Reducing Woody Encroachment to Conserve Rangeland Production in the Great Plains

Dirac Twidwell
University of Nebraska
A grand challenge for the 21st century is to avoid transitions in nature that are so severe their consequences go beyond the traditions of any single discipline.

Scientists now hypothesize that the most catastrophic transitions are those that transcend scale.
Science is well-positioned to support the scaling-up of conservation in the Great Plains
Rangeland Analysis Platform

Rangeland Cover
- 0-100% aerial cover
- 5 vegetation groups
- Annual time-step

Rangeland Production
- lbs/acre
- 2 vegetation groups
- Annual time-step
- 16-day time-step
The Great Plains Biome is Collapsing

1990

$177M spent in last Farm Bill

Southern Plains: $164.5 M
Southern Mountain: $59.6 M
Pacific: $25.6 M
Northern Plains: $12.5 M
Northern Mountain: $8.5 M
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Uden et al. 2020; Twidwell et al. 2021
The Problem of the "Improvement then Restoration" Paradigm

1.14M NRCS practices; Cady et al. in prep
The Problem of the "Improvement *then* Restoration" Paradigm

1.14M NRCS practices; Cady et al. in prep
## The Problem of the "Improvement *then* Restoration" Paradigm

<table>
<thead>
<tr>
<th>Practice</th>
<th>Proportion of Practices Implemented (by area)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Windbreak/Shelterbelt</td>
<td><img src="#" alt="Bar Chart" /></td>
</tr>
<tr>
<td>Livestock Pipeline</td>
<td><img src="#" alt="Bar Chart" /></td>
</tr>
<tr>
<td>Hedgerow Planting</td>
<td><img src="#" alt="Bar Chart" /></td>
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<tr>
<td>Range Planting</td>
<td><img src="#" alt="Bar Chart" /></td>
</tr>
<tr>
<td>Watering Facility</td>
<td><img src="#" alt="Bar Chart" /></td>
</tr>
<tr>
<td>Fence</td>
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<td>Prescribed Grazing</td>
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</tr>
<tr>
<td>Forage and Biomass Planting</td>
<td><img src="#" alt="Bar Chart" /></td>
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<tr>
<td>Brush Management</td>
<td><img src="#" alt="Bar Chart" /></td>
</tr>
<tr>
<td>Firebreak</td>
<td><img src="#" alt="Bar Chart" /></td>
</tr>
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<td>Prescribed Burning</td>
<td><img src="#" alt="Bar Chart" /></td>
</tr>
<tr>
<td>Forest Stand Improvement</td>
<td><img src="#" alt="Bar Chart" /></td>
</tr>
<tr>
<td>Tree/Shrub Maintenance</td>
<td><img src="#" alt="Bar Chart" /></td>
</tr>
</tbody>
</table>

**Proportion of Practices Implemented (by area):**
- **Ahead of Biome Collapse Boundary**
- **Behind Biome Collapse Boundary**

1.14M NRCS practices; Cady et al. in prep

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### Boundaries
- **2020 Biome Collapse**
- **1990 Biome Collapse**
- **Historic Great Plains**

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*Increasing practice applications funded*
The Problem of the "Improvement then Restoration" Paradigm

- Windbreak/Shelterbelt
- Livestock Pipeline
- Hedgerow Planting
- Range Planting
- Watering Facility
- Fence
- Prescribed Grazing
- Herbaceous Weed Control
- Forage and Biomass Planting
- Brush Management
- Firebreak
- Prescribed Burning
- Forest Stand Improvement
- Tree/Shrub Maintenance

1.14M NRCS practices; Cady et al. in prep

Proportion of Practices Implemented (by area)
The Top Drivers of Grassland Loss in the Great Plains Biome: Land Use Conversion & Woody Encroachment

Primary drivers of grassland loss

Land use conversion

Tree cover expansion

Tree Cover Value

- 0% to 4%
- ≥ 5%

Morford et al. in 2022
Biome-level consequences: Rancher livelihoods, Wildfire danger, Human health, Water, Endangered species, School funding, Regulatory pressure
Herbaceous production lost to tree encroachment in United States rangelands

Scott L. Morford | Brady W. Allred | Dirac Twinwell | Matthew O. Jones | Jeremy D. Maestas | Caleb P. Roberts | David E. Naugle

The Great Plains Lost 22.4 Million Tons of Rangeland Production to Woody Encroachment in 2019

Rangelands are the economic and cultural backbone of the Great Plains. Healthy, resilient rangelands power rural communities, host diverse wildlife, support recreation, and provide critical services like water and carbon storage. Grazing is the common thread that sustains these rangelands for people and wildlife. In 2019, rangelands in the 10-state Great Plains region produced 292.4 million tons of forage.

