

U.S-China Exchange on Loess Landforms

Plant Issues and Research (U.S)

**Northwest Agricultural & Forestry University
Yangling, Shaanxi, China**

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**Different Histories ---
Different Objectives**

Loess Plateau (China)



- Long history of human use
- Few native, locally adapted* plants remain.

Loess Hills (U.S.)



- Short history of human use
- Many native, locally adapted* plants remain

Loess Plateau (China)



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Loess Hills (U.S.)



- Short history of human use
- Many native, locally adapted* plants remain

* Advantages of restoring with locally adapted (i.e. native) plant species include:

- Suited to local environment (less watering, fertilizers, pesticides, etc.)
- Supports native biota (e.g. pollinators, decomposers, etc.).
- Preserves the natural character of the region.

Loess Plateau (China)



- Long history of human use.
- Few native, locally adapted plants remain.

Loess Hills (U.S.)



- Short history of human use.
- Many native, locally adapted plants remain.

Different histories are reflected in different objectives

Loess Plateau Objective: Controlling erosion to increase use for agriculture or reforestation.

Loess Hills Objective: Preservation of historic native plant and animal diversity.

**Iowa Loess Hill
Objective is
Maintaining Native
Diversity**

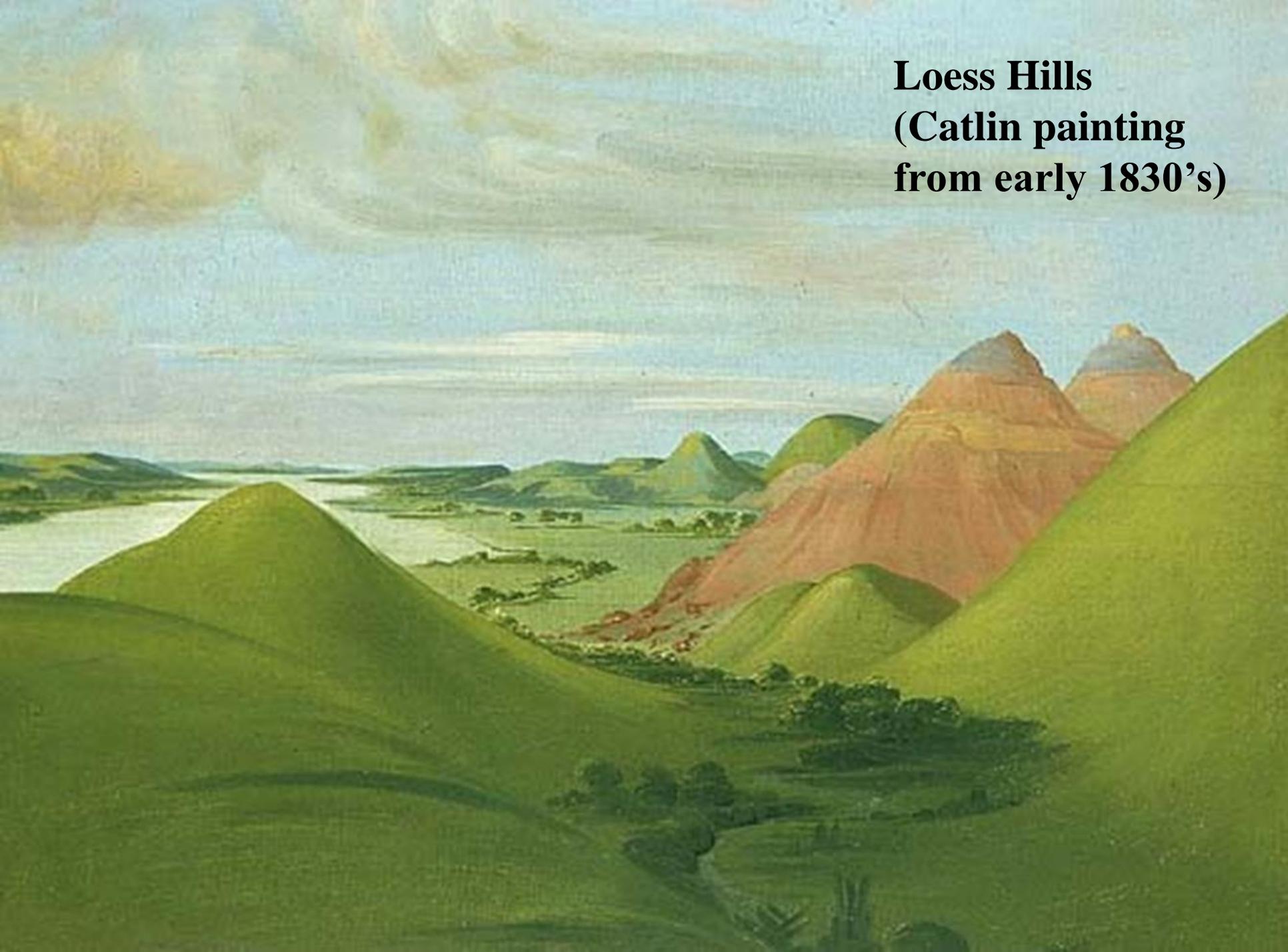
Biotic Diversity

- Maintains soil, water, and air quality
- Supports ability to adjust to environmental change (e.g. climate change)
- Benefit to agriculture, medicine, and cultural values.



