Litter dynamics in native grasslands

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NATURE CONSERVANCY CANADA

COSEWIC Committee on the Status of Endangered Wildlife in Canada

BCRC BEEF CATTLE RESEARCH COUNCIL

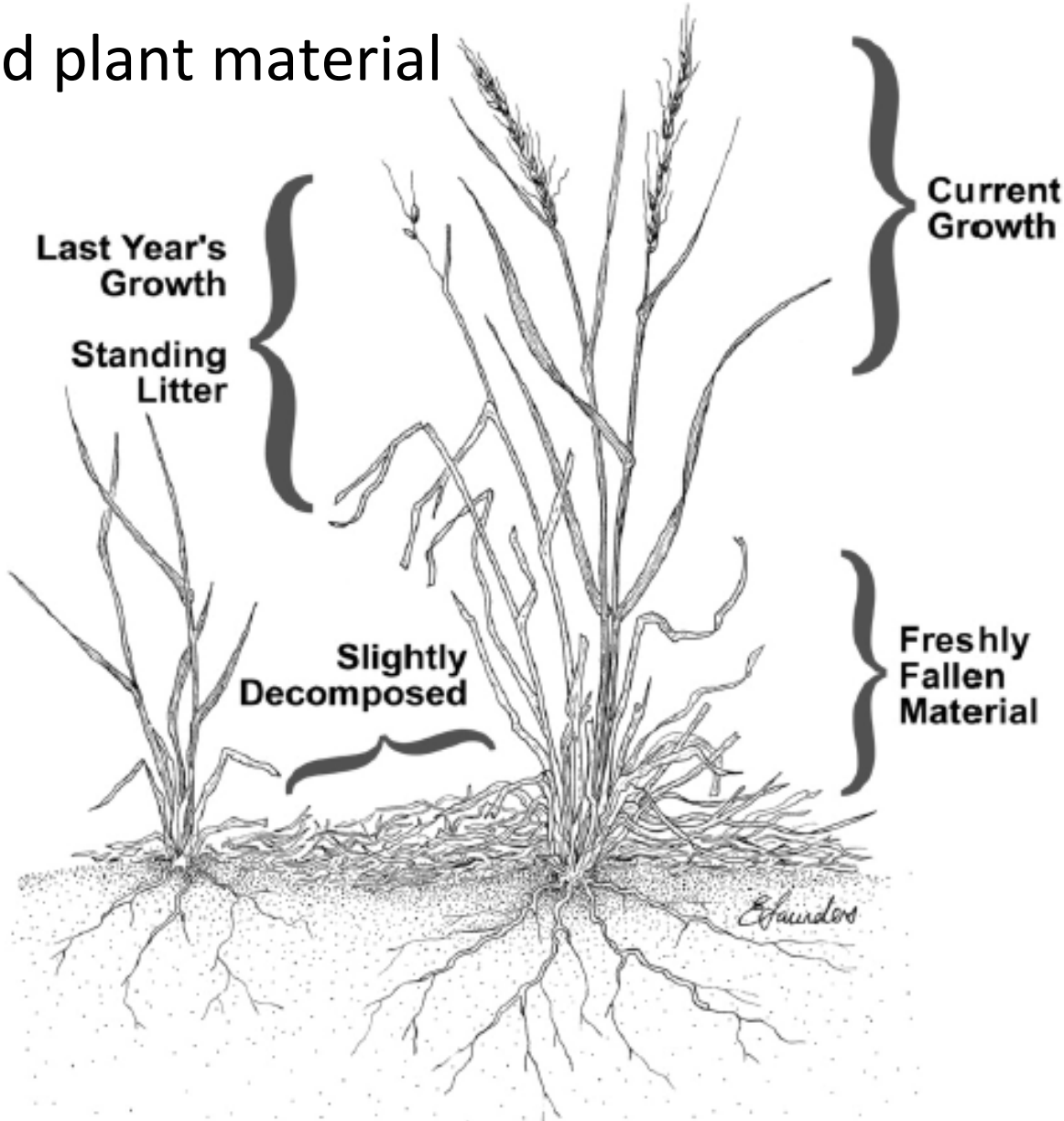
NSERC CRSNG

Western Grains Research Foundation

Saskatchewan GOVERNMENT OF SASKATCHEWAN

Litter

- Undecomposed dead plant material



PCAP (2008). Rangeland health assessment: native grassland and forest.

