Minimally Invasive Monitoring of Grassland Carbon Inputs in a Long Term Nitrogen Addition Experiment

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Background

- Nitrogen addition usually increases plant production in terrestrial grasslands by 50% (LeBauer and Treseder, 2008)
- Past experiments on the affect of N on plant growth focus on short-term addition of N at high deposition rates
- Harvest-based plant biomass measurements are destructive and not suitable for long term studies

Objectives

(1) Measure aboveground plant biomass
(2)Compare observed biomass (greenness/weight) with minimally invasive proxies of plant growth

Experimental Design

- University of California Sedgwick Natural Reserve
- 50 km NNW of Santa Barbara, CA
- N addition at 0, 1, 4, or 10 g N / m^2 y began in September 1999
- Six 2m x 4m plots at each N level at each site

Two Sites:

Method 1: Harvest

-Aboveground plant material was harvested from each plot on June 8th, 2008.
-Live and dead aboveground biomass sorted
- Samples dried at 60° C for 48 hours.
- Mass measured of live and dead plant material.

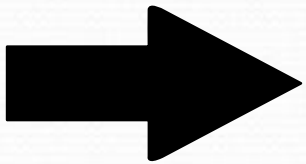
Methods 2a & b:

Noninvasive Methods of Estimating Biomass

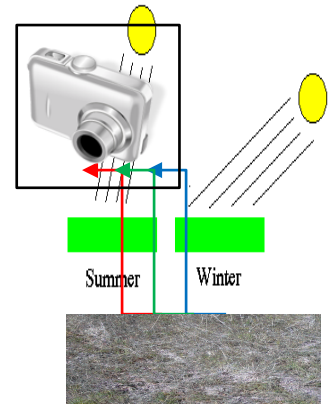
2a: Visual estimation
- Estimated percent of plot covered by green

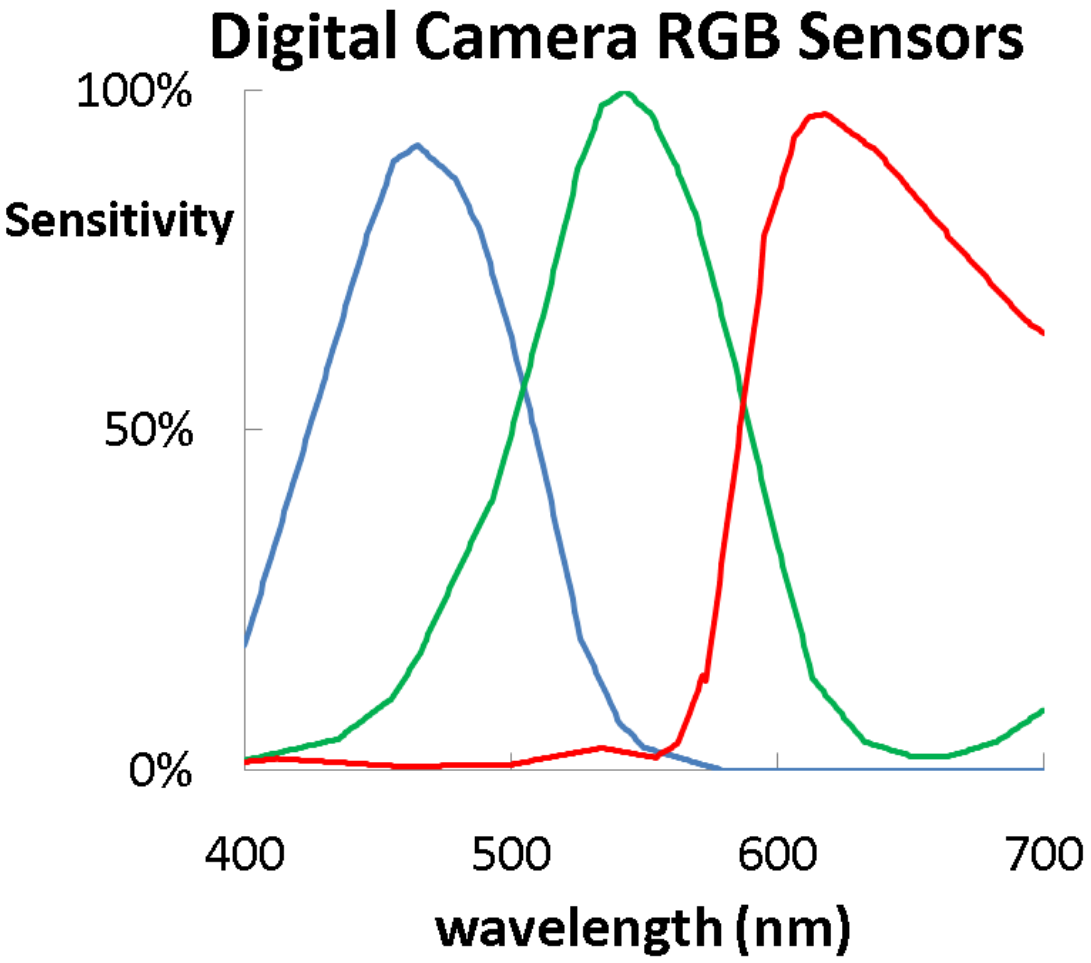
2b: Camera estimation
- Took images of plots with an Olympus S4 digital camera
- cropped images to 0.5m by 1m
- Used Image J RGB split tool to determine reflectance detected by each of the three sensors on the camera
- Calculated the relative intensity of green:
- % green = avg green / (avg. red + avg. blue + avg green)

