

Grassland vegetation dynamics

Part 1: Fire and woody encroachment

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Effects of Fire in Grasslands

Although most people say that following fires, **regrowth is more common than succession**, some species changes can occur, depending on:

1. **Fire intensity**
 - Increases with litter or mulch buildup
2. **Season of fire**
 - Fires cooler in spring, hotter in summer or fall
 - Different plants actively growing
 - Natural fires more common in warm season

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Effects of fire (2)

3. Type of grassland

- Fire may be less beneficial to shortgrass than tallgrass or mixed; also less likely to carry in shortgrass
- Fire frequency was highest in tallgrass (1-3 yr), and lowest in shortgrass (maybe 25-60 yr)

4. Plant growth-form

- Most woody species are killed
- Bunchgrasses more susceptible to damage by fires than sod-formers

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Ecosystem effects of fire

NPP can increase after fire; why?

How does fire affect hydrology?

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Lack of fire as a factor in grassland succession

Globally, **shrub expansion** attributed to fire suppression, overgrazing, climate change, increasing atmospheric CO₂

Some examples:

Utah juniper (*J. osteosperma*) in intermountain West
Red cedar (*Juniperus virginiana*) in tallgrass prairie
Mesquite (*Prosopis glandulosa* and *P. velutina*)
invasion of desert grasslands

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Utah juniper expansion in Bighorn Mtns

1904



1998



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Betancourt, Jackson et al.
<http://www.paztcn.wr.usgs.gov/wyoming/>

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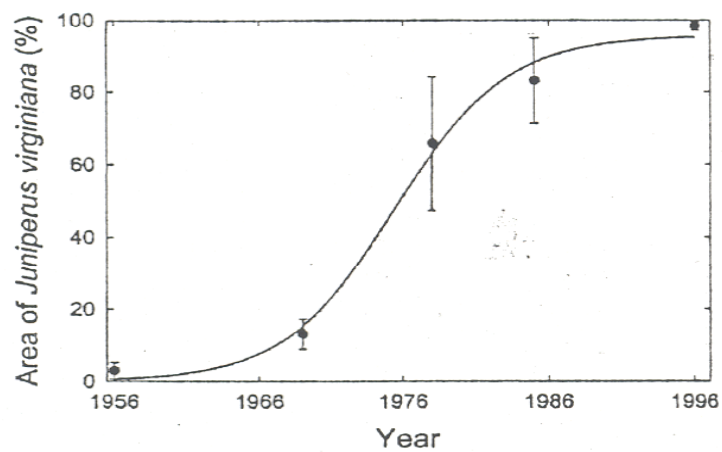
Eastern red cedar encroachment in Kansas



Rapid woody encroachment into tallgrass prairie

“Red cedar” (*Juniperus virginiana*) in KS tallgrass prairie has achieved 100% land cover in 40 years (Briggs et al., 2002)

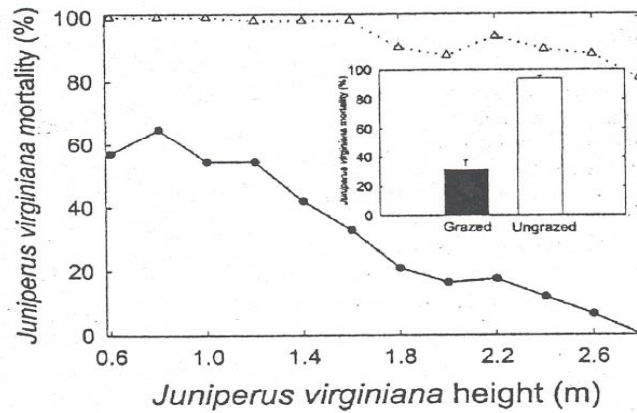
Note similarity of sigmoidal curve to other invasive species trends



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Interaction of fire and woody expansion



- Fire suppression due to fragmentation/suburbanization
- Grazing reduced fuel loads, and thus fire severity, and thus tree mortality

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Briggs et al. 2002

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Landscape fragmentation reduces opportunities for burning