Litter

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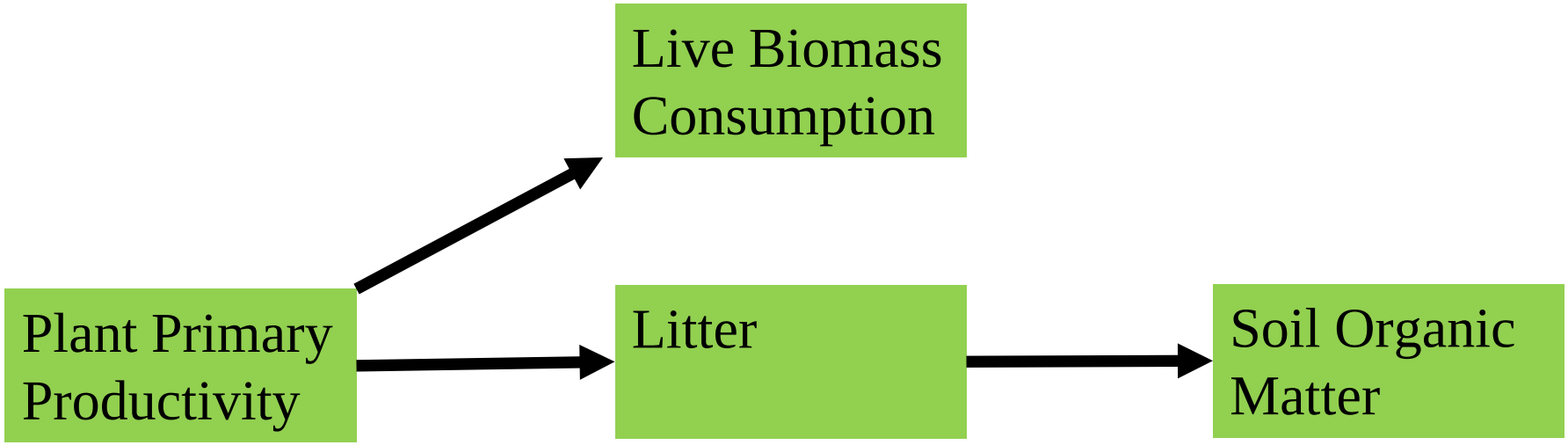

NATURAL MULCHES OR "LITTER" OF GRASSLANDS: WITH KINDS AND AMOUNTS ON A SOUTHERN PRAIRIE

E. J. DYKSTERHUIS AND E. M. SCHMUTZ

U. S. Soil Conservation Service, Fort Worth, Texas

THE BOTANICAL REVIEW

VOL. 57 JANUARY–MARCH, 1991 NO. 1

Plant Litter: Its Dynamics and Effects on Plant Community Structure

JOSÉ M. FACELLI

Institute of Ecosystem Studies
Mary Flagler Cary Arboretum

Journal of Ecology 1999, **87**, 984–994

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

SHAOJUN XIONG* and CHRISTER NILSSON*†

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Importance of litter long recognized in range health guidelines

Rangeland Health Assessment Litter Normals (lb/ac)					
Ecoregion	Ecosite	Healthy		Healthy with problems	Unhealthy
		Average	>65%	65%-35%	<35%
Dry Mixed Grassland	Loam	400	>260	260-140	<140
	Solonetzic	250	>160	160-85	<85
	Thin	150	>95	95-50	<50
Mixed Grassland	Loam	600	>390	390-210	<210
	Thin	300	>195	195-105	<105
Aspen Parkland	Loam	1500	>975	975-525	<525
	Sandy Loam	1100	>715	715-385	<385
	Sand	800	>520	520-280	<280
	Dunes	400	>260	260-140	<140
Cypress Upland	Loam	900	>585	585-315	<315

PCAP (2008). Rangeland health assessment: native grassland and forest.

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

Photo: Jim Romo

Litter a critical habitat element for many bird species at risk

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

Litter Volume Thresholds for Sprague's Pipit Probability of Occurrence		
Probability of Occurrence	**Litter Volume (kg/ha)**	**Litter Volume (lb/ac)**
Excellent	>600 kg/ha	>535 lb/ac
Good	400-600 kg/ha	355 – 535 lb/ac
Fair	200-400 kg/ha	180 – 355 lb/ac
Poor	<200 kg/ha	<180 lb/ac

Grilz (2014). Vegetation heterogeneity indicators for Sprague's Pipit (Anthus spragueii) habitat on native prairie managed by livestock grazing. Ranchers Stewardship Alliance.

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 assesment

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

Letts et al. (2015). Litter accumulation drives grassland plant community composition and functional diversity via leaf traits. Plant Ecology **216**: 357-370.
Hilger & Lamb (In Press). Quantifying Optimal Rates of Litter Retention to Maximize Annual Net Primary Productivity on Mixed-Grass Prairie. Rangeland Ecology & Management.

