Managed sheep grazing can improve soil quality and carbon sequestration at solar photovoltaic sites

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Abstract

Solar energy development is land intensive and recent studies have demonstrated the negative impacts of large-scale solar deployment on vegetation and soil. Co-locating vegetation with managed grazing on utility scale solar PV sites could provide a sustainable solution to meeting the growing food and energy demands, along with providing several co-benefits. However, the impacts of introducing grazing on soil properties at vegetated solar PV sites are not well understood. To address this knowledge gap, we investigated the impacts of episodic sheep grazing on soil properties (micro and macro nutrients, carbon storage, soil grain size distribution) at six commercial solar PV sites (MN, USA) and compared that to undisturbed control sites. Results indicate that implementing managed sheep grazing significantly increased total carbon storage (10-80%) and available nutrients, and the magnitude of change correlated with the grazing frequency (1-5 years) at the study sites. Furthermore, it was found that sites that experienced consecutive annual grazing treatments benefitted more than intermittently grazed sites. The findings will help in designing resource conserving integrated solar energy and food/fodder systems, along with increasing soil quality and carbon sequestration.

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BENEFITS OF MANAGED SHEEP GRAZING ON SOLAR PHOTOVOLTAIC SITES

Elizabeth Towner

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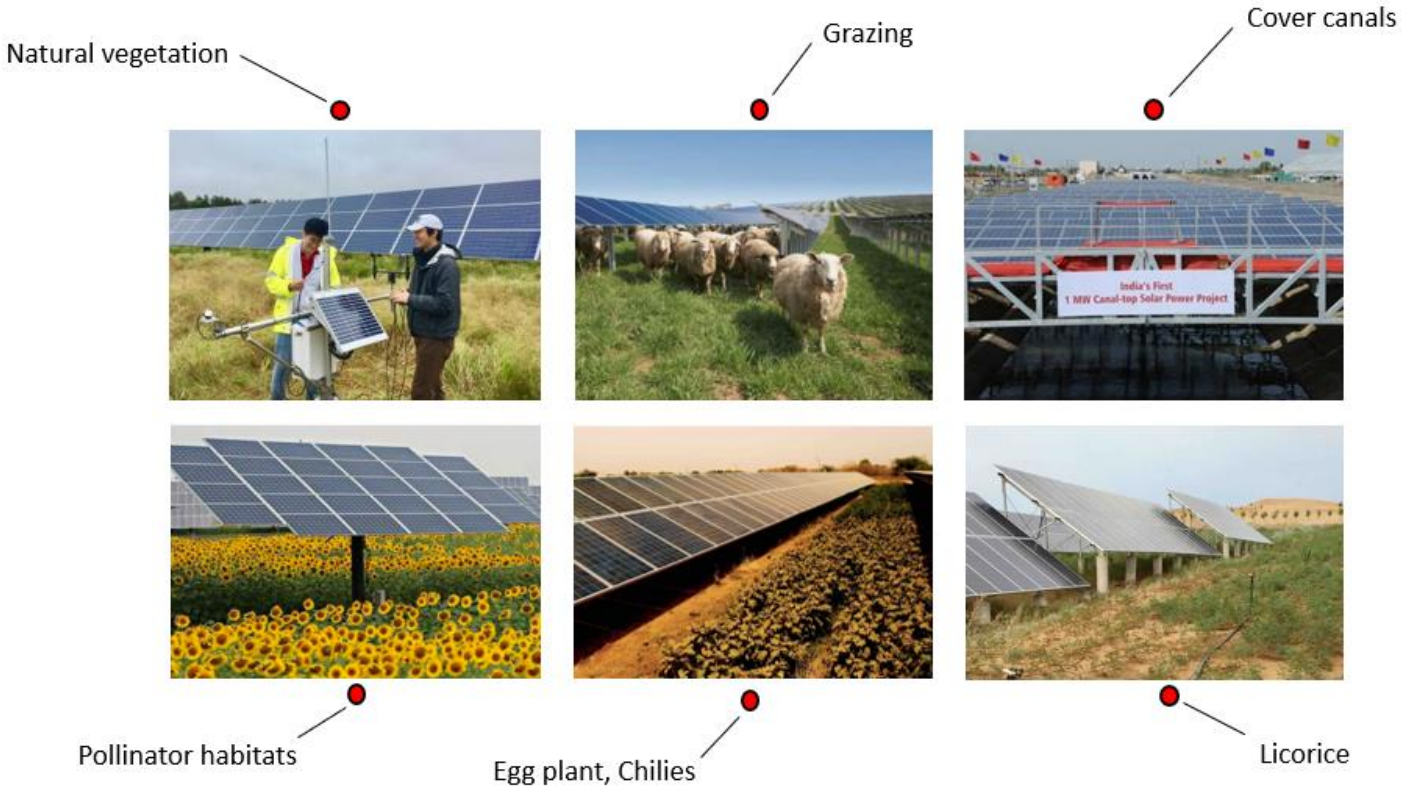
SOLAR ENERGY

