Importance of Seed Source in Shrub Reestablishment

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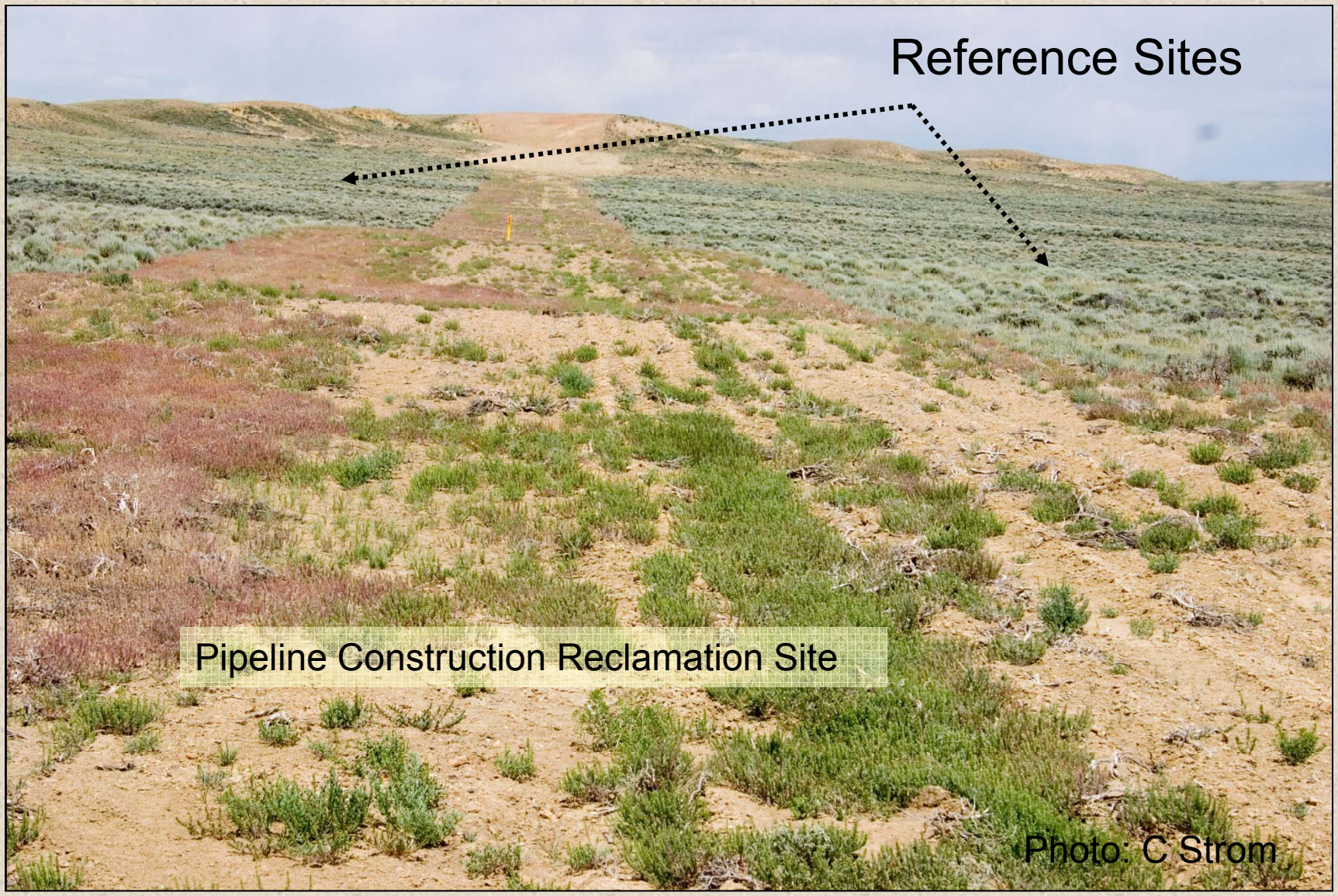
Revegetation

- Challenging
  - Low or variable precipitation, thin soils, steep slopes, cold and windy climate
  - ‘revegetation projects fail 10 to 35% of the time, depending on the geographic region.’
    - US Army Corps of Engineers

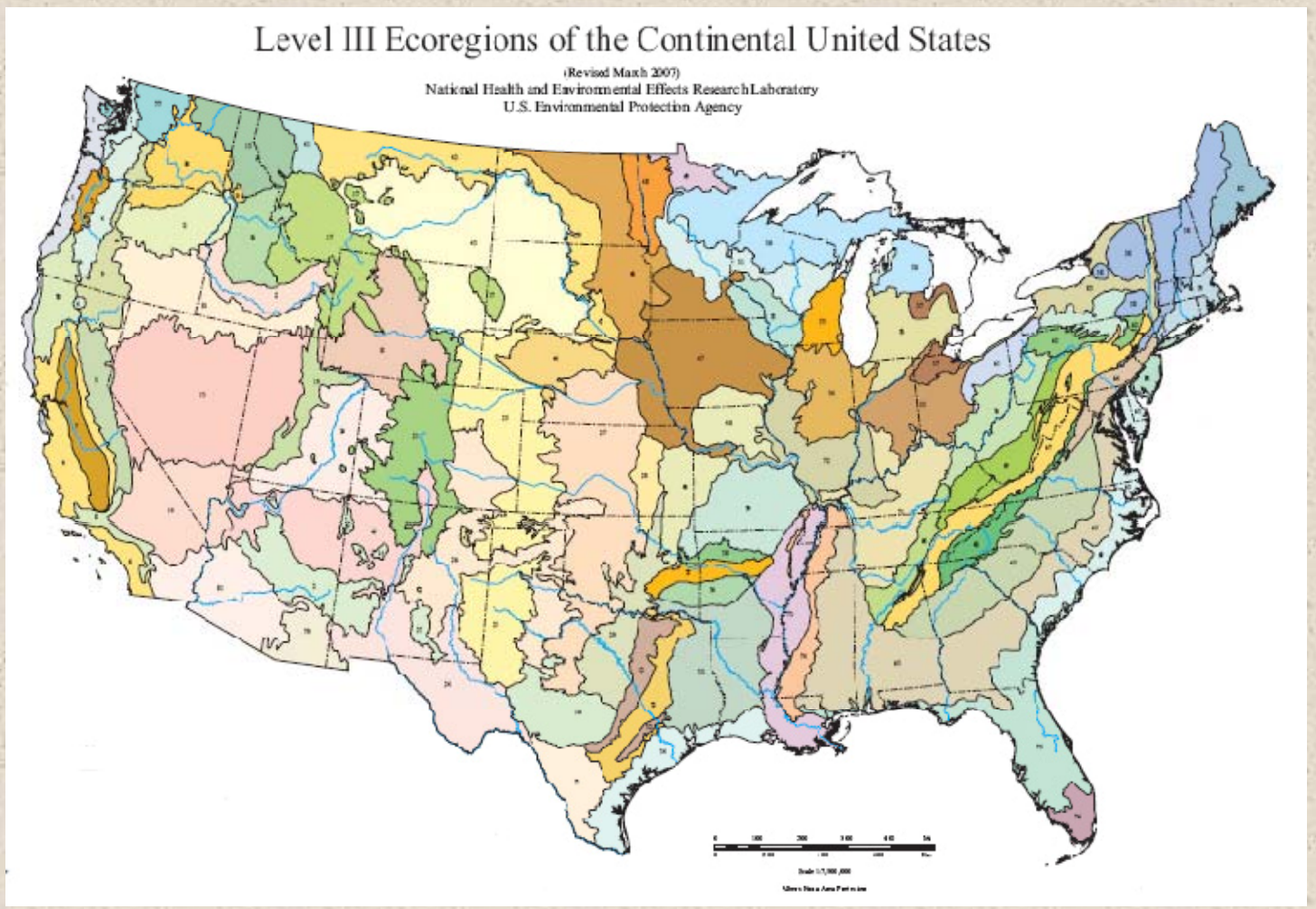
Designing a Reclamation Seed Mix

- Inventory pre-disturbance plant community
  - Set reclamation objectives
  - Determine seed mix
- Reclamation Objective
  - Reestablish a diverse, native plant community of grasses, forbs and shrubs

