

BENEFITS OF MANAGED SHEEP GRAZING ON SOLAR PHOTOVOLTAIC SITES

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MEETING

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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

Natural vegetation



Grazing



Cover canals



Pollinator habitats



Egg plant, Chilies



Licorice





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.



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

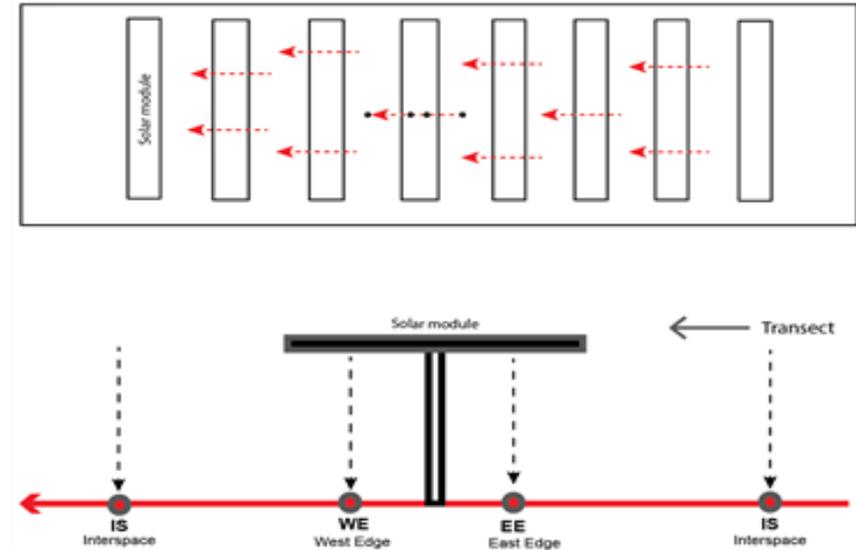


Figure 1. Soil sampling locations.



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 ($\text{NO}_3\text{-N} + \text{NH}_4\text{-N}$), and Mehlich III Extractable P, Mn, Zn, B, Cu, Fe, Al, S, Ca Mg, K, Na
- Particle size analysis

