Great Basin Factsheet Series
Number 14 • 2016

Information and tools to conserve and restore Great Basin ecosystems

Seeding Techniques for Sagebrush Community Restoration After Fire

Purpose: To outline important considerations and options for post-fire seeding, including the selection of seed mixes and seeding equipment for restoring sagebrush communities following fire. The emphasis is on lower-elevation communities where restoration needs are greatest. References and resources are offered for greater detail and guidance on specific topics.

In Brief:

- Post-fire seeding increasingly emphasizes restoration of plant community diversity and wildlife habitat, requiring seeding techniques for a variety of seed types.
- Low-elevation sagebrush communities are often priority areas for post-fire seeding, but they require careful planning and sometimes multiple treatments to ensure seeding success.
- Information is available to assist in making decisions regarding seed sources, seeding rates, and species compatibility when formulating seed mixes for post-fire seedings.
- Seeding equipment should be selected based on terrain, seedbed and burial depth requirements of seeded species, and potential impacts to residual plants and biological soil crusts.
- Rangeland drills can be modified to place seeds of different sizes in different rows allowing smaller seeds to be placed on the surface rather than in furrows, thus increasing the probability of establishment.

Introduction

Great Basin sagebrush communities are experiencing widespread degradation due to the introduction of invasive annual weeds and disturbances that promote weed expansion, including inappropriate grazing and fire. Many sites previously occupied by diverse communities of perennial grasses, forbs, and shrubs have been reduced to depauperate sagebrush stands that readily become dominated by invasive annuals following fire. Post-fire seeding may be necessary to prevent these areas from converting to annual grasslands.

For many years, post-fire seedings on public lands have followed a rehabilitation model where rapid establishment of perennial cover is the primary objective. To achieve this objective, managers have relied heavily on rangeland seeding techniques and plant materials originally developed for forage production. The use of rangeland drills to seed crested wheatgrass (Young and McKenzie 1982, Vallentine 1989) exemplifies this approach. The rehabilitation model is increasingly being replaced by a restoration model that includes plant community diversity and wildlife habitat as desired outcomes of post-fire seeding (PCA 2015, USDOI 2015). The shift towards restoration has led to an increased use of native plants and development of new or modified seeding techniques to accommodate multiple seed types (Monsen and McArthur 1995, Monsen et al. 2004, Benson et al. 2011). This factsheet presents information on seeding strategies and techniques that can be used to restore diverse sagebrush communities following fire. Other factsheets in this series provide complementary information on seeding big sagebrush and establishing shrubs from planting stock.

Deciding Whether to Seed

Post-fire seeding with limited resources requires a triage approach to prioritizing treatments. One approach is to focus on areas that have the greatest chance of successful seedling establishment, typically higher elevation areas with more favorable soil moisture and less competitive pressure from invasive annuals. The drawback of this approach is that these sites are less likely to require seeding due to inherent resilience. Careful attention should be paid to whether a site is likely to recover without seeding, because seeding may actually disrupt site recovery (Miller et al. 2015). Low- to mid-elevation sites may not need to be seeded if fire-resilient perennials are present and weed control measures (e.g. herbicides, biocontrols) are applied. Pre-emergent herbicides can be applied in the fall to reduce invasive annuals and thereby assist perennial plant growth and reproduction (see Great Basin Factsheet 3 for further discussion).

Another approach is to focus on areas with the most critical need for restoration following fire (e.g., crucial wildlife habitat corridors) or areas that are least likely to recover on their own (Miller et al. 2015). Lower-elevation Wyoming big sagebrush sites commonly fall into this category, although even in this case, sites in good condition may recover without seeding. The decision to seed a poor-condition, low-elevation sagebrush site is complicated by the fact that these sites are more difficult to seed and success is not guaranteed with a single treatment. Multiple attempts at seeding may be necessary in combination with weed control measures.

