

# ESTIMATING *Prosopis velutina* ABOVEGROUND BIOMASS: Field and Remote Sensing Approaches

C. McMurtry<sup>1</sup>, S. Archer<sup>1</sup>, M. McClaran<sup>1</sup>, D. Browning<sup>1</sup>, and H. Throop<sup>2</sup>; <sup>1</sup>School of Natural Resources, University of Arizona, Tucson, AZ 85721; <sup>2</sup>Biology Dept., New Mexico State University, Las Cruces, NM 88003

## MESQUITE ALLOMETRY

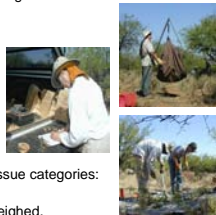
### OBJECTIVE:

- Develop algorithms to estimate *P. velutina* aboveground biomass.

### METHODS:

- Selected and measured 31 trees ranging in:

- **Stem # / Plant:** 1 - 4
- **Basal Diameter:** 0.5 - 39 cm
- **Total Basal Diameter:** 0.7 - 63 cm
- **Canopy Radius:** 0.2 - 6 m
- **Canopy Height:** 0.5 - 7 m



- Cut trees at ground level and separated into tissue categories:

- **Leaves:** Collected, dried and weighed.
- **Live Stems < 1 cm:** Collected, dried and weighed.
- **Live Stems > 1 cm:** Separated into five diameter classes (1-2.5, 2.5-10, 10-25, 25-35 cm, >35 cm) and weighed in field; fresh / dry mass ratios determined on subsample(s) from each class used to estimate total dry biomass.
- **Dead Stems:** Total mass measured in the field.

- Subsamples of each tissue type were ground and analyzed for % carbon content (Costech ECS 4010 elemental combustion system).

### RESULTS:

- Woody tissues comprised ~ 94% of *P. velutina* aboveground biomass (Table 1).

- Dead wood comprised 16% of total biomass.

- %C relatively comparable for all tissue types (45-50%; Table 1).

- Following natural log transformation, mesquite size metrics were strong predictors of total aboveground (Fig. 1) and component tissue biomass (data not shown).

Table 1. Mean (± SE) percentage contribution to total biomass (% TB) and carbon content (% C) of *P. velutina* tissues.

	% TB	% C
<b>Leaves</b>	6.0 ± 0.9	50.3 ± 0.1
<b>Stems</b>	94 ± 0.9	
< 1cm	27 ± 5	47.2 ± 0.2
1-2.5 cm	15 ± 3	47.4 ± 0.5
2.5-10 cm	16 ± 2	49.4 ± 0.3
10-25 cm	18 ± 3	50.2 ± 0.2
25-35 cm	0.8 ± 0.5	50.6 ± na
<b>Dead</b>	16 ± 2	45.1 ± 1.0

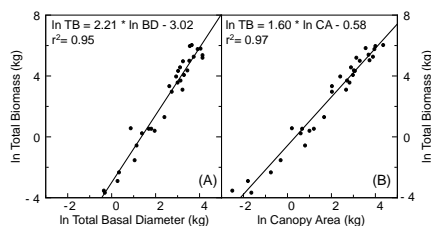


Figure 1. Relationships between *Prosopis velutina* total aboveground biomass (TB; kg) and (A) total stem basal diameter (BD; cm) and (B) canopy area (CA; m<sup>2</sup>). All data natural log transformed.

## OVERVIEW

- The extent to which changes in the size and abundance of woody plants on Southwestern rangelands affect ecosystem processes is not well known.
- Assessing the impacts of changes in velvet mesquite (*Prosopis velutina*) abundance on the C, N, and H<sub>2</sub>O cycles and land surface-atmosphere interactions requires quantitative knowledge of plant biomass.
- Direct measurements and complete inventories of woody plant biomass on a landscape scale are not practical; hence indirect, non-destructive population sampling approaches are required.
- Algorithms estimating mesquite biomass were developed by measuring basal diameter, canopy dimensions and height and then destructively harvesting 31 *P. velutina* trees across a size gradient.
- These allometric relationships were then used in conjunction with field surveys and aerial photos to ascertain the extent to which estimates of mesquite biomass might vary with typical sampling approaches.