- Solar energy is the fastest growing renewable.
- Predicted to fulfill 20-29% of global power by 2100.
- Solar energy requires a larger land footprint and long-term commitments for land use.
- Removal of vegetation leads to degradation of soil.

POSSIBLE SOLUTIONS



Source: ***Dupraz et al., 2011; Ravi et al; 2014; 2015, 2016***

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SOLAR GRAZING

- Potential Benefits:
  - Dual income for farmers
  - Vegetation management

- Questions:
  - Impact of solar grazing on carbon sequestration?
  - Impact nutrient status and soil properties?

STUDY SITE

Site	2017	2018	2019	2020
Albany	x	x	x	x
Lawrence Creek	x		x	x
Lake Pulaski	x		x	
Chisago			x	x
Montrose			x	x
Annandale				x

- 6 commercial solar PV sites in Minnesota (ENEL Green Power)
- Native pollinator friendly vegetation under panels
- 500-700 sheep grazing treatment for 2-3 weeks per year.

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SOIL SAMPLING

- Soil sampling once a year (15 soil cores each from top 5 cm from grazed and ungrazed sites)
- 0-30 cm deep samples
- Bulk density
- Soil compaction using soil penetrometer

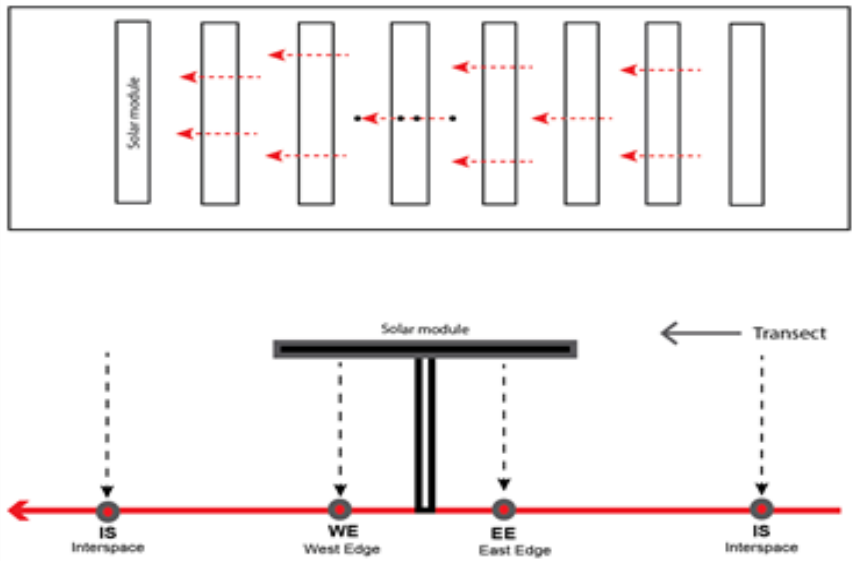


Figure 1. Soil sampling locations.

