Biological and Ecological Aspects of Big Sagebrush subspecies: Influences on Planting Success and Community Restoration

By

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Basin big sagebrush

Mountain big sagebrush

Wyoming big sagebrush

Identification and Distribution of Sagebrush taxa

- Define the Principal Species
- Identify Site Characteristics
- Determine Soils and Elevation Features
  - M.F. Mahalovich & E.D. McArthur 2004
  - A. Winward 2004
- Define Community Types and Species Association
  - B. Johnson 2001

Hybrid Populations – Importance, Areas of Occurrence, Identification

- Utilize Fluorescence Technique to Identify Species
  - Goodrich, McArthur, Winward
- Scores
  - >4.0 Mountain big sagebrush
  - 3.4-3.9 Break separating intermediate populations from Artrv
  - 2.3-3.3 Break separating intermediate population from Artrw
  - <2.0 Wyoming big sagebrush

Annual Precipitation Ranges for Big Sagebrush

- Wyoming big sagebrush 6.8-12.6 inches
- Intermediate plants 8.2-14.6 inches
- Mtn. big sagebrush 11.8-27.7 inches

Species Adaptation

- Populations of big sagebrush display close alliance to certain habitats-morphological specializations and adaptations have evolved along environmental gradient. Shultz (1986).
- Significant differences in growth rates occurred within and among subspecies in common garden studies, indicating adaptation to site origin. Davis and Stevens (1986).
- Differences have been reported in photosynthetic characteristics among subspecies that correlated with environmental conditions of their sites of origin. Frank et al (1986).
- Seed dormancy and germination patterns are habitat correlated among all three subspecies- each subspecies exhibits a different pattern of variation. Meyer and Monsen (1992).

Site Adaptability

Wyoming Big Sagebrush

- Strategy based on ability to tolerate abiotic stress.
- Sporadic seed production
- Adjustment to resource fluctuations.
- Slowest growth rate.
- Seedling- lowest maximum growth-attained earliest.

Basin big sagebrush

Site Adaptability

Basin Big Sagebrush

- Colonizing strategy
- Prolific seed production- smaller seeds
- Faster growth rates
- Seedlings- moderate root growth, maximum shoot growth

Site Adaptability

Mountain Big Sagebrush

- More competition- based strategy
- Regular production of average amount seed
- Higher investment in vegetative growth
- Average growth rate
- Seedlings- slowest root elongation, moderate stem elongation

Ploidy Levels-Affects on Plant Adaptation

- Multiple ploidy levels occur among 11 species
- 2 principal base chromosome numbers

  x= 8 and x= 9
- Ploidy levels may be an adaptive strategy
- Polyploides better adaptive to ecological extremes than diploid relatives
- Autopolyploidy alters tolerance
- Polyploids are smaller shrubs with lower growth rates & increase drought tolerance
- Planting tetraploid (4x) Wyoming big sagebrush on drier sites

Hybrid Population

Seed Production

- Recruitment from seed---limited resprouting
- Nearly all species are late summer flowering
- Seed ripens from early to mid-winter
- Seed matures early from high elevation habitats
- Seed matures late from warm habitats
- Seed production Artrt→Artrv→Artrw
- Single bushes may produce 500,000 seeds
- Partially self-fertile - isolated plants set seed
- Yields highly dependent on annual moisture
- Disease & browsing reduce yields, result in decadent stands

Seed Dispersal

- Seeds very small
  - 0.018g/100 seeds– ssp. tridentata
  - 0.025g/100 seeds– ssp. vaseyana and wyomingensis
- Maximum dispersal distance (30m) = 150 ft
- 85-90 % seeds fall within 1 meter of the canopy
- Most autumn maturing seeds gone in spring
- Seeds lost through winter/spring germination
- Only small fraction viable seeds remain in the seed bank (0.1%)