Pre-disturbance Plant Community



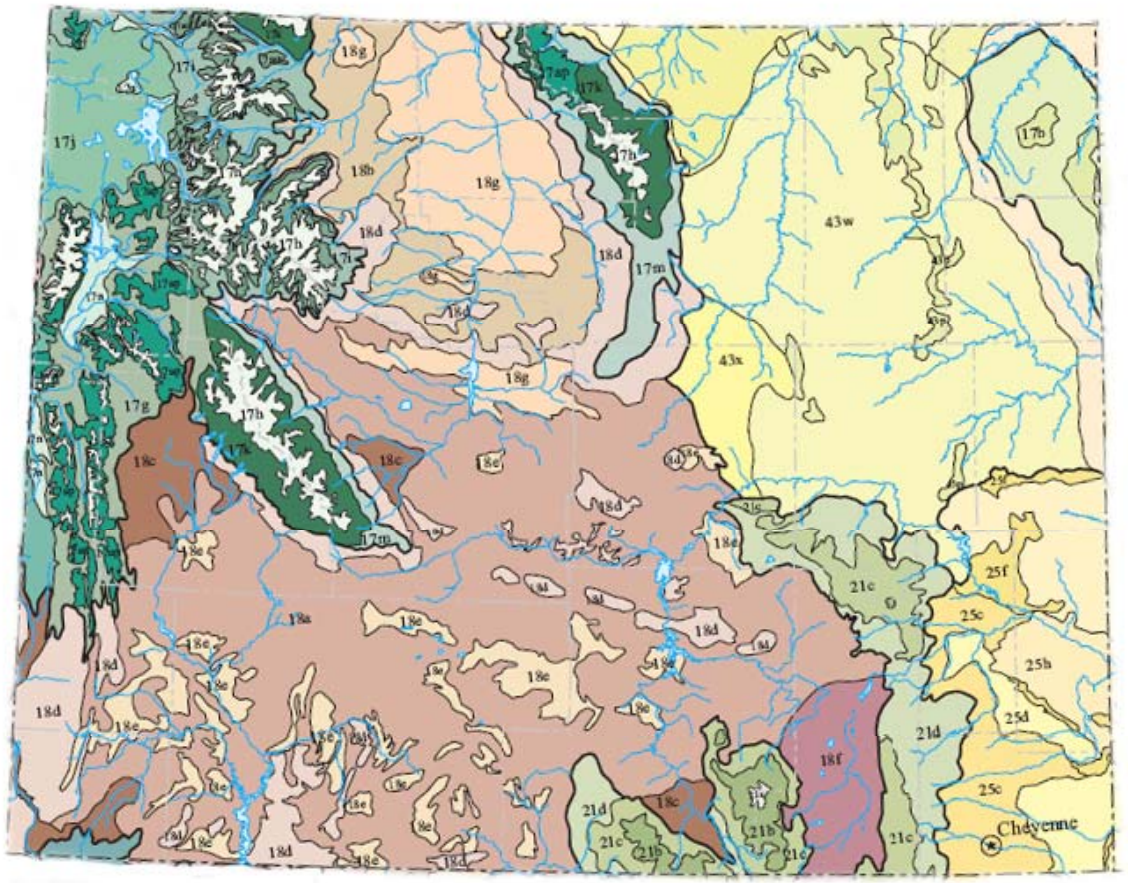
Pre-disturbance Plant Community - Ecoregions



- Ecoregions are large areas of similar climate where ecosystems recur in predictable patterns. – USFS