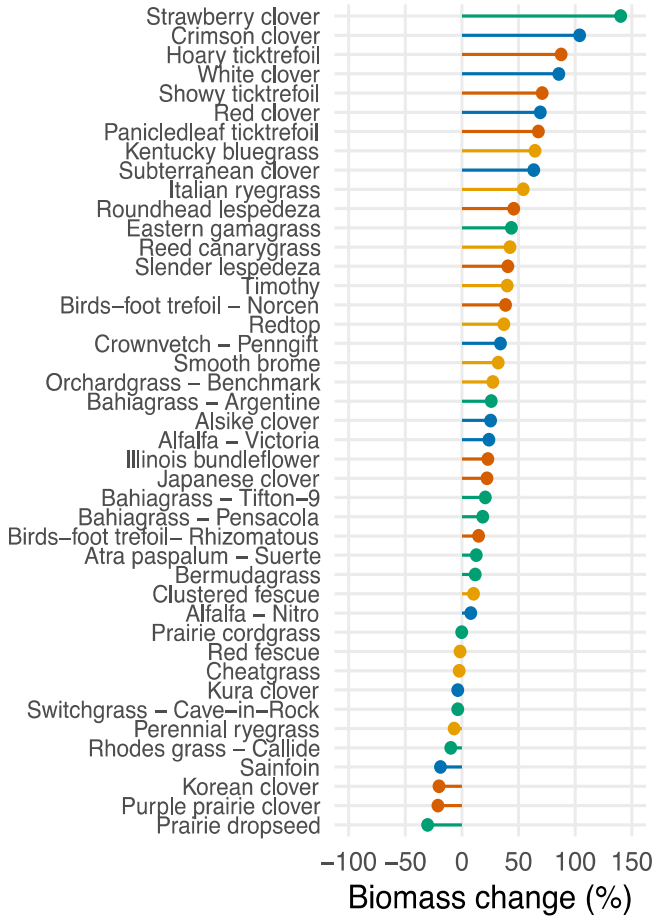
METHODS

- Soil analysis:
  - Total Organic Carbon
  - Total Carbon, Total Nitrogen
  - pH, Organic Matter, Est. N. release, Bray I Phosphorus, Exchange Capacity, % base saturation of Cation, Available Nitrogen (NO_3-N + NH_4-N), and Mehlich III Extractable P, Mn, Zn, B, Cu, Fe, Al, S, Ca Mg, K, Na
- Particle size analysis

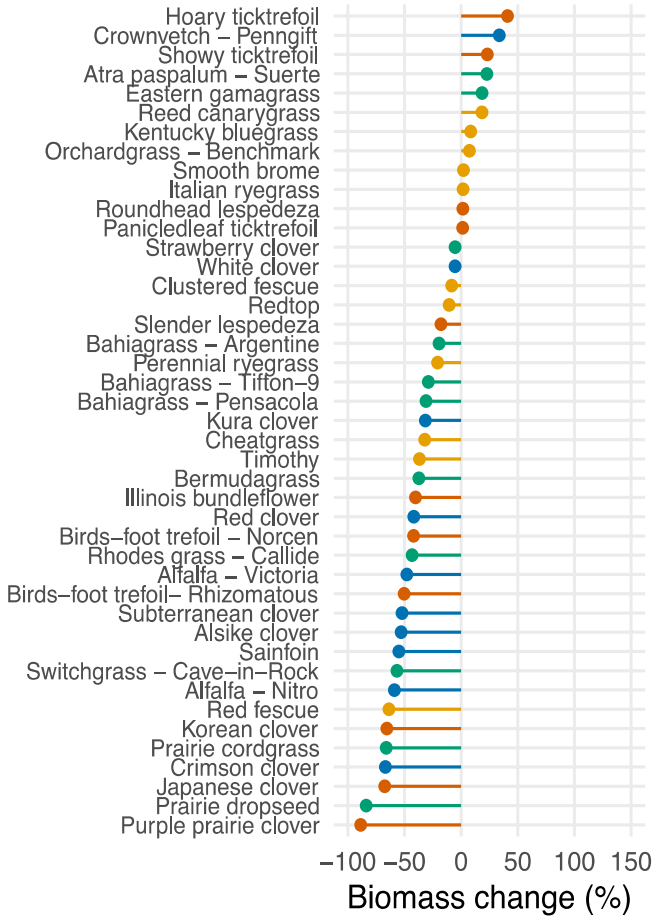
RESULTS

MEANINGFUL FORAGE PRODUCTIVITY CAN BE ATTAINED UNDER SHADE (OR PANELS)