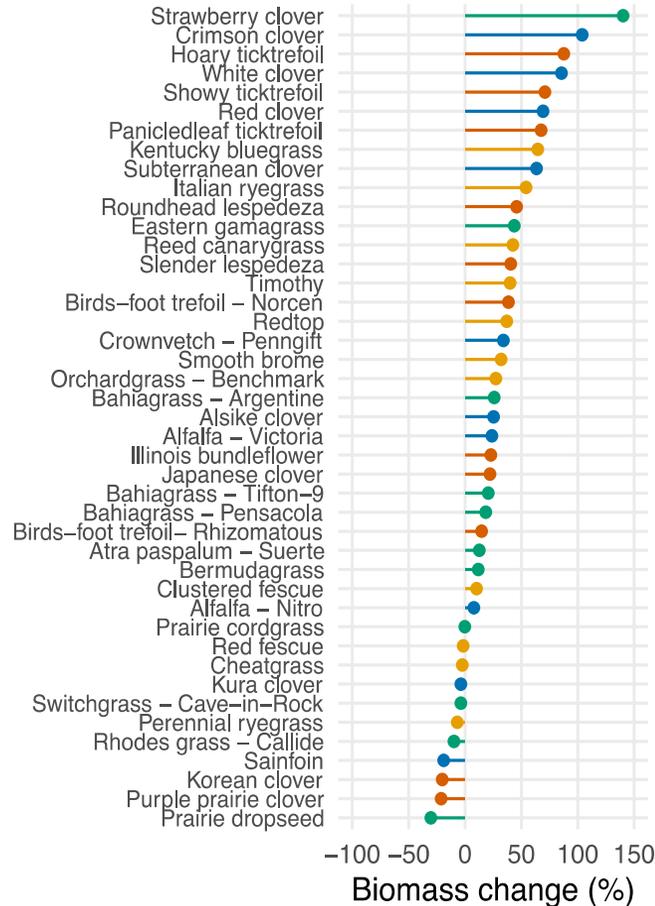




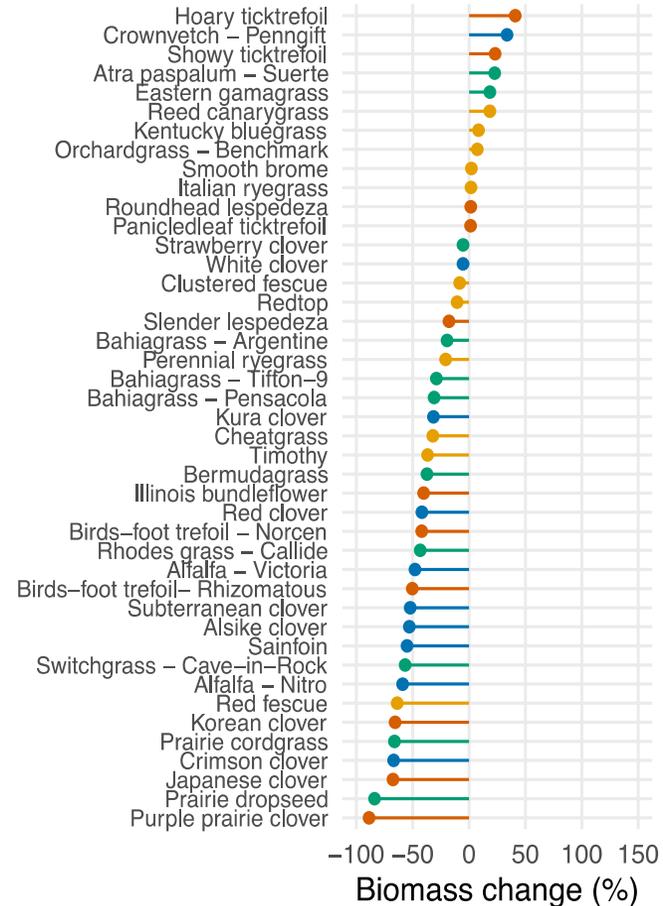
RESULTS