**Historic Loess Hills
dominated by grass
cover with scattered
bur oak trees.**

**Loess Hills
(Catlin painting
from early 1830's)**



Frequent fires, ignited by lightning or Paleo-Indians kept the Loess Hills grass-covered

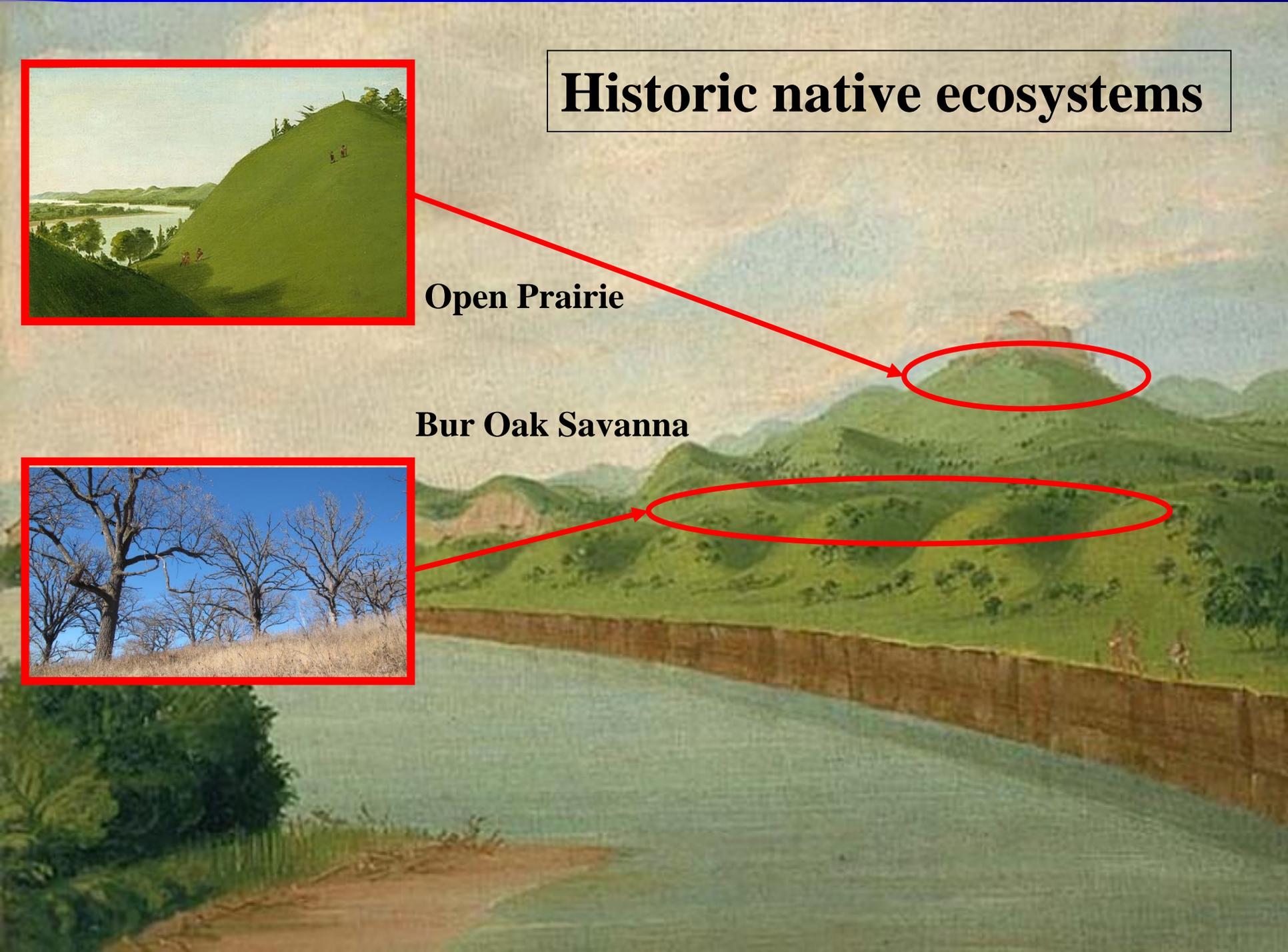


Historic native ecosystems



Open Prairie

Bur Oak Savanna



Loess Hills of Today:

- **Loess Hills Prairie:** Occurs mostly as scattered, often isolated, remnants.
- **Savannas:** Woody encroachment converted open canopy savannas to closed-canopy forests with trees < 80 years old surrounding scattered, open-growth, old savanna bur oaks.