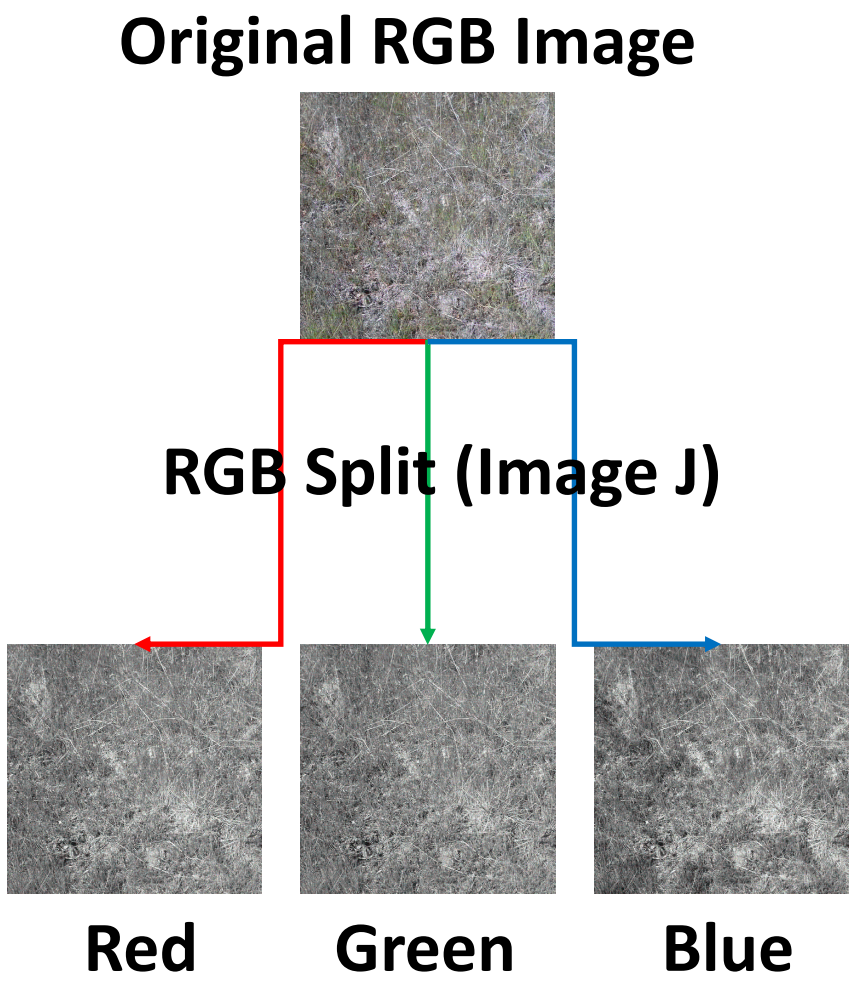
Cropped images to 0.5 m x 1 m



Biomass estimation with a digital camera







RGB Split tool in Image J

BLUE

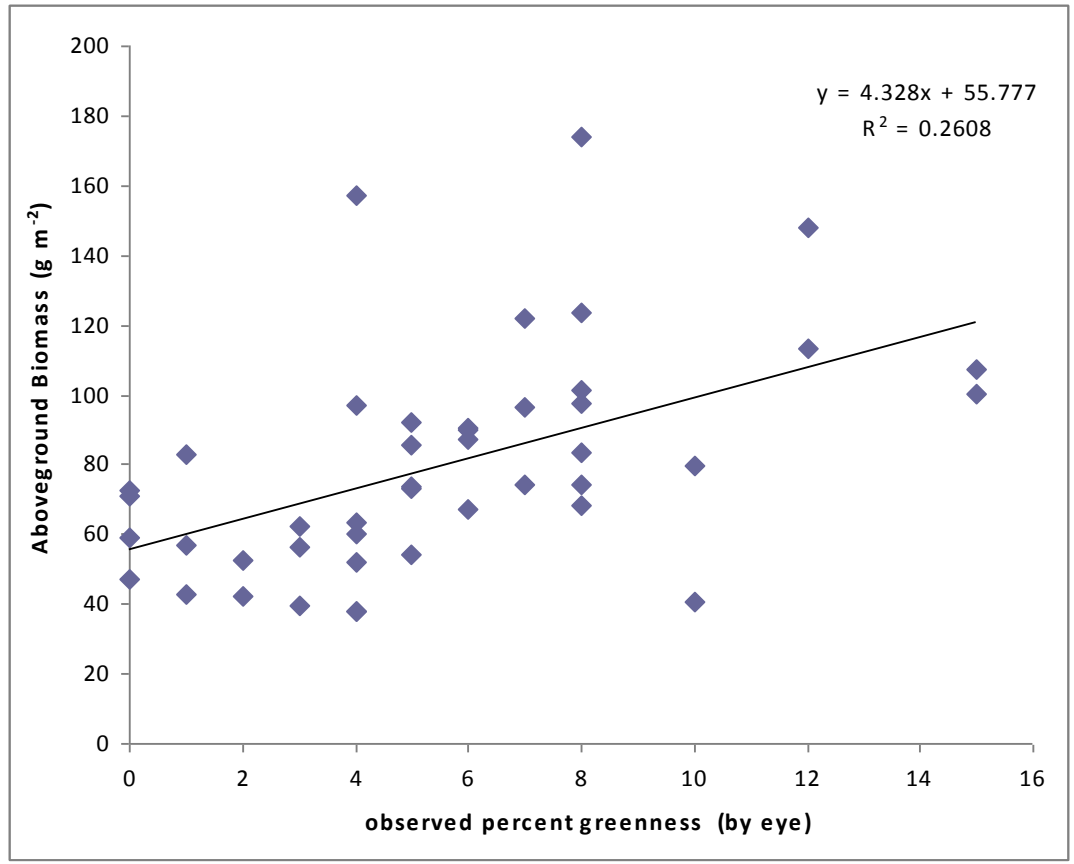
Red

Green

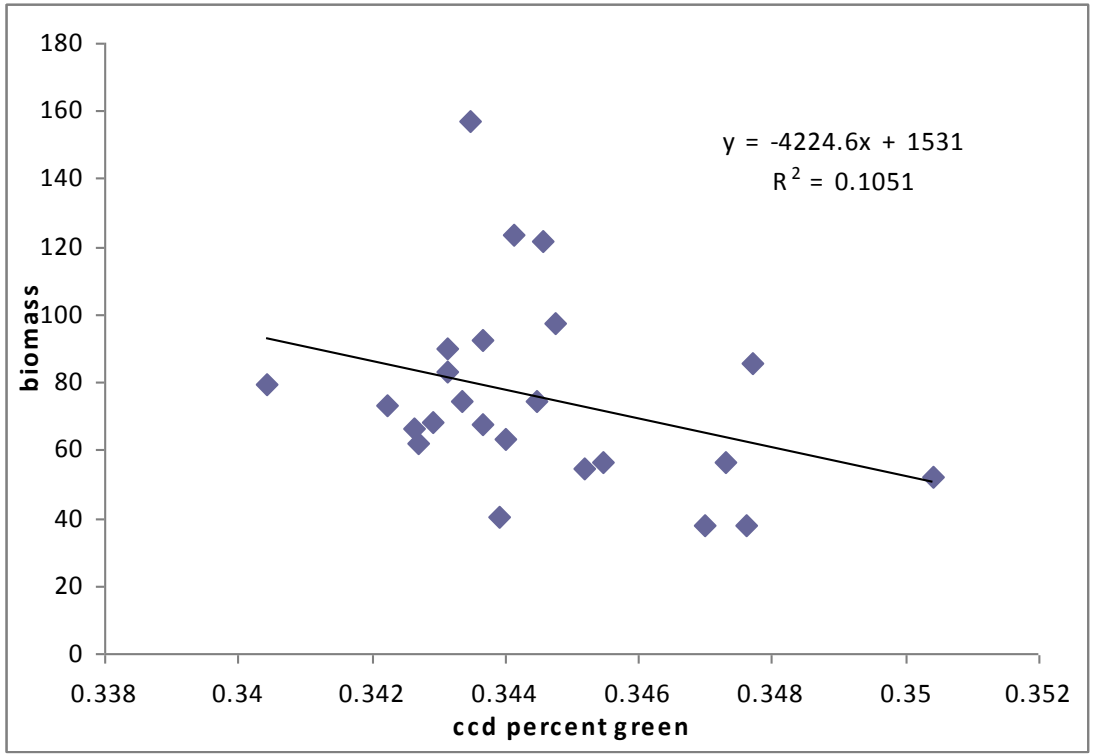
Results

1. Correlation between observed greenness and aboveground biomass was strong
2. The correlation between the CCD greenness and biomass was significant, but negative
3. The correlation between observed greenness (eye) and CCD greenness was negative
4. N had an effect on total biomass
5. N had an effect on observed greenness
6. Effect of N on the CCD measurement of greenness did not follow these patterns