### OBJECTIVES:

- Estimate aboveground *P. velutina* biomass on sites varying in plant density, canopy cover, size-class distribution and range management histories.

- Compare / contrast estimates derived from three common vegetation sampling methods.

### METHODS:

- Established and georeferenced 24- 30 x 30 m plots.

- Estimated total *P. velutina* aboveground biomass as follows:

- **Plot Census:** Measured canopy diameter of all *P. velutina* patches; CA algorithm (Fig. 1B) applied.

- **Belt Transect:** Measured basal diameter of all *P. velutina* trees rooted within four- 4 x 15 m belt transects; ~25% of plot area subsampled; BD algorithm (Fig. 1A) applied.

- **Aerial Photo:** *P. velutina* cover derived from June 1996 color-infrared digital ortho-photographs and classified with Maximum Likelihood supervised classification algorithm (ERDAS Imagine); CA algorithm (Fig. 1B) applied.

- NOTE: Results from 13 of the 24 sampled plots summarized below

### RESULTS:

- *P. velutina* density ranged from 5 to 143 trees / plot; ~55 to 1580 / ha (Fig. 2A).

- *P. velutina* canopy cover ranged from 6 to 40% (Fig. 2B).

- **Plot Census** estimates of aboveground *P. velutina* biomass density ranged from 0.11 to 0.94 kg / m<sup>2</sup>; or ~ 1100 to 9400 kg / ha (Fig. 2).

- **Aerial photo**-based biomass estimates were consistently lower than **Plot Census** estimates.

- **Belt transect** estimates were highly inconsistent, unrelated to *P. velutina* cover or density, and up to 5x higher than **Plot Census** estimates.

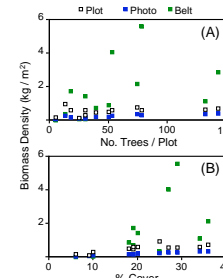


Figure 2. Relationships between estimated *P. velutina* above-ground biomass density (kg / m<sup>2</sup>) and (A) plant density and (B) % canopy cover for whole plot census (Plot), belt transect subsampling (Belt), and aerial photo image classification (Photo).

## LANDSCAPE-SCALE BIOMASS ESTIMATES, cont'd

- The three methods generated similar estimates only on sites with low *P. velutina* plant density and cover (Fig. 3).

- Reliability of **Aerial Photo and Belt Transect** relative to **Plot Census** estimates was confounded by interactions between tree density, relative size, and total cover.

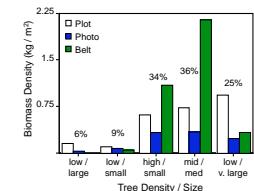


Figure 3. Effect of the interaction of *P. velutina* density, relative size, and cover on estimates of aboveground biomass density (kg / m<sup>2</sup>).

## CONCLUSIONS

- Aboveground biomass of individual *P. velutina* plants can be reliably / accurately predicted from diverse and easily measured, non-destructive metrics.
- However, scaling these to the stand-level using standard vegetation sampling protocols was problematic.
- The GIS / aerial photo method consistently underestimated biomass relative to census values. This may be due to:
  - shrub canopies below detection limits on aerial photos may contribute significantly to total biomass
  - photo classification algorithms may have attributed some shrub cover to shadowing; in our opinion, the most likely explanation.
  - applying CA algorithms developed on individual *P. velutina* plants to multi-plant patches caused an overestimation of shrub biomass in the plot census.
- Application of predictive algorithms for landscape-scale biomass prediction is complicated by the mosaic structure of Arizona rangelands.
- multiple sampling methods are applicable on sites with low densities of smaller plants.
- it may be necessary to increase sampling area and effort to accurately predict *P. velutina* biomass using field sampling on sites with higher plant size and / or density.

## ACKNOWLEDGEMENTS

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