Loess Hills 1906



In the early 1900's, trees generally were still absent from the steeper areas of the Loess Hills region (see hills in distance below), although valleys and lowlands were mostly farmed (corn in foreground).

Loess Hills 2017

Today, steeper areas remain unfarmed but trees have begun to encroach (see hills in distance). Farming continues to dominate valleys and lowlands (corn in foreground).



Principal Threats to Existing Native Ecosystems:

- **Land Development (direct loss of native habitat)**
- **Invasive Species (controlling invasive native and non-native species while also encouraging native species)**

Preserves are set aside to protect native ecosystems



Principal Threats:

- Land Development (direct loss of native habitat)
- Invasive Species (controlling invasive native and non-native species while encouraging native species)

Active prairie management is required to maintain diverse loess hills prairie.



Active protection and management of existing habitat is essential to retaining Loess Hills native ecosystems

Passive land management (such as doing nothing) results in woody plant encroachment and degradation of prairie diversity.





Invasion of aggressive, non-native species, such as leafy spurge (*Euphorbia esula*) (photos) also occurs without active control.



Research

(some with management implications)

Research in the Loess Hills

1. Past: Tree Distribution
2. Present: Plant Community Composition
3. Future: Plant Community Composition
4. Fire: Effects in the Loess Hills

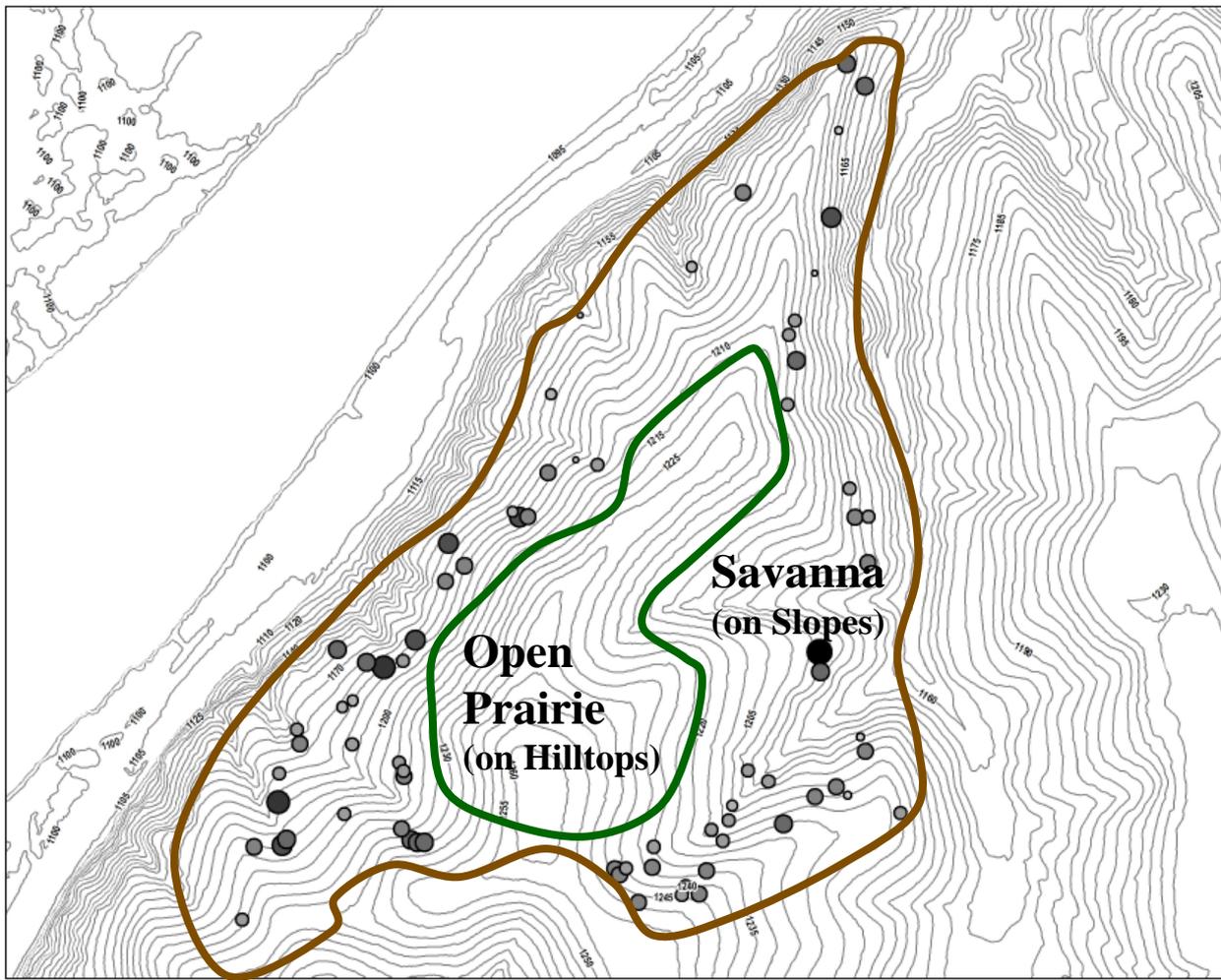


Figure 6. The distribution of bur oak with a dbh ≥ 50 cm throughout T.L. Davis Preserve. All trees sampled using dendrochronological procedures are represented by a dot on the map. A gradient of age is represented by the size and shading of each circle. Older trees are indicated by larger, darker circles.

Distribution of old bur oaks (small circles) on present Loess Hills is consistent with what is indicated in early paintings of the area.



Research in the Loess Hills

1. **Past: Tree Distribution**
2. **Present: Plant Community Composition**
3. **Future: Plant Community Composition**
4. **Fire: Effects in the Loess Hills**

Table 1. Distribution of tree and shrub species in the Loess Hills from South Dakota (Union County), Iowa, and Missouri (Atchison and Holt Counties). Adapted from Novacek et al. (1985).