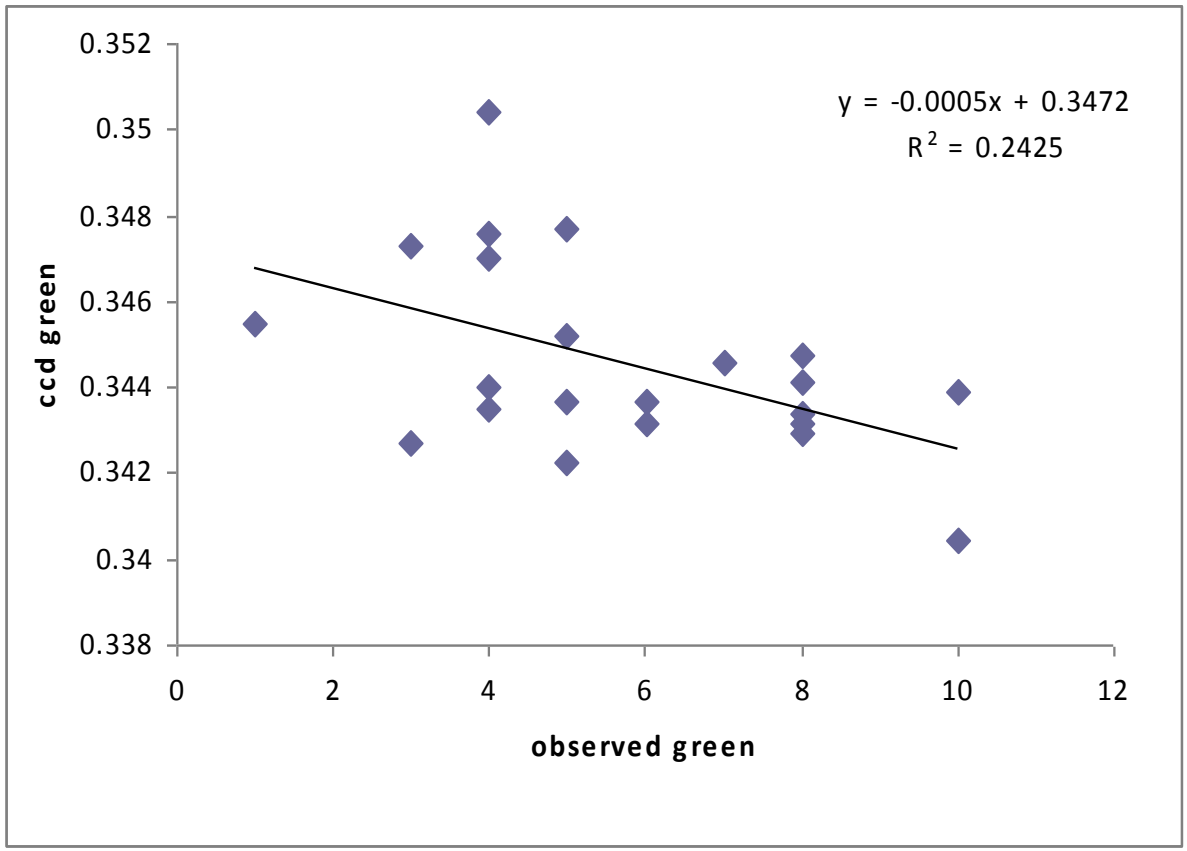
Observed Greenness vs. Aboveground Biomass



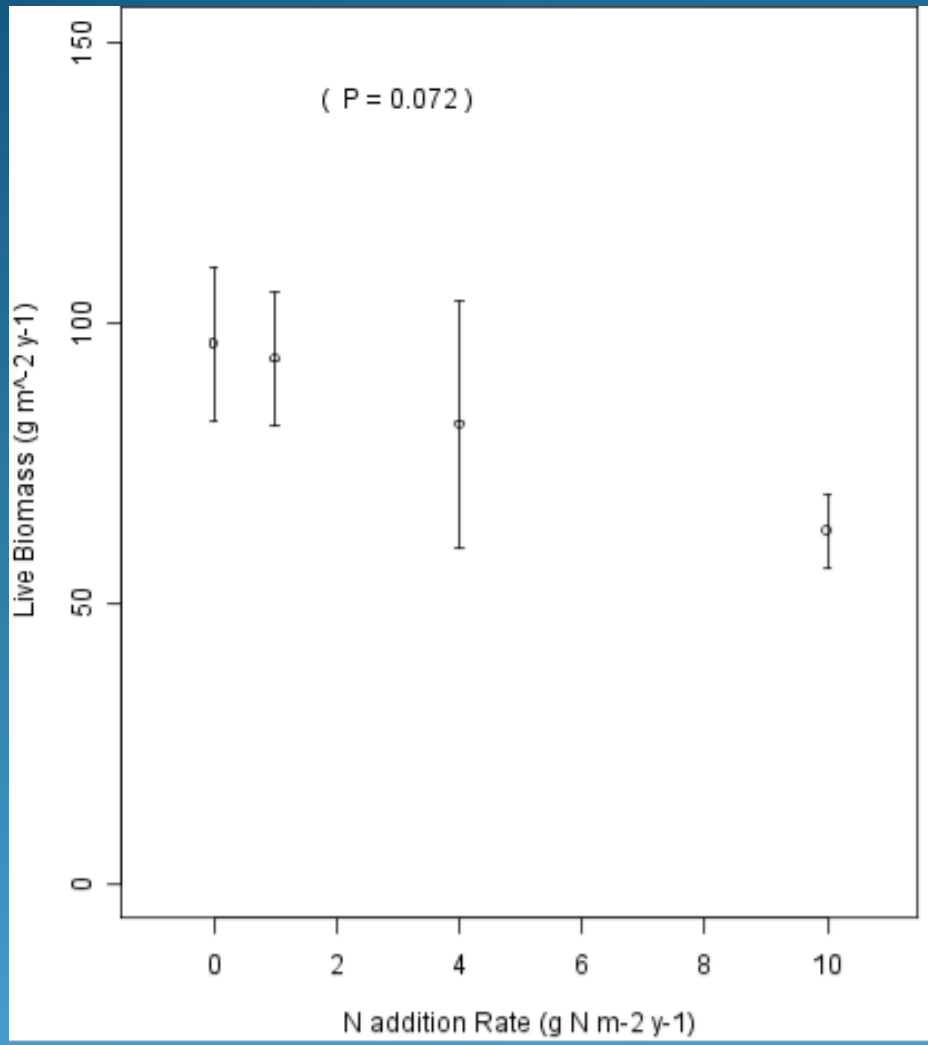
CCD Percent Greenness verses Aboveground Biomass