Today, woody encroachment is one of the greatest threats facing rangelands in the Great Plains. Invading trees outcompete and displace grasses and forbs, reducing rangeland production by up to 75 percent. Scattered woody plants may look harmless, but their expansion in rangelands results in major consequences to livestock production and wildlife. When we lose healthy rangelands, we lose the cultural, economic, and life-sustaining resources they provide.

According to scientists working alongside the NRCS’s Working Lands for Wildlife efforts, every state in the Great Plains lost rangeland production due to woody encroachment in 2019— a loss of 22.4 million tons.

NEW GUIDANCE FOR REVERSING AND PREVENTING WOODY ENCROACHMENT

Reactive to woody encroachment after trees have taken over makes it impossible to avoid rangeland production losses, perpetuating the problem as trees simply keep expanding into formerly treeless grasslands.

New guidance, developed as a collaborative effort among rangeland scientists in the Great Plains, outlines a more cost efficient and proactive strategy to keep rangelands productive and reverse losses due to woody encroachment.

Learn more at: https://www.wlfw.org/great-plains/woodland-expansion/
### National Rangeland Statistics

#### Rangeland Productivity Lost to Woody Encroachment

<table>
<thead>
<tr>
<th>State</th>
<th>Productivity lost to woody encroachment in 2019</th>
<th>Cumulative productivity lost to woody encroachment (1990-2019)</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Dakota</td>
<td>145,352 tons</td>
<td>2,076,178 tons</td>
</tr>
<tr>
<td>Nebraska</td>
<td>419,328 tons</td>
<td>3,881,756 tons</td>
</tr>
<tr>
<td>Kansas</td>
<td>2,060,106 tons</td>
<td>28,902,217 tons</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>4,491,096 tons</td>
<td>76,529,801 tons</td>
</tr>
</tbody>
</table>
National Rangeland Statistics

Rangeland Productivity Lost to Woody Encroachment

Equivalent to 698K Round Bales

Productivity lost to woody encroachment in 2019: 419,328 tons
Cumulative productivity lost to woody encroachment (1990-2019): 3,881,756 tons

Nebraska
Knox County, Nebraska
Rangeland Production Lost to Tree Encroachment

Production lost to tree encroachment in 2019
Cumulative production lost to tree encroachment (1990-2019)

<table>
<thead>
<tr>
<th></th>
<th>1990-2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production lost in 2019</td>
<td>29,814 tons</td>
</tr>
<tr>
<td>Cumulative loss</td>
<td>333,857 tons</td>
</tr>
</tbody>
</table>

Total rangeland productivity = 349,875 tons

Losses following Early Warning
Early Warnings for Woody Transitions – Knox County Area

1990
Early Warnings for Woody Transitions – Knox County Area

2020 – Similar to 2000 Riley County, KS
Cherry County, Nebraska

Rangeland Production Lost to Tree Encroachment

Production lost to tree encroachment in 2019: 8,707 tons
Cumulative production lost to tree encroachment (1990-2019): 79,814 tons

Total rangeland productivity = 2,797,753 tons
Arthur County, Nebraska

Rangeland Production Lost to Tree Encroachment

Production lost to tree encroachment in 2019: 64 tons
Cumulative production lost to tree encroachment (1990-2019): No losses

Total rangeland productivity = 345,169 tons
Early Warnings for Woody Transitions – Arthur County Area

1990
National Rangeland Statistics

Rangeland Productivity Lost to Woody Encroachment

Production loss in 2019:
- 0%
- 5%
- 10%
- 15%
- 20%
- 25%
- 30%
- 35%
- 40%

Great Plains Facts

✓ No county has restored lost yield after woody encroachment increases significantly

✓ No county has prevented woody encroachment from increasing
Ecological Transformations Require Bold Actions

Hugh Hammond Bennett helped establish Conservation Districts and SCS/NRCS in the 1930’s due to extensive soil erosion in the Great Plains.

The collapse of our grassland biome in the Great Plains is of comparable significance.
### Stages of Woody Plant Dominance

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
<th>Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woodland Transition</td>
<td>Woody plant dominance</td>
<td>Heavy machinery - mechanical removal, fire</td>
</tr>
<tr>
<td>Expansion</td>
<td>Scattered producing trees</td>
<td>Hand tools, heavy machinery - mechanical removal, fire</td>
</tr>
<tr>
<td>Dispersal &amp; Recruitment</td>
<td>Intact with seedlings or incoming seed</td>
<td>Fire, hand cutting, haying, mechanical removal, browsers</td>
</tr>
<tr>
<td>Intact Grassland</td>
<td>Treeless with no seed</td>
<td>Avoid introducing seed</td>
</tr>
</tbody>
</table>

**A Better Science Strategy is Now Available**

>20K Copies Distributed

**Reducing Woody Encroachment in Grasslands**

A Guide for Risk and Vulnerability

Twidwell et al. 2022
Reducing risk and vulnerability requires integrated management across multiple encroachment stages.
What happens if we do not manage seed contaminated acres?