Species	County									
	North..					...South				
	Union	Plymouth	Woodbury	Monona	Harrison	Pottawattamie	Mills	Fremont	Atchison	Holt
<i>Quercus alba</i>										x
<i>Acer nigrum</i>										x
<i>Quercus stellata</i>									x	
<i>Quercus prinoides</i>									x	x
<i>Asimina triloba</i>								x	x	x
<i>Quercus muhlenbergii</i>							x	x	x	x
<i>Quercus imbricaria</i>						x		x		
<i>Carya tomentosa</i>						x		x		
<i>Platanus occidentalis</i>						x	x	x	x	x
<i>Amelchier arborea</i>						x	x	x	x	x
<i>Quercus velutina</i>					x	x	x	x	x	x
<i>Fraxinus americana</i>					x	x	x	x	x	x
<i>Cercis canadensis</i>					x	x	x	x	x	x
<i>Carya ovata</i>					x	x	x	x	x	x
<i>Morus rubra*</i>				x	x	x	x	x	x	x
<i>Corylus americana</i>				x	x	x	x	x	x	x
<i>Staphylea trifolia</i>			x	x	x	x	x	x	x	x
<i>Quercus borealis*</i>			x	x	x	x	x	x	x	x
<i>Ostrya virginiana*</i>		x	x	x	x	x	x	x	x	x
<i>Carya cordiformis</i>		x	x	x	x	x	x	x	x	x
<i>Ulmus rubra*</i>	x	x	x	x	x	x	x	x	x	x
<i>Ulmus americana*</i>	x	x	x	x	x	x	x	x	x	x
<i>Lilia americana*</i>	x	x	x	x	x	x	x	x	x	x
<i>Quercus macrocarpa*</i>	x	x	x	x	x	x	x	x	x	x
<i>Ribes missouriense*</i>	x	x	x	x	x	x	x	x	x	x
<i>Rhus glabra*</i>	x	x	x	x	x	x	x	x	x	x
<i>Prunus virginiana*</i>	x	x	x	x	x	x	x	x	x	x
<i>Prunus americana*</i>	x	x	x	x	x	x	x	x	x	x
<i>Juglans nigra*</i>	x	x	x	x	x	x	x	x	x	x
<i>Gymnocladus dioica*</i>	x	x	x	x	x	x	x	x	x	x
<i>Fraxinus pennsylvanica*</i>	x	x	x	x	x	x	x	x	x	x
<i>Crataegus mollis</i>	x	x	x	x	x	x	x	x	x	x
<i>Cornus drummondii*</i>	x	x	x	x	x	x	x	x	x	x
<i>Celtis occidentalis*</i>	x	x	x	x	x	x	x	x	x	x

Tree species composition of today's Loess Hills woodlands changes from north to south.



Loess Hills landform region of western Iowa.



Bur Oak (*Quercus macrocarpa*)

**Dominant trees of Loess Hills
of western Iowa Loess Hills:
Paw paw is only found in the
southern portion of the Loess
Hills.**



Hackberry (*Celtis occidentalis*)



Paw paw (*Asimina triloba*)

Research in the Loess Hills

1. **Past: Tree Distribution**
2. **Present: Plant Community Composition**
3. **Future: Plant Community Composition**
4. **Fire: Effects in the Loess Hills**

Quantitative species composition of T.L. Davis Preserve, a bur oak dominated Loess Hills Woodland. Percent (%) is based on sum of relative frequency, dominance, and density.

