization is a primary goal in vegetation management following either wild or prescribed fire. Hot fires which kill perennial herbaceous cover create significant risk for soil erosion and invasion of annual grasses. However, perennial bunchgrasses often survive wildfire and must be encouraged to produce seed in the first two years after a fire. In plant communities where invasive annual grasses were present before fire and perennial grass species are a minor portion of species composition, artificial regeneration through seeding is recommended. Site selection is important: shallow, rocky soils may exhibit very low success rates. Site preparation is also critical for seeding success; this usually includes broadleaf weed control and may include chemical treatment for invasive annual grasses and broadleaf weeds. Finally, seeded species should be chosen carefully: species should match the capacity of the soil and overall management goals for the land.

Introduction

Dry season Intermountain West wildfires often leave in their wake much exposed soil through near-elimination of both plant canopy and litter cover. Exposed soils are at great risk of wind and water erosion, especially in the first significant precipitation event following the fire (Figure 1). Re-establishment of herbaceous cover, especially grasses, as soon as possible after a fire is critical to stabilizing topsoil, capturing precipitation, and resisting undesirable plants in the first growing season following the fire.

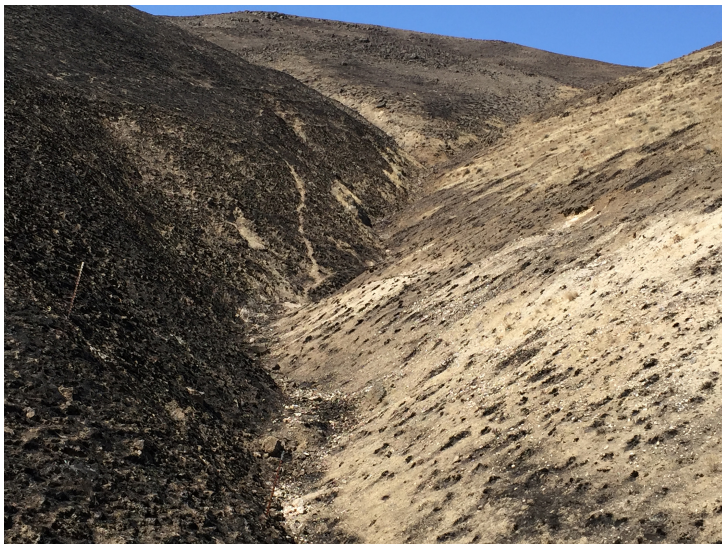

Figure 1. Steep burned slope without plant cover.

Ecosystems in this region are adapted to periodic fire, and research shows that a healthy stand of grasses and forbs will usually recover without human intervention within two to three years. However, many wildfires occur where invasive annual grasses have moved into natural plant communities. These are at greater risk of frequently recurring wildfire.

Several questions need to be answered before seeding after a wildfire. First, is seeding necessary? This involves evaluating the severity of the fire and the pre-fire vegetation composition in order to determine the likelihood and timing of its recovery.

Second, what is the goal of seeding? Soil stabilization, establishing a native plant community, competition with a known heavy weed load, wildlife habitat improvement, and providing forage for domestic livestock are among the dominant objectives for undertaking seeding, whether following wildfire or not. After fire, the need to stabilize burned soils may dictate a species mix that prioritizes ease of establishment or fall germination.

Third, if seeding is determined as the best course of action, what species does one purchase, how many species should be in a purchased seed mix, how and when should seed be applied, and what follow-up care is necessary to ensure stand establishment?

To Seed or Not to Seed

Land with perennial grass cover usually recovers from wildfire within two to three years. Grass species with finer leaves and a denser growth form, such as Idaho fescue, needlegrasses, and rough fescue, tend to be more susceptible to destruction by fire. Grasses with a taller growth form and more disperse leaf patterns, such as bluebunch wheatgrass, squirreltail, and Sandberg bluegrass, tend to be resistant to mortality from fire.

Cheatgrass Areas. One of the greatest risks from wildfire in the Intermountain West is conversion of low-condition shrub-steppe to cheatgrass, sometimes called downy brome (Miller et al. 2011). The bare ground and nutrient flush caused by wildfire promotes high germination rates of cheatgrass already present (Figure 2).

Cheatgrass germinates in the fall, which gives it an advantage over perennials germinating the following spring. The increase in cheatgrass abundance notoriously increases fire frequency, producing a feedback loop, or “snowball” effect, which has converted millions of acres of rangeland from a sagebrush-perennial grass community to cheatgrass and sagebrush. This conversion to a new, less desirable stable state is often the result of combined disturbances, such as overgrazing and fire.

