BIOLOGICAL AND ECOLOGICAL ASPECTS OF BIG SAGEBRUSH SUBSPECIES: INFLUENCES ON PLANTING SUCCESS AND COMMUNITY RESTORATION

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Identification and Distribution of Big Sagebrush Subspecies

- Define the principal species
- Identify site characteristics: Climatic conditions
- Determine soils and elevation features
  - M.F. Mahalovich & E.D. McArthur 2004
  - A. Winward 2004
- Define community types
  - B. Johnson 2001
- Determine the presence of specific species

Big Sagebrush Subspecies

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).
- Populations evolve to be adapted with different understory species.

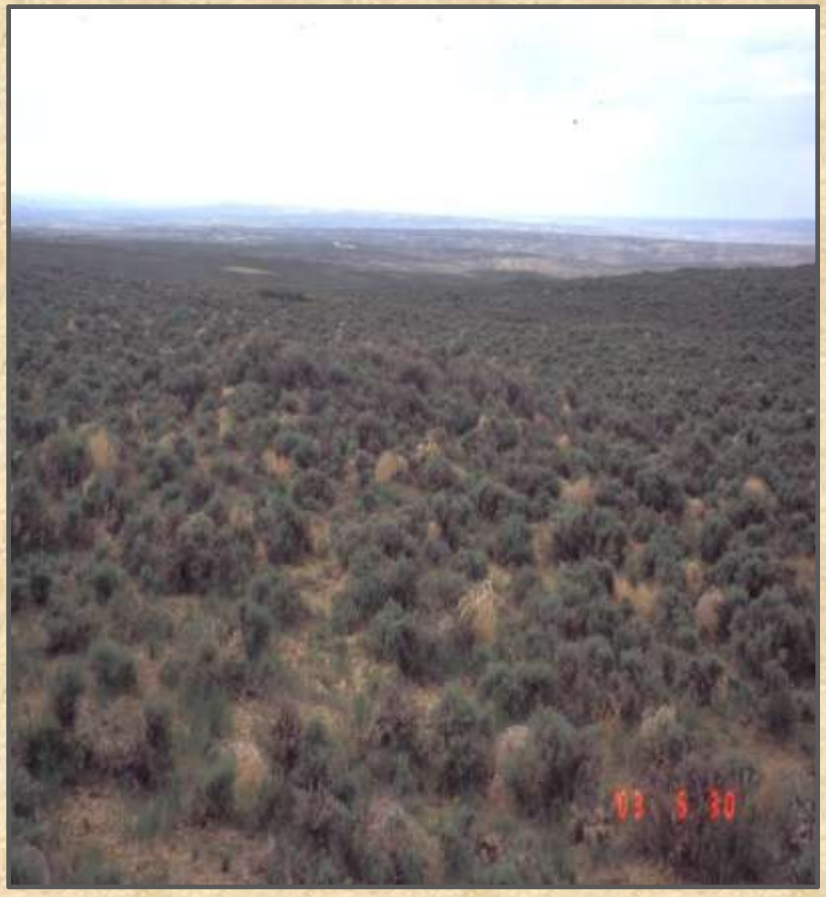
Annual Precipitation Ranges for Big Sagebrush Subspecies

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

Site Adaptability

Wyoming Big Sagebrush

- Strategy based on ability to tolerate abiotic stress.
- Sporadic seed production
- Adjustment to resource fluctuations.
- Slowest growth rate.
- Seedling- slowest maximum growth
- Seeds of all subspecies are small- l- 4.5 million/kg



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 are better adaptive to ecological extremes than diploid relatives
- Autopolyploidy alters tolerance
- Polyploids are smaller shrubs with lower growth rates and increase drought tolerance
- Planting tetraploid (4x) Wyoming big sagebrush on drier sites is recommended

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

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 seasonal and consecutive years moisture
- Disease & browsing reduce yields

Seed Dispersal

- Seeds are 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
- Seeds germinate during winter/spring period
- Only a small fraction (0.1%) of autumn maturing seeds remain in the seed bank after the first spring period

Seed Germination-Habitat Correlated
Cold Habitats

- Germination rates are correlated to mean January temperature
- Populations from cold winter sites-
  - Require mechanisms to reduce fall germination
  - Requires long periods cold chilling-20 weeks
  - 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 is reduced
  - Slower germination may increase survival
  - Provides favorable soil moisture and temperatures