Seed Cleaning

- Large plants of Basin big sagebrush may produce 500,000 seeds
- Seeds of all subspecies are small- 4.5 million/kg
- Upon maturity, seeds slowly shatter and are dispersed by wind
- Seeds are hand harvested by flailing or stripping
- Seeds and debris normally air dry to 12-15% moisture
- Large twigs and debris are removed by fanning/screening process.
- Seed lots usually clean to a purity of 12% or higher

Seed Germination

- Seeds usually non-dormant at harvest- require light
- Primary dormancy is removed by moist chill
- Seeds germinate over wide array of temperatures
- Germination principally occurs in the spring

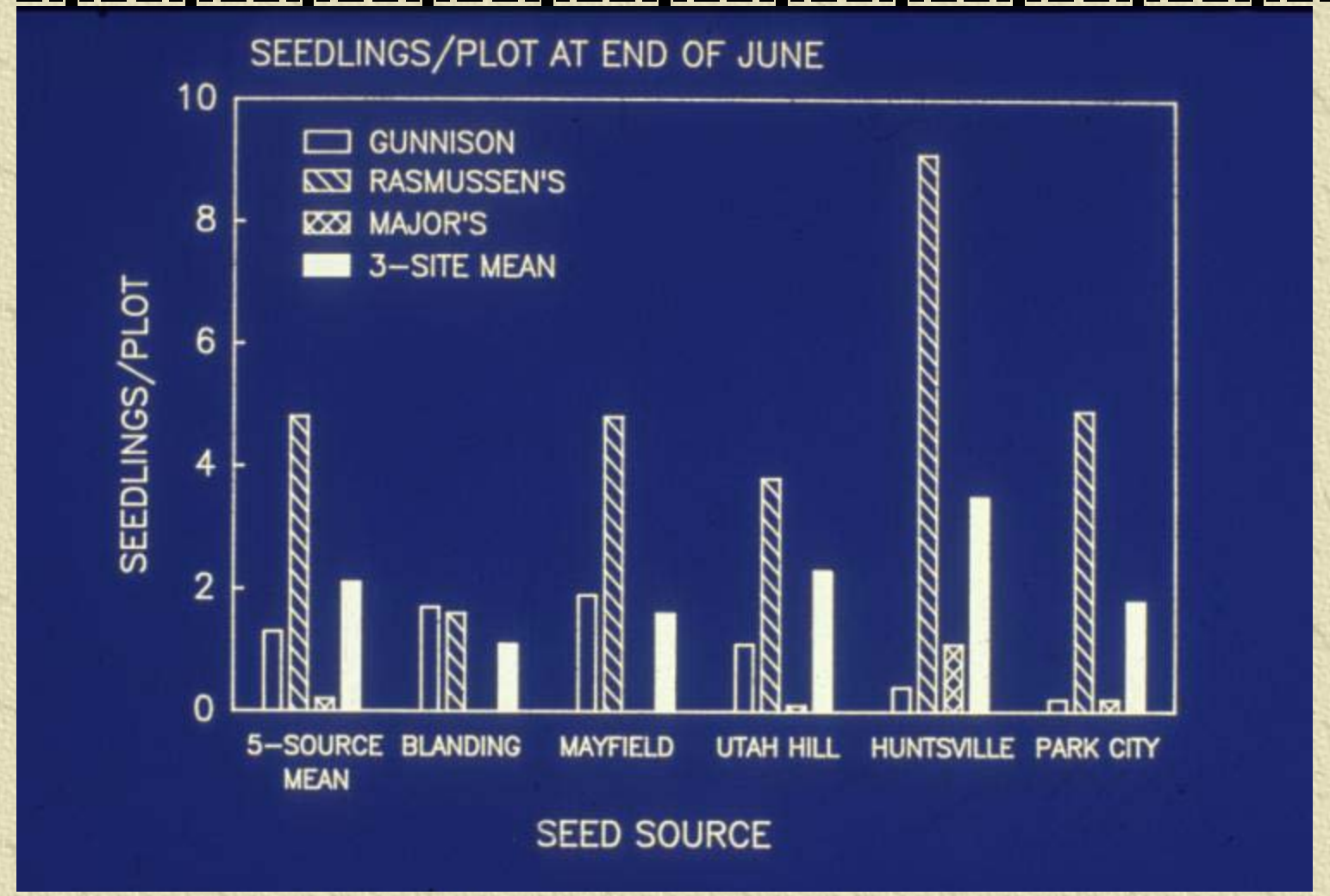
Seed Germination-Habitat Correlated

- Germination rate correlated to mean Jan. temperature
- Population from cold winter sites-
  - Require mechanisms to reduce fall germination
  - Requires long periods cold chilling (2-4 weeks)
  - 20 week chill removes all dormancy
  - Slow germination (>10 days to 50% germination)
  - Light limits germination-100% light requiring
- Germination at near-freezing is slow
  - (100 days to 50% germ)
- Germination occurs beneath the snowpack
  - Risk from premature germination reduced
  - Slower germination increases survival
  - More favorable soil moisture and temperature conditions

Germination Scenarios-Warm Habitats

- Winter conditions optimal for establishment
- Early emergence is an advantage
- Seeds are non-dormant, but respond rapidly to chill treatments