45% Shade



80% Shade



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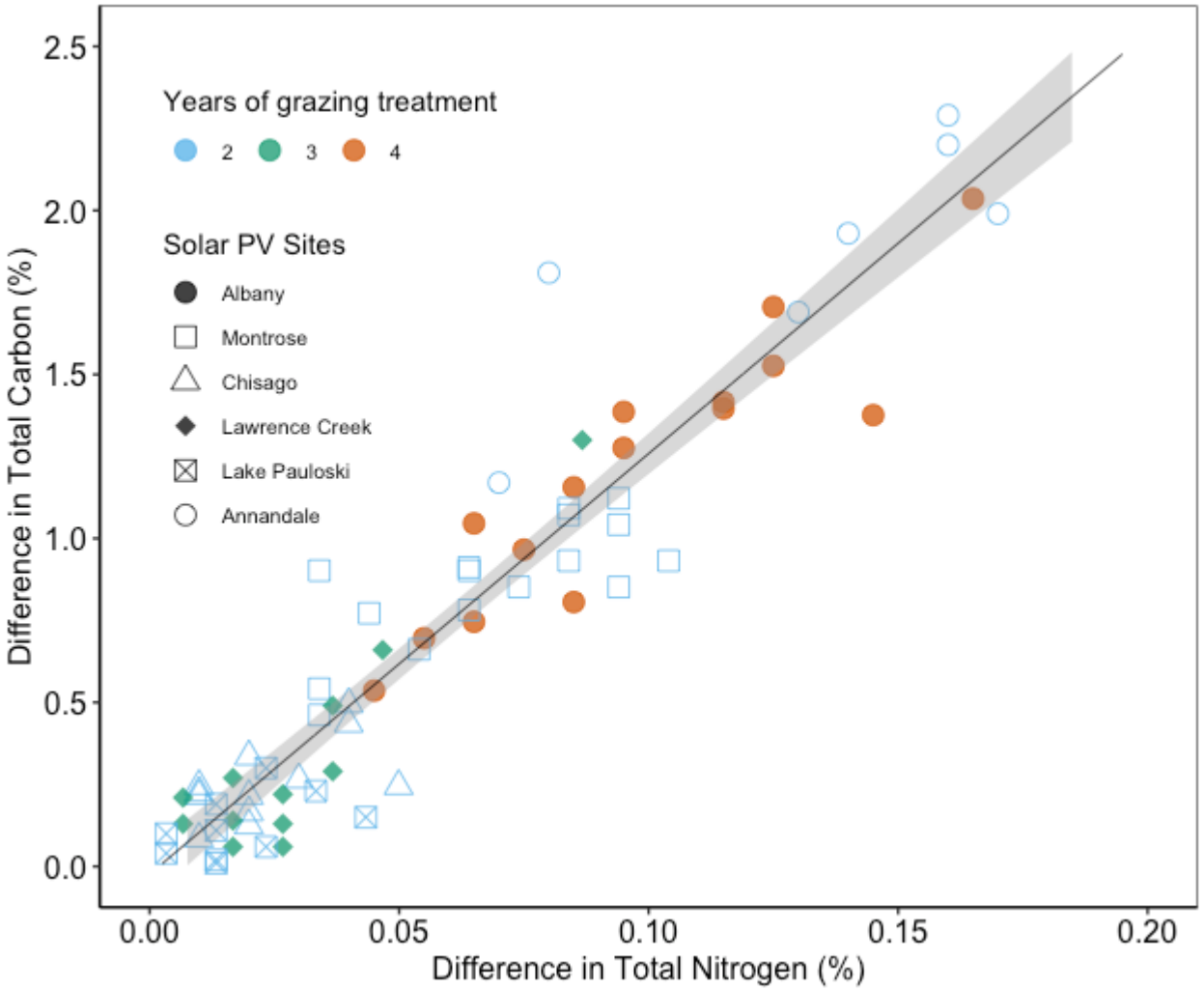

RESULTS

- Higher content of both carbon and nitrogen in grazed sites compared to control sites
- No correlation with grazing frequency