Seeding is commonly implemented within the year following a fire in an effort to take advantage of reduced annual weed abundance immediately post-fire, and to quickly establish perennial cover. However, delaying seeding until a later year may be sensible if drought conditions are predicted for the upcoming winter and spring. The best season to seed is usually late fall or winter. If seeded too early in the fall, seeds lacking a stratification requirement may germinate prematurely and be killed by winter frosts. High soil moisture in the spring may limit the timely use and effectiveness of ground equipment.

Seed Mixes and Seeding Rates

Seed mixes should be formulated to incorporate species that are native and adapted to the site, have known potential to establish through seeding, and are available from commercial vendors or other sources including agency seed warehouses. Soil surveys, ecological site descriptions (NRCS Web Soil Survey 2015), and vegetation map products (e.g., LANDFIRE 2015) can be useful for identifying characteristic native species for a given site. Information on species suitability for seeding can be obtained from guides developed by land management agencies (see Resources List: Monsen et al. 2004, Lambert 2005a, Ogle et al. 2012, USDA PLANTS 2015). These guides contain recommendations regarding seeding rates, depth of seeding, and seeding technique for many ecologically important plant species. Information on seed vendors can be obtained from online databases provided by the Native Seed Network and RNGR National Nursery and Seed Directory. Seeds purchased or collected for seeding projects should ideally be obtained from within the same provisional seed zone, or if available, empirical seed zone (Bower et al. 2014) as the site to be seeded. Table 1 lists some of the species that have been recommended for low-elevation sagebrush zones.

Differences in competitive ability should be taken into consideration when selecting seed mixes, seeding rates, and seeding strategies (Monsen et al. 2004, p. 140-145). Many forbs and shrubs (as well as some grasses) compete poorly with rapidly-growing perennial grasses that usually dominate post-fire seed mixes. Species with different competitive abilities should be spatially segregated, e.g., by placement in separate drill rows (see examples of compatible combinations in Table 1). As an alternative to spatial segregation, seeding rates of competitive species can be reduced to provide more space for less-competitive species within the seeded matrix, but this may be undesirable on sites where weed suppression is desired. Higher rates are generally necessary with broadcast seeding compared to drill seeding and with small seeds compared to larger seeds.

Seed mixes for low-elevation sagebrush communities should be dominated by grasses, with forbs and shrubs included in proportions appropriate for desired establishment densities. Seed number per unit weight and percentage pure live seed will affect bulk seeding rates. Examples of generic seed mixes and seeding rates for low-elevation big sagebrush sites are shown in Table 2.

Seeding Techniques

Different seeding techniques are necessary for different types of terrain (Monsen et al. 2004, Chapter 4). Techniques that apply seed directly from equipment onto the ground, such as rangeland drills, spreader seeders, cultipackers and imprinters, are generally the best choice for seeding wherever terrain permits. Sites that are too steep, rocky, or debris-covered for these techniques can be aerially seeded, although establishment from aerial seedings may be low on low-moisture sites.

Mechanical soil disturbance should be kept to a minimum on sites with residual biological soil crusts and native perennials capable of resprouting after fire. Minimum-till drills offer lower-impact alternatives to conventional rangeland drills (Monsen et al. 2004, Chapter 4).

Seeding techniques should also be selected based on seed size and depth requirements (Table 1). Drill-seeding is most suitable for species with relatively large seeds that can tolerate burial depths of 1/4 inch or more. Smaller seeds are likely to fare better when spread on the soil surface and pressed into the soil with cultipackers or other imprinter-type devices. Some rangeland drills can be configured to place seeds of different sizes at appropriate depths in separate rows, or can be modified for this purpose (Figure 1). Seed boxes on such drills must have separate compartments for each seed type and row. Triple seed boxes have been developed to accommodate three types of seed: small seed, cool season/grain (large seed), and fluffy/chaffy seed. Common species of each seed type are listed in Table 1. The Truax Roughrider drill by Truax Co., Inc. comes with the option of substituting drill disks with imprinter wheels on rows designated for smaller seeds.