- Rapid germination (50% germ. within 10 days)
- Less light requiring-only 50-75% light requiring
- Shallow buried seeds with light requirement amount to small carryover

Effects of Habitat Conditions on Establishment of Different Sagebrush Ecotypes



Implications of Seed Origin on Planting Success

- Germination is regulated to coincide with conditions favoring establishment
- Movement of seeds from cold winter environment to mild winter environments or reversing the exchange results in less optimum establishment.
- Virtually all seeds germinate in the spring from fall seedings.
- Natural seedling recruitment is required to maintain stands of big sagebrush. Planting less-adapted ecotypes can result in poor seedling recruitment patterns

Seedbed Ecology

- Require surface/shallow planting depths
- High mortality from rapid drying surfaces
- Frost intolerant
- High mortality due to competition
  - Intraspecific competition
  - Herbaceous plants
- Influence of native & introduced species
- Value of rabbitbrush cover crop
- Dependent on winter snow cover

Field Germination Percentages for Mountain Big Sagebrush, Rubber Rabbitbrush, and Antelope Bitterbrush at Nephi, Utah for Five Different Retrieval Dates

Dates	2/25/93	3/11/93	3/18/93	3/25/93	5/24/93
Species	Snow Cover	Open Surface	Saturated Soils	Dry Soils	Dry Soils
Artrv	43.4	74.3	74.3	74.3	74.3
Chna	80.6	94.4	94.4	94.4	94.4
Putr	8.8	13.1	63.8	70.6	70.6