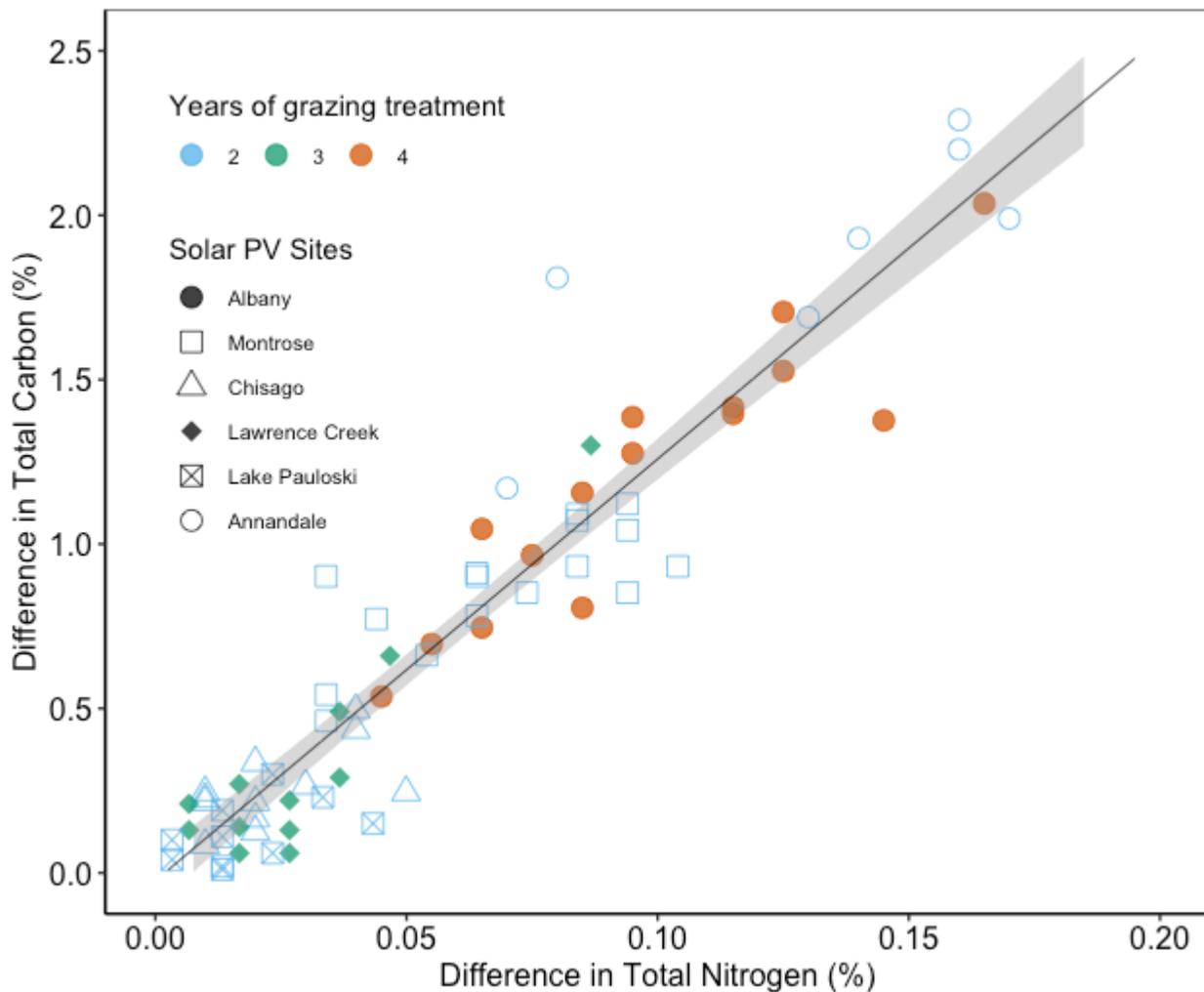
MEANINGFUL FORAGE PRODUCTIVITY CAN BE ATTAINED UNDER SHADE (OR PANELS)