An informative video on rangeland drill calibration is available from the Rangeland Technology and Equipment Council (Outka-Perkins 2010). St. John (2008) provided similar guidance specific to the Truax Roughrider drill. See also Monsen et al. (2004), Wiedemann (2007), Benson et al. (2011) and St. John et al. (2012) for descriptions of seeding techniques and equipment options.

Table 1. Common species suitable for seeding at low-elevation sagebrush sites (derived from Monsen et al. 2004, Lambert 2005a, Ogle et al. 2012, USDA PLANTS 2015). This list is not exhaustive, and not all species are suitable for all sites. Species and seed sources should be selected based on adaptation to planting site conditions.

Common Name	Latin Name	Community[1]	Seed Box[2]	Depth[3]	Group[4]
Grasses					
Bluegrass, Sandberg	*Poa secunda*	BA, BL, WY	SS, LS	≤ ¼-¾"	ABJK
Dropseed, sand	*Sporobolus cryptandrus*	BA, WY	SS	≤ ¼"	AK
Fescue, Idaho	*Festuca idahoensis*	BA, WY	LS	¼-¾"	BJ
Fescue, six-weeks	*Vulpia octoflora*	BA, WY	SS	≤ ¼"	AK
Needle-and-thread	*Hesperostipa comata*	BA, BL, WY	LS	¼-1"	BJ
Needlegrass, Thurber's	*Achnatherum thurberianum*	BA, WY	LS	¼-½"	BJ
Ricegrass, Indian	*Achnatherum hymenoides*	BA, BL, WY	LS	½-4"	CD
Squirreltail, bottlebrush	*Elymus elymoides*	BA, BL, WY	LS	¼-½"	C
Wheatgrass, bluebunch	*Pseudoroegneria spicata*	BA, WY	LS	¼-1½"	C
Wheatgrass, Snake River	*Elymus wawawaiensis*	WY	LS	¼-¾"	C
Wheatgrass, thickspike	*Elymus lanceolatus*	BA, WY	LS	¼-1"	C
Wheatgrass, western	*Pascopyrum smithii*	BA, BL, WY	LS	¼-1"	BJ
Wildrye, basin	*Leymus cinereus*	BA, WY	LS	¼-1"	BJ
Shrubs					
Bitterbrush, antelope	*Purshia tridentata*	BA	LS	½-1½"	EJ
Ephedra, green	*Ephedra viridis*	BA, BL, WY	LS	¼-¾"	EJ
Ephedra, Nevada	*Ephedra nevadensis*	BA, BL, WY	LS	¼-¾"	EJ
Hopsage, spiny	*Grayia spinosa*	BA, WY	FC, SS[5]	≤ ¼"	FGK
Peachbrush, desert	*Prunus fasciculata*	WY	LS	½-1"	EJ
Rabbitbrush, low	*Chrysothamnus viscidiflorus*	BA, BL, WY	FC, SS[5]	≤ ¼"	FGK
Rabbitbrush, rubber	*Ericameria nauseosa*	BA, WY	FC, SS[5]	≤ ¼"	FGK
Sagebrush, basin big	*Artemisia tridentata* ssp. *tridentata*	BA, BL	SS	≤ ¼"	GK
Sagebrush, black	*Artemisia nova*	BL	SS	≤ ¼"	GK
Sagebrush, low	*Artemisia arbuscula*	BA, BL,	SS	≤ ¼"	GK
Sagebrush, Wyoming big	*Artemisia tridentata* ssp. *wyomingensis*	BA, WY	SS	≤ ¼"	GK
Saltbush, fourwing	*Atriplex canescens*	BA, WY	LS	¼-¾"	EJ
Winterfat	*Krascheninnikovia lanata*	BA, BL, WY	FC	≤ ¼"	F
Forbs					
Agoseris, pale	*Agoseris glauca*	BA, WY	SS	≤ ¼"	HK
Aster, Pacific	*Symphyotrichum chilense*	BA	FC, SS[5]	≤ ¼"	HK
Balsamroot, arrowleaf	*Balsamorhiza sagittata*	BA	LS	¼-½"	IJ
Biscuitroot, nineleaf	*Lomatium triternatum*	BA, WY	SS	≤ ¼"	HK
Buckwheat, sulphur-flower	*Eriogonum umbellatum*	BA, BL, WY	SS	≤ ¼"	HK
Dusty-maiden, Douglas'	*Chaenactis douglasii*	BA, BL, WY	SS	≤ ¼"	HK
Flax, Lewis	*Linum lewisii*	BA, WY	SS	≤ ¼"	HK
Fleabane, shaggy	*Erigeron pumilus*	BA, BL, WY	SS	≤ ¼"	HK
Globemallow, gooseberryleaf	*Sphaeralcea grossulariifolia*	BA, BL, WY	SS	≤ ¼"	HK
Globemallow, Munro's	*Sphaeralcea munroana*	BA, BL, WY	SS	≤ ¼"	HK
Globemallow, scarlet	*Sphaeralcea coccinea*	BA, BL, WY	SS	≤ ¼"	HK
Goldeneye, Nevada showy	*Heliomeris multiflora* var. *nevadensis*	BA, WY	SS	≤ ¼"	HK
Hawksbeard, tapertip	*Crepis acuminata*	BA, WY	LS	¼-½"	IJ
Milkvetch, basalt	*Astragalus filipes*	BA, WY	LS	¼-½"	IJ
Penstemon, firecracker	*Penstemon eatonii*	BA	SS	≤ ¼"	HK
Penstemon, scabland	*Penstemon deustus*	WY	SS	≤ ¼"	HK
Penstemon, low	*Penstemon humilis*	BA	SS	≤ ¼"	HK
Penstemon, Palmer's	*Penstemon palmeri*	BA, BL, WY	SS	≤ ¼"	HK
Penstemon, royal	*Penstemon speciosus*	WY	SS	≤ ¼"	HK
Sweetvetch, Utah	*Hedysarum boreale*	BA	LS	¼-¾"	IJ
Tansyaster, hoary	*Machaeranthera canescens*	BA, BL, WY	SS	≤ ¼"	HK
Yarrow, western	*Achillea millefolium* var. *occidentalis*	BA, WY	SS	≤ ¼"	HK