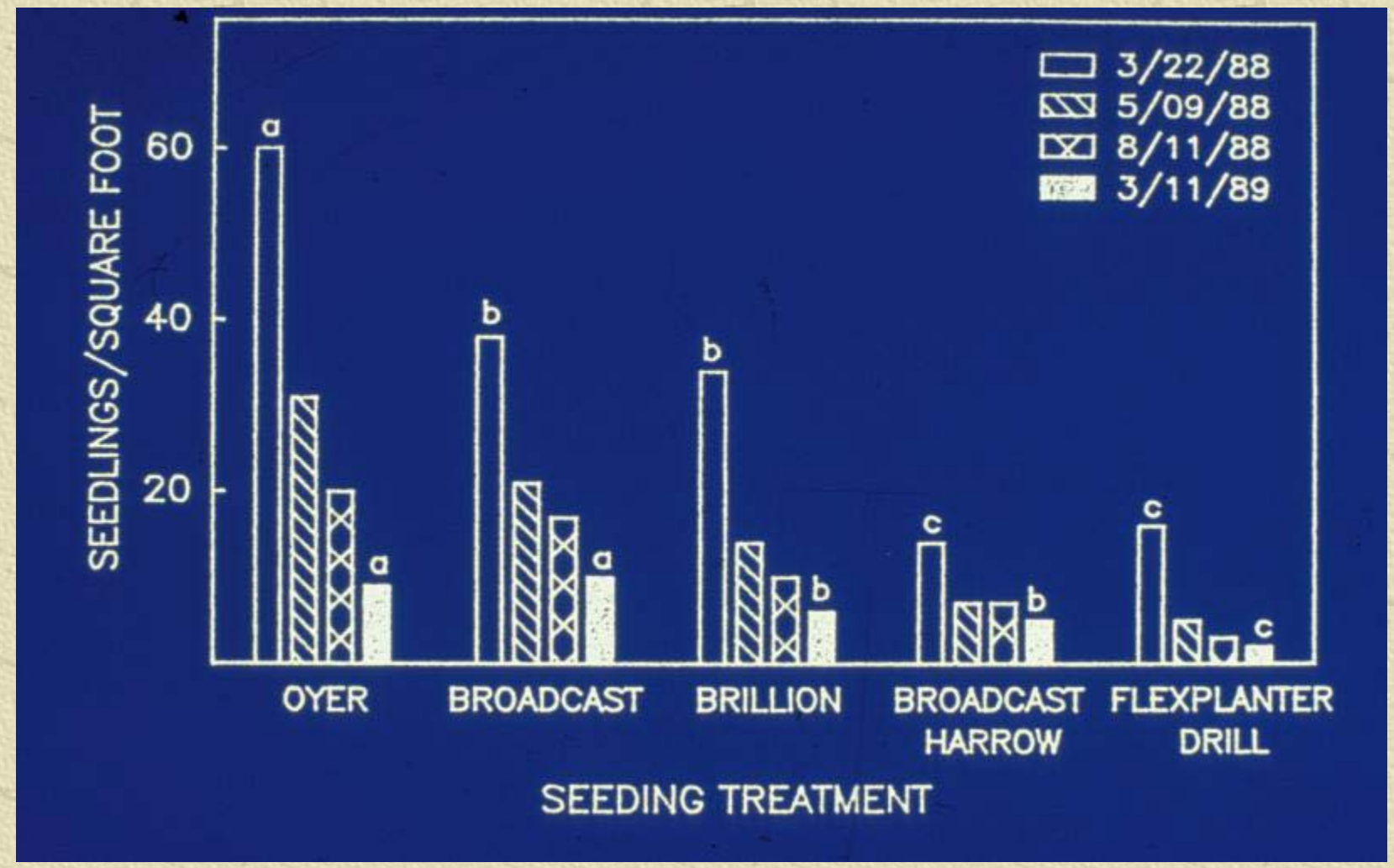
Seedbed Preparation & Seeding

- Removal of competition is necessary
- Recommended Seeding rates 0.10 – 0.25 lb.pls/ac
- Shallow planting depths - 0.25 inch
- Surface compaction is beneficial
- Broadcast distribution is highly successful
- Fall & winter plantings essential