Bur oak is dominant but does not regenerate well under tree canopy so, in the absence of fire, is expected to be replaced over time by other species

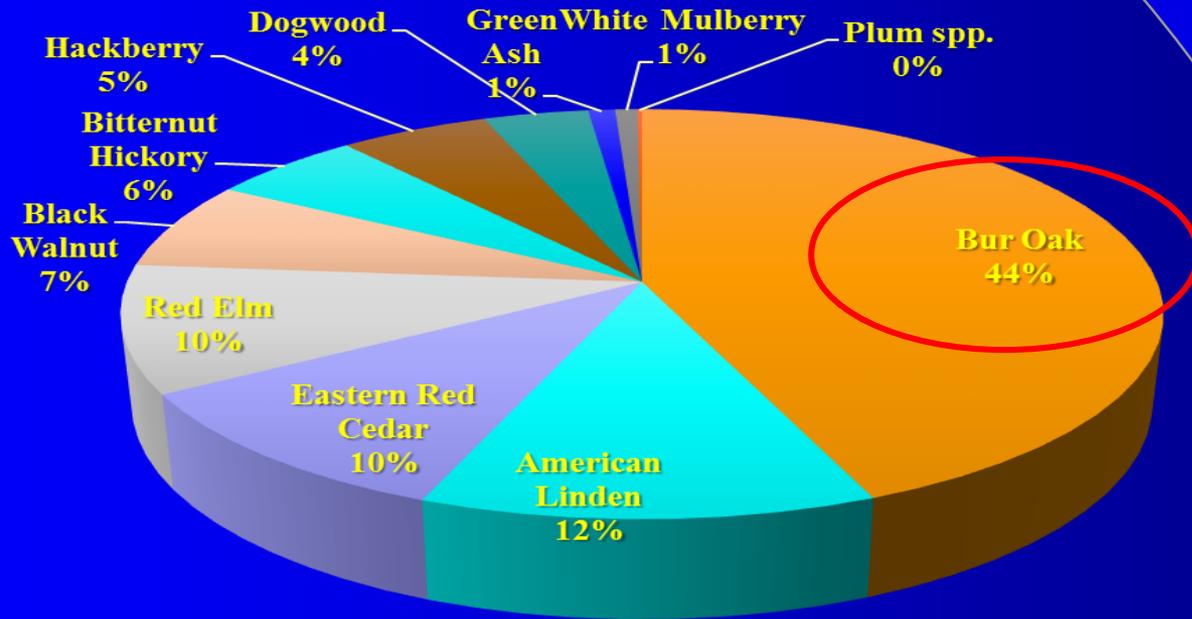


Table 3. General successional sequence suggested by trees ages of an Iowa Loess Hills woodland.

Elevational segment	Time Period and Species Occurrence				
	≤1850	1851-1900	1901-1950	1951-2000	Future
Upper slopes	Bur oak savanna	Woodland of bur oak	Woodland of bur oak, green ash	Woodland of bur oak, green ash ironwood	Woodland of ironwood, hackberry, black walnut, red oak
Mid slopes	Bur oak savanna	Woodland of bur oak	Woodland of bur oak, green ash, elms, hackberry, American linden, ironwood	Woodland of bur oak, green ash elms, hackberry, American linden, ironwood	Woodland of hackberry, ironwood, elms, American linden, black walnut, hickory
Lower slopes	Bur oak savanna	Woodland of bur oak, hackberry	Woodland of bur oak, hackberry elms, American linden, ironwood	Woodland of bur oak, hackberry, elms, American linden, ironwood	Woodland of hackberry, ironwood, elms, American linden, black walnut, hickory

**Historic Bur
Oak Savanna**

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**Historic Bur
Oak Savanna**