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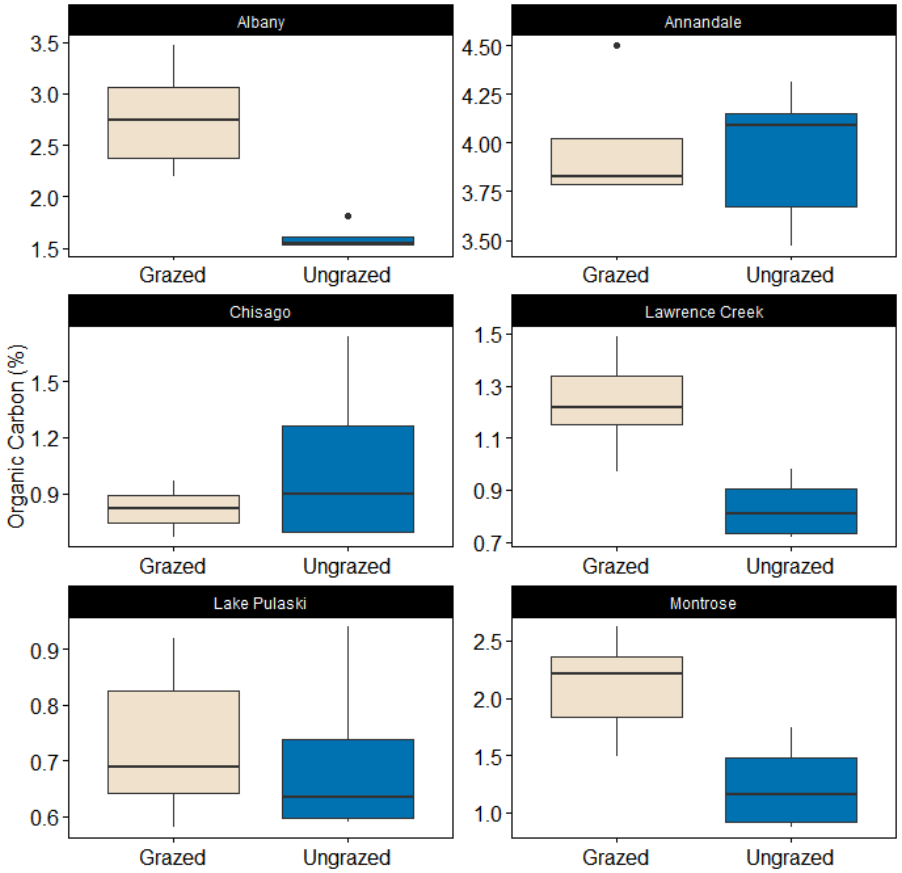
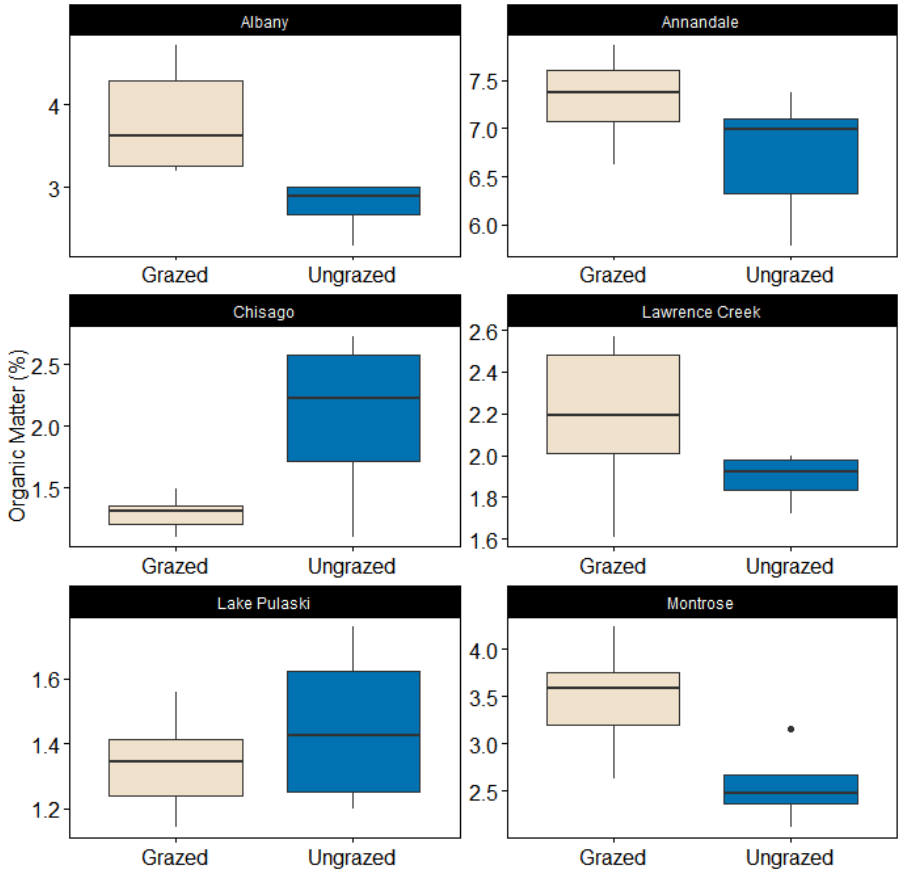
Organic Carbon (%)



Organic Matter (%)



