

# BENEFITS OF MANAGED SHEEP GRAZING ON SOLAR PHOTOVOLTAIC SITES

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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    |

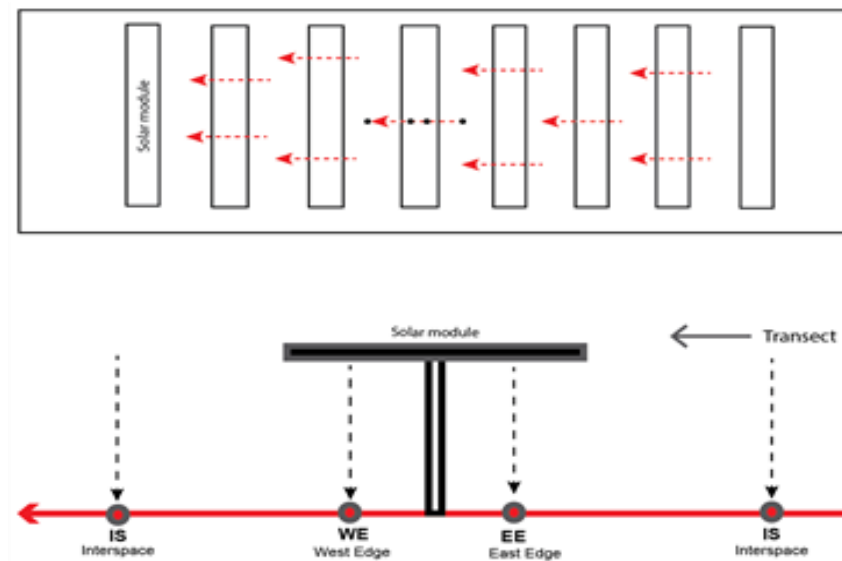
- 6 commercial solar PV sites in Minnesota (ENEL Green Power)
- Native pollinator friendly vegetation under panels
- 500-700 sheep grazing treatment for 2-3 weeks per year.





# 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





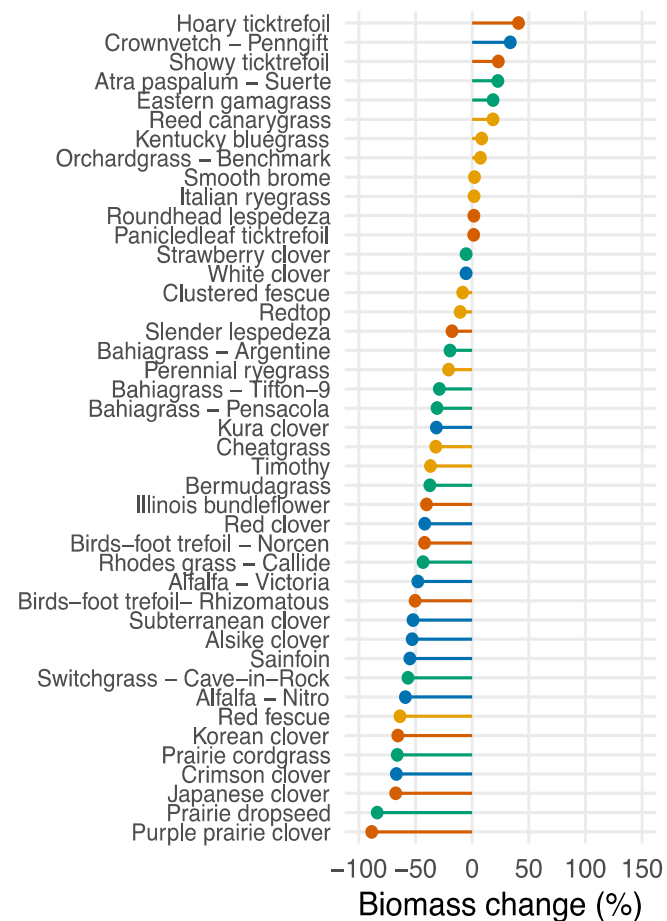
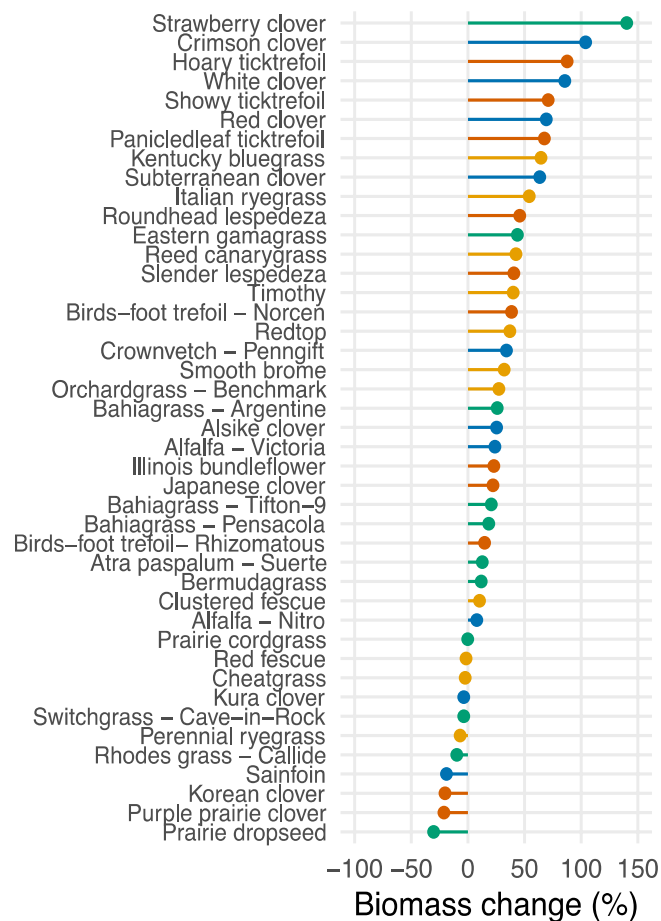