Traditional Approach on 3,000 acres

<table>
<thead>
<tr>
<th>Encroachment stage</th>
<th>Description</th>
<th>% of site</th>
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<tbody>
<tr>
<td>Intact</td>
<td>Treeless with no seed</td>
<td>10%</td>
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<tr>
<td>Dispersal &amp; Recruitment</td>
<td>Intact with seedlings or incoming seed</td>
<td>20%</td>
</tr>
<tr>
<td>Encroachment</td>
<td>Scattered, seed producing trees</td>
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<tr>
<td>State Transition</td>
<td>Woody plant dominance</td>
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Brush Management

$109K
What happens if we do not manage seed contaminated acres?

Traditional Approach on 3,000 acres

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<td>Dispersal &amp; Recruitment</td>
<td>Intact with seedlings or incoming seed</td>
<td>80%</td>
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What happens if we do not manage seed contaminated acres?

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Reducing risk and vulnerability requires integrated management across multiple encroachment stages.

Seed dispersal drives risk and vulnerability.

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Defend the Core

Prescribed fire
(338.2; 338.4; 338.68)
Mechanical, Hand tools
(314.276)
Haying (?)
Browsing (?)

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Defend the Core → Grow the Core

Prescribed fire
(338.4; 338.68)
Mechanical
(314.3; 314.38; 314.5)

Prescribed fire
(338.2; 338.4; 338.68)
Mechanical, Hand tools
(314.276)
Haying (?)
Browsing (?)
Defend the Core → Grow the Core

Encroached acres

Seed contaminated acres

Intact acres

None to minimal

VULNERABILITY

Encroachment stage | Description | % of site
--- | --- | ---
Intact | Treeless with no seed | 100%
Dispersal & Recruitment | Intact with seedlings or incoming seed | 0%
Encroachment | Scattered, seed producing trees | 0%
State Transition | Woody plant dominance | 0%
Identifying Cores and Building Resilience in the Great Plains

1. Identify the existing transition between grass-tree regional states
2. Locate intact areas to anchor conservation efforts (intact grasslands <5% cover)
3. Refine core areas with field inventories and local knowledge to identify incipient invasion within the core that is undetectable by technology
4. Overlay data and knowledge on wildlife priorities
5. Identify landowner networks with the cultural will to act
6. Co-produce scenarios for customized solutions
7. Track outcomes, adapt over time, and grow the core with success stories
NRCS Released their First Biome-Scale Framework for Conservation Action in America’s Grasslands
Our top priority is conserving resilient and intact working rangelands. To achieve this outcome we must halt threats before they begin, reinstate fire back into the system, and work at scales that matter.

Woodland Expansion (7,900,000 acres)

Land Use Conversion (440,000 acres)
Transitioning from productive grassland to woody plant dominance is the greatest threat facing grasslands in Kansas. Ranchers have new tools, science, and a funding opportunity to help address woody plant encroachment in targeted rangelands through the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS).

Woody plant encroachment puts pressure on working rangelands by decreasing livestock production and increasing wildfire risk as well as harming grassland biodiversity and increasing threat to animal species living in this biome.

New scientific tools now provide unprecedented opportunities to track woody encroachment and develop strategic approaches to combat it. When combined with landowner expertise, Kansas ranchers and NRCS can defend intact grasslands, reduce vulnerability to future encroachment, and cut long-term maintenance costs.

USDA NRCS is adopting a new approach to addressing this widespread threat through the Kansas Great Plains Grassland Initiative (GPGI). The initiative is part of the NRCS Working Lands for Wildlife (WLFW) framework calling to conserve the last remaining iconic grassland regions in the Great Plains biome.

RANCHER DRIVEN, SCIENCE INFORMED, AGENCY SUPPORTED

Great Plains Grassland Initiatives

- State-based implementation of new national guidance for grassland conservation
- Focus is on addressing drivers of large-scale grassland loss

Great Plains Grassland Initiative (Phase 1 Implementation)

Grasslands (Phase 1 Technical Guidance; Future GPGI Candidates)
<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 200m From Seed Source (Intact Stage)</td>
<td></td>
</tr>
<tr>
<td>200m From Seed Source (Dispersal/Recruitment Stage)</td>
<td></td>
</tr>
<tr>
<td>5-10% Tree Cover (Encroachment Stage)</td>
<td></td>
</tr>
<tr>
<td>15-30% Tree Cover (Encroachment Stage)</td>
<td></td>
</tr>
<tr>
<td>&gt; 30% Tree Cover (Encroachment Stage)</td>
<td></td>
</tr>
<tr>
<td>&gt; 45% Tree Cover (Woodland Transition/Forest)</td>
<td></td>
</tr>
</tbody>
</table>