45% Shade



80% Shade



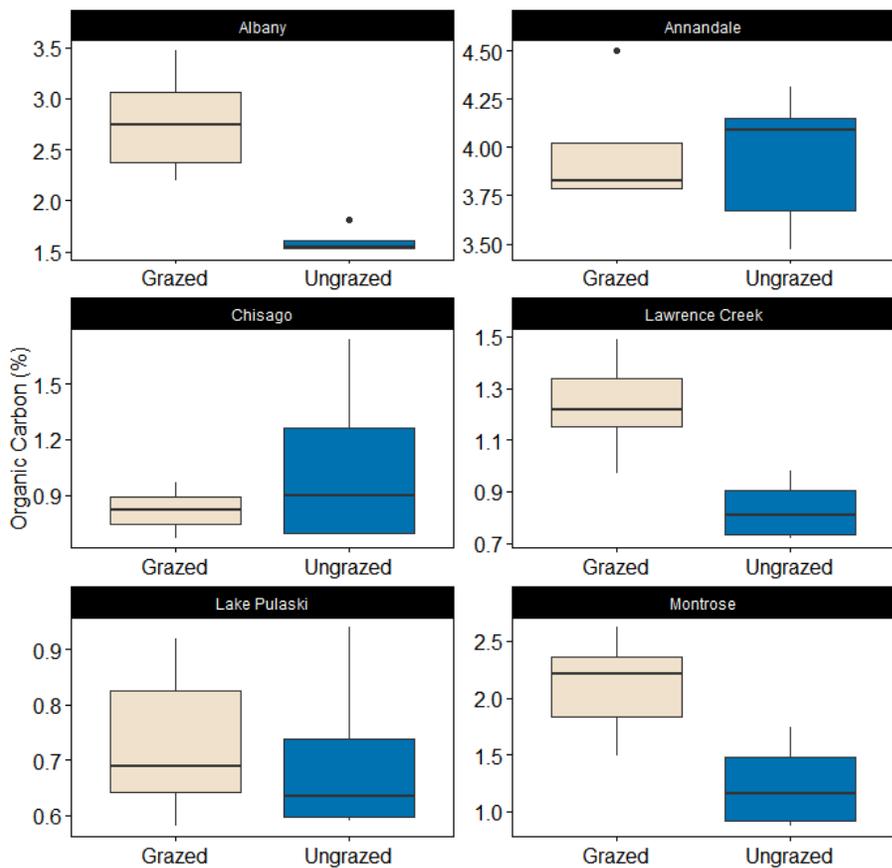


RESULTS

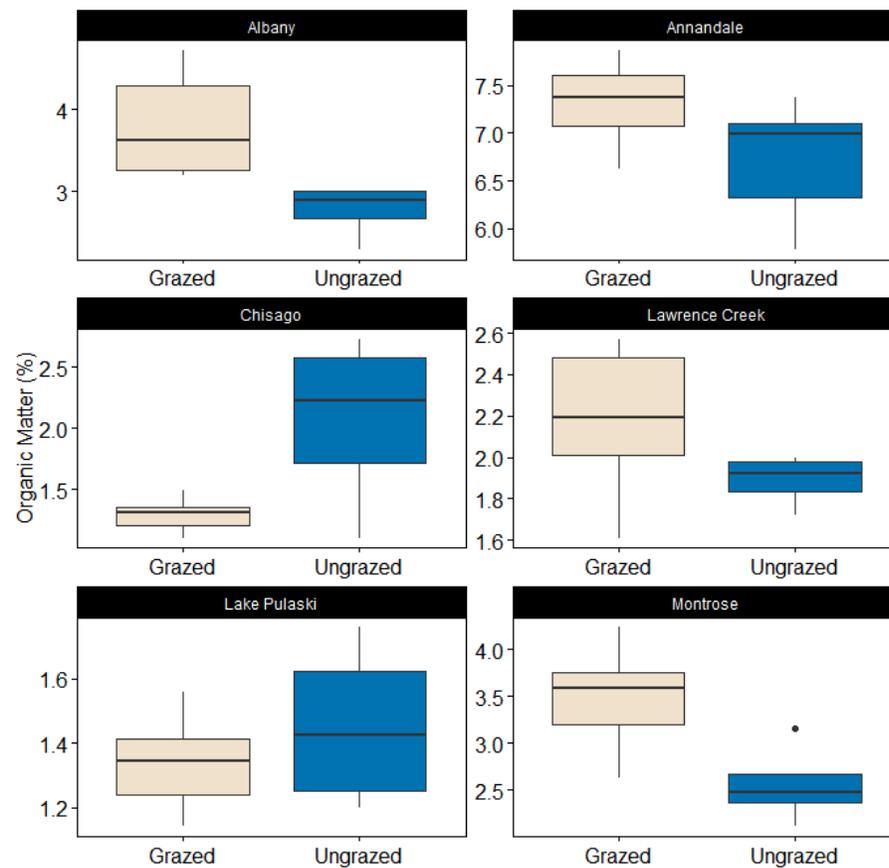
- Higher content of both carbon and nitrogen in grazed sites compared to control sites
- No correlation with grazing frequency



Organic Carbon (%)