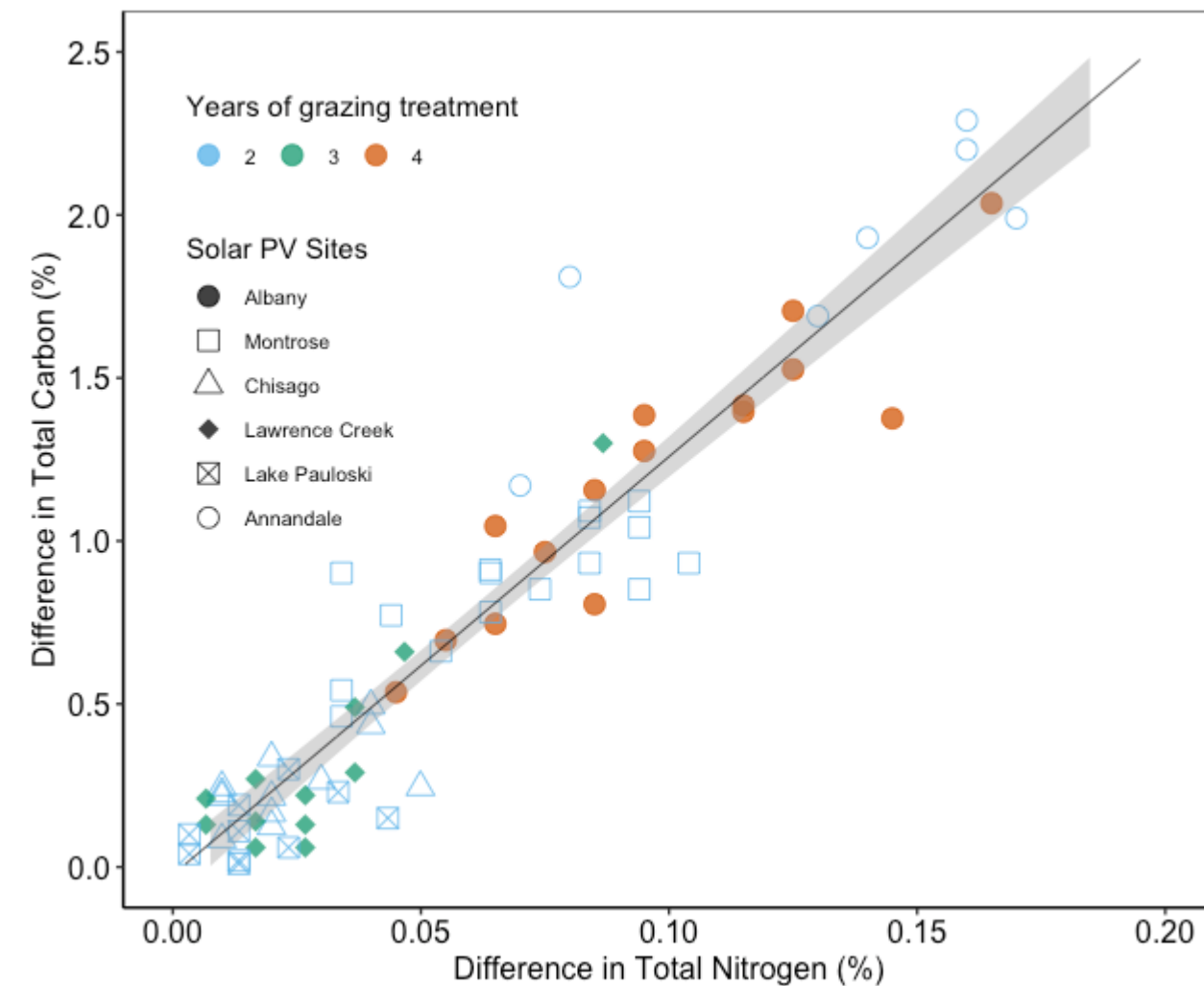
## RESULTS

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

45% Shade

