

Restoring shrub-steppe after wildfire: shrub planting as a viable tool in habitat rehabilitation

Heidi Newsome, Wildlife Biologist, U.S. Fish and Wildlife Service, Mid-Columbia River National Wildlife Refuge Complex

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Hanford Reach National Monument

Designated by Presidential Proclamation 7319, June 9, 2000

195,000 acres superimposed over the Department of Energy (DOE) Hanford Site





Monument Environmental Setting

- Hottest and Driest part of Washington State
- Rain shadow of Cascade Mountains
- **6" precipitation** annually on average
- Most precipitation comes in winter
- Elevation range from 350 3,660 ft.
- Soils are primarily alluvial silts and sands deposited during the Ice Age Floods







Hanford Reach National Monument Management Goals

- Protect and restore the native habitats and biodiversity of the shrub-steppe ecosystem.
- Monitor, protect, and recover native plants and animals that are federally or state listed and any other species that are in any other way considered sensitive.





Fire History 277,354 Total acres 169,083 FWS acres (56,406 have re-burned)



* Only includes fires over 300 acres

U.S. Fish & Wildlife Service









Example: 24 Command Fire

- National BAER Team
- Loss of life
- Loss of property
- 164,884 acres







Changes in Shrub Cover



Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*); spiny hopsage (*Atriplex* [= *Grayia*] *spinosa*); winterfat (*Eurotia lanata*); threetip sagebrush (*Artemisia tripartita*). Bars = 1 standard deviation. 2004 values with accompanying script letter are statistically lower than pre-fire values: a = P < 0.0001; b = P < 0.005; c = P < 0.05; d = P < 0.10.



Nursery Stock Types and Treatments

- 10 cubic inch tublings
- 4 cubic inch tublings
- Bare Root Plants
 - Hydrogel
 - Mycorrhizae









Site Selection

- Native understory
- Shrubs pre-fire
- Large blocks

Methods

- Installed by professional planting crews
- 350-450 plants/acre
- $\sim 10'$ spacing







Sagebrush Monitoring Field Technique

- Plants mapped at time "zero" immediately post-planting and considered "Healthy"
- 100 meter transect as baseline
- 10-12 meters wide
- ~100 plants per transect
- Origin point randomly selected within planting polygons
- Plants classified as "Healthy", "Stressed", "Dead"





Environmental Variables recorded for each monitoring plot (02)

- Slope
- Aspect
- Heat Load Index
- Elevation
- Percent cover cheatgrass
- Percent cover Bluebunch wheatgrass
- Percent cover all perennial grasses
- Percent cover all grasses







2001 Plantings vs. 2002 Plantings

- Planted 173,348 plants
- 9 polygons, **500** acres
- 18 monitoring transects installed
- Monitored **1992** individual plants
- Approximately **1%** of total planted

- Planted **717,403** plants
- 13 polygons, **1600** acres
- 26 monitoring transects installed
- Monitored **2880** individual plants
- Approximately **0.5%** of the total planted





Overall Percent Survival of Plantings by Stock type





Stock Type % Survival by Planting Year, After 3 years



Chi-square test($\chi^2 = 378.414$; P < 0.0001), pairwise chi-square Bonferonni corrected α ($\alpha = 0.05$).National Wildlife Refuge System



% Flowering (Year 3, 2002 cohort only)



Nursery Stock Type (PERMANOVA followed by Tukey HSD, P = 0.05).



Correlations between Wyoming Big Sagebrush Survival (2002-04) and Environmental, Community and Treatment Variables

	Survival (%)	
	Alive +	Alive
	Stressed	only
Elevation	-0.23	-0.20
Slope	-0.45 ^b	-0.45 ^b
Aspect	-0.09	-0.10
Heat load index	0.33	0.31
Condition (\pm : BR = 1; tubling = 0)	-0.20	-0.16
Hydrogel (±)	-0.20	-0.16
Mycorrhizae (±)	-0. 81 ^a	-0.78 ^a
Sagebrush planted density	0.12	0.07
Percent cover		
Cheatgrass	0.00	0.03
Bluebunch wheatgrass	-0.27	-0.30
All perennial bunchgrasses	-0.08	-0.11
All grasses	-0.31	-0.31

The symbol \pm indicates presence-absence variables. Values accompanied by the following superscripts are significant: a - P < 0.0001; b - P < 0.05.



Seasonal Precipitation 2001-2005

Data courtesy Hanford Meteorological Station (HMS), Hanford Site, Washington

Precipitation Normal — Precipitation Actual





Exploring BR + Mycorrhizae

- Wyoming big sagebrush forms mycorrhizal associations
- Plants in BR + & BR treatments were sampled
- All roots were colonized with mycorhrizae, but a non-mychorrizal fungus (unknown origin) was also present

Conclusion:

Wet years following 2002 plantings, combined with the application of mycorrhizal gel in addition to hydrogel, may have restricted oxygen to plant roots and decreased survival of BR + mycorrhizal treatment.



Pros and Cons

Bare root Stock

PROS

- Larger size initially
- Begin flowering sooner
- Easier to scale up production

Tubling Stock

PROS

- •4" similar to 10"
- •Easier to install
- Consistent survival

CONS

- Variable stock quality
- Variable survival

CONSLonger time to floweringMonitoring more intensive









<u>No</u> recruitment of big sagebrush seedlings was recorded within the shrub seed treatment plots in 2004.



Economic Comparison

Initial Cost Per Acre by Stock type

Resulting Plant density per acre

59

0











Conclusions After 3 Years Monitoring

- Plantings placed 249,410 surviving seedlings across ~2100 acres
- Densities ranged from 45 to 225 plants/acre
- Most planted seedlings in 2005 were vigorous and expected to develop a shrub component *in excess* of what would have established without active planting
- As surviving plants become reproductive, natural establishment should begin to augment plantations





Wrap up

- Out planting of nursery grown stock is more reliable than direct seeding as a method for restoring shrubs to the landscape
- Development of high-quality shrub-steppe habitat with in-tact native understory vegetation and microbiotic crusts favors planting over seeding
- Planting can have a comparable cost when compared to seeding, especially if several years of seeding are required to establish shrubs from seed