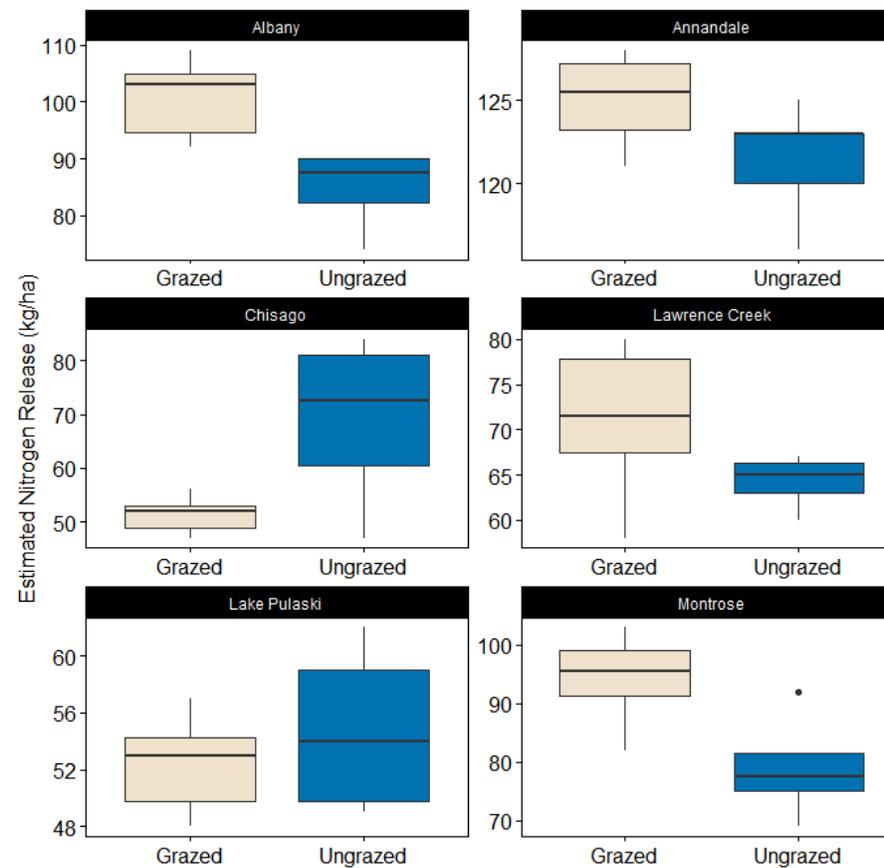
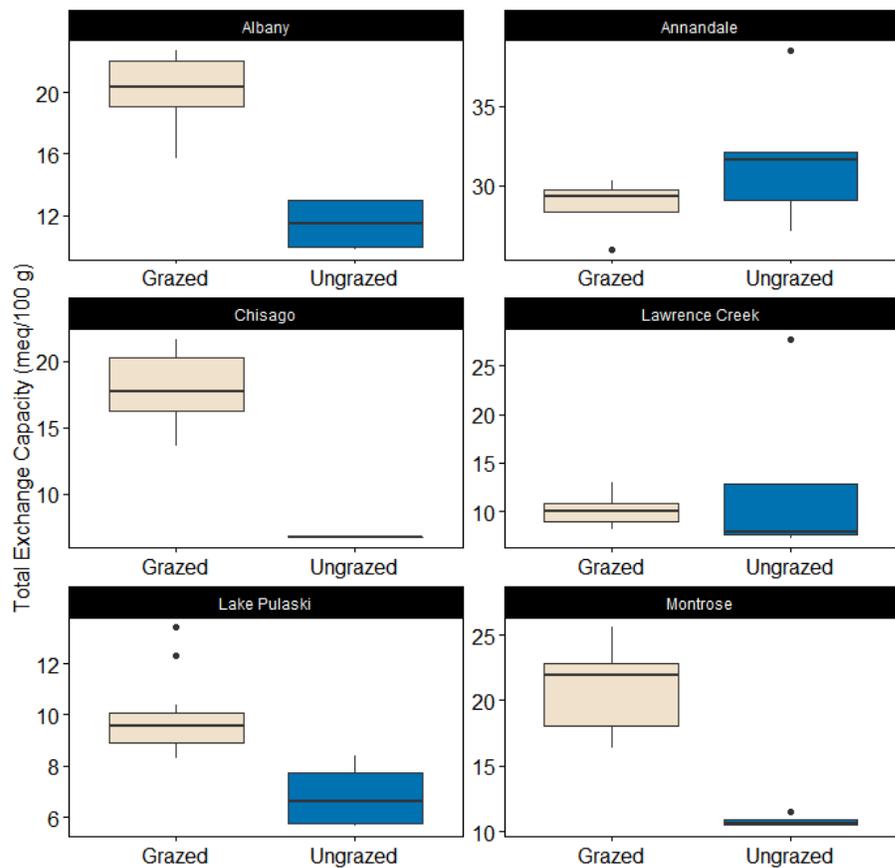
Organic Matter (%)