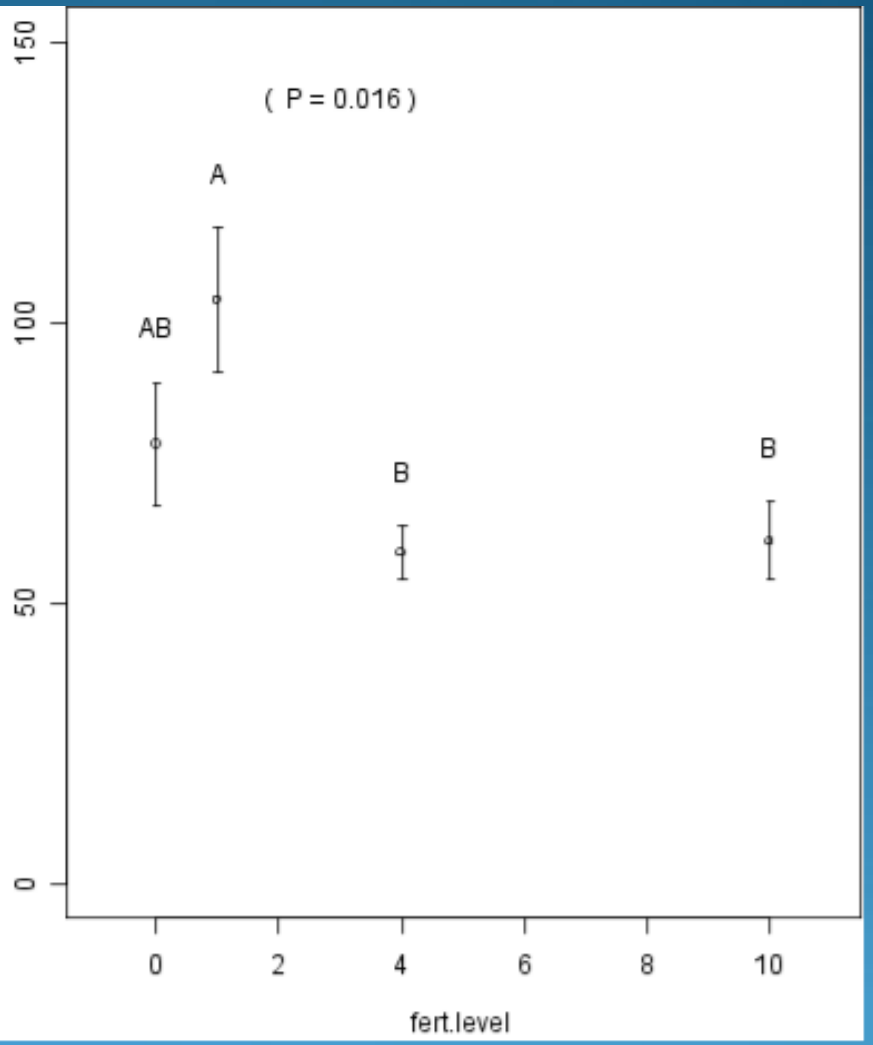
Observed Greenness vs. CCD Measured Green



