Cold (Temperate) Desert Shrublands

Reading: Knight, Ch. 6 and p. 133-140

Climatic conditions

- Warm deserts grade up into cold deserts, with some overlap in species
- Cold desert shrublands may receive *less* precip than warm deserts, but have lower evaporation rates, hence higher P/E ratios
- Warm desert P/E averages 0.3
- Cold desert P/E about 0.5-0.7
- Much precip falls as snow, melts in spring and is stored in soil profile; snow distribution patterns play a major role in vegetation mosaic
- Elevation range: ~1000 meters to lower treeline

Cold desert vegetation varies with moisture, elevation, and salinity

- Intermountain basins west of the Great Plains are dominated by shrublands
- Sagebrush vegetation types are most common
  - Historically there were 44 million ha of sagebrush (West and Young 2000)
  - largest semi-arid ecosystem in North America (~10% of land area)
- Saltbush-greasewood vegetation
  - Saline areas
  - 17 million ha

Halophytic shrublands

Many basins and playas have “haloseres,” following gradients of soil salinity and water table depth

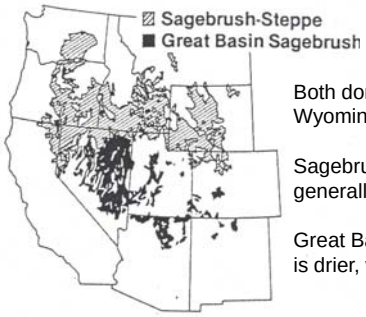
Most saline/shallower water table

Saltwort > inland saltgrass, alkali sacaton > greasewood > saltbushes, kochia > winterfat > horsebrush > sagebrush

Least saline/deeper water table

Halophytic vegetation surrounding playa

Two subdivisions of sagebrush vegetation type

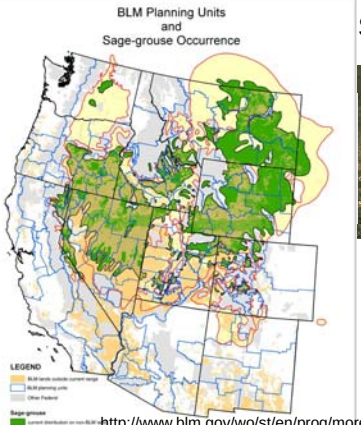


After Kuchler 1970

Both dominated by Wyoming big sagebrush

Sagebrush steppe is generally moister, cooler

Great Basin sagebrush is drier, warmer



Sage grouse habitat

http://www.blm.gov/wo/st/en/prog/more/sage_grouse_home2.html

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Two subdivisions of sagebrush vegetation type

- Sagebrush steppe: moister, contains codominant bunchgrass component, greater biodiversity
  - Sagebrush steppe was once more extensive; has been converted to farmland or degraded by excessive grazing
  - More pristine sites have up to 80% cover, with microphytic crust of lichen, algae and moss
  - Sagebrush steppe evolved with browsers such as Shasta ground sloth, mastodon, and camels, which disappeared ~12,000 BP

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Two subdivisions…

- Great Basin Sagebrush: more arid, more bare ground, fewer taxa with more intraspecific variation
  - More cool-season grasses in western part of range, more warm-season sod-forming grasses in eastern part of range
  - "Islands of fertility" have developed, with much lower grass cover between shrubs; herbs grow under shrubs, nutrients accumulate there
  - Great Basin sagebrush type is thus more susceptible to erosion and degradation than sagebrush steppe

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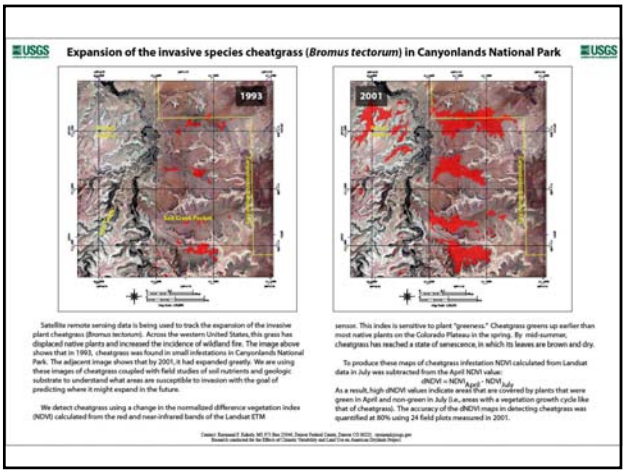
Sagebrush steppe can be resistant to cheatgrass invasion

- Rapid recovery from fire if perennial grasses are well established
- Cheatgrass invasion after summer wildfires but not after prescribed burning in spring

Great Basin sagebrush is susceptible to cheatgrass invasion

Great Basin sagebrush communities take many years to establish after a disturbance.