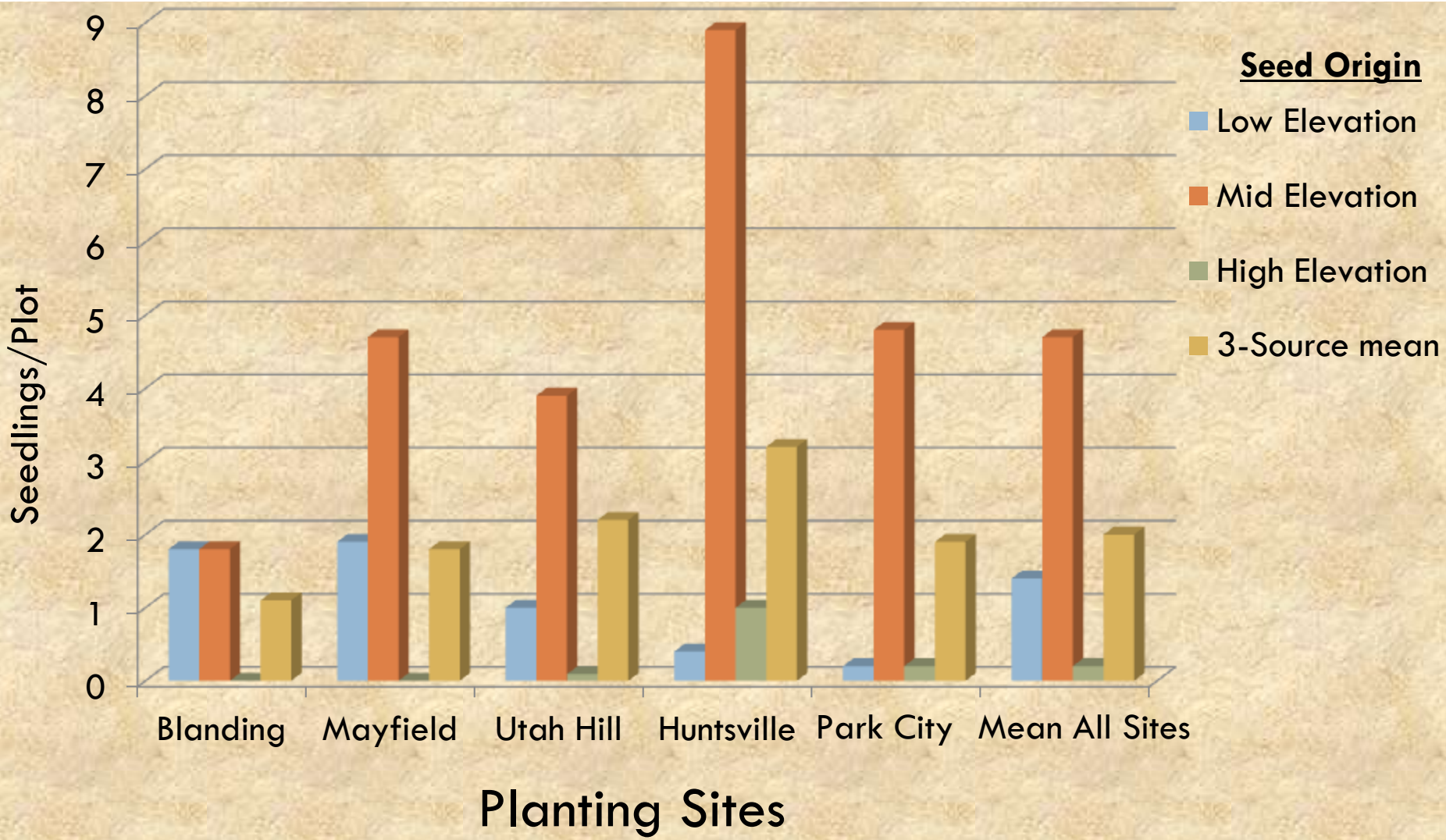
Germination Scenarios-Warm Habitats

- Seeds are non-dormant, respond rapidly to chill
- Winter conditions optimal for establishment
- Early emergence is an advantage
- Rapid germination (50% germ. within 10 days)
- Less light requiring - only 50-75% required
- Small carryover of buried seeds

Implications of Seed Origin on Planting Success

- Germination is regulated to coincide with conditions favoring establishment
- Movement of seeds from cold winter environments 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