Figure 2. Burned rangeland with cheatgrass infestation, especially on disturbed soil such as firebreaks.

Soil Stability. Areas at highest risk of soil erosion are those that had poor perennial grass cover before a fire. These often include areas where the forest or shrub canopy was very dense, leaving little herbaceous cover, such as grasses, in the understory. The roots of shrubs and short trees provide some soil stability, especially deep in the soil profile, but grasses and forbs are primarily responsible for holding fine soil particles together, promoting soil aggregates, and preventing sediment loss. Where perennial grasses are absent, little remains below the soil surface after a fire to stabilize bared soil.

Further, the litter (dead plant material) which is deposited on top of the soil surface by grasses each fall and winter provides physical buffering of raindrop impacts, slows evaporation of soil moisture, and keeps soil cool. While rangeland planting/seeding has not been directly correlated to erosion control in published studies, the link between soil cover and soil stability is well documented (Nearing et al. 2005; De Baets et al. 2006).

Perennial Grasses. Fires on rangeland often move so fast that grass plant crowns survive even though everything is black and the shrubs and trees are dead. If this is the case, perennial grass will often "green up" in response to fall moisture (Figure 3). In fact, where perennials were present before fire, these "herbaceous species recover within two to three years post-fire, regardless of the season of the burn" (Fuhlendorf et al. 2011); further, seeding efforts have been shown in places to impede natural recovery where native species did not experience high mortality (Dodson and Peterson 2009).

The notable exception is where invasive annual grasses are present because they expand predictably and dramatically following fire (Miller et al. 2011). Big sagebrush-dominated plant communities, which burn hot, are at great risk of cheatgrass invasion, but because they usually leave a very clean seedbed behind and occur on higher potential soil types, these sites are good candidates for seeding.

Figure 3. Surviving perennial grass after fire.

Prioritization of potential seeding sites, then, includes soils with poor perennial grass cover and areas that have greater likelihood of supporting seeded plants (i.e., sites with some soil depth).

Heavy rainfall after fire is likely to cause severe erosion on steep slopes regardless of efforts to minimize erosion (Figure 4).

A 2011 literature review of 52 studies found that all but two studies concluded that weed control was either necessary or beneficial to successful establishment of seeded species. Weed control prior to establishment of seedlings is necessary for native and non-native plants to survive that critical first growing season (Mangold et al. 2007). This can hardly be overemphasized.

Cheatgrass and other annual grasses are the biggest impediment to rangeland seeding because they are so competitive during the time when perennial seedlings are getting established. Most invasive annual grasses can be controlled with non-selective herbicides or with germination-inhibitor herbicides. As the name suggests, a germination inhibitor must be applied before germination occurs, often shortly before the first rain of the autumn (which prompts germination).

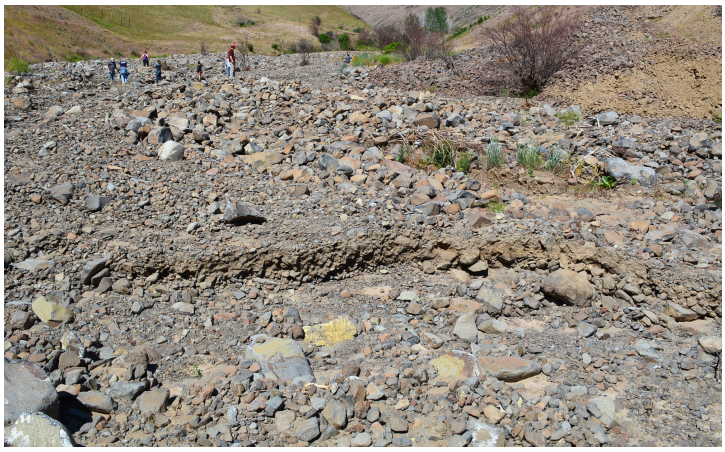

Figure 4. Severe erosion from heavy fall rain following the Colockum Tarps Fire of 2013 in central Washington.

Figure 5. Annual weed rosettes on rangeland pasture in spring.

Consider the timing necessary to accomplish weed control. Annual broadleaf weeds are most effectively controlled in the "rosette" stage, which usually occurs in the spring but may occur in the fall for certain key noxious weedy forbs common on rangeland, such as spotted and diffuse knapweed (Figure 5).

