Fire Ecology in the Northern Great Plains

Lance Vermeire
Fort Keogh Livestock & Range Research Lab
• Summer fire & Post-fire grazing
• Fire season and return interval
• Weedy species management
• Lethal heat dosage
• Bud response
• Fire effects on forage quality
Spring Precipitation in Miles City

Drier than avg 59% of years
Median is 90% of avg
Dry Spring
275 lb/ac
Wet Spring
1312 lb/ac
Post-fire Utilization

- Fire shifted composition toward described historic community
- Grass productivity was never reduced
- Up to 50% use in June and July appears safe
Fire Effects

- **Mass (kg ha⁻¹)**
  - **Old dead**
  - **Current-yr**

<table>
<thead>
<tr>
<th>Year</th>
<th>Burned</th>
<th>No Fire</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Post-fire Deferment

Summer Fire
Grazed following growing season:
   Mid-May, Late June, Early August
Experiment repeated
Current-Yr Biomass (kg ha⁻¹)

Grazing Initiation Period

- Mid-May
- Late June
- Early August

Grass
Forb
## Average Burn Dates (2006-2013)

<table>
<thead>
<tr>
<th>Fire Season</th>
<th>Return Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2-yr</td>
</tr>
<tr>
<td>Summer</td>
<td>Aug 27</td>
</tr>
<tr>
<td>Fall</td>
<td>Oct 31</td>
</tr>
<tr>
<td>Spring</td>
<td>Apr 19</td>
</tr>
</tbody>
</table>
Total Current-Year Biomass

![Bar chart showing total current-year biomass across different fire return intervals and seasons. The chart includes error bars, and letters indicate statistical significance between groups.]
Litter & Non-Native Species

\[ y = 0.006x^2 - 0.13x + 5 \]
\[ R^2 = 0.61 \]
Non-Native Species

Canopy Composition (%)

- No Fire
- Summer
- Fall
- Spring

Fire Return Interval

- 2
- 3
- 6

Statistical letters indicate significant differences.
Summary

- 2-yr interval is fastest on average
- Fire effects are complex & species-specific
- Total biomass is resistant
- Composition is sensitive
- Fall and summer fire at short intervals favor rangeland integrity
Fire Season Effect on Brome Density

- Japanese brome

<table>
<thead>
<tr>
<th>Season</th>
<th>Plant Density (No. m⁻²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer</td>
<td>400</td>
</tr>
<tr>
<td>Fall</td>
<td>450</td>
</tr>
<tr>
<td>Spring</td>
<td>500</td>
</tr>
<tr>
<td>None</td>
<td>1600</td>
</tr>
</tbody>
</table>
Fire Effects on Weed Seed Emergence

Japanese brome

Spotted knapweed

Russian knapweed

Leafy spurge

Fuel load (g m$^{-2}$)

Emerged seed (%)
Heat Effects on Eggs

![Bar chart showing the proportion of eggs hatched at different fire exposure times (seconds). The x-axis represents fire exposure times (0, 9, 23, 46 seconds), and the y-axis represents the proportion of eggs hatched. There are two categories: Migratory and White-Whiskered eggs. The chart indicates that the proportion of eggs hatched decreases with increased fire exposure time.]
Needle-and-thread

Probability of Plant Mortality

- Predicted Probability
- 95% CI

Fuel Load 100s (kg·ha⁻¹)
Blue grama

Proabilty of Plant Mortality vs. Fuel Load (100s kg·ha⁻¹)

- Predicted
- Probability
Western wheatgrass & threadleaf sedge mort. < 1%

For 50% probability of mortality:

Blue grama 7.5 min, 1134 °F, 7130 lb/ac
Needleandthread 10.4 min, 1162 °F, 7575 lb/ac
Western wheatgrass

Fuel load (100s kg·ha⁻¹)

Biomass change relative to control

\[ y = -0.0101x^2 + 0.3608 \]

\[ R^2 = 0.70 \]
Immediate Fire Effects
Blue Grama

---Active buds---
\( P < 0.01 \)

---Dormant buds---
\( P < 0.01 \)

---Dead buds---
\( P = 0.41 \)
Immediate Fire Effects
Western Wheatgrass

- **Active buds**: $P < 0.05$
- **Dormant buds**: $P = 0.57$
- **Dead buds**: $P = 0.43$

Buds tiller$^{-1}$

<table>
<thead>
<tr>
<th>Season</th>
<th>Pre</th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall</td>
<td></td>
<td><strong>a</strong></td>
</tr>
<tr>
<td>Spring</td>
<td></td>
<td><strong>b</strong></td>
</tr>
<tr>
<td>Summer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Summer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Purple threeawn

![Bar graph showing axillary bud production in different fire treatments.](image)

- **No Fire**: Axillary buds per tiller are significantly higher compared to other treatments.
- **Fall Fire**: Axillary bud production is intermediate.
- **Summer Fire**: Axillary bud production is lower than fall fire but higher than no fire.

Legend:
- **Active**
- **Dormant**

Statistics:
- Different letters (a, b) indicate significant differences between treatments.
Purple threeawn

- **Total**:
  - No Fire
  - Fall Fire
  - Summer Fire

- **Active**:
  - No Fire
  - Fall Fire
  - Summer Fire

- **Dormant**:
  - No Fire
  - Fall Fire
  - Summer Fire

Axillary buds plant$^{-1}$
Take-home message

- Productivity is resistant
- Preferred natives are favored
- Fire effects are species-specific
- Moderate grazing after fire is safe
- Fuel load and heat dosage are good predictors
- Bud bank may be the key
- Increased forage quality is short-lived
Questions or comments?