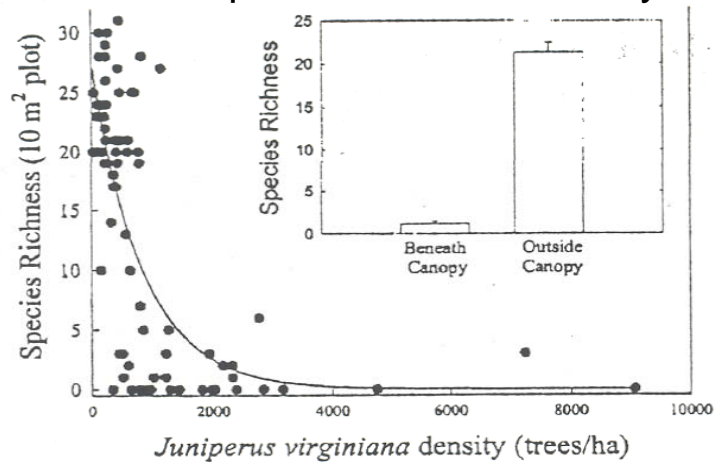


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<http://pss.okstate.edu/personnel/faculty/englepi.html>

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Consequences for biodiversity



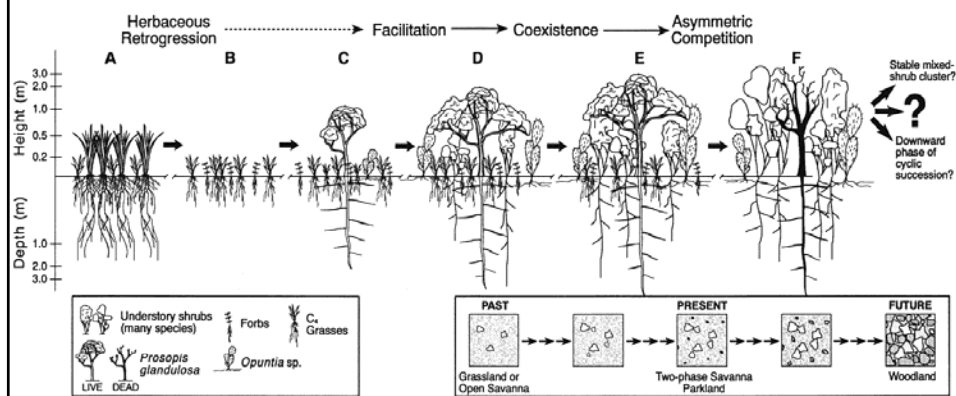
- Species richness declined drastically under red cedar
- What will be the next step in this successional sequence?

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Briggs et al. 2002

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Woody encroachment alters ecosystem structure and function