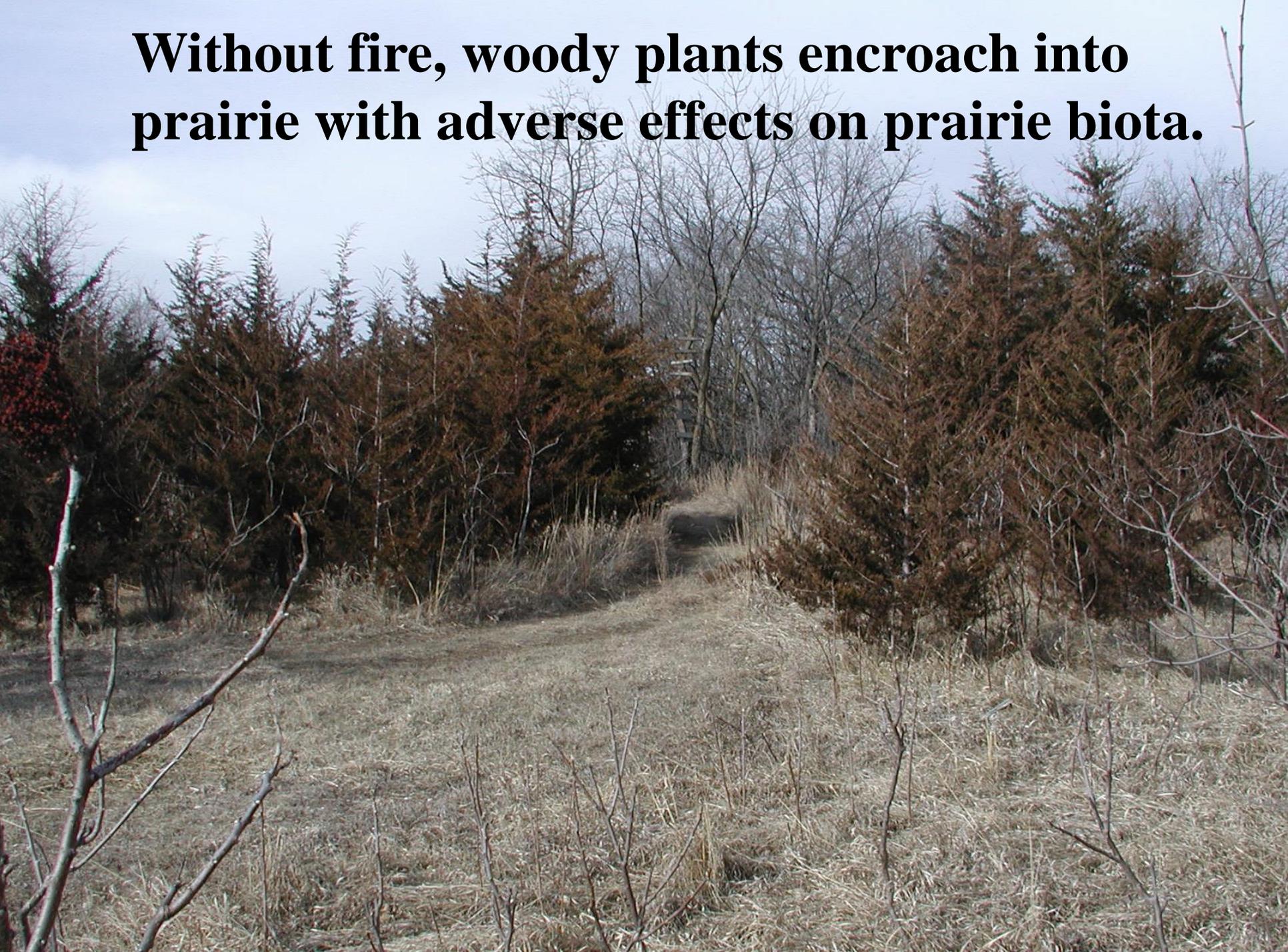


**Future Hackberry
Woodland**

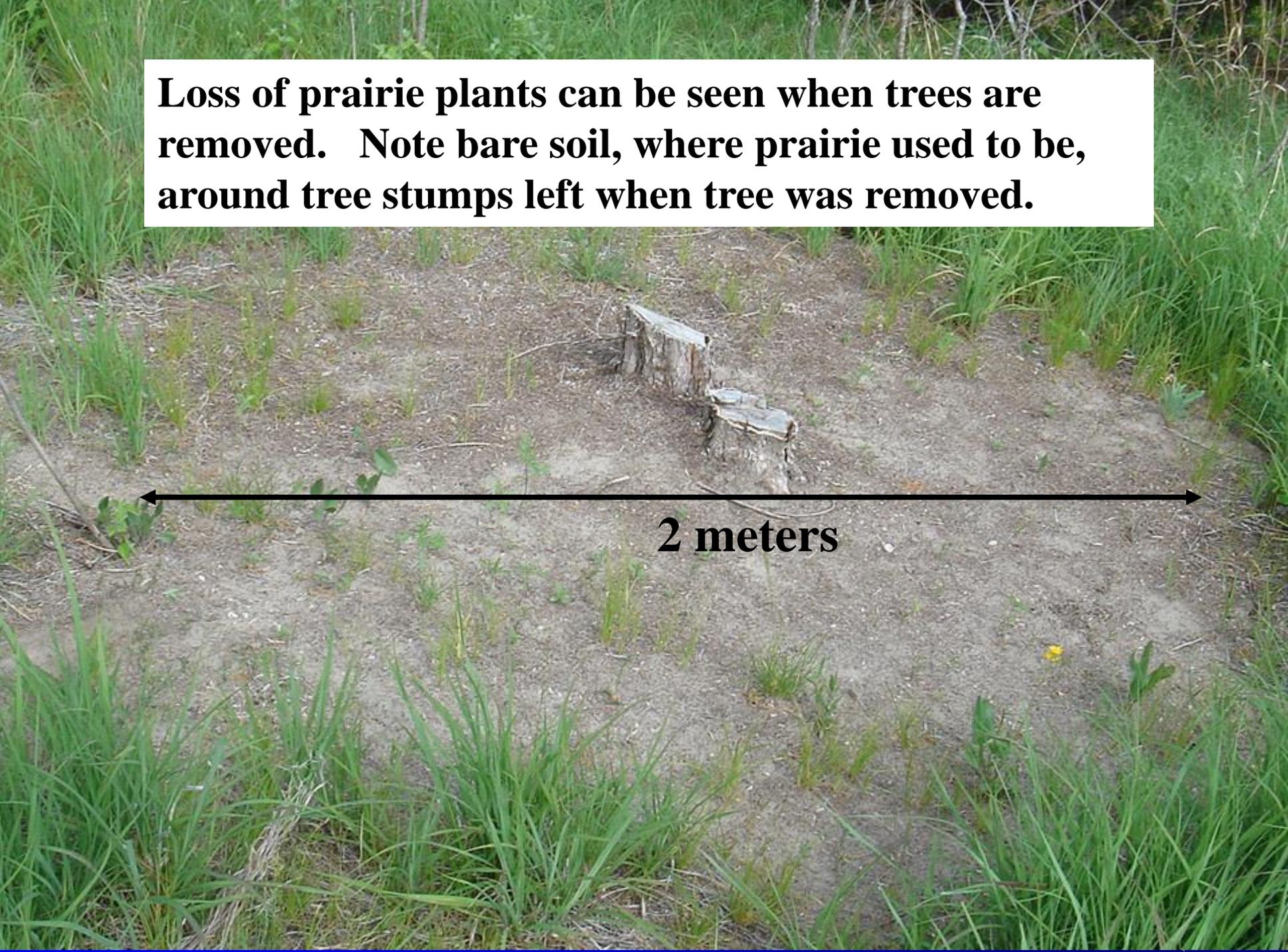
Research in the Loess Hills

1. **Past: Tree Distribution**
2. **Present: Plant Community Composition**
3. **Future: Plant Community Composition**
4. **Fire in the Loess Hills**

Without fire, woody plants encroach into prairie with adverse effects on prairie biota.



Loss of prairie plants can be seen when trees are removed. Note bare soil, where prairie used to be, around tree stumps left when tree was removed.