Seeding Equipment

- Aerial Seeding
- Broadcast/chaining
- Compact seeders
- Interseeding

Sagebrush Seedling Establishment from Different Methods of Planting



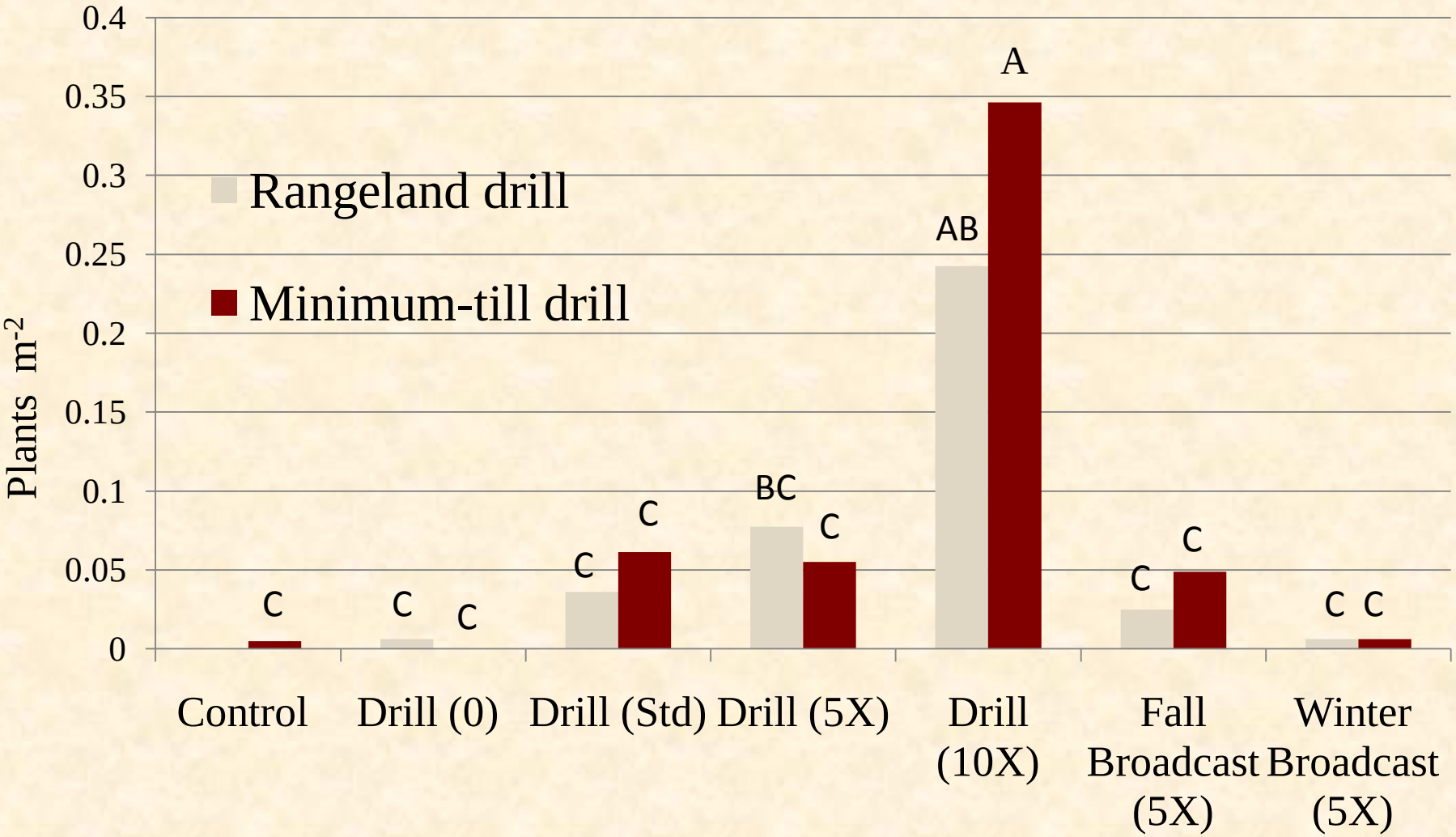
Advancement of Drilling Equipment

- Transition from planting single-species to diverse grass, herb, shrub plantings
- Available equipment not suited for multiple species planting with varied sizes and shaped seeds at appropriate depths and rates
- Need to conserve residual natives, biological soil crusts and soil microorganisms