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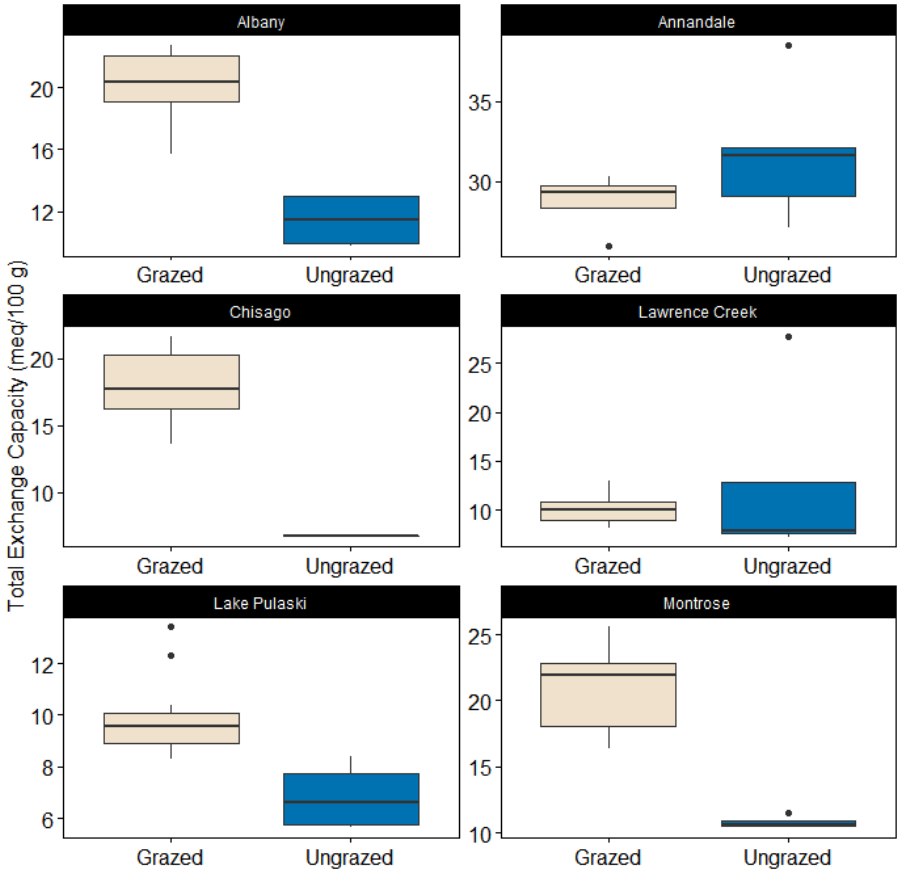
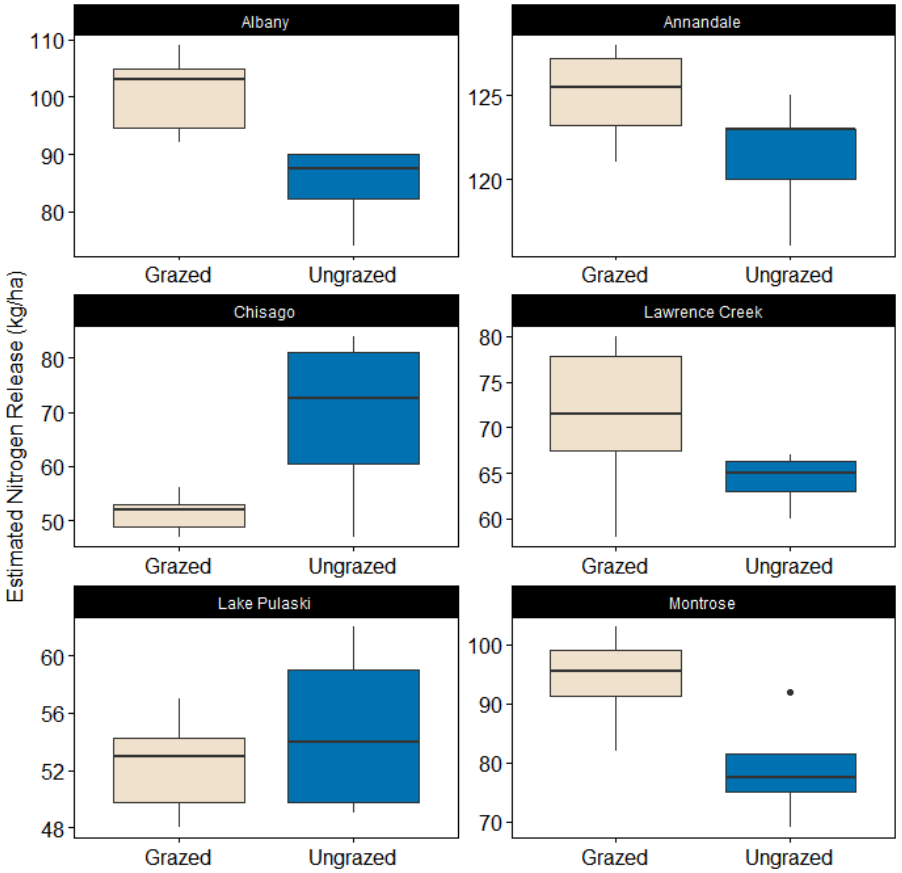
Total Exchange Capacity (meq/100g)