Effects of Habitat Conditions on Establishment of Different Sagebrush Ecotypes



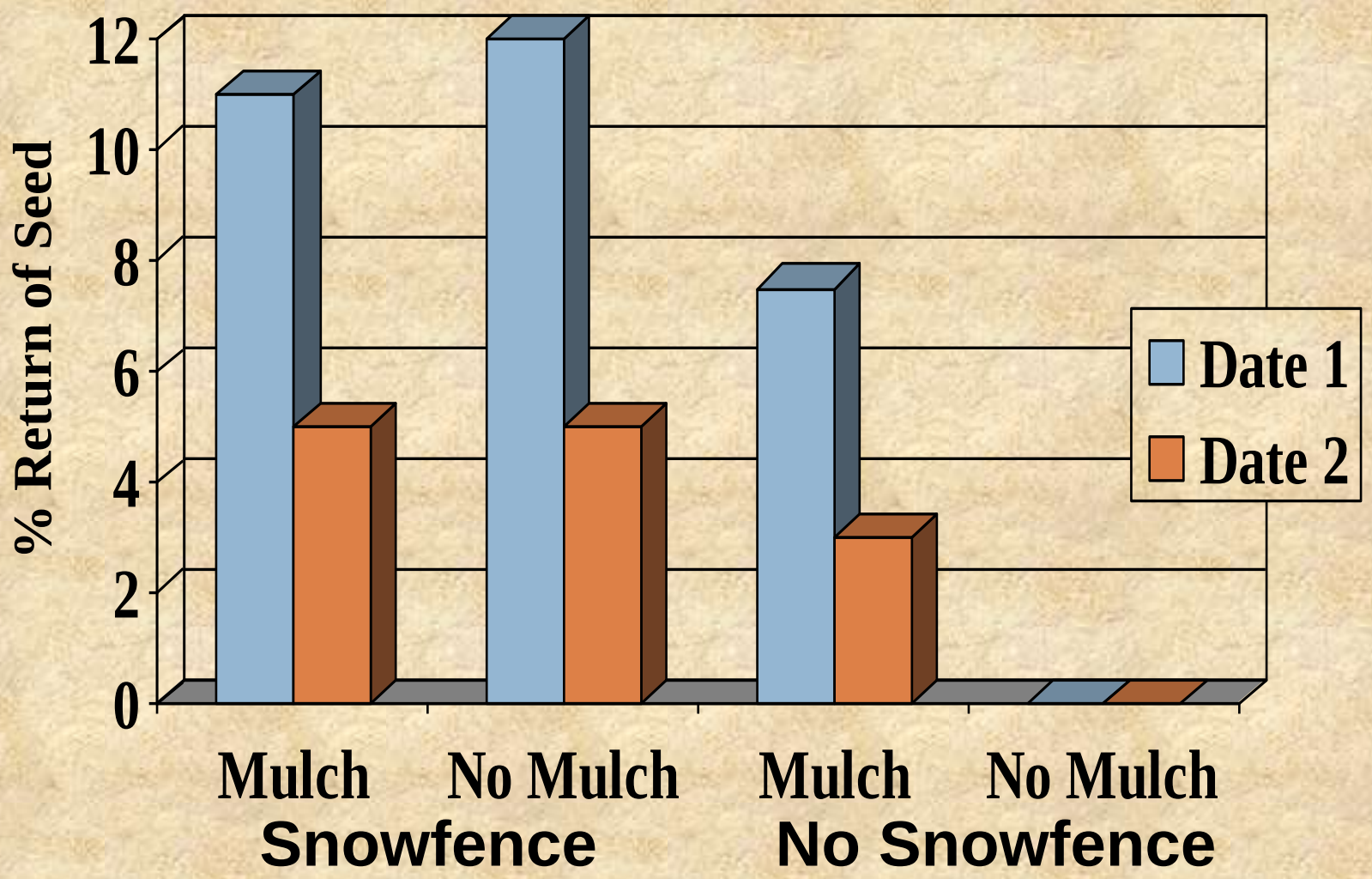
Seedbed Ecology

- Seeds are normally cleaned to 12-20% purity
- Usually 0.12 to 0.24 PLS planted/ac
- Requires surface/shallow planting depths
- High mortality occurs from rapid drying surfaces
- Success is dependent on winter snow cover
- Small seedlings are frost intolerant
- High seedling mortality is often due to competition
  - Intraspecific competition is moderately important
  - Herbaceous plants are highly competitive

Percent seedling emergence for mountain sagebrush, rabbitbrush, and bitterbrush at Nephi, Utah for five 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