Minimum till Drill

Rangeland Drill

•Scooby Seeding 2010 – Sagebrush Density

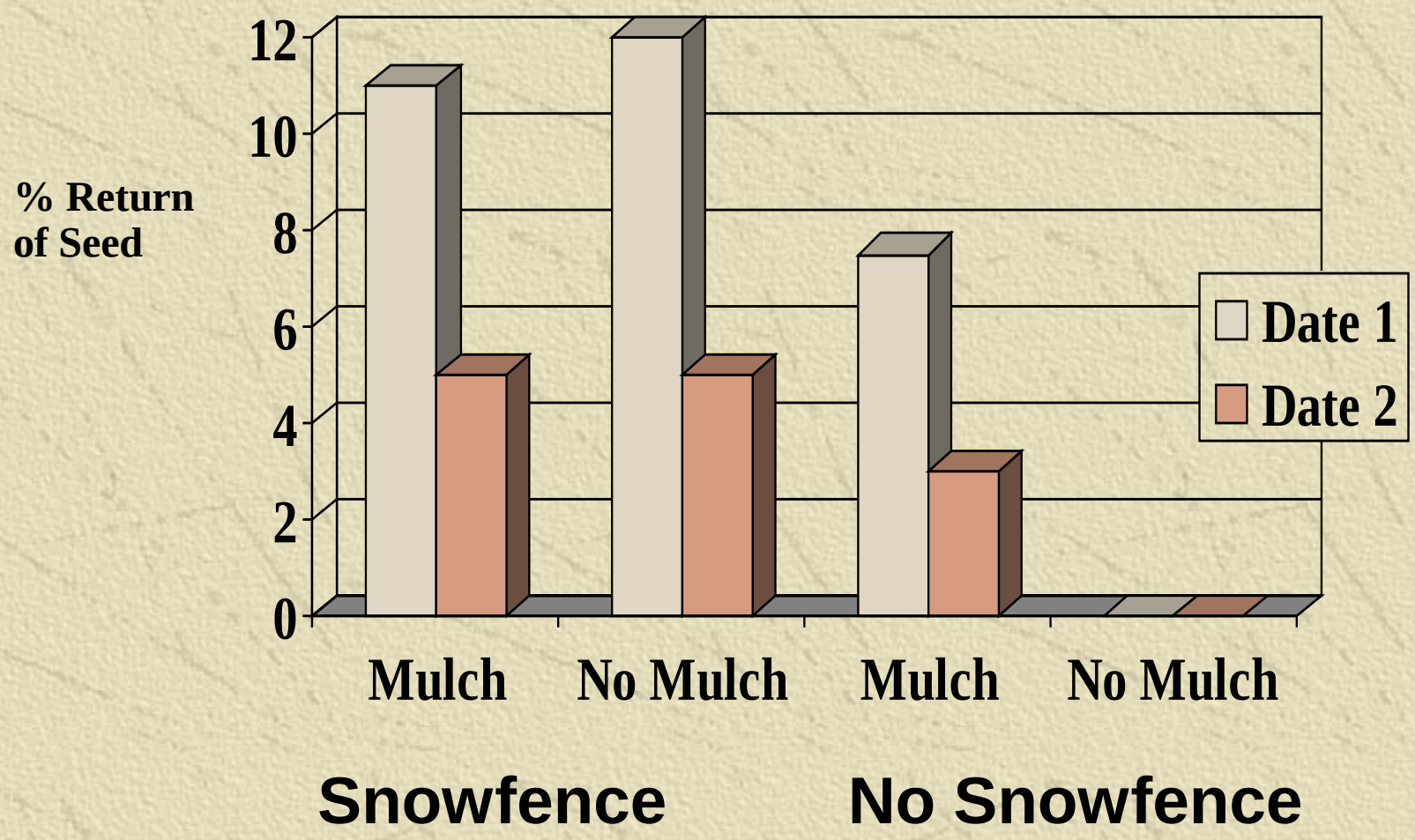


Sagebrush Seedling from Seeding

Number of Sagebrush Seedling Per Acre From Aerial Seeding- Dry Creek, Idaho

	Chained Sites		Non-Chained Sites	
	Aspect		Aspect	
Species	South	North	South	North
Mtn. Sage	30,930	15,671	6,186	7,010
Bitterbrush	2,062	885	--	412