Estimated Nitrogen Release (kg/ha)



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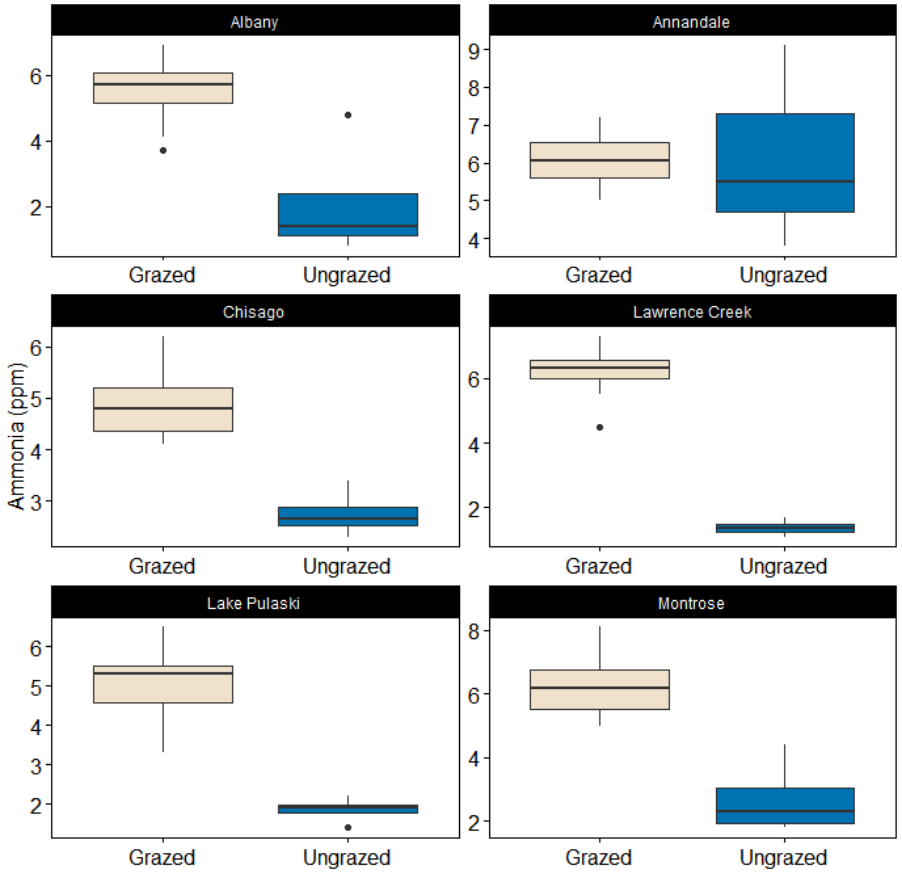
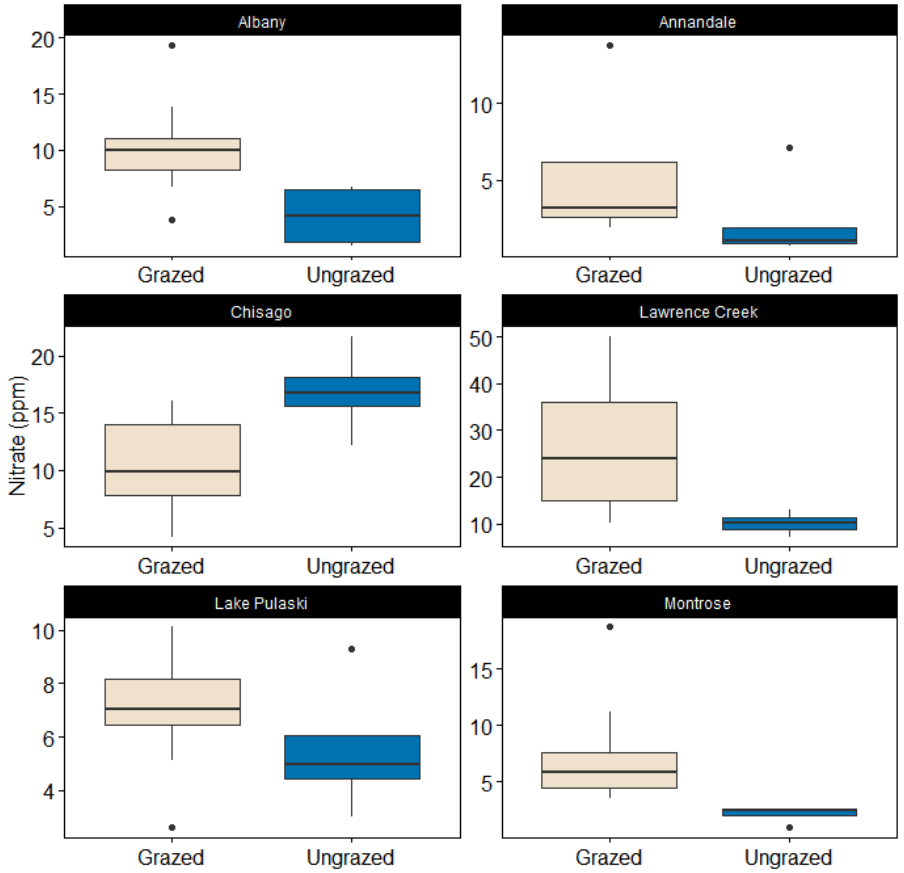
Ammonia (ppm)