Study Area – Mixed Grass Prairie, Central Saskatchewan, Canada

Photo: Martin Brummell

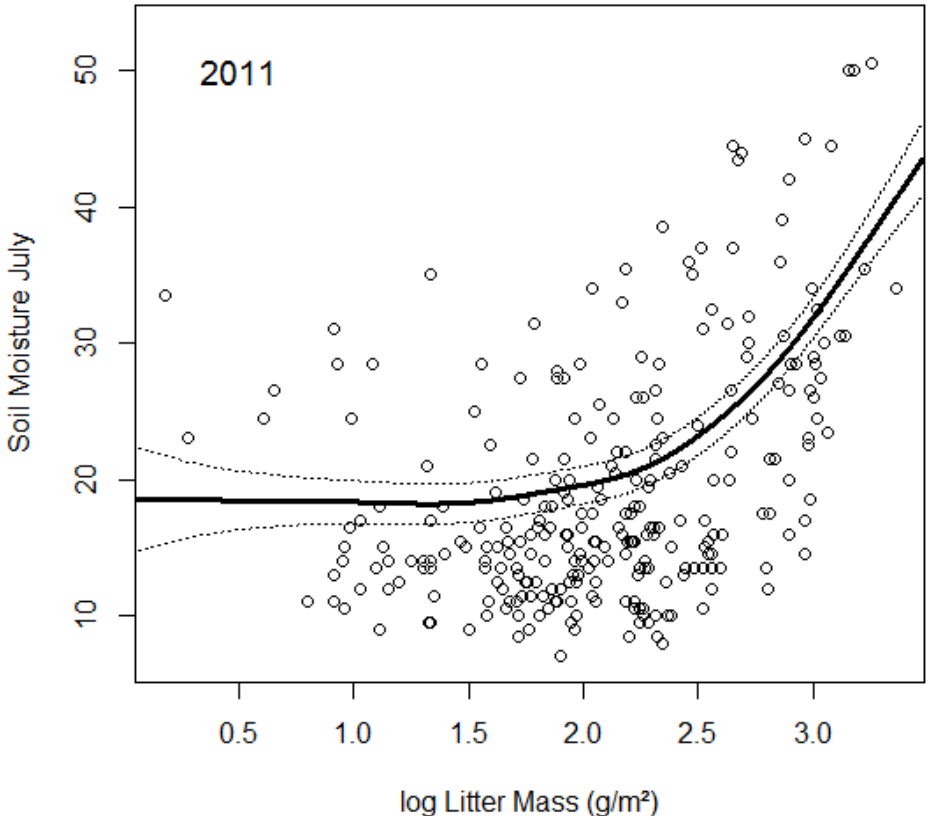
Methods – collect litter from plots between 1 and 40m^2 at a reference site

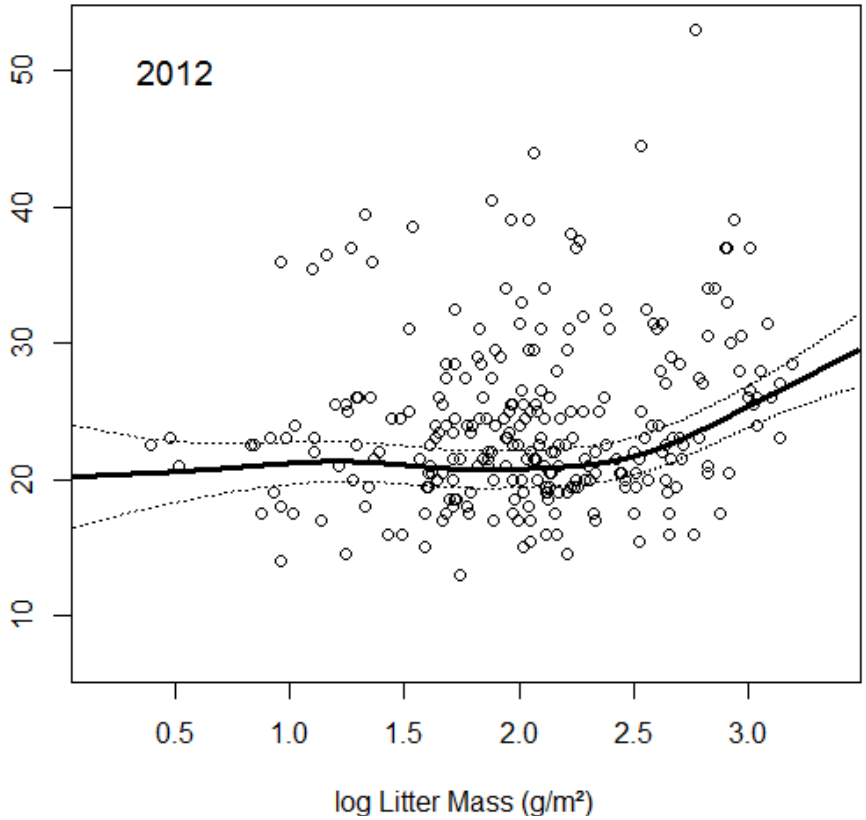
Photo: Jim Romo

Methods – add collected litter to $10m^2$ study plots in fall. Productivity and diversity measured in following growing season.