Ecoregions

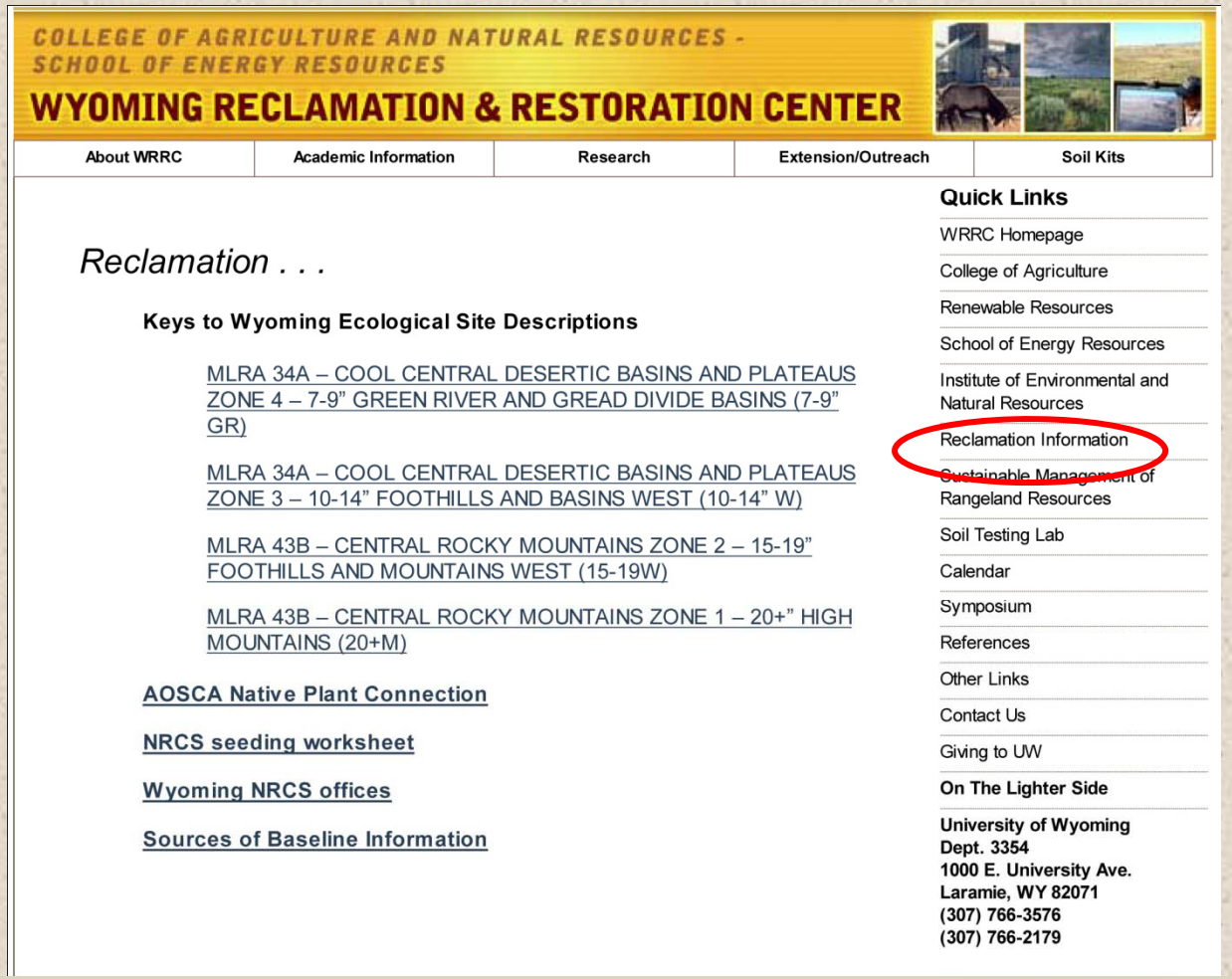
Level IV



Wyoming

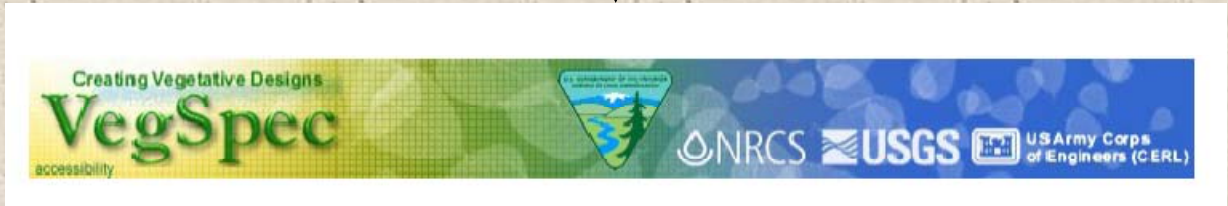
- Ecoregions are divided into domains (climate), divisions (climates within domains), provinces (vegetation), and sections (province subdivisions based on terrain).

Pre-disturbance Plant Community



Available keys are similar to taxonomic keys and describe sites based on soils, hydrology, vegetation and topography.

Pre-disturbance Plant Community



"VegSpec is a decision support system designed to *assist in the selection of appropriate plant species* for site-specific conservation problems."

http://plants.usda.gov

Pre-disturbance Plant Community

VegSpec only provides a broad species list for consideration.

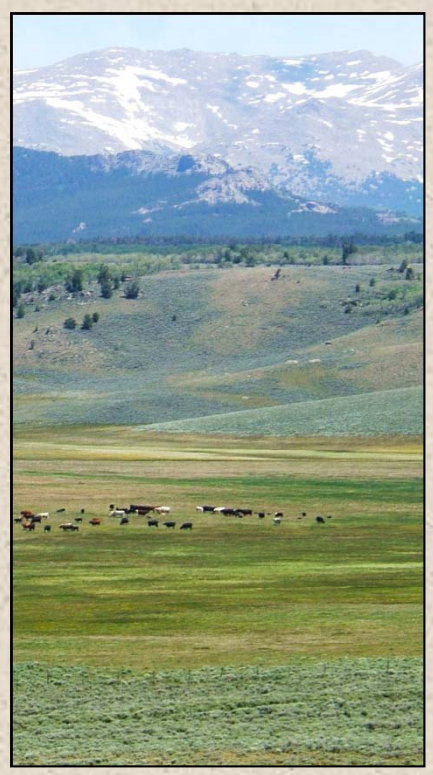
"VegSpec is a decision support system designed to *assist in the selection of appropriate plant species* for site-specific conservation problems."

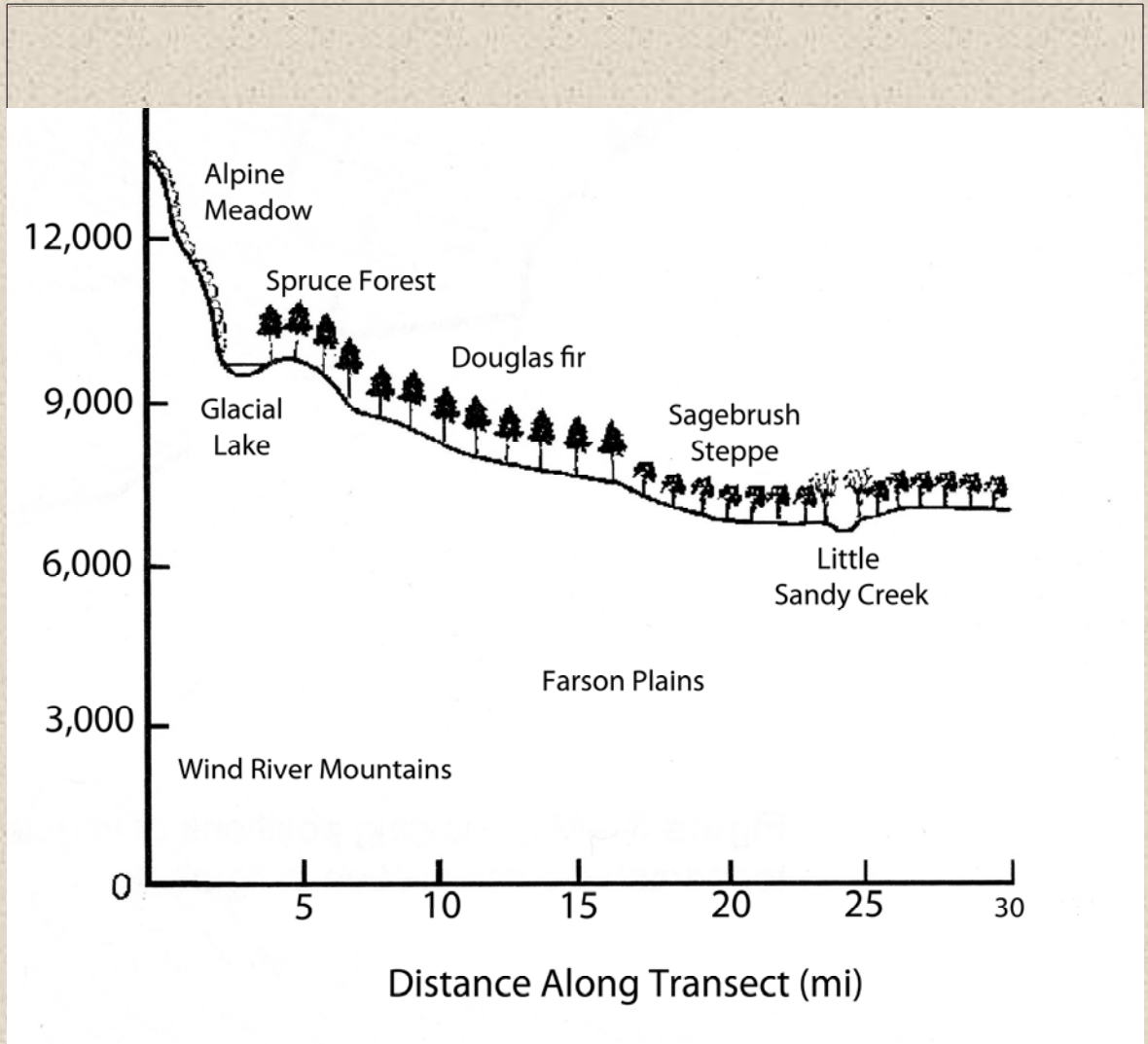
http://plants.usda.gov


Long-term success in restoring a species to
a given site is dependent upon obtaining
plant materials adapted to the site.

