Woody Debris in Desert Grasslands ?

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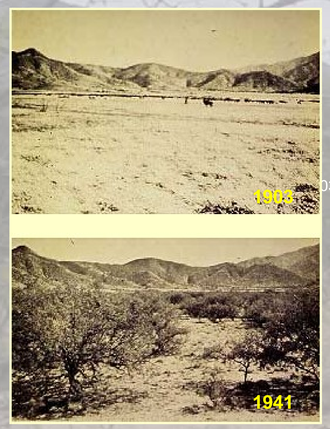
ABSTRACT

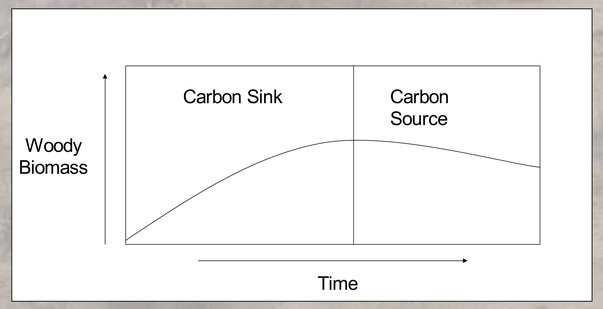
Woody plant encroachment has been documented in rangeland ecosystems worldwide; however, its effects on the global carbon cycle are not well-understood. The carbon mass of live plants and soils has been measured in many of these systems, but carbon in non-living plant material (detritus) has not been documented. Our objective was to quantify coarse woody debris biomass in a desert grassland undergoing mesquite (*Prosopis velutina*) invasion and model its relationship to mesquite size. Coarse woody debris (CWD) was collected from 41 plants ranging in size from 0.11 to 59 m² in canopy area and 0.02 to 970 kg in aboveground biomass. The total CWD ranged from 0 to 24 kg per tree and accounted for up to 10% of total aboveground shrub biomass. A strong non-linear relationship was observed between mesquite canopy area and coarse woody debris mass ($r^2 = 0.92$). This relationship can be used in conjunction with remote sensing of canopy area to predict coarse woody debris biomass over large areas.

INTRODUCTION



Enhanced woody plant abundance and growth in rangeland ecosystems has been cited as a significant component of the modern carbon sink. To adequately quantify and predict the effects of this type of land cover change on the global carbon cycle, we must understand how ecosystems might transition from sinks to sources of carbon over time (Figure 1). This means that in addition to tracking plant and soil carbon pools, detrital biomass or coarse woody debris must also be accounted for. Although shrublands, savannas and woodlands are geographically extensive, there is little available data on coarse woody debris in these ecosystems.

Figure 1: Theoretical figure of carbon dynamics accompanying woody encroachment into dryland ecosystems, with net increases in carbon storage during woody plant stand development and net losses of carbon via decomposition of woody debris following stand maturation.

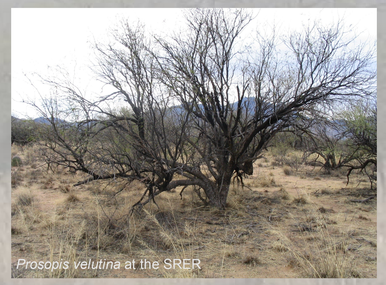


OBJECTIVES

- Quantify coarse woody debris in a dryland ecosystem undergoing woody plant encroachment
- Calculate fraction of aboveground *Prosopis* biomass that is detritus
- Establish relationships between *Prosopis* shrub canopy area and coarse woody debris biomass

HYPOTHESES

- Coarse woody debris biomass will be positively correlated with shrub size/age
- As woody plant encroachment progresses, storage of carbon in detrital pools will increase


Prosopis velutina at the SRER

STUDY SITE

Desert grasslands at the Santa Rita Experimental Range, 80 km south of Tucson, Arizona. Encroachment by the shrub *Prosopis velutina* [Woot.] has been well-documented over the past 100+ years.

METHODOLOGY

- Selected 41 shrubs varying in size/age
- For each shrub, measurements included:
  - Basal diameter of each stem
  - Bole-to-canopy dripline distance (= canopy radius) in eight equally spaced directions. Canopy area was computed as a circle whose radius was the mean of these eight measurements.
- All coarse woody debris > 6 cm in length and > 1 cm in diameter in the subcanopy zone was collected, sorted into diameter size classes (Class I: 0-1 cm; Class II: 1-2.5 cm; Class III: 2.5-10 cm) and weighed in the field
- Subsamples of diameter size classes were collected for wet/dry weight conversion.

Table 1: Total standing biomass and course woody debris by radius size class

Shrub Radius Classes (m)	Standing Biomass (kg)	CWD Biomass (kg)	% CWD of total
0-0.49	0.1480	0.0017	1.15
0.5-0.99	1.3293	0.0547	3.95
1.0-1.49	8.3724	0.3800	4.34
1.5-1.99	16.1137	1.0517	6.13
2.0-2.49	50.9073	2.6762	4.99
2.5-2.99	88.4075	9.8747	10.05
>3.0	174.0680	17.0365	8.91

- Coarse woody debris biomass was highly correlated with mesquite canopy area over the range of shrubs measured (0.2 to 4 m² canopy area).

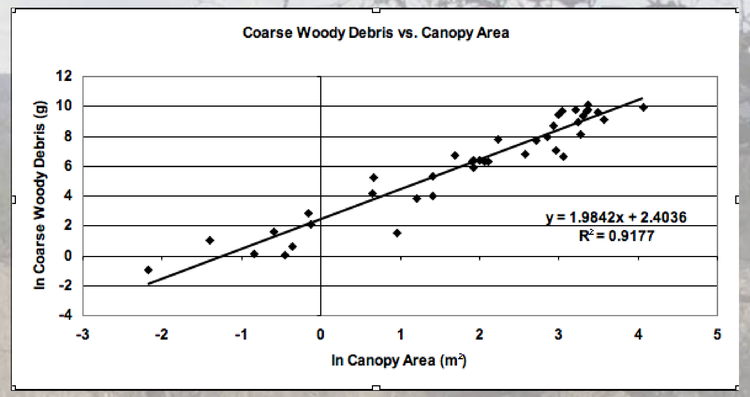


Figure 2: Coarse Woody Debris vs. Canopy Area

- A significant positive relationship between coarse woody debris biomass and mesquite canopy area was observed.

CONCLUSIONS

- As stands mature and *Prosopis* plants increase in size, carbon storage in coarse woody debris will become increasingly important.
- However, detrital carbon represents a long-term carbon source since these pools are susceptible to decomposition. Rates of CWD decomposition are not well-known in drylands and will depend on interactions between biotic (e.g., termites) and abiotic (moisture, temperature) factors.
- Knowing the relationship between shrub canopy area and coarse woody debris biomass will allow us to use historical aerial photography to make spatially-explicit reconstructions of CWD distributions.
- An ongoing study is quantifying coarse woody debris input rates.
- Results of this study will be useful for parameterizing and constraining ecosystem process models seeking to predict how woody plants alter the carbon cycle in drylands.

THANKS

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