[1]Low elevation sagebrush community: BA=Basin Big Sagebrush, BL=Black Sagebrush, WY=Wyoming Big Sagebrush

[2]Appropriate compartment of a triple seed box: FC=fluffy/chaffy, LS=large seed (cool-season/grain), SS=small seed

[3]Optimal seeding depths vary by soil type, will generally be near the lower end of listed depth range in fine-textured soil, near the upper end of listed depth range in coarse-textured soil

[4]Groups of compatible species for seeding together (e.g. in the same drill row):

A=surface-seeded grass
B=drill-seeded grass (low-competitiveness)
C=drill-seeded grass (high-competitiveness)
D=deep drill-seeded grass
E=drill-seeded shrubs
F=surface-seeded chaffy/fluffy seeds
G=surface-seeded shrubs
H=surface-seeded forbs
I=drill-seeded forbs
J=drill-seeded grass, forbs and shrubs
K=surface-seeded grass, forbs and shrubs

[5]If cleaned of appendages, seeds of these species may be placed in small seed box rather than fluffy/chaffy seed box

Table 2. Examples of seed mixes for restoration of low-elevation sagebrush communities, showing possible species combinations and seeding rates in lbs/acre, devised for a rangeland drill with ten rows, triple seed boxes and depth settings that can be adjusted individually by row.