Adapted Species

- Species-level

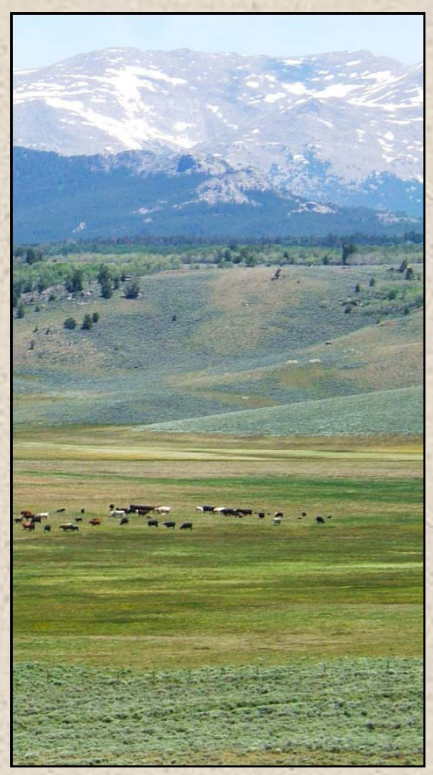


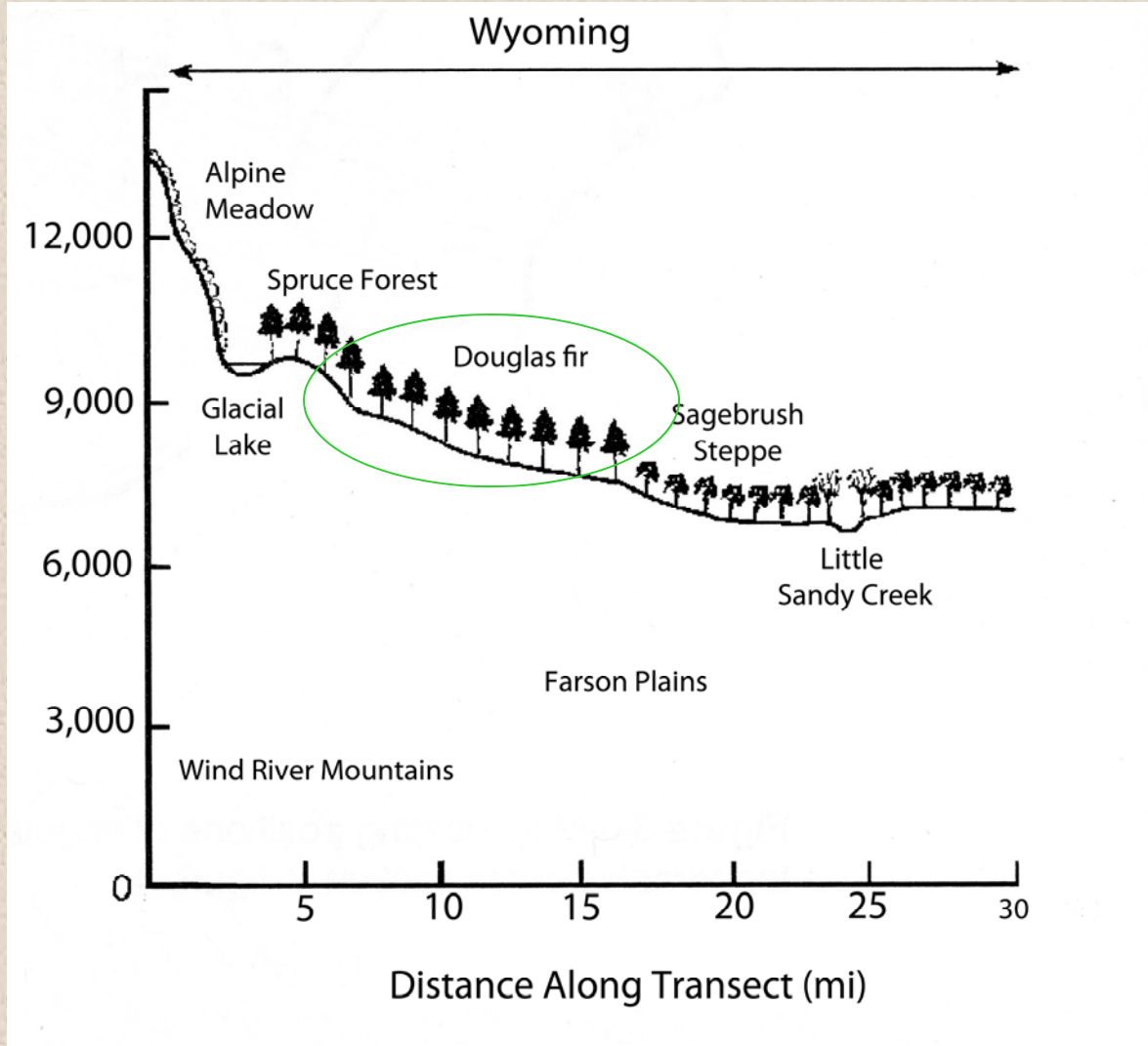


Monson et al. RMRS-GTR-136-vol 1

Adapted Species

- Species
- Populations





Monson et al. RMRS-GTR-136-vol 1

Local Adaptation

Plant Ecotypes: distinct genotypes (or populations) within a species, resulting from adaptation to local environmental conditions.