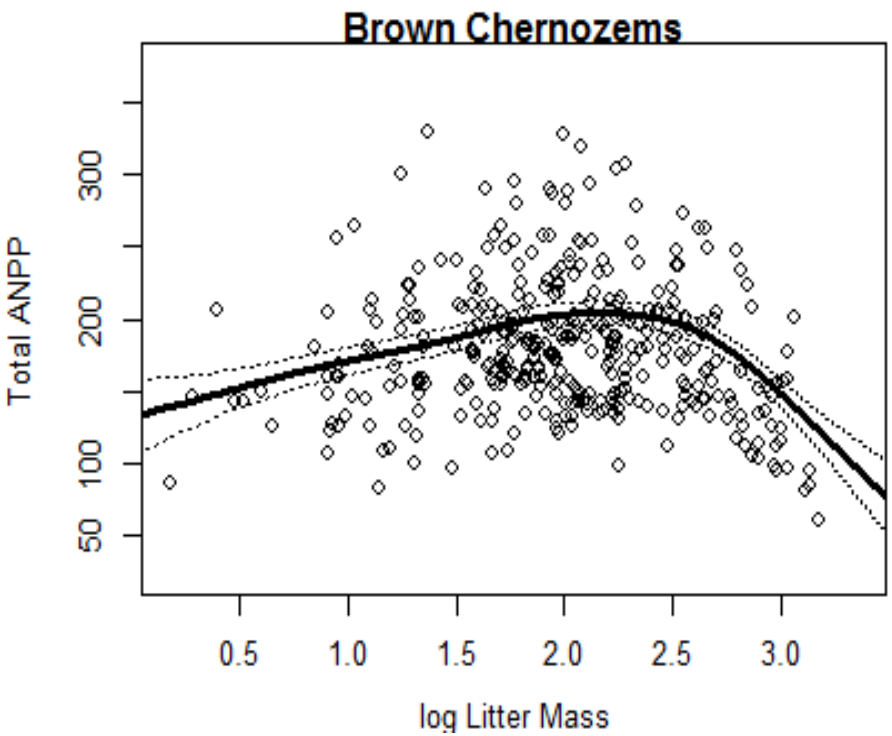
Photo: Jim Romo

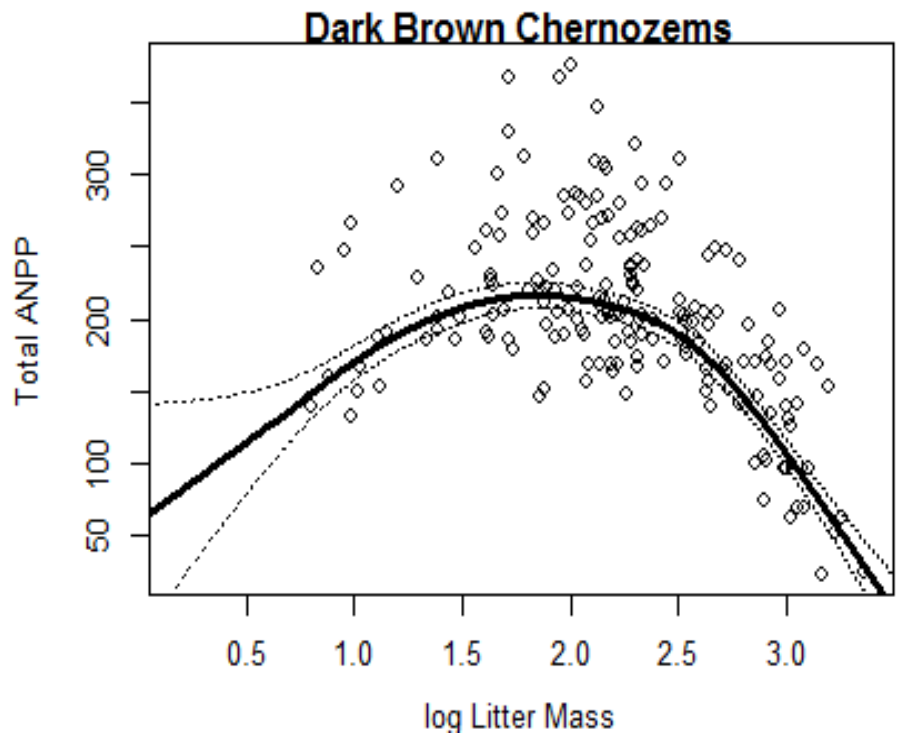
Litter improved soil moisture conditions