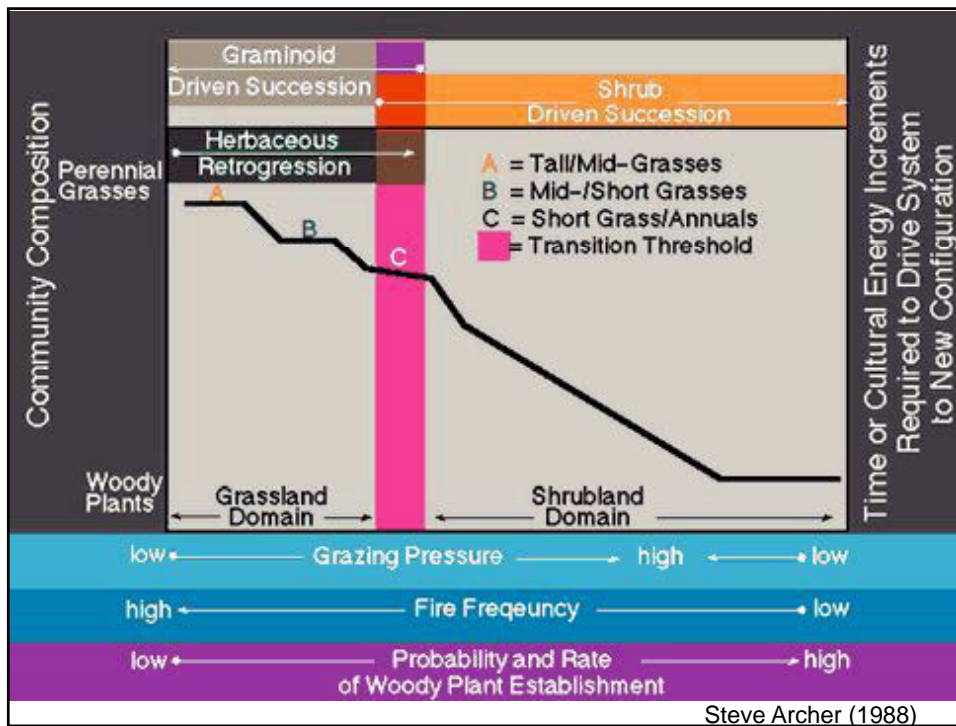


Livestock disperse mesquite seeds
Active and passive facilitation

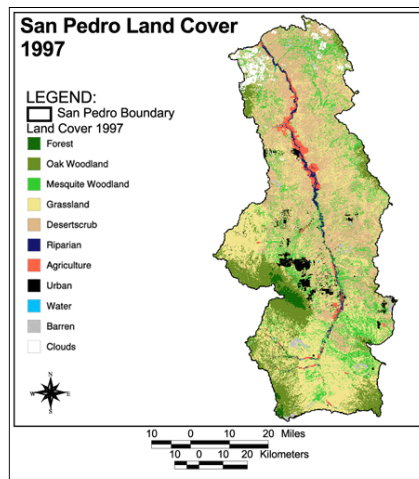
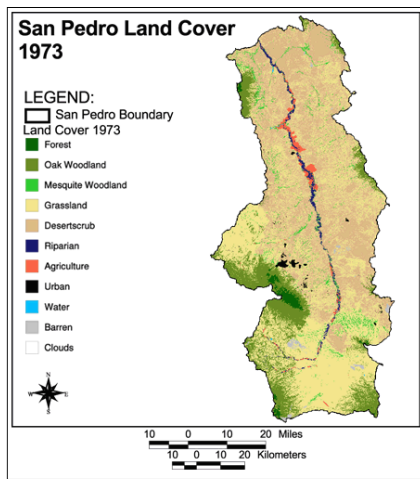
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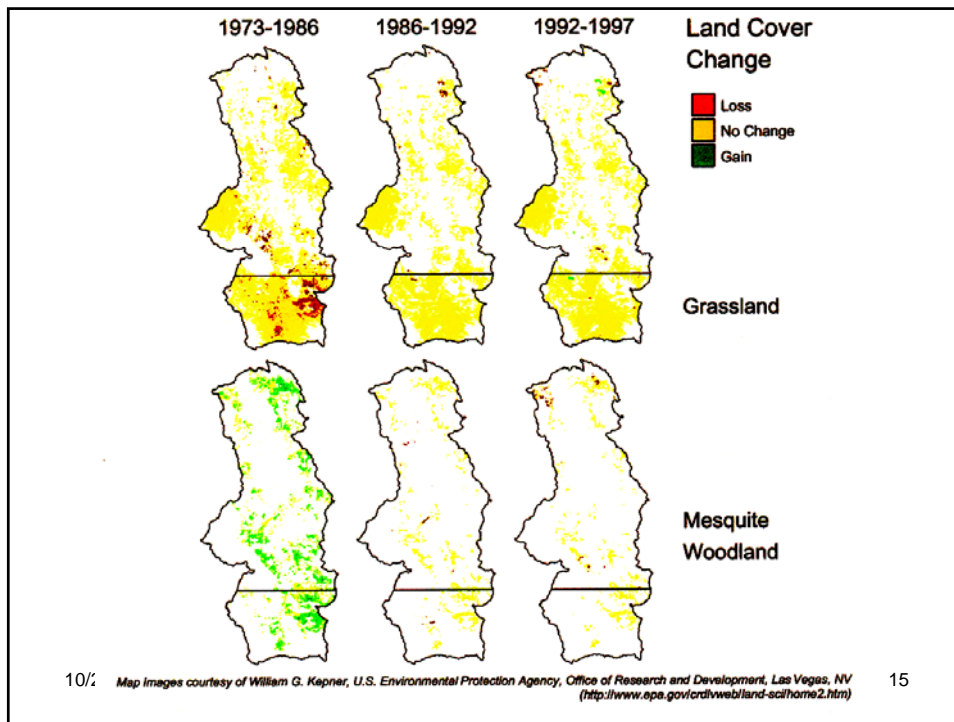
Steve Archer 1995

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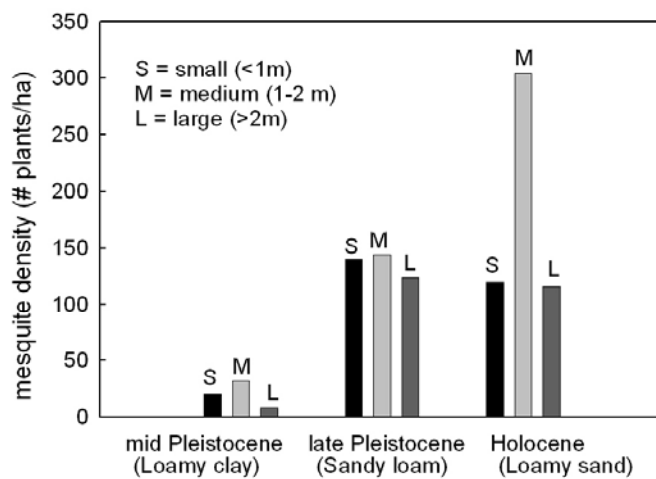