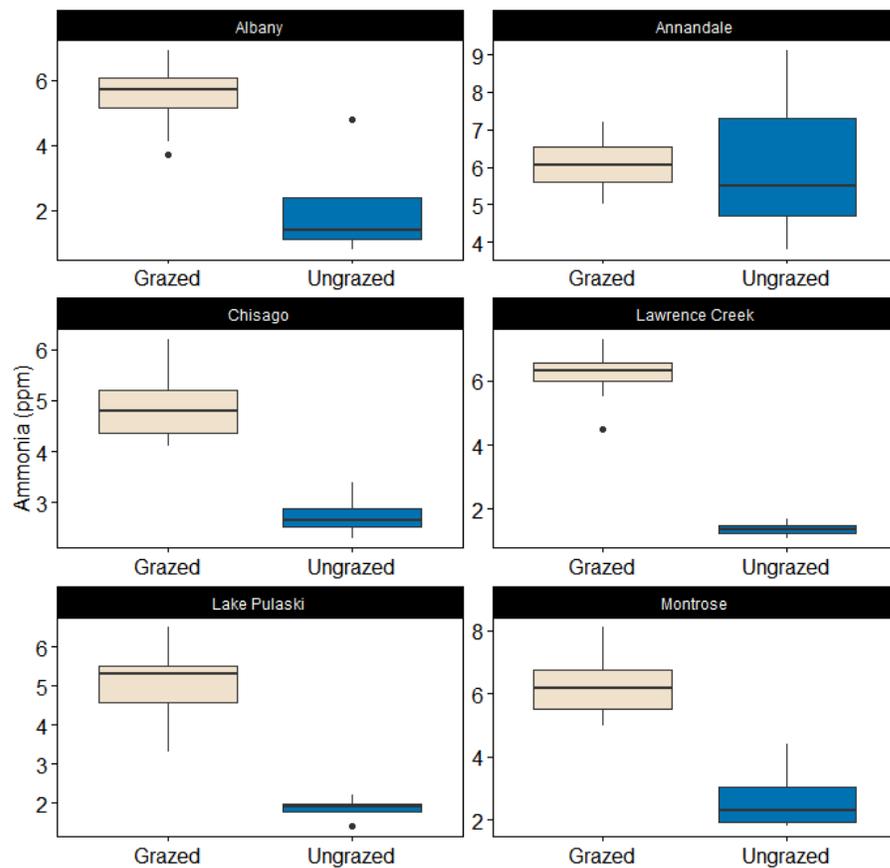
Total Exchange Capacity (meq/100g)

Estimated Nitrogen Release (kg/ha)