Live Biomass vs. N Addition Rates

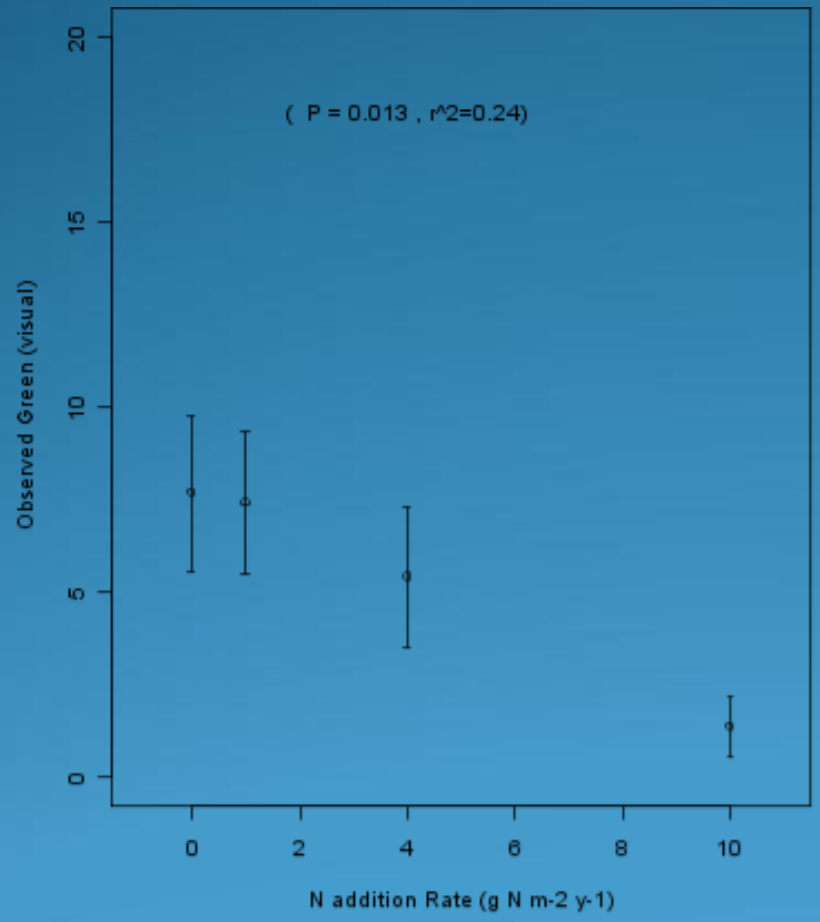


Hill

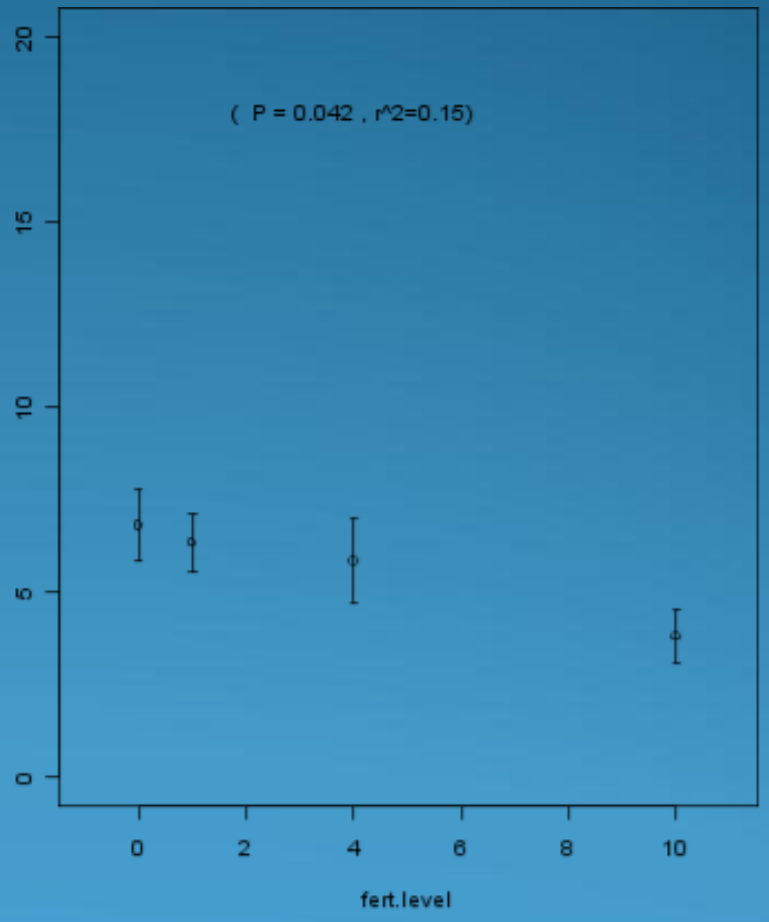


Valley

Observed Greenness vs. N Addition Rates

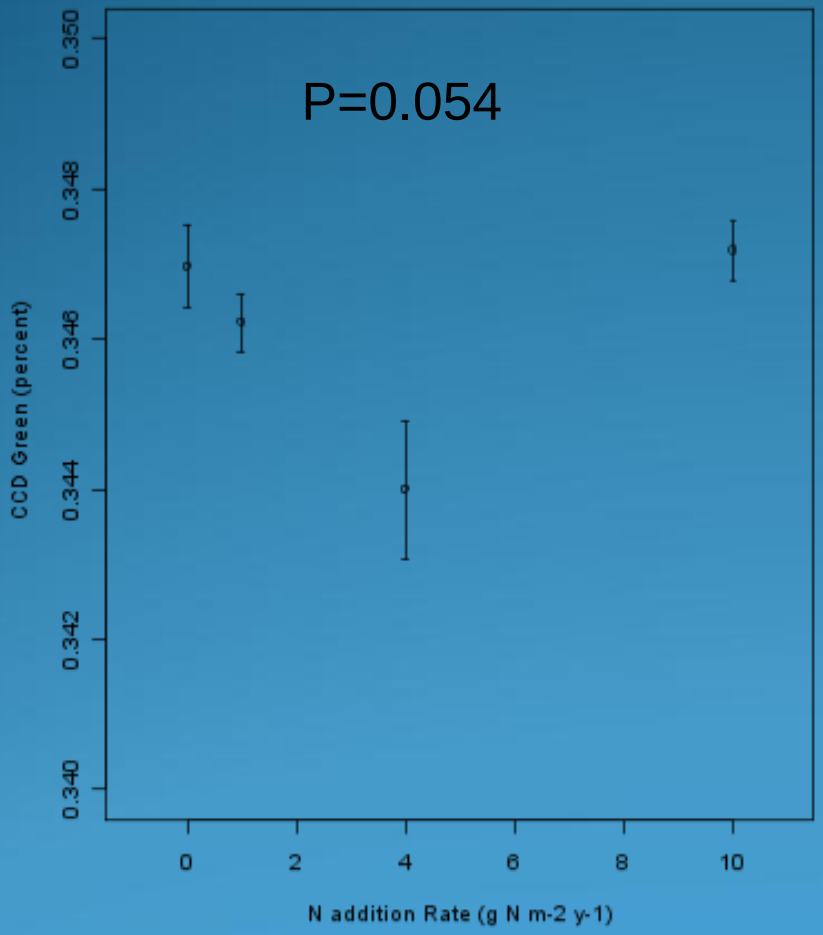


Hill

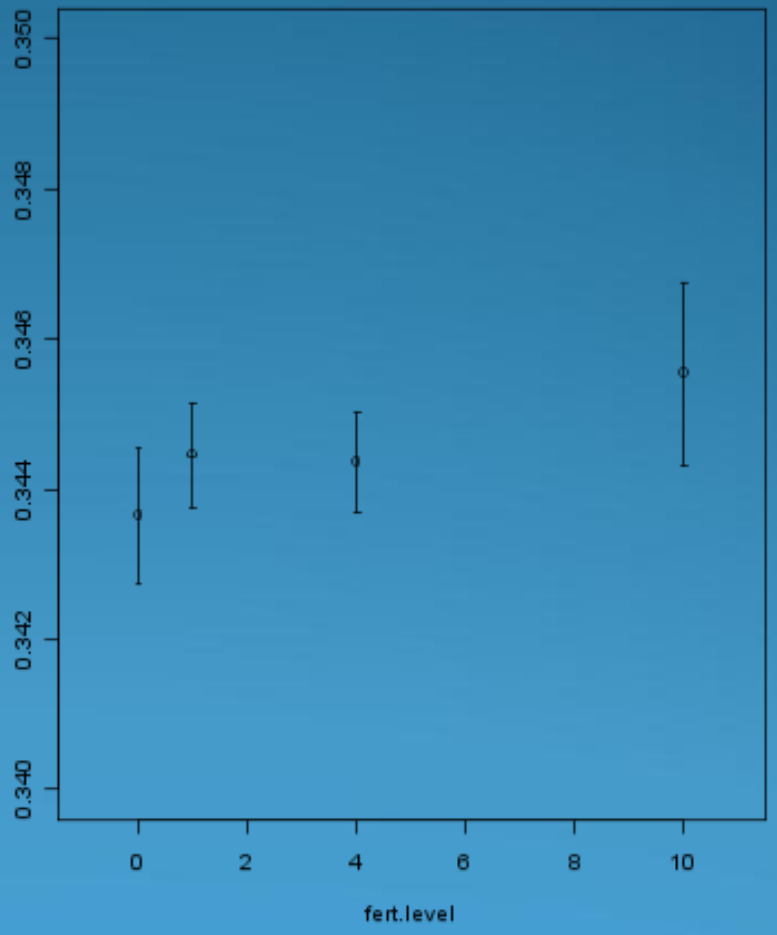


Valley

Percent CCD Greenness vs. N Addition Rates

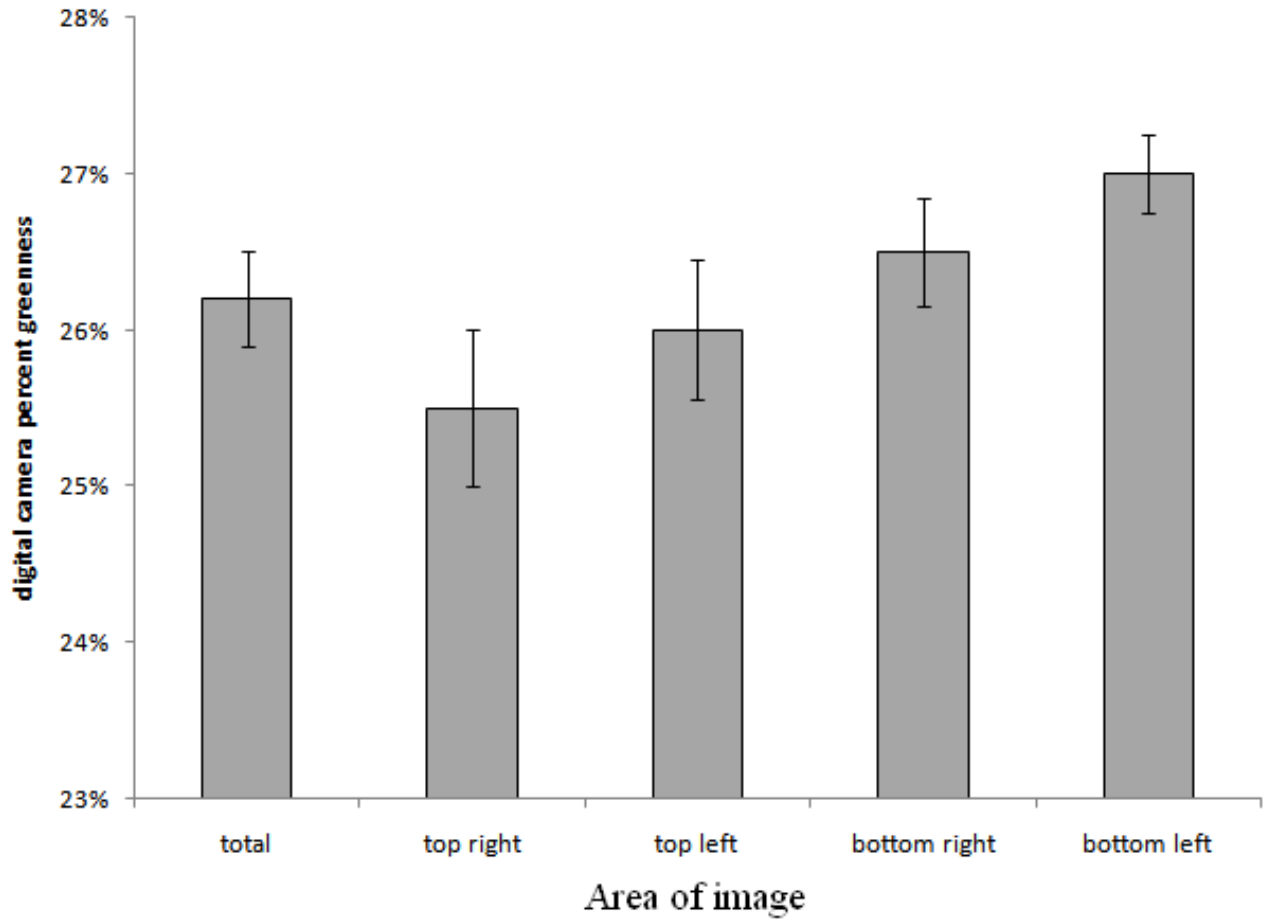


Hill



Valley

CCD Greenness depends on area of image analyzed (P=0.002)



Discussion

- N had an effect on live biomass:
- N had an effect on Observed Greenness
- Observed greenness has a strong correlation with biomass, but not strong enough to replace measurements.
- CCD greenness did not correlate positively with biomass.
- Including percent cover by each species in multiple regression would likely improve non-destructive biomass estimates based on visually estimated greenness

Conclusions

• As N addition rates increase from zero to ten gNm-2/y over 2008 the live biomass decreases on the hill and the valley .

•As N addition rates increase from zero to ten gNM-2/y the observed greenness decreases.

•Percent CCD greenness vs. N addition rates didn't have the same relationship as observed greenness and live biomass (they increased).

Conclusions

- Using different parts of the images when cropping them in gimp to calculate greenness significantly changed the channel percent
- Therefore it is important to keep the area cropped consistent between images

- Additionally, I looked at root intersections and converted scanned images of roots into image binaries in gimp (black and white). The next step would be to discern root length and compare this with the above ground biomass

Experimental Error

- Cropping the images to conduct RBG could have affected the analysis results because at different sections in the images there were varying amounts of light and RBG colors.

Acknowledgments

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