The rosette stage is when the plant has grown basal leaves, which are right against the soil surface, and before it begins to elevate leaves on a stalk.

Where there is a sufficient remnant population of desirable perennial plants, it may be advantageous to use selective herbicides to kill the undesirables and then interseed into the existing plant community.

Herbicide recommendations for specific weed control objectives and species are available in the Pacific Northwest Weed Management Handbook (Peachey 2010).

Seed Selection. Select seed that is suited to the site and vegetation management goals. A seed mix is preferable to a single species because each species has different strengths and weaknesses and a combination of species has greater biological resiliency to disturbances such as grazing, fire, insects, drought, prolonged cold, excess moisture, etc., than a monoculture (Figure 6).

Native seed is more expensive but is often better adapted to native soils. Note that there is a difference between seed for species that are native to a multi-state region and native species seed that is collected locally from those species. For example, bluebunch wheatgrass from the Rattlesnake Hills of Washington, where there is seven inches of annual precipitation, may be genetically different from bluebunch wheatgrass from the western slopes of the Rocky Mountains, where there is 25 inches of annual precipitation.


Figure 6. Cheatgrass and seeded perennials in first year following fire.

There is evidence that locally adapted seed may exhibit superior performance on local soils. A list of native and introduced grasses that work well in much of eastern Washington is provided in Table 1.

Sterile hybrid cover crop species are sometimes included in post-fire rehabilitation seed mixes because they will usually germinate in the fall immediately after a fire and provide greater short-term soil stabilization than perennials alone.

There are hundreds of grass, shrub, and forb species, available from seed companies in the Northwest, that could be used for rehabilitation seeding and that are suitable to the area. Table 1 lists the species most widely available, naturally abundant, cost-effective, and most tolerant of a wide variety of soil and microclimate conditions.

Recommended Seed Mixes. The seed mix selected should fit your management objectives and site limitations or conditions. A wildlife habitat planting, for example, may emphasize seed-producing forbs and include fewer grasses. A strict soil stabilization mix for a hillside might be primarily hard fescue or sheep fescue and annuals for rapid establishment.

However, there are a number of species that show up in many seed mixes, regardless of focus, that create a useful general seed mix for eastern Washington in rainfall zones (6–24 in. annual precipitation). These species have a relatively wide ecological amplitude, which means they tolerate a wider range of soil conditions and germination conditions and are useful for soil reclamation, livestock forage, wildlife habitat, native restoration, etc. These species are also the most useful for re-establishing herbaceous cover after fire where few perennials were present previously. The proposed mixes listed in Table 2 have been published by USDA-NRCS for post-fire seeding in eastern Washington for erosion and weed control.

Table 1. Dryland seeding species list.

Common name	Scientific name	Native/ Introduced	Ease of Establishment	Notes
Bluebunch wheatgrass	*Pseudoroegneria spicata*	N	Moderate	Most abundant native grass; wide range of soil conditions
Sandberg bluegrass	*Poa secunda*	N	Moderate	Abundant native grass; tolerates very shallow soil
"Sherman" big bluegrass	*Poa secunda (ampla)*	N	Moderate	Long-lived perennial bunchgrass, very early season growth
Basin wildrye	*Leymus cinereus*	N	Moderate	Tall, competitive bunchgrass; good for wildlife cover or winter pasture; long-lived
Mountain brome	*Bromus carinatus*	N	Moderate	
Blue wildrye	*Elymus glaucus*	N	Easy	Short-lived; good re-seeder
Idaho fescue	*Festuca idahoensis*	N	Difficult	Dominant in higher precipitation zones
Siberian wheatgrass	*Agropyron fragile*	I	Easy	Extremely drought-tolerant; easy to establish
Thickspike wheatgrass	*Elymus lanceolatus*	N	Easy	Drought tolerant; short-lived
Intermediate wheatgrass	*Thinopyrum intermedium*	I	Easy	
Slender wheatgrass; bearded wheatgrass	*Elymus trachycaulus*	N	Moderate	Tolerates saline soils; good forage; commonly used for reclamation of disturbed sites
Crested wheatgrass	*Agropyron cristatum*	I	Easy	Establishes quickly; short-lived

Additional information for these species is available at plants.usda.gov. Plant guides are available for many species, which describe methods for propagation and establishment.

Table 2. USDA-NRCS recommendations for post-fire seed mixes.