A photograph showing a tree stump in a prairie field. The stump is located in the center of the frame, surrounded by a circular area of bare soil. The surrounding area is covered with green prairie grasses. A black double-headed arrow is drawn across the image, indicating a distance of 2 meters. The text "2 meters" is written below the arrow.

2 meters

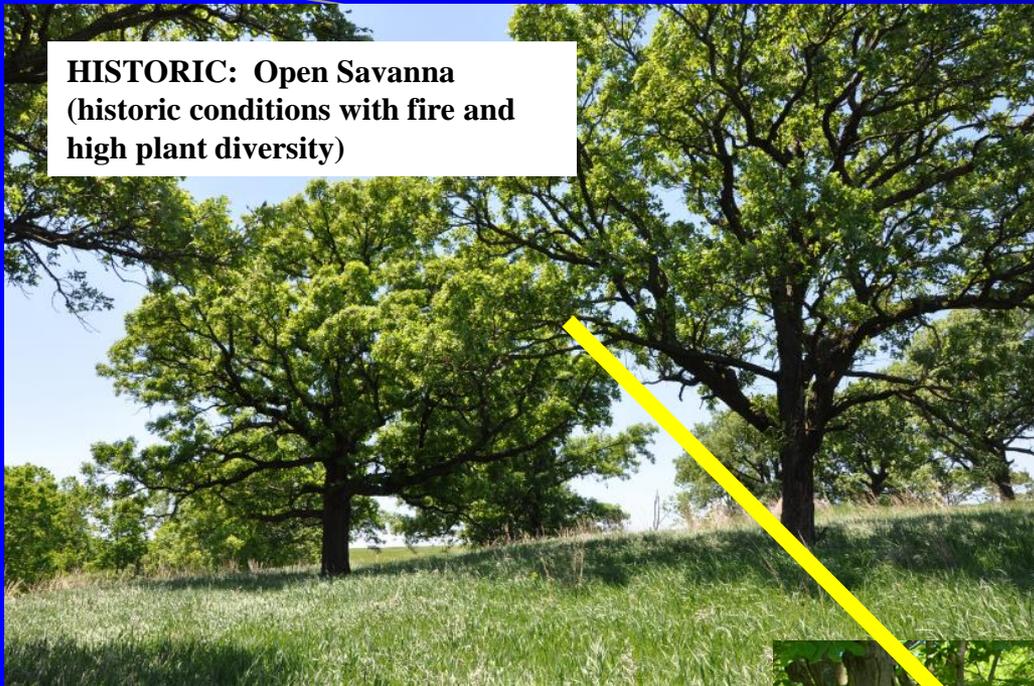
Reintroducing fire is important to maintaining native ecosystems.