When cheatgrass invades, fire frequency increases and may prevent sagebrush re-establishment.



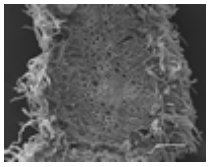
Big Sagebrush Range

The dominant shrub across the intermountain west.

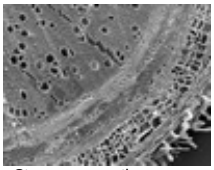
Why?

Some sagebrush drought adaptations

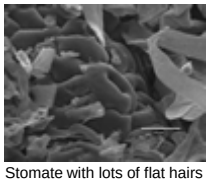
- *Artemesia* leaves are very hairy
- Leaves are seasonally dimorphic
  - Spring leaves are large, fall off when soil dries out
  - Early summer leaves are small, persist through winter
  - Photosynthesis occurs during winter
- Root system is dimorphic:
  - taproot for obtaining deep water;
  - shallow, fibrous roots for rapid acquisition of nutrients and water
- Plant hydraulics: small xylem vessels, low water potential, high resistance to cavitation



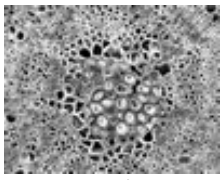
Leaf cross-section



Stem cross-section



Stomate with lots of flat hairs



Stem cross-section w/xylem and phloem

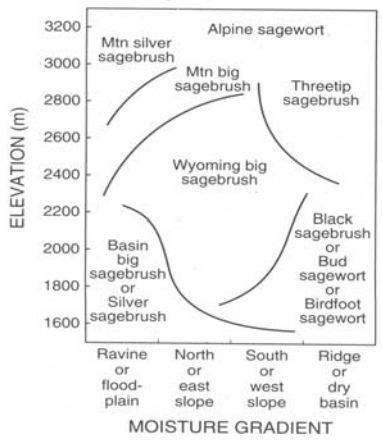
Photomicrographs courtesy of Kusum Naithani

More Sagebrush Adaptations

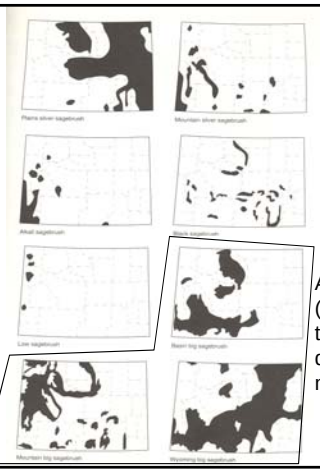
- Seedling recruitment is likely to coincide with wet episodes
- Plants are long-lived (100 years or more) but most species do not resprout after burning
- Is sagebrush r-selected or K-selected?
- Terpenes (sagebrush aroma) are defensive compounds that reduce herbivory
  - Livestock avoid sagebrush but native ungulates utilize for winter browse

Sagebrush species groups

- Two main groups of sagebrush species: tall and low
- Different species can be segregated along soil moisture and temperature gradients
- Seedling establishment is critical in determining distributions
  - *A. tridentata* ssp. *wyomingensis* seeds germinate readily in moist hollows in early spring, but not if any salts are present
  - Many don't survive the dry summer
  - 6 months later, no viable seeds are present



Ordination of major sagebrush types against elevation and moisture gradients (Knight, 1994, Fig. 6.3)



Distribution of sagebrush species in Wyoming

Artemisia tridentata (big sagebrush) is the most widely distributed, with 3 main subspecies

Big Sagebrush Subspecies

- There are three subspecies of sagebrush found along elevation and moisture gradients
  - Morphological and physiological differences are maintained in common garden experiments
- Wyoming big sagebrush (spp. Wyomingensis)
  - Consistently tetraploid
  - Low elevation and dry end of moisture limit
- Basin big sagebrush (spp. tridentata)
  - Diploid or tetraploid
  - Intermediate elevation and moisture limit
- Mountain big sagebrush (spp. vaseyana)
  - Consistently diploid
  - High elevation and moisture limit

Big sagebrush subspecies hybridize

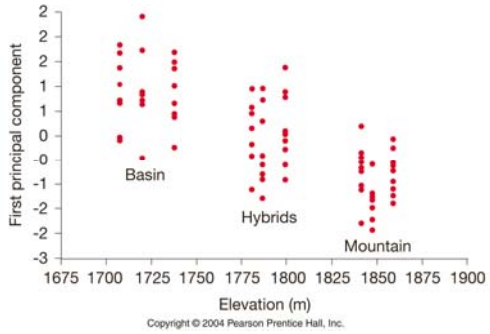


Figure 15.14 Hybrid sagebrush are intermediate in form between parental subspecies. Measurements included morphological traits such as height, circumference, crown diameter, and branch length.