Seedling Establishment of Wyoming Big Sagebrush-Black Butte Mine

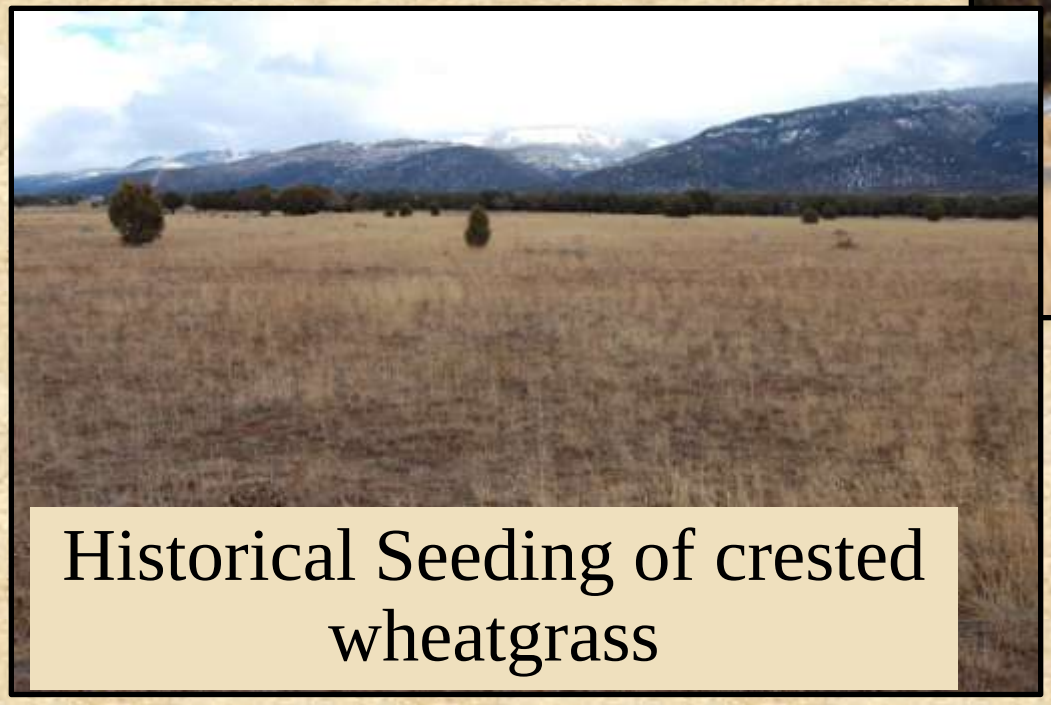


Seedbed Preparation-Association of Understory Species

Initial establishment and plant survival is dependent on associated species

- Control of existing perennial herbs and weeds is necessary
- Sagebrush seedlings and young plants are most compatible with native herbs
- Seeding sagebrush directly with introduced grasses is not advisable

Cheatgrass Disturbance



Historical Seeding of crested wheatgrass

Occupation of Pinyon/ Juniper

Fairway crested wheatgrass -1940 planting

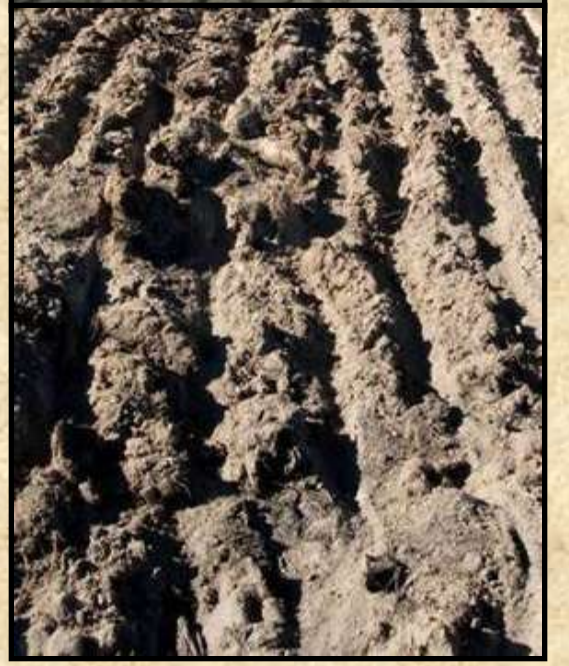
Sequence of natural recovery -Native grasses/shrubs