Post-fire view showing dead or scorched eastern red cedar but lush prairie vegetation.

HISTORIC: Open Savanna
(historic conditions with fire and
high plant diversity)



Today, without fire,
savanna and woodlands
(left) have become dense
stands of trees with
reduced plant diversity
(lower right)



TODAY: Dense forest (widely
scattered large bur oak) (present
conditions without fire and low plant
diversity)

Removing invasive woody plant requires more than fire. Additional management needed includes:

- **Cutting**



- **Herbicide Application**



Results of Fire Treatment Research

1. **Burning treatments applied in spring, summer, or fall did not result in different degrees of species diversity**

Although

2. **Individual species responses did differ by season.**



Spring burns favor sedges
(*Carex* spp)



Summer burns favor silky prairie clover
(*Dalea enneandra*)



Fall burns favor rigid golden rod
(*Solidago rigida*)

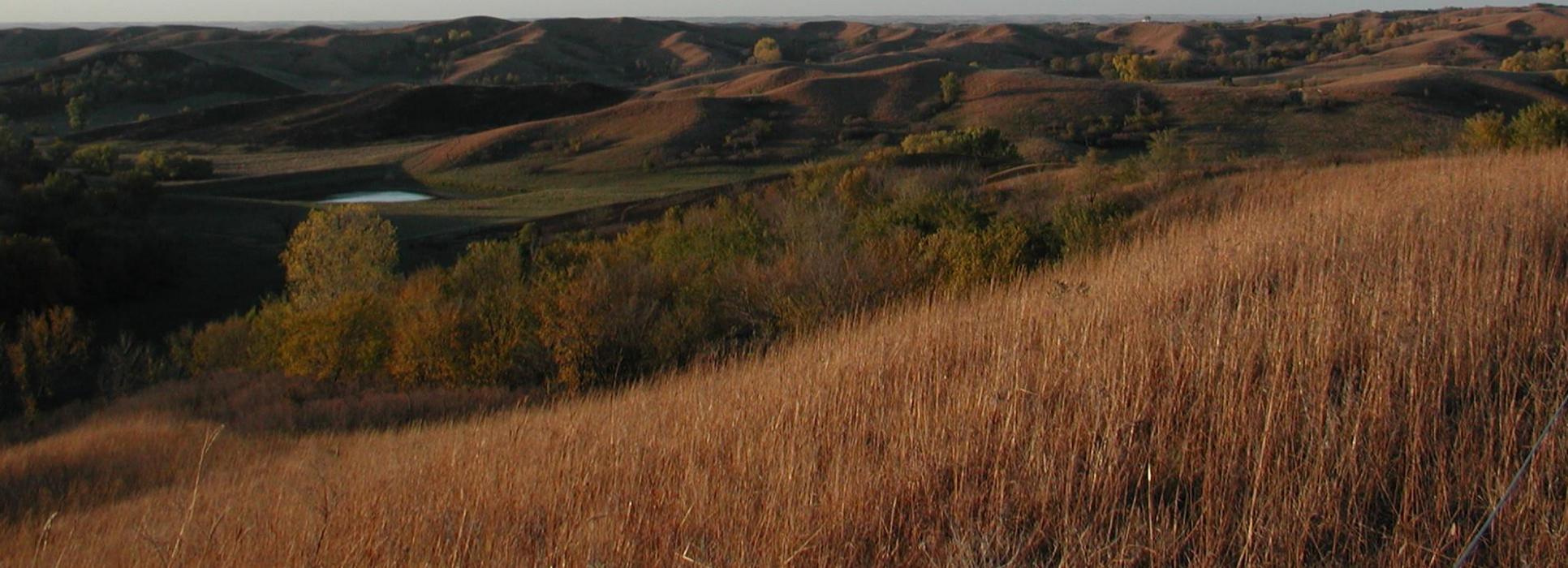


Silky asters favor no burning
(*Symphyotrichum sericeum*)

Summary: Fires at different times of the year, over time, maintain a diverse prairie flora



In the end, the objective of an effort dictates what to do. For the Iowa Loess Hills, maintaining prairie and woodland diversity is the goal that has driven research and management efforts in the U.S.





"... a world treasure ... our best-kept secret."—Dean M. Roosa

FRAGILE GIANTS

A NATURAL
HISTORY OF THE
LOESS HILLS

Cornelia F. Mutel

Questions?