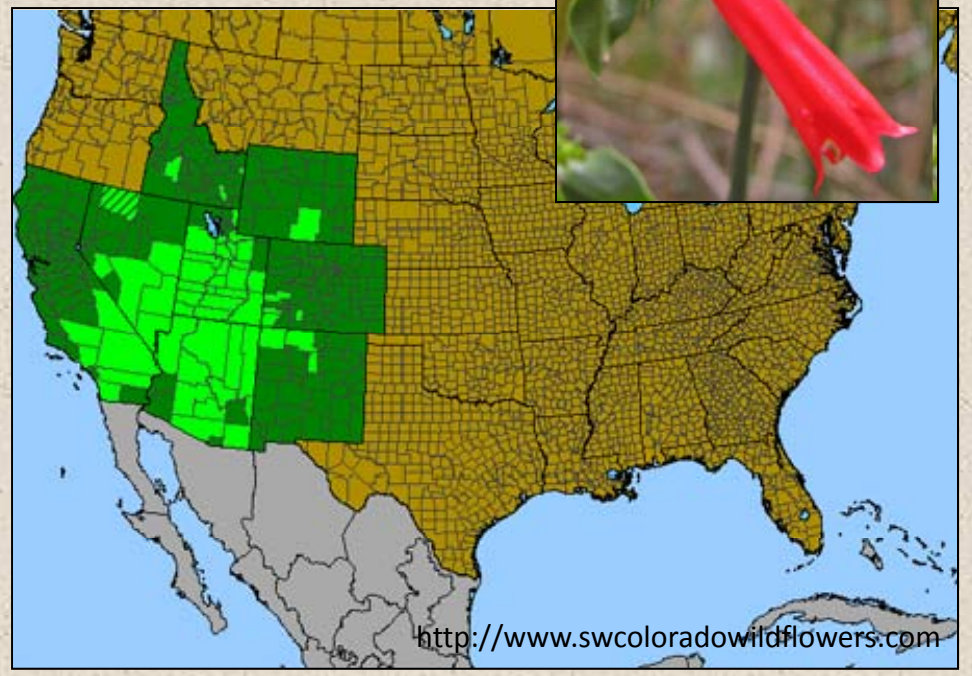
races, varieties, cultivars

G. Turesson 1922 The species and variety as ecological units.

Ecotypic Variation - Elevation

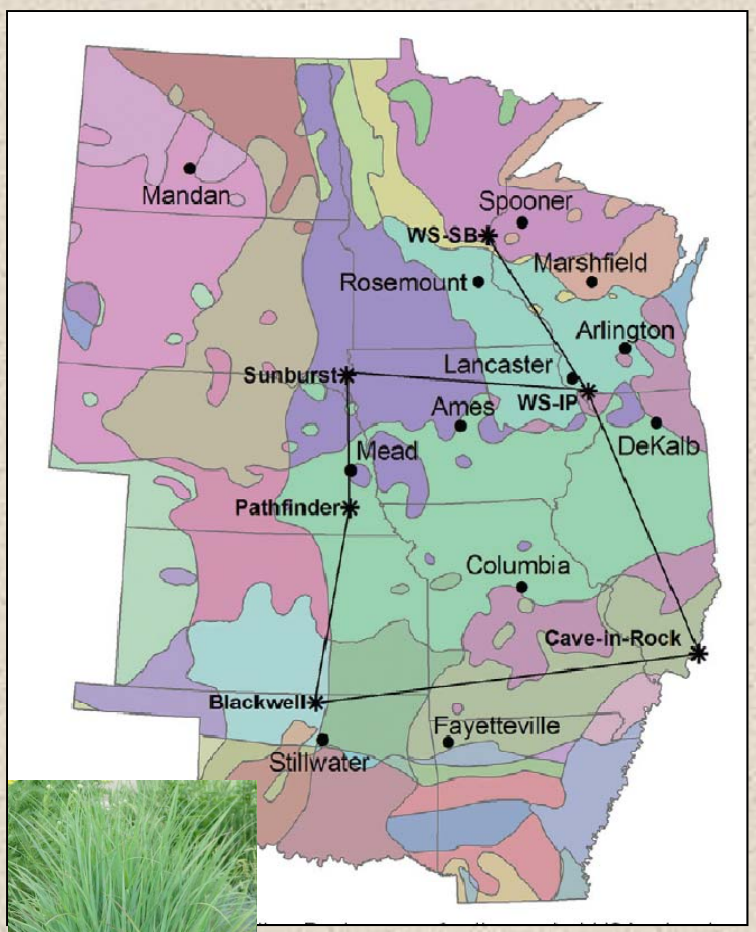
Firecracker Penstemon, *Penstemon eatonii*

- Habitat correlated variation in seed germination.
- 'Between-population variation in germination response to chill is…correlated with the climate at the site of seed origin."
- Place seeds in a climate context.



Meyer 92 Bull Tor Bot Club
Meyer et al. 95 Amer J Botany

Ecotypic Variation - Latitude



Casler et al. '07 Crop Science

Switchgrass, *Panicum virgatum*

- Relative importance of latitude and longitude for adaptation and agronomic performance (biomass).
- Significant effect of latitude (north-south) but not longitude.
- Latitudinal ecotypes

Ecotypic Variation – Elevation and Latitude

Mountain mahogany, *Cercocarpus montanus*

Ecotypic Variation – Elevation and Latitude

Mountain mahogany, *Cercocarpus montanus*

- Seed dormancy - 8 NM seed sources
- Southernmost sources lacked stratification requirement
- Northern and high altitude sources required longest stratification duration
- Latitudinal and altitudinal ecotypes

Rosner et al. 2003 J. Range Management

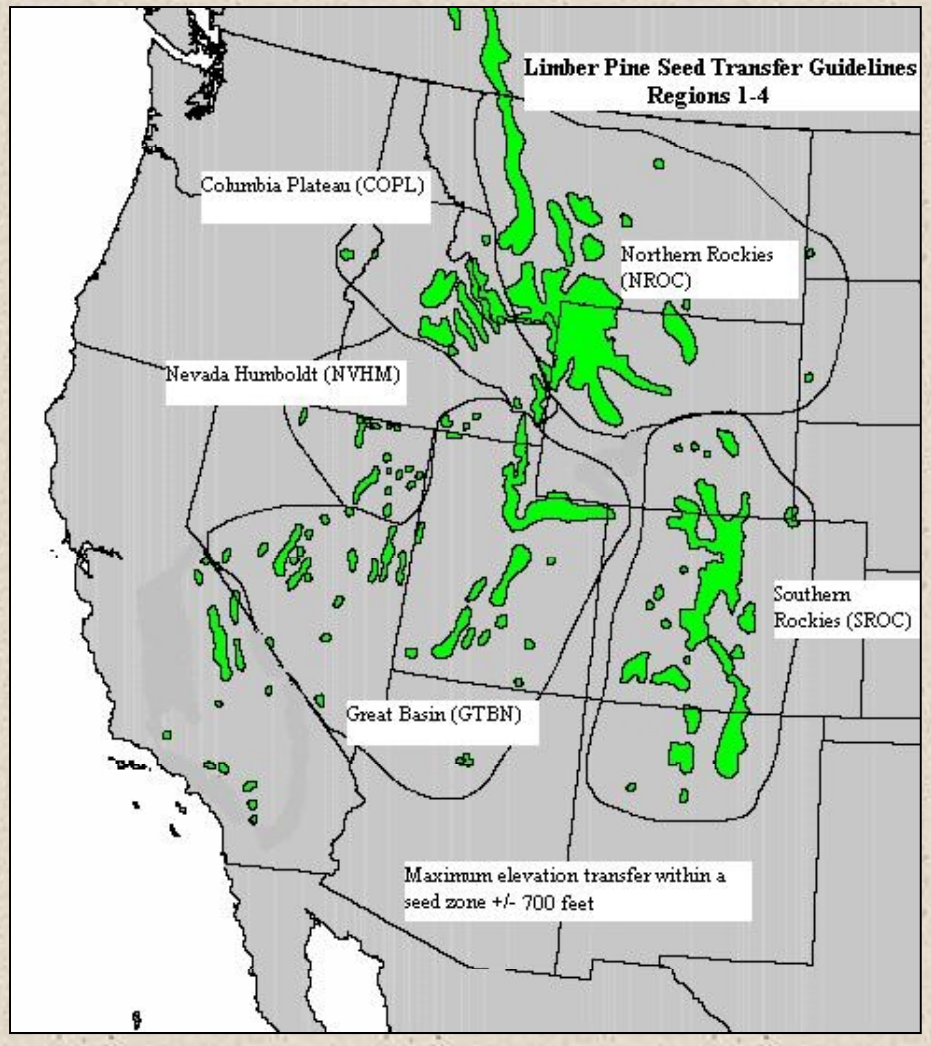
So what do we introduce?

Seed transfer zones: regions within which seeds may be transferred with no detrimental effects for population fitness

Also known as local “provenance.”

Seed Zones

- Available for decades for commercial forest trees
- Common garden studies
- Heritable, adaptive variation among sites



Ex. *Pinus flexilis*

Local Provenance

Eucalyptus marginata

Introduced Provenance 1

Introduced Provenance 2

Delineating seed collection zones ideally includes...

- taxonomic knowledge
- distribution disjunctions
- life history (dispersal, breeding system)
- geographic distance
- habitat matching (ecological distance)
- **direct analysis of adaptation (genetics, common gardens)**

If seed zones undefined?

- Guidelines for seed sourcing

1. Collect locally, from similar environments
2. Determine breeding system of target species
3. Multiple plants within collection zone
4. Verify taxonomy

Guidelines - Local Collections and Similar Environments

- Geographic distance
  - Sites further apart more likely to differ environmentally
- Environmental distance
  - Similar climate, aspect and soils