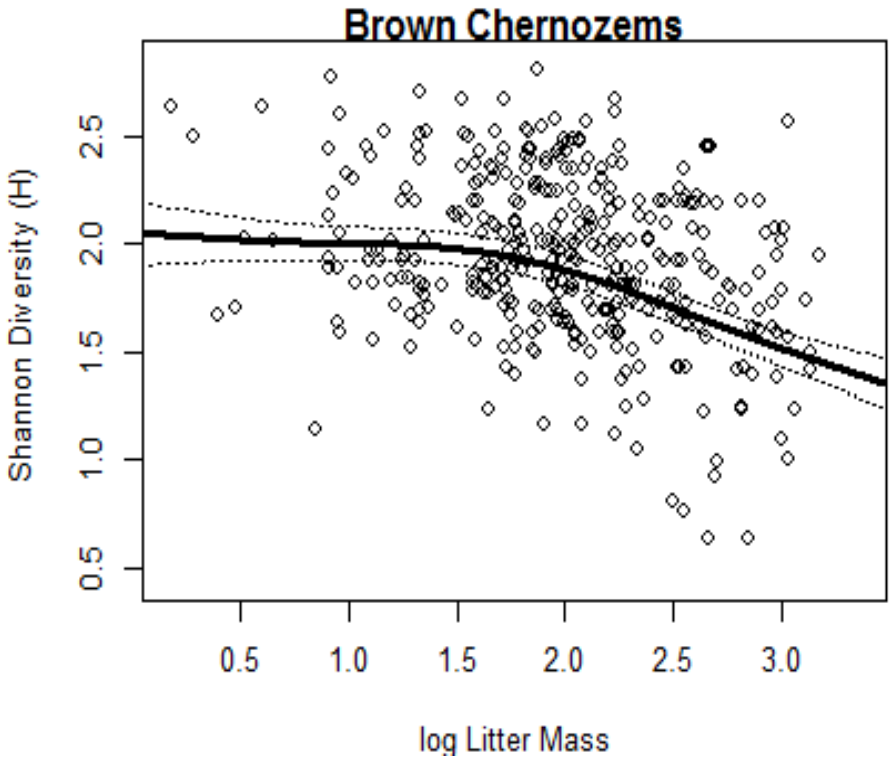


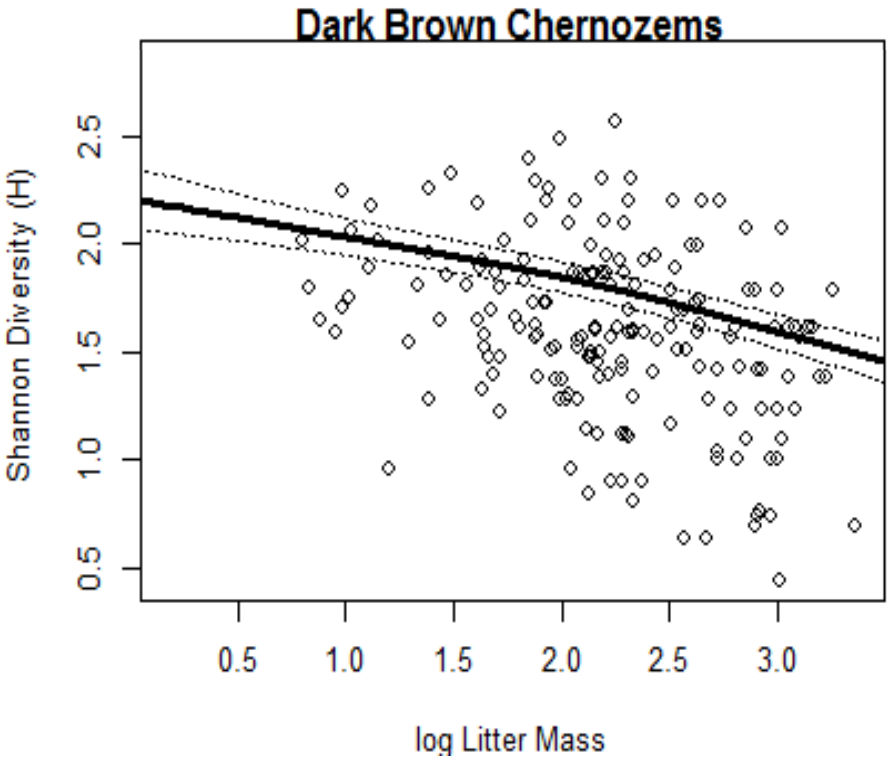
Litter improved productivity – to a point