**Legend**

- **Red**: Band_1
- **Green**: Band_2
- **Blue**: Band_3

**Advanced Tools**

- **Livestock Pipeline Tools BETA**
  - Create Reference Grid
  - Extract LiDAR Survey
  - Field Summary
  - High Range Slopes (314)
  - Ortho Tree Extraction
  - Woody Encroachment Risk Summary

- **Network Analyst Tools**
  - Parcel Fabric Tools
  - Schematics Tools
  - Server Tools
  - Space Time Pattern Mining Tools
  - Spatial Analyst Tools
  - Spatial Statistics Tools
  - Tracking Analyst Tools
WHEREAS, rangelands include a rich and varied landscape of grasslands, woodlands, vernal pools, riparian areas, and wetlands which support numerous imperiled and native plant and animal species, and
WHEREAS, many rangelands are today at significant risk of conversion to development and other uses, and
WHEREAS, these rangelands and the species that rely on these habitats largely persist today due to grazing and other land stewardship practices of the ranchers that have owned and managed these lands and committed to their health, and
WHEREAS, these rangelands are a critical foundation of the economic and social fabric of the U.S. ranching industry and rural communities and will only continue to provide these societal benefits if rangelands remain in ranching, and
WHEREAS, woody encroachment is quickly consuming rangelands,

THEREFORE BE IT RESOLVED, NCBA shall work aggressively to accomplish the following:

Educate the public regarding the environmental benefits associated with grazing and rangeland agriculture
Streamline processes regarding consultations and other regulatory requirements to eliminate current disincentives to voluntary conservation efforts
Provide tax incentives and other benefits to those ranchers actively working to benefit the environment
Pursue the expansion of the use of safe harbor agreements, exclusion of critical habitat, and use of the 4(d) rule for the listing of habitat and species

Seek more funding through willing partners for removal of invasive woody species and research for long term solutions

BE IT FURTHER RESOLVED, NCBA shall work on a national level to partner with state affiliates, conservation, and agricultural organizations to achieve these goals.
The Central Grassland Roadmap Initiative has identified core and at-risk grassland bird populations across the central Great Plains in order to focus conservation and restoration on the best remaining grassland habitat.

Source: Central Grassland Roadmap Initiative.

A New Mantra has Emerged:
Defend the Core → Grow the Core → Mitigate Impacts

State of the Birds Report
United States of America
2022

CORE AND AT-RISK GRASSLAND BIRD POPULATIONS
The Central Grassland Roadmap Initiative has identified core and at-risk grassland bird populations across the central Great Plains in order to focus conservation and restoration on the best remaining grassland habitat.

Source: Central Grassland Roadmap Initiative.
Reducing Woody Encroachment in Grasslands
A Guide for Risk and Vulnerability

Field Training Handbook
[In Development]
A Network of Regional Models of Success on Private Lands
Case Study 1:
The Loess Canyons Experimental Landscape

Scaling-Up Collaboration
Since 2005, the Loess Canyons Rangeland Alliance has grown from a handful of visionary producers to an entire community committed to reinstating fire to save their grazing lands from the onslaught of redcedar invasion. Working together as a prescribed burn association, this partnership provides a rare example in the Great Plains of successfully halting the transition of a rangeland ecoregion to woodlands. Backed with support from NRCS, Pheasants Forever, and Nebraska Game & Parks Commission, the Loess Canyons grasslands have stabilized, benefitting livestock production and species like bobwhite quail and the imperiled American burying beetle.

“We didn’t want our kids or grandkids to say, ‘Why didn’t Dad take care of those cedars when he had the chance?’” reflects Scott Stout. “We decided the time to get after cedars is now - and we came together as a community to do something about it.”
— Scott Stout, N-M Ranch Inc. and President of Loess Canyons Prescribed Burn Association, NE.
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News

In Nebraska’s Loess Canyons, Setting Trees Ablaze Gives Prairie Birds a Boost

For generations Great Plains ranchers saw fire as a foe. Now they’re banding together and embracing it as a tool to restore grassland habitat.
Thank You!

Reducing Woody Encroachment in Grasslands
A Guide for Risk and Vulnerability

E-1054
Oklahoma Cooperative Extension Service
Division of Agricultural Sciences and Natural Resources
Oklahoma State University

Additional links:
Rangeland Analysis Platform: http://rangelands.app
Eastern redcedar science literacy website: http://cedarliteracy.unl.edu