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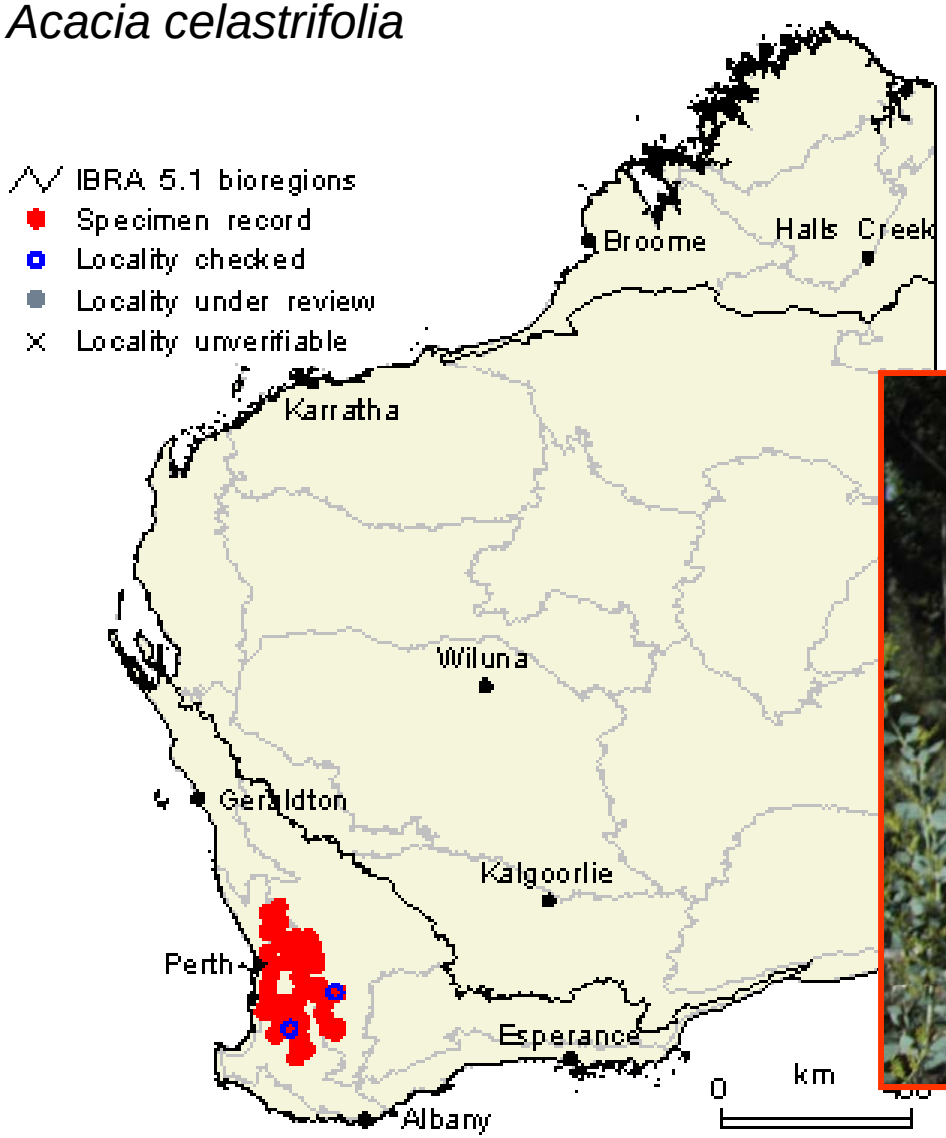
Case study: Weedy Behavior of *Acacia celastrifolia*

Acacia celastrifolia



Map by Paul Gioia, WA Herbarium. Current at June 03, 2008

J. Koch

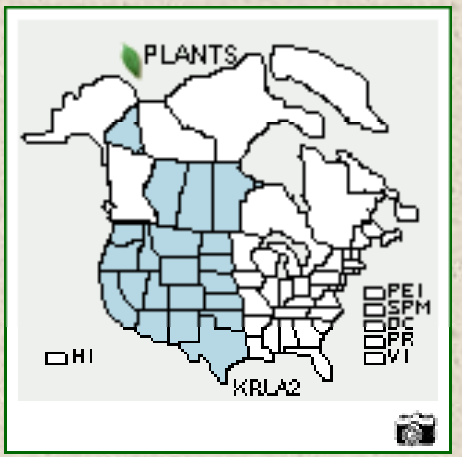
Vigorous recruitment and regeneration in thinned and burnt areas of rehabilitation

Cost approx $20k pa

Winterfat

- Palatability
- Growth rate and growth form
- Ecotypic variation is common
- Short (common) and tall growth forms
- Cultivars
  - Hatch (UT)
  - Northern Cold Desert (UT, CO)
  - Open Range (MT, WY)

Krascheninnikovia lanata



If seed zones undefined?

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Guidelines – Breeding System

- Determine the breeding system of target species
  - Outcrossing species experience higher rates of gene flow
  - Species which self fertilize are more likely to be differentiated among sites

If seed zones undefined?

- Guidelines for seed sourcing

1. Collect locally, from similar environments
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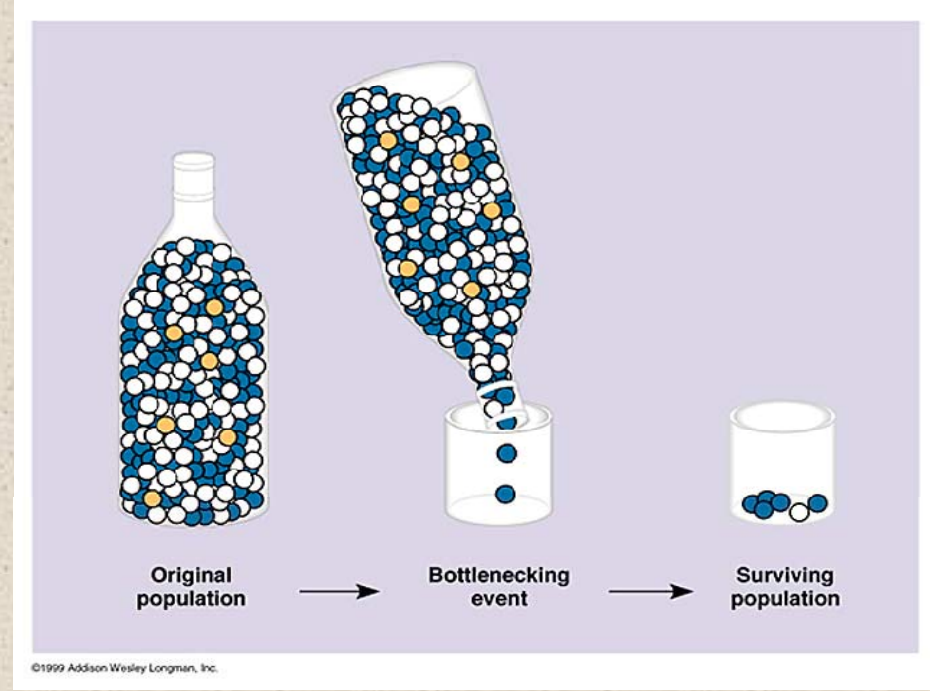
Guidelines – Multiple Plants

- Maintain genetic diversity
  - Limited # of sources
  - Founding individuals represent portion of original population diversity



Inbreeding

"Inbreeding depression in white clover (non-inbred on left, inbred on right)"

-V. Connolly, Breeding Improved Varieties Of White Clover

If seed zones undefined?

