Late-Season Burning: A Strategy for Sericea Lespedeza Control

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Department of Agronomy, Kansas State University
Tallgrass Prairie in North America

- Covered 165 million acres prior to European settlement
  - 6.2 million acres (4%) remains
- The remnant is home to more than:
  - 500 plant species
  - 700 insect species
  - 300 bird species
  - 40 mammal species
  - Countless microorganisms
- More ecologically diverse than rain forest ecosystems
- Provides sustainable income for many families and rural communities
What’s so special about the Flint Hills?
Soil structure ill-suited to tillage
Frequent prescribed fire
Why do we burn?
Inexpensive and comprehensive brush control
Why do we burn?
Improved growth performance of yearling cattle
Economic Impact of Prescribed Fire

• Estimated net income from improved cattle growth in the Flint Hills
  • $20 to 50 million annually

• Inexpensive control of woody-stemmed plants
  • Estimated cash cost of prescribed burning ≈ $0.75 / acre
  • Estimated cash cost of herbicide w/o application costs ≈ $3 to 82 / acre
  • Estimated cost of mechanical brush control ≈ $85 to 300 / acre
  • Preservation of the native prairie ≈ Priceless!
Liabilities Associated with Prescribed Fire

• Use confined to a dogmatically narrow period of time in early spring
  • Late March and April

• Smoke Management
  • Downwind municipalities deal with degraded air quality when burning activities are concentrated in early spring

• Labor Management
  • Early spring is the busiest and most stressful time of year for Kansas farmers and ranchers

• Fire Safety
  • Prescribed fires can be difficult to control and appropriate weather is relatively rare during early spring

• Early-spring fires do not control the most pernicious invasive species
  • Sericea lespedeza is the most visible of these
Sericea Lespedeza: A Landscape Killer

- Deeply-rooted perennial
- Tolerant of poor soils
- Robust canopy
- Resistant to grazing
- High in condensed tannins
- Prolific seed production
- Extended seed dormancy

- Treatment with specialty herbicides is common
  - Herbicide treatment results in collateral damage to non-target native plants, insects, and wildlife

September 2, 2016
Effects of Growing-Season Prescribed Burning on Vigor of Sericea Lespedeza
Growing-Season Burns for Sericea Lespedeza Control

- This presentation reports results from a 4-yr experiment on native tallgrass prairie that is affected by sericea lespedeza
  - National Fish & Wildlife Foundation (project no. 2003.12.039817)
- The 126-acre site was divided into nine burn units (about 14 acres each) that were burned annually for 4 consecutive years
- Prescribed fire treatments were:
  - Early spring (1 April ± 11 d)
  - Mid-summer (1 August ± 2 d)
  - Late summer (1 September ± 3 d)
Pasture # 5
Burned 04.11.16
Pictured on 04.11.16
Pasture # 7
Burned 08.01.14
Pictured on 08.01.14

Pasture # 3
Burned 08.30.14
Pictured on 09.02.14
Figure 1. Sericea lespedeza, % basal plant cover

- Early spring
- Mid-summer
- Late summer

Means with unlike superscripts differ ($P \leq 0.01$)

- SEM = 1.559

a, b Means w/ unlike superscripts differ ($P \leq 0.01$)
Figure 2. Effect of growing-season fire on SL aerial frequency

- Early spring
- Mid-summer
- Late summer

Treatment - $P < 0.01$
Time - $P = 0.36$
Treatment x time - $P = 0.28$
SEM = 5.43

Means w/ unlike superscripts differ ($P \leq 0.02$)
Figure 3. *Sericea lespedeza* whole-plant weight at dormancy

<table>
<thead>
<tr>
<th>Time</th>
<th>Whole-plant DM weight, mg/plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early spring</td>
<td>4,000</td>
</tr>
<tr>
<td>Mid-summer</td>
<td>1,000</td>
</tr>
<tr>
<td>Late summer</td>
<td>1,000</td>
</tr>
</tbody>
</table>

SEM = 452.7

Means w/ unlike superscripts differ ($P < 0.01$)
Figure 4. Sericea lespedeza seed production

Means w/ unlike superscripts differ (P < 0.01)

SEM = 139.4
What happened to the sericea?