Example 1: lower diversity mix

Drill Rows	Seed Box[1]	Depth	Species	Lbs/acre
1,3,5,7,9,10	LS	1/2"	Bluebunch wheatgrass	2.0
			Bottlebrush squirreltail	1.0
			Indian ricegrass	1.0
2,6	LS	1/4"	Needle-and-thread	0.5
			Thurber's needlegrass	0.5
			Sandberg's bluegrass	0.5
			Basalt milkvetch	0.5
4,8	SS	surface[2]	Munro's globemallow	0.5
			Scabland penstemon	0.5
			Western yarrow	0.2
			Wyoming big sagebrush	0.5
			Rubber rabbitbrush	0.5
			Total	**8.2**

Example 2: higher diversity mix

Drill Rows	Seed Box[1]	Depth	Species	Lbs/acre
1,3,5,7,9	LS	1/2"	Bluebunch wheatgrass	2.0
			Bottlebrush squirreltail	1.0
10	LS	2"	Indian ricegrass	1.0
2	LS	1/2"	Needle-and-thread	0.5
			Thurber's needlegrass	0.5
			Western wheatgrass	0.5
4	SS	surface[2]	Sandberg's bluegrass	0.5
			Munro's globemallow	0.5
			Scabland penstemon	0.5
			Western yarrow	0.2
			Pale agoseris	0.2
			Threadstalk milkvetch	0.2
			Nineleaf biscuitroot	0.2
6	SS & FC[3]	surface[2]	Wyoming big sagebrush	0.8
			Rubber rabbitbrush	0.5
			Winterfat	0.5
8	LS	1/2"	Antelope bitterbrush	0.5
			Green ephedra	0.5
			Basalt milkvetch	0.5
			Arrowleaf balsamroot	0.2
			Tapertip hawksbeard	0.2
			Total	**11.5**

[1]Appropriate compartment of a triple seed box: FC=fluffy/chaffy, LS=large seed (cool-season/grain), SS=small seed

[2]Disks should be lifted or removed for surface seeding and ideally substituted with imprinter wheels

[3]Seeds dispensed from different seed boxes on the same row

Figure 1. Rangeland drill (P & F Services manufacturer, Kemmerer model) modified to allow for different sizes of seeds in alternate rows. Note triple seed boxes and aluminum pipes installed to dispense seed from small seeds onto soil surface. On rows designated for small seeds, disks are raised above ground level to preclude furrow formation.

Authors

Jeff Ott
Research Geneticist
USFS Rocky Mountain Research Station
jeott@fs.fed.us

Anne Halford
Restoration Ecologist
Bureau of Land Management
ahalford@ca.blm.gov

Nancy Shaw
Research Botanist (Emeritus)
USFS Rocky Mountain Research Station
nancylshaw@fs.fed.us

References

Bower, A. D., B. St Clair and V. Erickson. 2014. Generalized provisional seed zones for native plants. Ecological Applications 24:913-919. http://www.treesearch.fs.fed.us/pubs/47587.

Lambert, S. M. 2005b. Seeding considerations in restoring big sagebrush habitat. pp. 75-80 In Shaw, N. L., M. Pellant, and S. B. Monsen, comps. Sage-grouse habitat restoration symposium proceedings; 2001 June 4–7; Boise, ID. Proceedings RMRS-P-38. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. http://www.fs.fed.us/rm/pubs/rmrs_p038/rmrs_p038_075_080.pdf.

Monsen, S. B., and E. D. McArthur. 1995. Implications of early Intermountain range and watershed restoration practices. pp. 16-25 In Roundy, B. A; E. D. McArthur, J. S. Haley, and D. K. Mann, comps. Proceedings: wildland shrub and arid land restoration symposium; Gen. Tech. Rep. INT-GTR-315. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. http://www.fs.fed.us/rm/pubs_int/int_gtr315/int_gtr315_016_025.pdf.

Plant Conservation Alliance [PCA]. 2015. National Seed Strategy for Rehabilitation and Restoration, 2015-2020. http://www.blm.gov/seedstrategy.

U.S. Department of the Interior [USDOI]. 2015. Secretarial Order 3336: Rangeland Fire Prevention, Management and Restoration. http://www.forestsandrangelands.gov/rangeland/documents/SecretarialOrder3336.pdf.

Vallentine, J. F. 1989. Range Development and Improvements. San Diego, CA: Academic Press. 523 p.

Young, J. A., and D. McKenzie. 1982. Rangeland drill. Rangelands 4:108-113. http://www.rangelanddrills.com/downloads/History_of_Rangeland_Drill.pdf.