- Guidelines for seed sourcing

1. Collect locally, from similar environments
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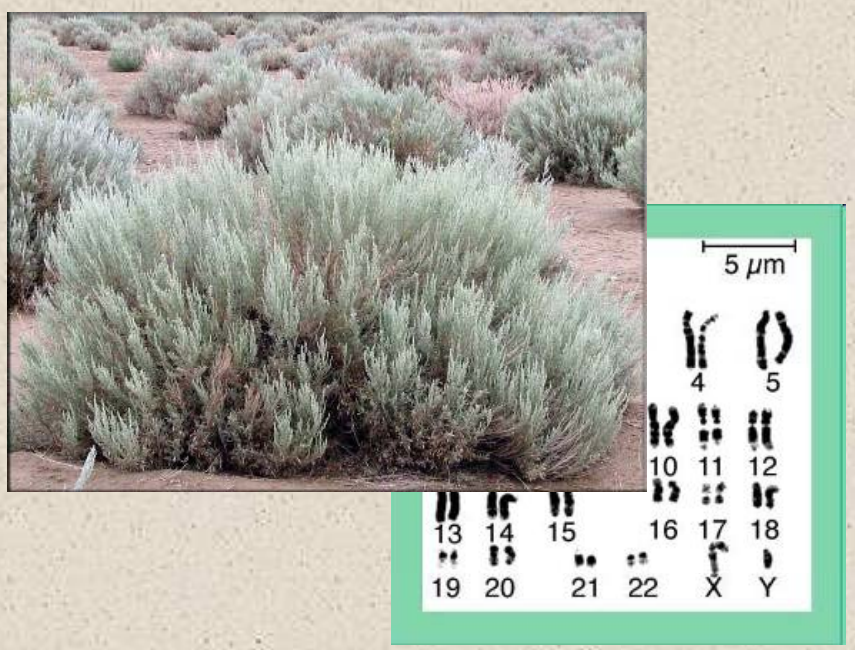
4. Verify taxonomy

Guidelines - Taxonomy

- Avoid introductions of subspecies or varieties
- Similar ploidy (chromosome number)

Lupinus arboreus



Artemesia tridentata

Case Study: Taxonomic Questions

- Environmental Mitigation
  - Road realignment
  - Contractor hydroseeded slopes with native grasses
  - Unknown seed source
  - *Bromus carinatus* (native) plants differed in flower morphology and may be hybrids with introduced Brome

Western Shrubs

- Some patterns of ecotypic variation
  - Artemesia species (P)
  - Currants (G)
  - Fourwing saltbush (G) (P)
  - Mountain mahogany (G)
  - Shadscale (G) (P)
  - Winterfat (G)

G: habitat-correlated patterns of germination
P: polyploidy

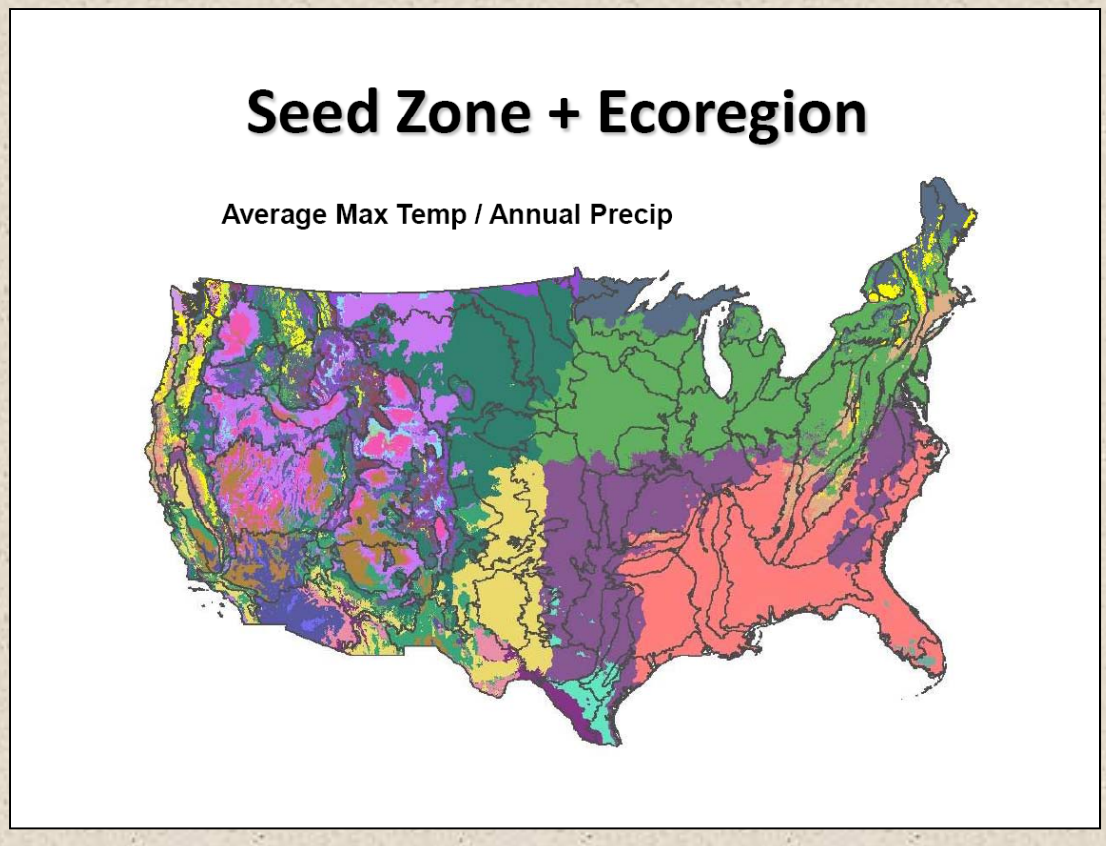
If seed zones undefined?

- Guidelines for seed sourcing

  1. Collect locally, from similar environments
  2. Determine breeding system of target species
  3. Multiple plants within collection zone
  4. Verify taxonomy

- Provisional seed zones

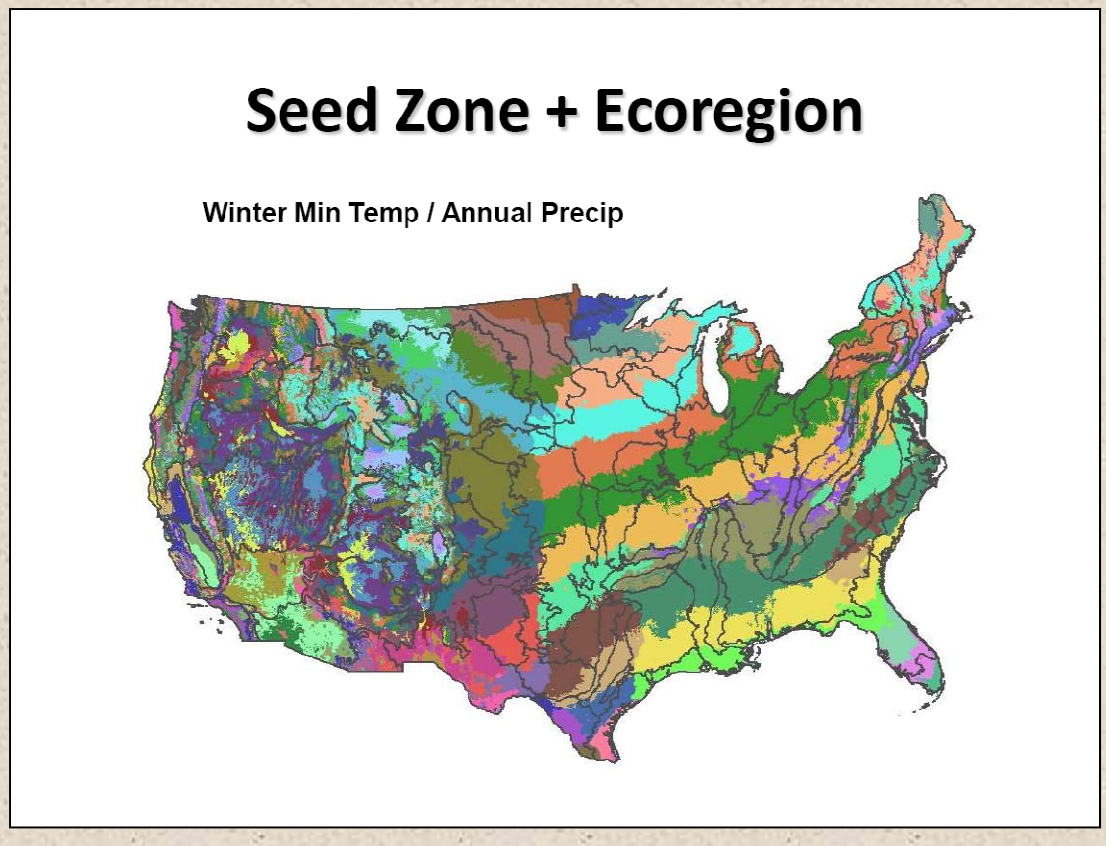
Generalized Provisional Seed Zones



Bower, St. Clair and Erickson
2010 USFS

- Based on high resolution climate data (min and max temperature, precipitation), superimposed with Level III Ecoregions
- Predict appropriate sources for seed collections of species for which there are *no prior genetic data*
- Summer: grasses and herbaceous plants