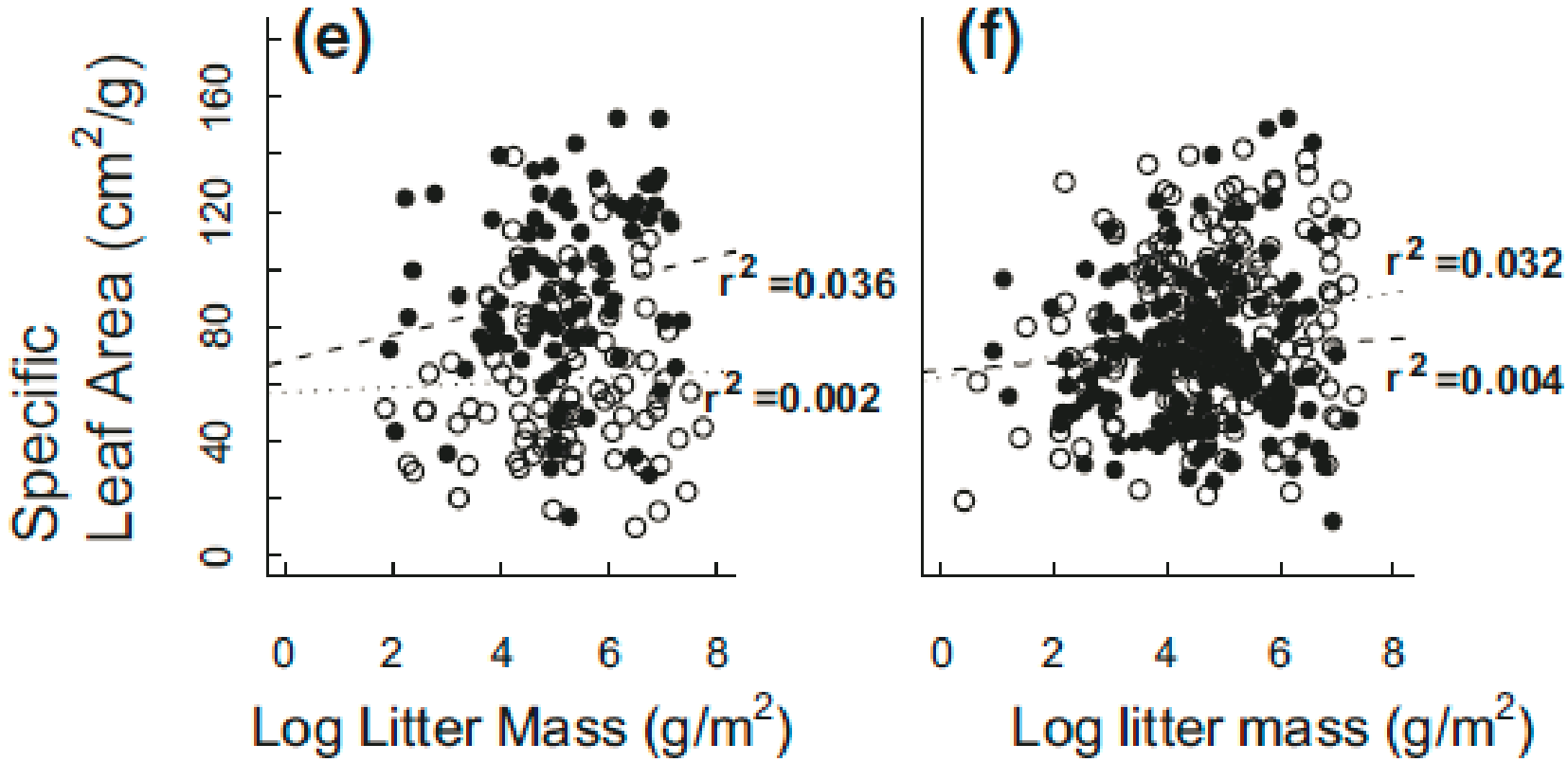
Litter reduced species diversity





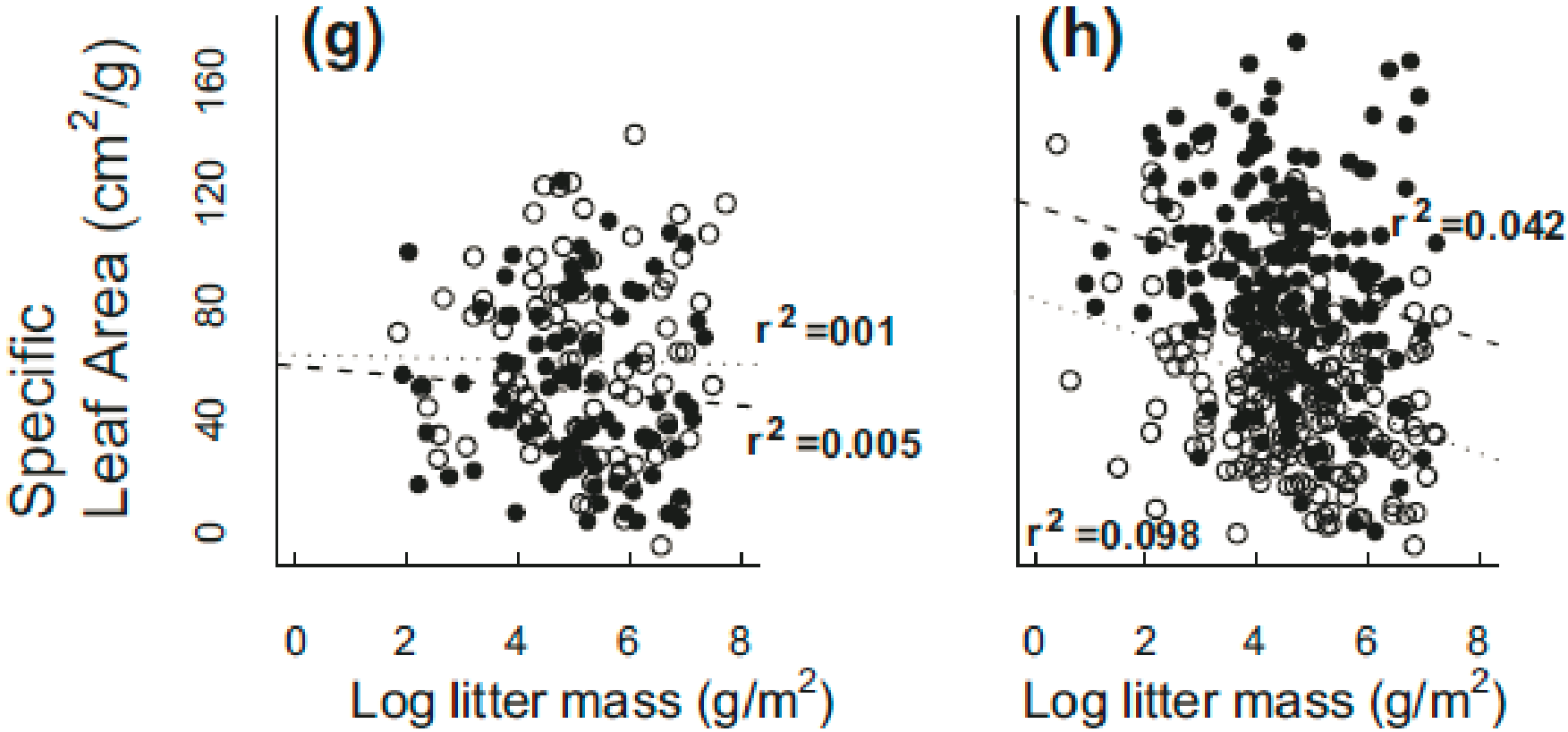
Diversity declines due filtering of species unable to tolerate high litter