Resources

Benson, J. E., R. T. Tveten, M. G. Asher and P. W. Dunwiddie. 2011. Shrub-Steppe and Grassland Restoration Manual for the Columbia River Basin. http://wdfw.wa.gov/publications/01330/wdfw01330.pdf.

Lambert, S. M. 2005a. Guidebook to the Seeds of Native and Non-native Grasses, Forbs and Shrubs of the Great Basin. U.S. Department of the Interior, Bureau of Land Management, Idaho BLM Technical Bulletin 2005-04. http://www.blm.gov/pgdata/etc/medialib/blm/id/publications/technical_bulletins.Par.93717.File.dat/tb05-04.pdf.

[LANDFIRE] U.S. Department of Agriculture, Forest Service; U.S. Department of the Interior, LANDFIRE Project. 2015. http://www.landfire.gov.

Miller, R. F., J. C. Chambers, and M. Pellant. 2015. A field guide for rapid assessment of post- wildfire recovery potential in sagebrush and piñon-juniper ecosystems in the Great Basin: Evaluating resilience to disturbance and resistance to invasive annual grasses and predicting vegetation response. Gen. Tech. Rep. RMRS-GTR-338. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO. http://www.fs.fed.us/rm/pubs/rmrs_gtr338.pdf.

Monsen, S. B., R. Stevens, and N. L. Shaw, comps. 2004. Restoring Western Ranges and Wildlands. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Gen. Tech. Rep. RMRS-GTR-136. 3 Volumes. http://www.fs.fed.us/rm/pubs/rmrs_gtr136_1.html.

[NRCS Web Soil Survey] U.S. Department of Agriculture, Natural Resources Conservation Service, Web Soil Survey. 2015. http://websoilsurvey.sc.egov.usda.gov.

Ogle, D., L. St. John, M. Stannard, and L. Holzworth. 2012. Conservation plant species for the Intermountain West. Boise, ID; Salt Lake City, UT; Spokane, WA: U.S. Department of Agriculture, Natural Resources Conservation Service, Technical Note Plant Materials No. 24, Jan. 2012 Revision. http://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/idpmstn10793.pdf.

Outka-Perkins, L. 2010. Calibrating Your Rangeland Drill (DVD). U.S. Department of Agriculture, Forest Service, Missoula Technology and Development Center, 1022-2D03-MT-DC. http://rtec.rangelands.org/DrillCalibration.htm.

P & F Services. 2015. Rangeland seed drills and wildland reclamation. http://rangelanddrills.com.

St. John, L., B. Cornforth, B. Simonson, D. Ogle, and D. Tilley. 2008. Calibrating the Truax Rough Rider Seed Drill for Restoration Plantings. Boise, ID: U.S. Department of Agriculture, Natural Resources Conservation Service, Technical Note Plant Materials No. 20, April 2008 Revision. http://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/idpmctn7659.pdf.

St. John, L, D. Tilley, J. Scianna, J. Jacobs, D. Ogle, M. Majerus, and L. Holzworth. 2012. Mixing seed with rice hulls. Boise, ID and Bozeman, MT, USA: U.S. Department of Agriculture, Natural Resources Conservation Service, Technical Note Plant Materials 7 (revised). 16 p. http://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/idpmctn11458.pdf.

Truax Company, Inc. 2015. Truax Roughrider - Rangeland Drill. http://www.truaxcomp.com/rangeland.html.

[USDA PLANTS] U.S. Department of Agriculture, Natural Resources Conservation Service, PLANTS Database Fact Sheets. 2015. http://plants.usda.gov/java/factSheet.

Wiedemann, H. 2007. Revegetation Equipment Catalog. http://reveg-catalog.tamu.edu.

Great Basin Factsheets are developed and produced collaboratively by the groups below. Jeanne Chambers edited the factsheets, Lael Gilbert created the design and was responsible for layout, and Nolan Preece shot the photo for the masthead, which is of Monitor Valley in central Nevada.