Generalized Provisional Seed Zones



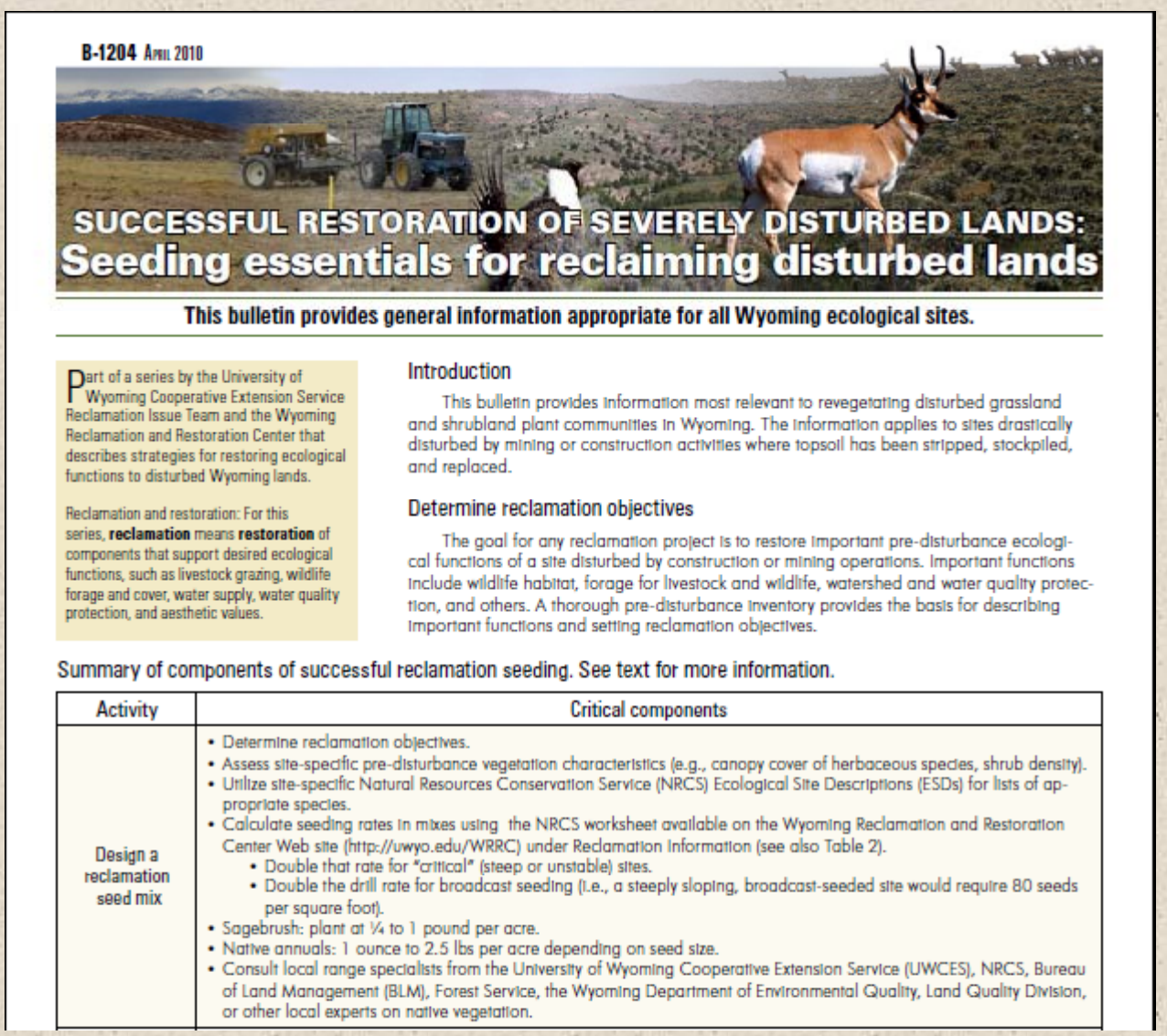
Bower, St. Clair and Erickson
2010 USFS

- **Winter: trees, shrubs and woody plants**
- Latitudinal bands in the East
- Seed zones represent considerable topographic diversity in the West

Wyoming Reclamation and Restoration Center

http://uwadmnweb.uwyo.edu/wrrc/Rec_Bulletins.asp

B-1204



B-1204 April 2010

SUCCESSFUL RESTORATION OF SEVERELY DISTURBED LANDS:
Seeding essentials for reclaiming disturbed lands

This bulletin provides general information appropriate for all Wyoming ecological sites.

Part of a series by the University of Wyoming Cooperative Extension Service Reclamation Issue Team and the Wyoming Reclamation and Restoration Center that describes strategies for restoring ecological functions to disturbed Wyoming lands.

Reclamation and restoration: For this series, **reclamation** means **restoration** of components that support desired ecological functions, such as livestock grazing, wildlife forage and cover, water supply, water quality protection, and aesthetic values.

Introduction

This bulletin provides information most relevant to revegetating disturbed grassland and shrubland plant communities in Wyoming. The information applies to sites drastically disturbed by mining or construction activities where topsoil has been stripped, stockpiled, and replaced.

Determine reclamation objectives

The goal for any reclamation project is to restore important pre-disturbance ecological functions of a site disturbed by construction or mining operations. Important functions include wildlife habitat, forage for livestock and wildlife, watershed and water quality protection, and others. A thorough pre-disturbance inventory provides the basis for describing important functions and setting reclamation objectives.

Summary of components of successful reclamation seeding. See text for more information.

Activity	Critical components

Design a reclamation seed mix	• Determine reclamation objectives.
	• Assess site-specific pre-disturbance vegetation characteristics (e.g., canopy cover of herbaceous species, shrub density).
	• Utilize site-specific Natural Resources Conservation Service (NRCS) Ecological Site Descriptions (ESDs) for lists of appropriate species.
	• Calculate seeding rates in mixes using the NRCS worksheet available on the Wyoming Reclamation and Restoration Center Web site (http://uwyo.edu/WRRC) under Reclamation Information (see also Table 2).
	  • Double that rate for "critical" (steep or unstable) sites.
	  • Double the drill rate for broadcast seeding (i.e., a steeply sloping, broadcast-seeded site would require 80 seeds per square foot).
	• Sagebrush: plant at ¼ to 1 pound per acre.
	• Native annuals: 1 ounce to 2.5 lbs per acre depending on seed size.
	• Consult local range specialists from the University of Wyoming Cooperative Extension Service (UWCES), NRCS, Bureau of Land Management (BLM), Forest Service, the Wyoming Department of Environmental Quality, Land Quality Division, or other local experts on native vegetation.

<u>Successful revegetation</u>:

- Seed mix
- Seedbed
- Planting methods

Shrub reestablishment

- Resources to determine native species appropriate for seeding
  - Reference sites
  - Ecoregion maps
  - Online resources

- Adapted species and populations for seeding
  - Seed zones
  - Guidelines for seed sourcing when seed zones are unavailable
  - Provisional seed zone system

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