• Sericea plants were progressively weakened over time
  • Unlike herbicide treatments, understory and overstory plants were equally affected by growing-season fires

• Growing-season fires strongly suppressed seed production

• Regardless of when fire is applied, it scarifies sericea seeds and stimulates germination (Wong et al., 2012)
  • Seeds germinated in spring = juvenile plants with a full growing season to mature = maximum survival odds
  • Seeds germinated in September or October = juvenile plants with little time to mature before winter = minimum survival odds
So... what happened to everything else?
Figure 5. Bare soil, % of total area

- Early spring
- Mid-summer
- Late summer

$P = 0.88$  
SEM = 8.79
Figure 6. Litter cover, % of total area

- Early spring
- Mid-summer
- Late summer

$P = 0.93$
$SEM = 9.04$
Figure 7. Plant cover, % of total basal area

- Early spring
- Mid-summer
- Late summer

\[ P = 0.29 \]
\[ SEM = 1.05 \]
Figure 8. Effects of growing-season fire on forage biomass

Treatment - $P = 0.78$
SEM = 360.2

Standing biomass, kg DM / ha

Mid-July

Early spring
Mid-summer
Late summer
### Table 1. Graminoid cover, % of total basal cover

<table>
<thead>
<tr>
<th>Item</th>
<th>Early spring</th>
<th>Mid-summer</th>
<th>Late summer</th>
<th>SEM*</th>
<th>P-value†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total grass cover, %</td>
<td>82.8</td>
<td>85.9</td>
<td>86.5</td>
<td>2.17</td>
<td>0.20</td>
</tr>
<tr>
<td>C4 grasses, %</td>
<td>67.7</td>
<td>65.9</td>
<td>64.8</td>
<td>3.40</td>
<td>0.70</td>
</tr>
<tr>
<td>C4 tall grasses, %</td>
<td>36.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>41.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>22.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.52</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>C4 mid grasses, %</td>
<td>28.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>23.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>39.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.48</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>C4 short grasses, %</td>
<td>3.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.00</td>
<td>0.04</td>
</tr>
<tr>
<td>C3 grasses and sedges, %</td>
<td>15.1</td>
<td>19.7</td>
<td>21.7</td>
<td>3.11</td>
<td>0.11</td>
</tr>
<tr>
<td>Annual grasses, %</td>
<td>0.07</td>
<td>0.33</td>
<td>0</td>
<td>0.227</td>
<td>0.31</td>
</tr>
</tbody>
</table>

* Mixed-model SEM associated with comparison of treatment main effect means.
† Treatment main effect.
<sup>a, b</sup> Within row, means with unlike superscripts differ ($P \leq 0.05$).
### Table 2. Specific graminoids, % of total basal cover

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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Big bluestem, %</td>
<td>18.4 a</td>
<td>18.1 a</td>
<td>11.9 b</td>
<td>2.61</td>
<td>0.02</td>
</tr>
<tr>
<td>Indian grass, %</td>
<td>12.1 ab</td>
<td>15.0 a</td>
<td>9.4 b</td>
<td>2.13</td>
<td>0.04</td>
</tr>
<tr>
<td>Switchgrass, %</td>
<td>5.5</td>
<td>4.0</td>
<td>1.5</td>
<td>1.70</td>
<td>0.07</td>
</tr>
<tr>
<td>Little bluestem, %</td>
<td>14.2 a</td>
<td>11.8 a</td>
<td>23.0 b</td>
<td>3.76</td>
<td>0.01</td>
</tr>
<tr>
<td>Sideoats grama, %</td>
<td>9.9</td>
<td>7.4</td>
<td>11.0</td>
<td>3.27</td>
<td>0.53</td>
</tr>
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Table 3. Forb cover, % of total basal cover

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<tbody>
<tr>
<td>Total forb cover, %</td>
<td>15.4</td>
<td>12.1</td>
<td>11.2</td>
<td>2.28</td>
<td>0.16</td>
</tr>
<tr>
<td>Perennial forbs, %</td>
<td>15.3(^a)</td>
<td>10.9(^b)</td>
<td>9.7(^b)</td>
<td>2.05</td>
<td>0.02</td>
</tr>
<tr>
<td>Annual forbs, %</td>
<td>0.1(^a)</td>
<td>1.2(^b)</td>
<td>1.5(^b)</td>
<td>0.52</td>
<td>0.02</td>
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<td>2.05</td>
<td>0.02</td>
</tr>
<tr>
<td>Sericea lespedeza, %</td>
<td>7.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.4&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.7&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.56</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Baldwin’s ironweed, %</td>
<td>0.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.4&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.16</td>
<td>0.01</td>
</tr>
<tr>
<td>Western ragweed, %</td>
<td>3.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.9&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.7&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.53</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Major wildflowers, %</td>
<td>0.6&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.9&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>1.4&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.28</td>
<td>0.03</td>
</tr>
<tr>
<td>Annual forbs, %</td>
<td>0.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.5&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.52</td>
<td>0.02</td>
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<td>9.7&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.05</td>
<td>0.02</td>
</tr>
<tr>
<td>Sericea lespedeza, %</td>
<td>7.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.4&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.7&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.56</td>
<td>&lt; 0.01</td>
</tr>
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<td>Baldwin’s ironweed, %</td>
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<td>0.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.4&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.16</td>
<td>0.01</td>
</tr>
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<td>Western ragweed, %</td>
<td>3.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.9&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.7&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.53</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Major wildflowers&lt;sup&gt;‡&lt;/sup&gt;, %</td>
<td>0.6&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.9&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>1.4&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.28</td>
<td>0.03</td>
</tr>
<tr>
<td>Annual forbs, %</td>
<td>0.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.5&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.52</td>
<td>0.02</td>
</tr>
</tbody>
</table>