Seedbed Preparation & Seeding

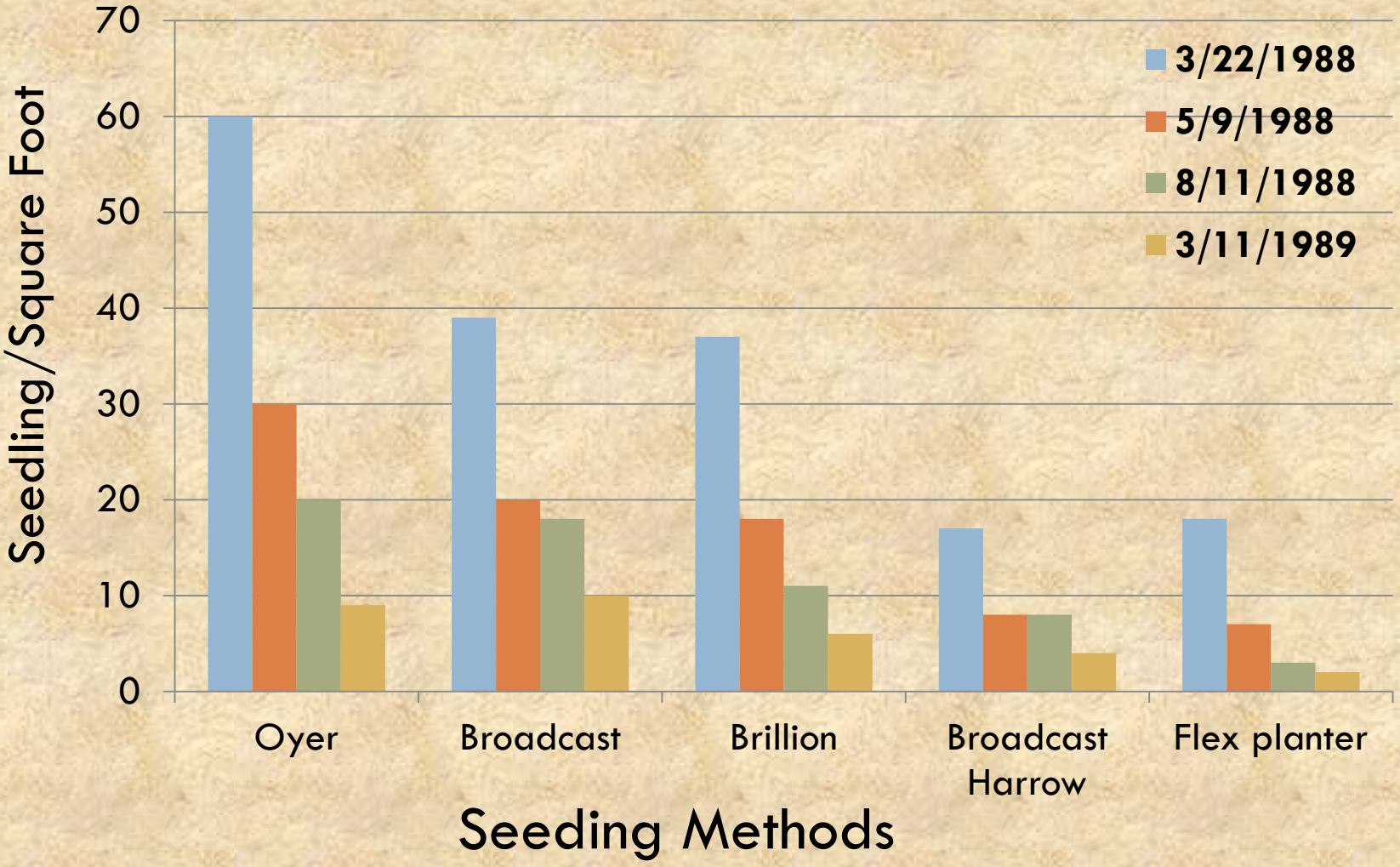
- Controlling competition is essential
- Recommended seeding rates 0.10 – 0.25 lb.pls/ac
- Shallow planting depths are essential - 0.25 inch
- Broadcast distribution and coverage is normally successful
- Fall & winter plantings are essential
- Litter cover is beneficial

Planting Equipment

Broadcasting Compact Seeder Drill Seeding



Sagebrush Seedling Establishment from Different Methods of Planting



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

Controlling Competition

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

Year of establishment

Third year after seeding

Enhancement of Sagebrush Sites

- Reduction of competition-complete removal of shrubs is not beneficial or advisable

Modification Measures to Reduce Sagebrush Competition

- Burning and plowing are not recommended
- Treatments create unfavorable seedbeds and eliminates onsite seed source

Anchor Chain

Chained Stand of Wyoming Big Sagebrush

Cabling of Big Sagebrush

Pipe Harrow or Dixie Harrow

Effects of Pipe Harrowing

Shrub Recovery Six Years after Pipe Harrowing Treatment

Summary- Considerations

- Determine the principal objectives
- Define measures to restore entire plant communities
- Determine climatic variables
- Identify and use site adapted species & populations
- Recognize the required seedbed conditions
- Utilize appropriate equipment and practices
- Recognize the influence of associated species