- 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

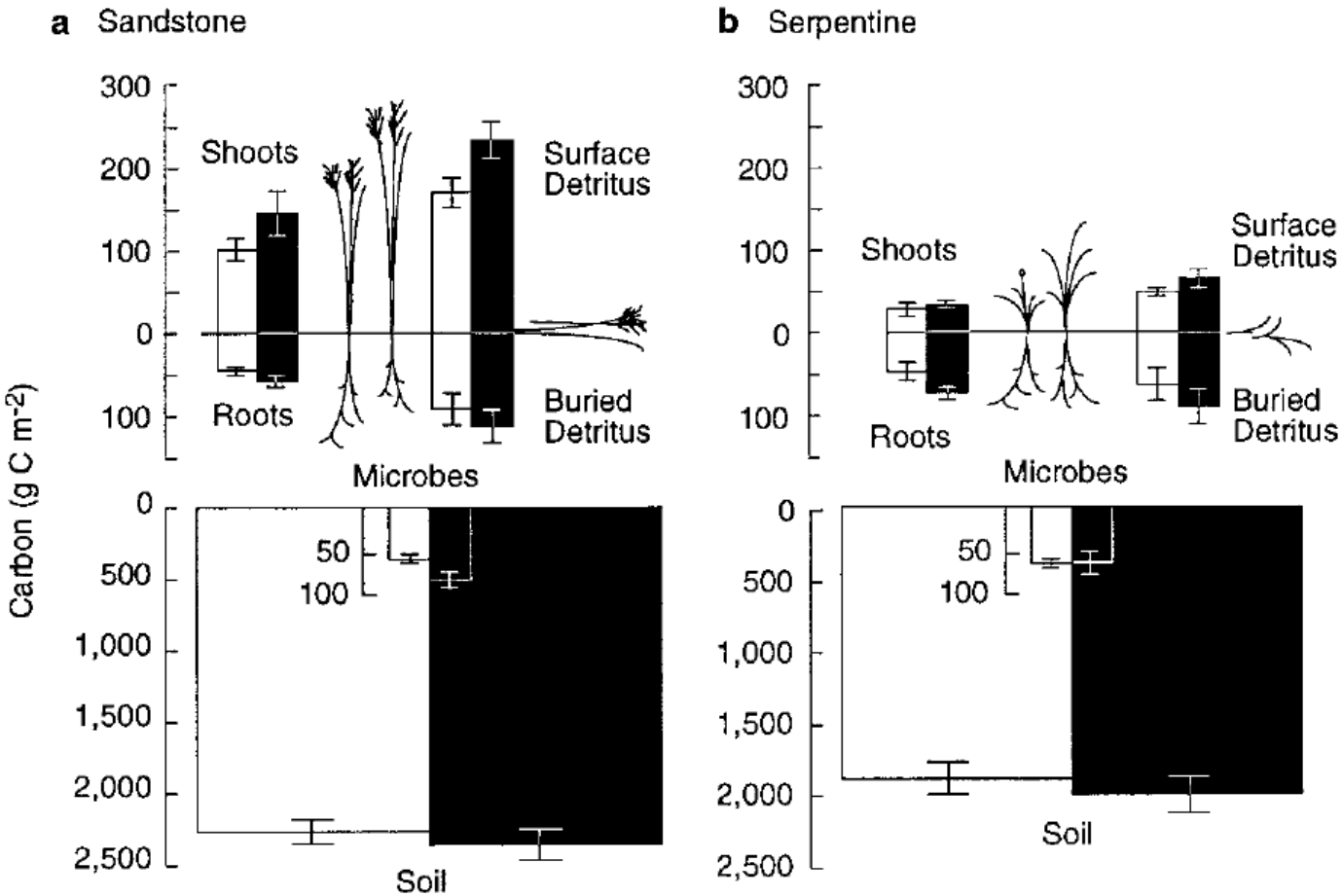
Matt Lavin;
https://commons.wikimedia.org/wiki/File%3AVicia_americana_(3646448599).jpg