* Mixed-model SEM associated with comparison of treatment main effect means.
† Treatment main effect.
‡ Combined basal cover of catclaw sensitive briar, dotted gayfeather, heath aster, prairie coneflower, purple poppy-mallow, purple prairie-clover, round-headed prairie clover, and white prairie-clover.

<sup>a, b</sup> Within row, means with unlike superscripts differ (P ≤ 0.05).
Figure 9. Shrub cover, % total basal cover

- Early spring
- Mid-summer
- Late summer

$P = 0.50$

SEM = 0.476
Figure 10. Increaser shrubs*, % total basal cover

- Early spring
- Mid-summer
- Late summer

Combined cover, % basal cover

Basal cover, %

* Combined basal cover of roughleaf dogwood, smooth sumac, and buckbrush.

a, b Means w/ unlike superscripts differ ($P = 0.04$)
## Table 4. Species richness (no. of plant species identified)

<table>
<thead>
<tr>
<th>Item</th>
<th>Early spring</th>
<th>Mid-summer</th>
<th>Late summer</th>
<th>SEM*</th>
<th>P-value†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall species richness</td>
<td>22&lt;sup&gt;a&lt;/sup&gt;</td>
<td>27&lt;sup&gt;b&lt;/sup&gt;</td>
<td>27&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.6</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Native species richness</td>
<td>21&lt;sup&gt;a&lt;/sup&gt;</td>
<td>25&lt;sup&gt;b&lt;/sup&gt;</td>
<td>26&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.6</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Graminoid richness</td>
<td>10</td>
<td>11</td>
<td>11</td>
<td>0.6</td>
<td>0.46</td>
</tr>
<tr>
<td>Forb richness</td>
<td>10&lt;sup&gt;a&lt;/sup&gt;</td>
<td>15&lt;sup&gt;b&lt;/sup&gt;</td>
<td>15&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.2</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Forb evenness</td>
<td>0.70&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.76&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.81&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.039</td>
<td>0.02</td>
</tr>
<tr>
<td>Forb diversity</td>
<td>0.57&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.73&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.83&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.066</td>
<td>&lt; 0.01</td>
</tr>
</tbody>
</table>

<sup>a, b</sup> Within row, means with unlike superscripts differ (P ≤ 0.05).
Conclusions

• Forage biomass on all treatments averaged ≥ 4,000 lbs DM/acre over 4 years on July 17
  • Prescribed fire timing did not affect peak forage production
  • Minor shifts between big bluestem and little bluestem basal cover occurred on the September treatment only

• Mid-summer & late-summer prescribed fires reduced basal & aerial frequency of SL

• Mid-summer & late summer prescribed fires dramatically decreased seed production by SL

• Improved forb heterogeneity in mid- and late summer treatments is a strong indication of improving rangeland health
Implications

• Growing season prescribed burning is consistent with responsible ecosystem stewardship in the Flint Hills

• Growing-season prescribed burning appears be an inexpensive and comprehensive means to control SL
  • Current cash cost of prescribed burning is about $0.75 / acre
  • Current cash cost of fall-applied herbicide is $18 to $36 / acre
  • No collateral damage to desirable, non-target forbs

• Growing-season prescribed burning is temporally compatible with locally-favored grazing management schemes
  • Effects on animal performance are unknown but the cost of any performance decrease is unlikely to exceed the margin between burning and spraying costs
Implications

• Smoke Management
  • Burning SL-affected acreage outside of the conventional fire season would decrease incidence of downwind air-quality problems

• Labor Management
  • Burning some acreage outside of the ‘normal’ window of time may result in improved time and labor management for ranchers

• Fire Safety
  • Much of the ‘energy’ of a growing-season fire is spent vaporizing water
  • These fires burn with much less intensity, heat, and speed than conventional, dormant-season fires; loss of control is less likely