Seed Mixes	Broadcast rate (pounds live seed/acre)
Rangeland native mix	
Bluebunch wheatgrass (or Snakeriver wheatgrass in 6–12 in. precipitation)	6 lb
Sandberg bluegrass	1 lb
'Sherman' big bluegrass	1 lb
Thickspike wheatgrass	6 lb
Rangeland non-native mix	
Intermediate wheatgrass	8 lb
Pubescent wheatgrass	8 lb
White Dutch clover	1 lb
Forest native mix	
Bluebunch wheatgrass	8 lb
Slender wheatgrass	4 lb
Mountain brome	6 lb
Junegrass (*Koeleria macrantha*)	0.5 lb

Seeding

Timing of Seed Application. Fall dormancy planting is generally considered superior to spring planting (Hardegree et al. 2011). Fall seeding is typically more successful on non-irrigated acreage in the Intermountain West because:

1. seedlings are able to take advantage of fall and winter moisture;
2. it is late enough that seedlings won't germinate and frost-kill; and
3. soils dry out relatively quickly in the spring depending on unpredictable precipitation, making spring seeding notoriously unsuccessful.

Planting earlier carries the risk that seed will germinate but fail to grow enough to gain winter hardiness and seedlings will be frost-killed. At higher elevations these soil conditions exist before November 1, but usually not before October 15 (Benson et al. 2011). Therefore, rangeland and forest seedings where fire is not a factor are typically conducted in fall once plant dormancy is reached.

However, soil conditions may be a primary consideration when seeding after fire, and, specifically, may require a late summer application. The bare, loose mix of exposed soil and ash is a nearly ideal seedbed, but this may seal off with the first significant rain and quickly become an inhospitable seedbed. For this reason, seeding earlier than dormancy is usually preferable (August, September) in order to ensure seed-to-soil contact and some soil coverage (1/8–1/4 in.).

Soil Preparation. There are several site conditions one needs to create for successful germination of perennial seeds.

1. Perennial grass seed must contact bare mineral soil to germinate. Failure to achieve seed-to-soil contact is the greatest risk in the germination phase. If seeds are sitting on top of dead plant material (commonly called litter or thatch), seeds will either dry out or be consumed by birds and rodents. After fire, excessive litter is rare. Tillage is not recommended for low rainfall sites and native soils. If the burned area to be seeded has capped soils, harrowing or raking may be effective to provide germination sites. Tillage may facilitate serious soil erosion and mass germination of weed seeds that are already in the soil seed bank.
2. Seeds need 1/8–1/4 in. soil coverage. Late fall (dormant) seeding accomplishes this through freeze/thaw cycles which draw the seed into the soil. However, raking, dragging, or rolling with a cultipacker or heavy roller is helpful to create seed-to-soil contact and reduces the risk of seed consumption by wildlife.
3. Where slope is sufficient to allow water runoff and soil erosion, and where there is little remaining rooted vegetation to stabilize soil, it may be necessary to artificially create enough surface roughness to generate microsites for germination, and physical barriers for water that may try to carry seed away. If raking, lightly cultivating, or harrowing, travel with the contour of the slope as much as possible to minimize the potential for soil erosion.
4. As mentioned previously, the seed site should be free of invasive plants. The presence of annual weeds or perennials that are competing for the same resources as the seedling is the most common and significant cause of failure in the establishment phase. This does not mean eliminating all live vegetation on the entire seeding area, since dryland areas typically have spaces between plants, but reseeding is usually done where all or part of the existing vegetation is unwanted and some level and form of vegetation control is beneficial (Figure 7). (See previous note on site preparation.)
5. A moderate amount of mulch or plant residue on or in the soil surface is beneficial. Following fire, there is often very little plant residue and seed-to-soil contact is particularly important.

Figure 7. Seeded perennials may be sparse up to three years after a wildfire.

Seed Application Methods. There are two methods for seeding: broadcasting and direct seeding/drilling.

Broadcasting: Broadcast seeding is easier on rough terrain where there are rocks, slopes, uneven ground, or taller vegetation like shrubs, but broadcasting has a lower success rate than drilling. If you choose broadcast seeding, consider dragging something like a harrow over the site to scarify (scratch up) the soil surface and provide opportunity for seeds to contact mineral soil.

Drilling: Grain drills generally do not work except in deeper, rock-free soils, but a rangeland drill is designed to work around these obstacles and dramatically increases the success rate—that is, the germination and establishment of seeds (Haferkamp et al. 1987).