Mesquite (*Prosopis velutina*) encroachment into desert grassland





Abundance of woody plants in desert grassland is related to age of alluvial surface



Fravolini, unpublished

Desert grassland looks like African savanna

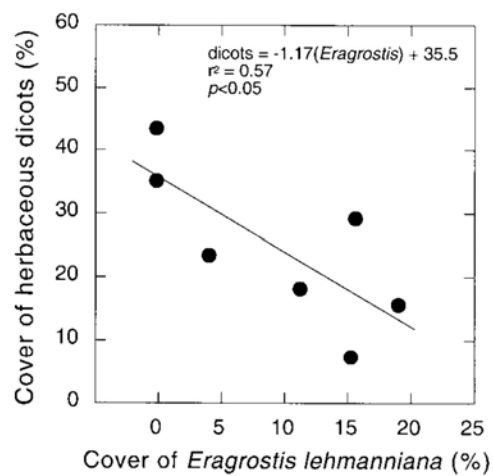


Lehman's lovegrass (*Eragrostis lehmanniana*) –
non-native C4 grass invader from south Africa

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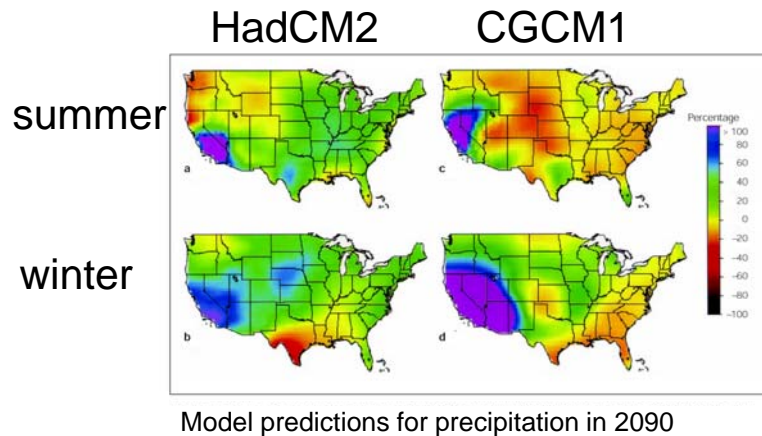
Effects of grass invasion on biodiversity



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Williams and Baruch 2000¹⁸

What role does climate change play in woody encroachment?



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US GCRP, 2003

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Manipulative experiments help demonstrate mechanisms of woody encroachment



Soil type

- loamy clay
- sandy loam

Grass cover

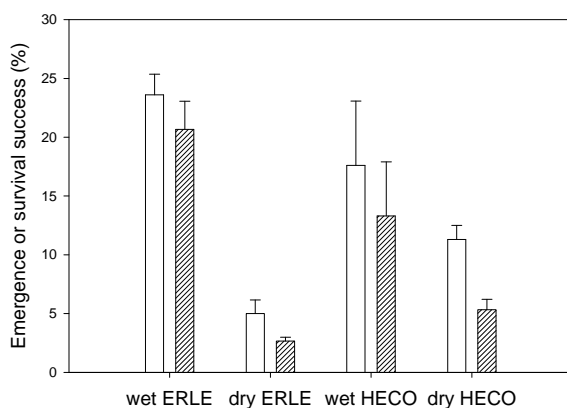
- *Heteropogon contortus*
- *Eragrostis lehmanniana*
- bare

Irrigation regime

- summer wet (+50%)
- summer dry (-50%)



Mesquite seedling emergence (open bars) and survival (hatched bars) in summer wet and dry treatments.



Invasive grass reduced mesquite seedling success during dry years but increased it during wet years, compared to native grass

ERLE = *Eragrostis lehmanniana* (non-native African grass)
 HECO = *Heteropogon contortus* (native grass)

Williams et al. unpublished

Summary

- Grasslands are adapted to fire (and grazing)
 - Higher NPP
- Without fire, woody encroachment occurs
 - Transition to new stable state
 - Lower biodiversity
 - Higher productivity
 - Interactions with moisture seasonality and other invasive species