Conclusions and Implications

- Litter – productivity effects are non-linear and inherently variable.
  a) 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
  a) Heterogeneity of litter carryover essential if dual management goals of high diversity and productivity important

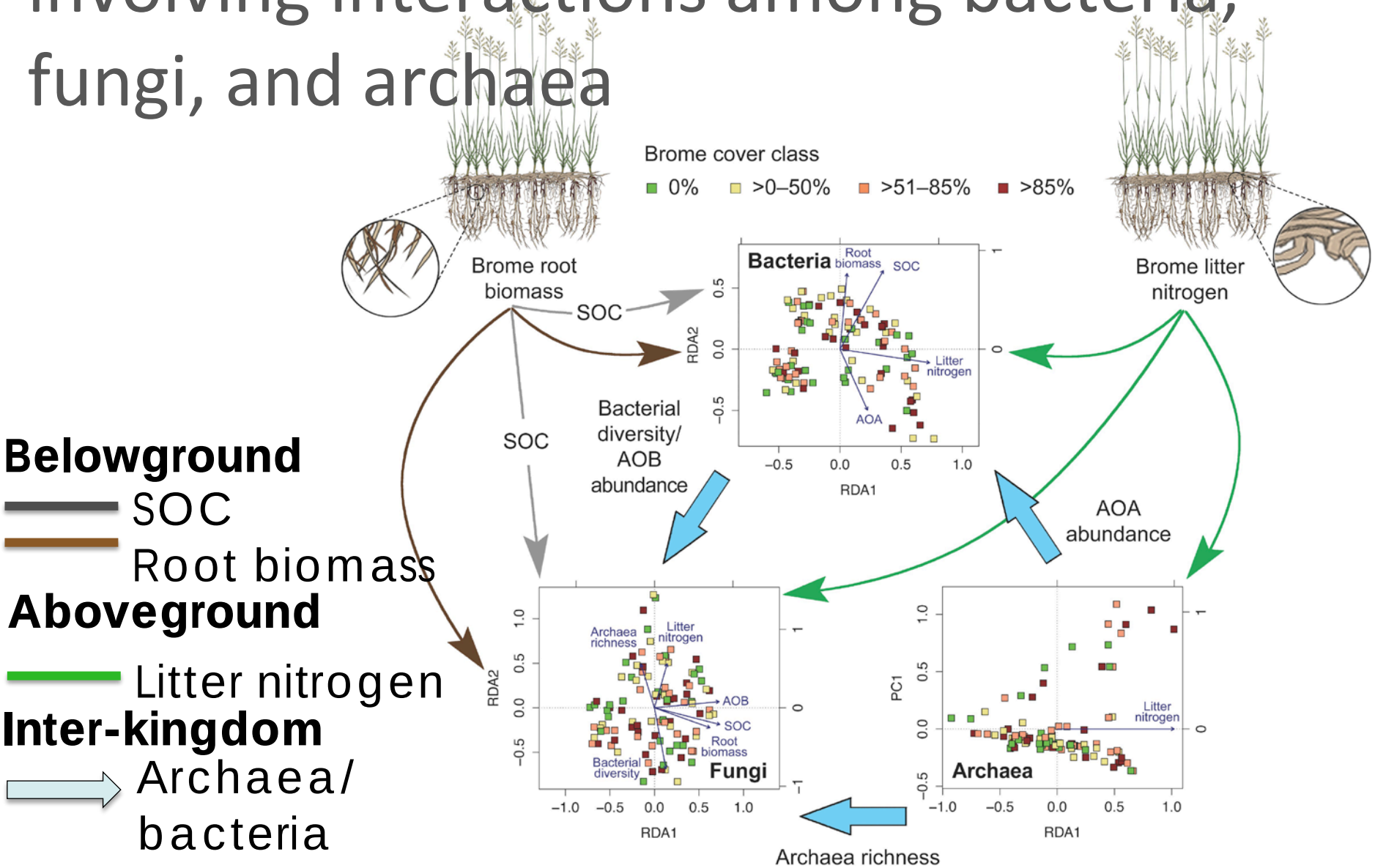
Where does litter go?

- Primary source of carbon and nitrogen inputs to the soil



Hungate, B. A., et al. (1997). "The fate of carbon in grasslands under carbon dioxide enrichment." Nature **388(6642): 576-579.**

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



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?

Photo: Martin Brummell