Aftercare for New Plants

If the seeding is for pasture forage, do not graze until the year after establishment, and then only if plants cannot be pulled by hand and not until seed shatter. If you can pull the grass plants out roots and all, grasping them at the base, they are not ready for grazing. It is preferable to avoid grazing until after grasses have produced mature seed; grazing during the vegetative stage of growth will reduce the long-term density and vigor of the stand. Weed control may still be necessary, especially in Years One and Two, post-seeding. (See Figure 8.)

Any kind of soil disturbance often stimulates weed seeds already present in the soil seed bank to germinate and establish. It is not uncommon to have a profusion of weeds you didn't even know were there to show up following a light mechanical treatment. Herbicide recommendations are dependent entirely on the weed species present (Peachey 2010).

Figure 8. Successful rangeland seeding in year five.

Additional Resources

Natural Resource Conservation Service (NRCS) Technical Note 1 is a rangeland and grazed forest seeding guide for eastern Oregon and Washington. The seeding guide, in the form of a Microsoft Access 2007 database, provides seeding suggestions for conservation efforts east of the Cascade Mountains crest.

The guide provides common name, scientific name, seeds/lb, seeding rate, growth form, etc. for range and forestland species. Links to in-depth information on plant ID, pasture species selection, range and pasture planning, seedbed preparation, seed quality, and drill calibrations are included. Links are also provided for information on western Oregon and Washington pasture and hayland species.

For directions on how to access the seeding guides online, visit the Natural Resources Conservation Service website, Technical Note 1 (Stannard et al. 2011).

References

Benson, J.E., R.K. Tveten, M.G. Asher, and P.W. Dunwiddie. 2011. Shrub-Steppe and Grassland

Restoration Manual for the Columbia River Basin. Olympia: Washington Department of Fish and Wildlife (WDFW).

De Baets, S., J. Poesen, G. Gyssels, and A. Knapen. 2006. Effects of Grass Roots on the Erodibility of Topsoils During Concentrated Flow. *Geomorphology* 76: 54–67.

Dodson, E.K. and D.W. Peterson. 2009. Seeding and Fertilization Effects on Plant Cover and Community Recovery Following Wildfire in the Eastern Cascade Mountains, USA. *Forest Ecology and Management* 258: 1586–93.

Fuhlendorf, S.D., R.F. Limb, D.M. Engle, and R.F. Miller. 2011. Assessment of Prescribed Fire as a Conservation Practice. In *Conservation Benefits of Rangeland Practices*, edited by D.D. Briske, ch. 2. United States Department of Agriculture (USDA): Natural Resources Conservation Service (NRCS).

Haferkamp, M.R., D.C. Ganskopp, R.F. Miller, and F.A. Sneva. 1987. Drilling Versus Imprinting for Establishing Crested Wheatgrass in the Sagebrush-Bunchgrass Steppe. *Journal of Range Management* 40: 524–30.

Hardegree, S.P., T.A. Jones, B.A. Roundy, N.L. Shaw, and T.A. Monaco. 2011. Assessment of Range Planting as a Conservation Practice. In *Conservation Benefits of Rangeland Practices*, edited by D.D. Briske, ch. 4. USDA: NRCS.

Mangold, J.M., C.L. Poulsen, and M.F. Carpinelli. 2007. Revegetating Russian Knapweed (*Acroptilon repens*) Infestations Using Morphologically Diverse Species and Seedbed Preparation. *Rangeland Ecology & Management* 60: 378–85.

Miller, R.F., S.T. Knick, D.A. Pyke, C.W. Meinke, S.E. Hanser, M.J. Wisdom, and A.L. Hild. 2011. Characteristics of Sagebrush Habitats and Key Limitations to Long Term Conservation. In *Studies in Avian Biology*, edited by S.T. Knick and J.W. Connelly, vol. 38, pp. 145–84. Berkeley: University of California Press.

Nearing, M.A., V. Jetten, C. Baffaut, O. Cerdan, A. Couturier, M. Hernandez, Y. Le Bissonnais, M.H. Nichols, J.P. Nunes, C.S. Renschler, V. Souchere, and K. van Oost. 2005. Modeling Response of Soil Erosion and Runoff to Changes in Precipitation and Cover. *Catena* 61: 131–54.

Peachey, E., ed. 2010. Pacific Northwest Weed Management Handbook. *Pacific Northwest Extension Publication* MISC0049. Washington State University.

Stannard, M., G. Kuhn, W. Crowder, M. Chaney, T. Dring, G. Rouse, R. Fleenor, and J Kouns. 2011. NRCS Eastern Oregon/Washington Rangeland and Grazed Forest Seeding Guide. USDA: NRCS.