Nitrate (ppm)



Similar increase was seen in other nutrients at grazed sites, including Mg, Na, K, P, Ca, S

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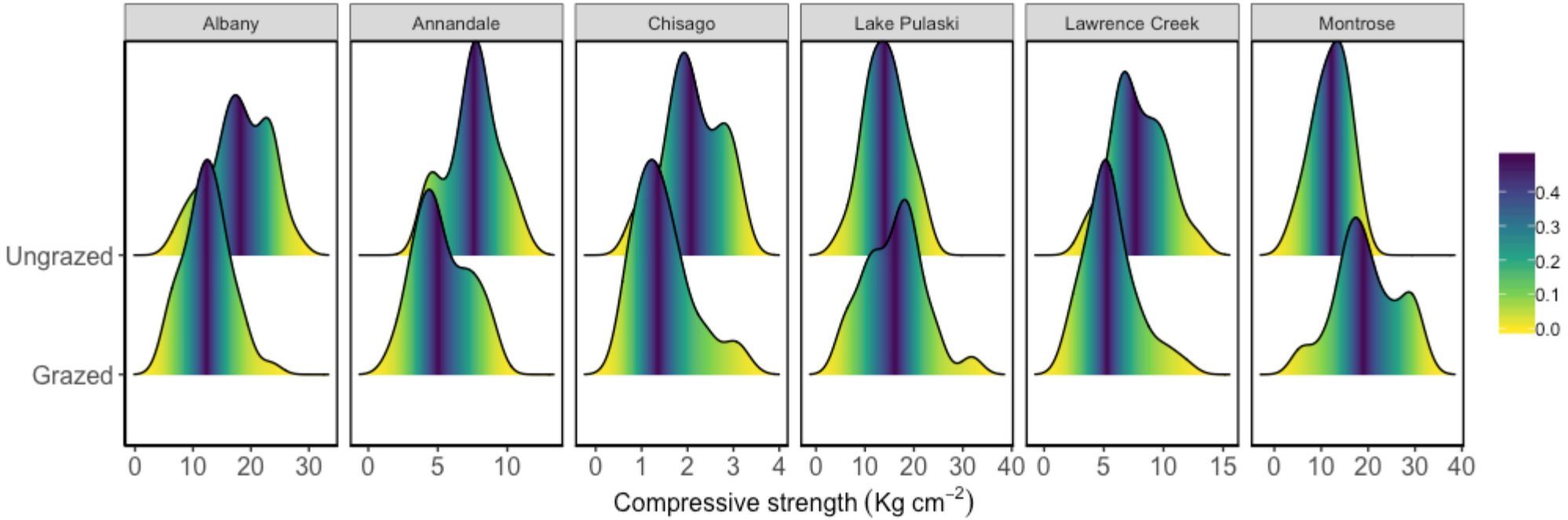
COMPRESSIVE STRENGTH

- Grazing has no significant impact on sandy or loamy soils based on our short time period
- Compaction in soil increases over time, especially in clay soils



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CONCLUSION

- Managed episodic grazing can be used as a strategy for carbon sequestration and vegetation management
- Soil properties show an overall improvement and benefits depend on soil properties
- Future work: long term measurements on soil carbon and hydrological properties

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THANK YOU

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