Litter dynamics in native grasslands

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Litter
- Undecomposed dead plant material

Litter

- Undecomposed dead plant material
NATURAL MULCHES OR "LITTER" OF GRASSLANDS: WITH KINDS AND AMOUNTS ON A SOUTHERN PRAIRIE

E. J. Dyksterhuis and E. M. Schmutz
U. S. Soil Conservation Service, Fort Worth, Texas

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Plant Litter: Its Dynamics and Effects on Plant Community Structure

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The effects of plant litter on vegetation: a meta-analysis

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Importance of litter long recognized in range health guidelines

<table>
<thead>
<tr>
<th>Ecoregion</th>
<th>Ecosite</th>
<th>Healthy Average</th>
<th>Healthy &gt;65%</th>
<th>Healthy 65% - 35%</th>
<th>Unhealthy &lt;35%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry Mixed Grassland</td>
<td>Loam</td>
<td>400</td>
<td>&gt;260</td>
<td>260-140</td>
<td>&lt;140</td>
</tr>
<tr>
<td></td>
<td>Solonetzic</td>
<td>250</td>
<td>&gt;160</td>
<td>160-85</td>
<td>&lt;85</td>
</tr>
<tr>
<td></td>
<td>Thin</td>
<td>150</td>
<td>&gt;95</td>
<td>95-50</td>
<td>&lt;50</td>
</tr>
<tr>
<td>Mixed Grassland</td>
<td>Loam</td>
<td>600</td>
<td>&gt;390</td>
<td>390-210</td>
<td>&lt;210</td>
</tr>
<tr>
<td></td>
<td>Thin</td>
<td>300</td>
<td>&gt;195</td>
<td>195-105</td>
<td>&lt;105</td>
</tr>
<tr>
<td>Aspen Parkland</td>
<td>Loam</td>
<td>1500</td>
<td>&gt;975</td>
<td>975-525</td>
<td>&lt;525</td>
</tr>
<tr>
<td></td>
<td>Sandy Loam</td>
<td>1100</td>
<td>&gt;715</td>
<td>715-385</td>
<td>&lt;385</td>
</tr>
<tr>
<td></td>
<td>Sand</td>
<td>800</td>
<td>&gt;520</td>
<td>520-280</td>
<td>&lt;280</td>
</tr>
<tr>
<td></td>
<td>Dunes</td>
<td>400</td>
<td>&gt;260</td>
<td>260-140</td>
<td>&lt;140</td>
</tr>
<tr>
<td>Cypress Upland</td>
<td>Loam</td>
<td>900</td>
<td>&gt;585</td>
<td>585-315</td>
<td>&lt;315</td>
</tr>
</tbody>
</table>

Litter is a key factor controlling plant community structure in grasslands

- Traps moisture improving grassland productivity
- Acts as a mechanical barrier filtering out certain species
- Litter quality a key driver of soil processes
Litter a critical habitat element for many bird species at risk


<table>
<thead>
<tr>
<th>Probability of Occurrence</th>
<th>Litter Volume (kg/ha)</th>
<th>Litter Volume (lb/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>&gt;600 kg/ha</td>
<td>&gt;535 lb/ac</td>
</tr>
<tr>
<td>Good</td>
<td>400-600 kg/ha</td>
<td>355 – 535 lb/ac</td>
</tr>
<tr>
<td>Fair</td>
<td>200-400 kg/ha</td>
<td>180 – 355 lb/ac</td>
</tr>
<tr>
<td>Poor</td>
<td>&lt;200 kg/ha</td>
<td>&lt;180 lb/ac</td>
</tr>
</tbody>
</table>

Dominic Sherony; https://upload.wikimedia.org/wikipedia/commons/c/cd/Anthus_spragueii%2C_Sherony_2.jpg
Current litter research priorities

- Improving understanding of litter – moisture – productivity relationships
- Better characterizing species at risk requirements for litter
- Litter – soil process linkages
- Soil carbon sequestration
- Updating litter guidelines in range health assessment
Case study: impacts of litter retention on grassland productivity and community structure in the mixed grass prairie

- Practical: do testing current carryover guidelines maximize grassland productivity?
- Structural: how does litter act to filter some species out of grassland communities?
- Wild question: what are the effects of very high litter accumulations


Study Area – Mixed Grass Prairie, Central Saskatchewan, Canada

Photo: Martin Brummell
Methods – collect litter from plots between 1 and 40m$^2$ at a reference site

Photo: Jim Romo
Methods – add collected litter to 10m² study plots in fall. Productivity and diversity measured in following growing season.
Litter improved soil moisture conditions

Graph showing the relationship between log litter mass (g/m²) and soil moisture in July for 2011 and 2012.
Litter improved productivity – to a point
Litter reduced species diversity
Diversity declines due to filtering of species unable to tolerate high litter.

- Surviving grasses had thicker, tougher leaves.
Diversity declines due filtering of species unable to tolerate high litter

- Surviving forbs had thinner, weaker leaves
Survivors under high litter: Kentucky Bluegrass

Matt Lavin;
https://commons.wikimedia.org/wiki/File%3APoa_pratensis_(3924614544).jpg
Survivors under high litter: American Vetch

Matt Lavin;
https://commons.wikimedia.org/wiki/File%3AVicia_americana_(3646448599).jpg
Conclusions and Implications

- Litter – productivity effects are non-linear and inherently variable.
  - Litter retention targets at the peak of the curve will, on average, maximize productivity at a landscape scale
- Plant diversity is maximized at lower levels of litter than productivity
  - Heterogeneity of litter carryover essential if dual management goals of high diversity and productivity important
Where does litter go?

- Primary source of carbon and nitrogen inputs to the soil

Decomposition dynamics complex involving interactions among bacteria, fungi, and archaea

**Belowground**
- SOC
- Root biomass

**Aboveground**
- Litter nitrogen

**Inter-kingdom**
- Archaea/
  - bacteria
Where does litter research need to go?

- Full carbon budgets – how to balance grazing needs against future productivity and long-term carbon sequestration
- Inclusion of upper litter limits into range health guidelines
- Role of heterogeneity – can fine scale (1-10m) variation in litter retention allow us to meet both range productivity and biodiversity goals?
Thank You

Photo: Martin Brummell