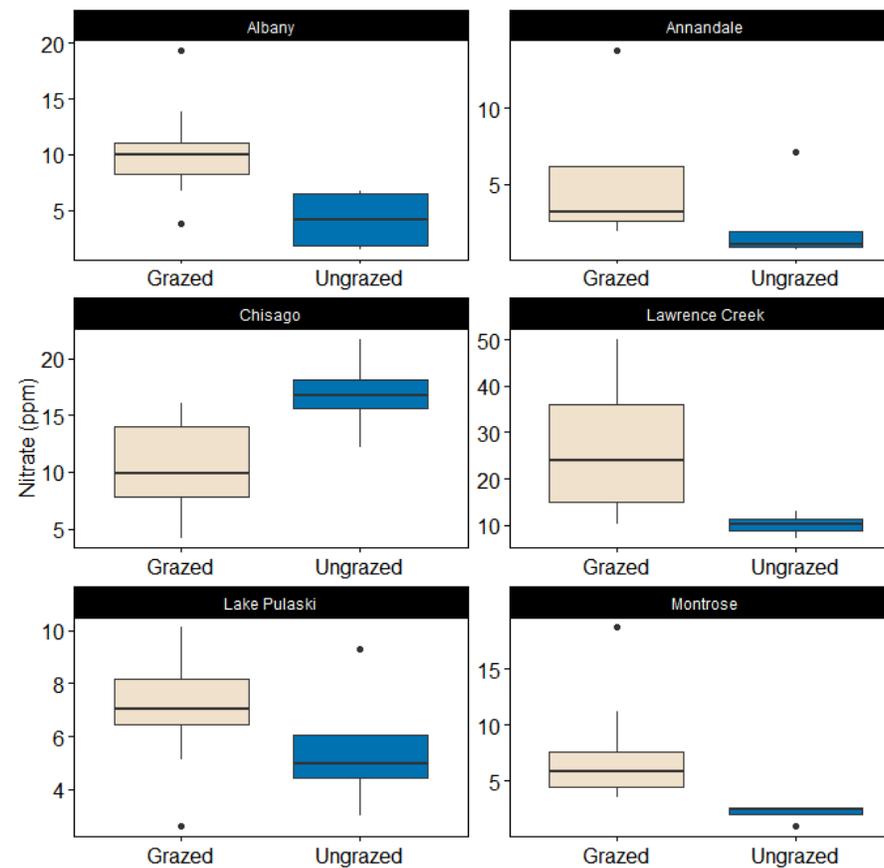




Ammonia (ppm)



Nitrate (ppm)

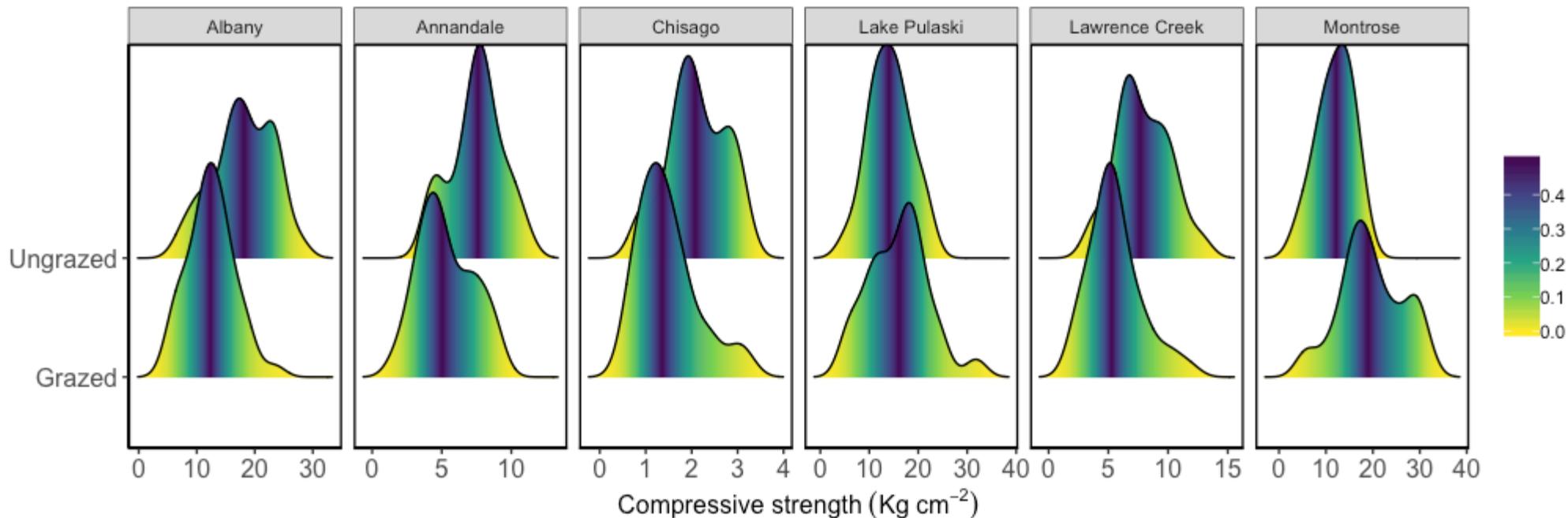


Similar increase was seen in other nutrients at grazed sites, including Mg, Na, K, P, Ca, S



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





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



THANK YOU

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