Seedling Establishment of Wyoming Big Sagebrush-Black Butte Mine



Implications for Restoration

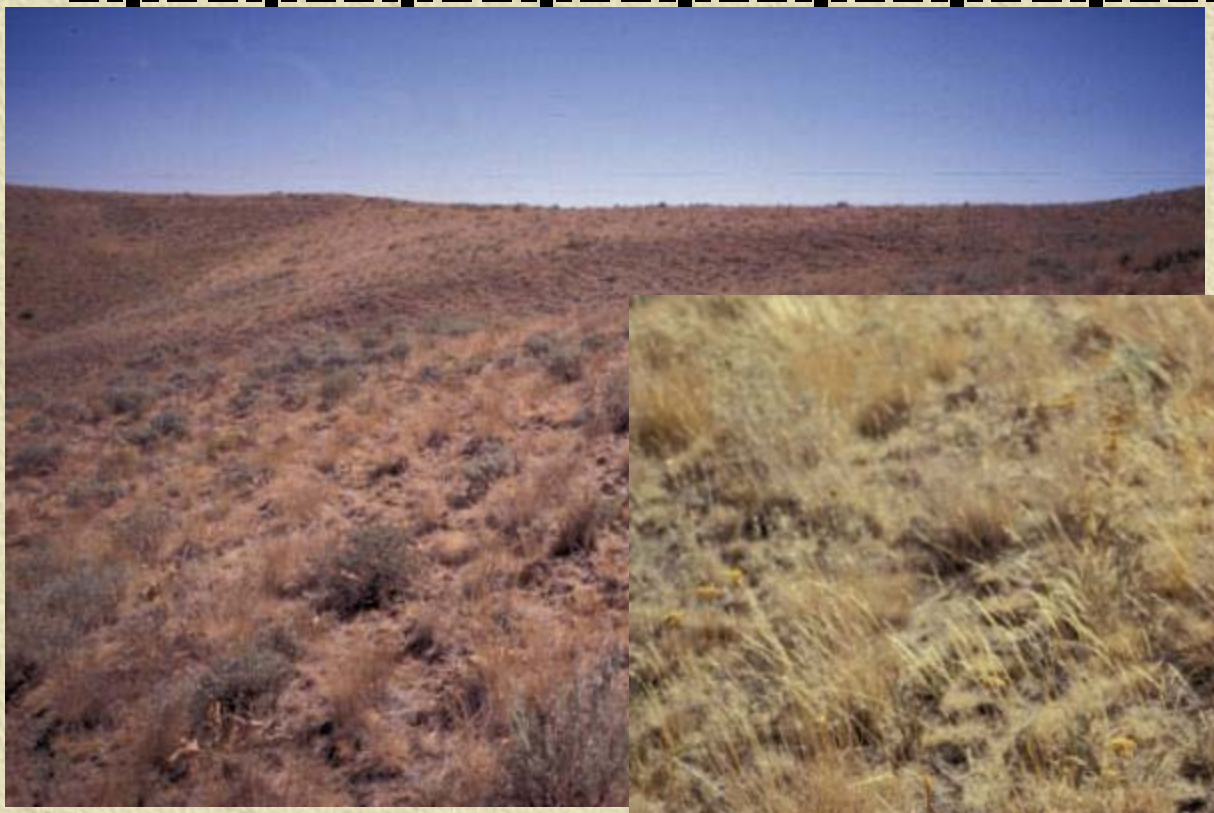
- Select site adapted species
  - Develop and map seed zones
- Seed quality, 10-20% purity, 80-90% viability
  - Store seeds in cool environments
- Seed 0.10-0.25 lb.pls/acre
- Separate seeded species

Enhancement of Sagebrush Disturbances

- Reduction of competition-complete removal of shrubs is not necessary
  - Recommend chaining, cabling

Controlling Competition

Big sagebrush can successfully recruit into native stands of perennial grasses.



Enhancement of Sagebrush Disturbances

- Burning and plowing not recommended
- Creates unfavorable seedbeds

Site Enhancement

Utilizing nurse crops of other shrubs, principally rabbitbrush, to enhance big sagebrush seedling survival is an appropriate technique on large open disturbances.

Anchor Chain

Hansen Seed Dribbler

Chained
Stand of Big Sagebrush

Cabling of Big Sagebrush

Lawson Aerator

Pipe Harrow or Dixie Harrow

Effects of Pipe Harrowing