80% Shade





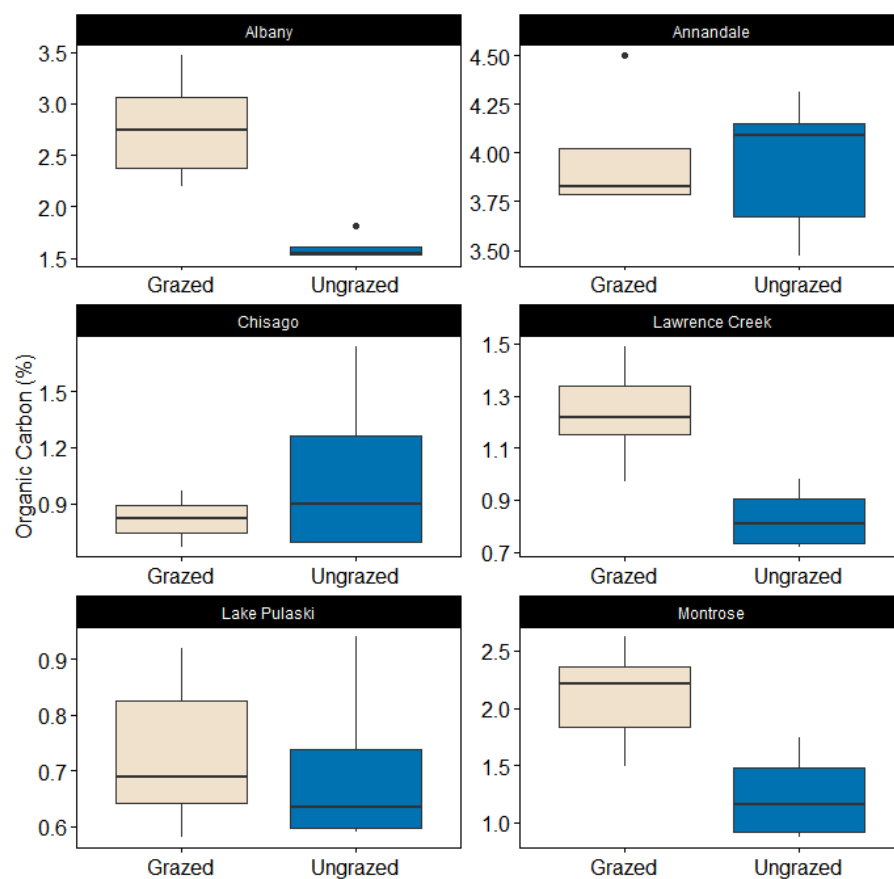
## RESULTS

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

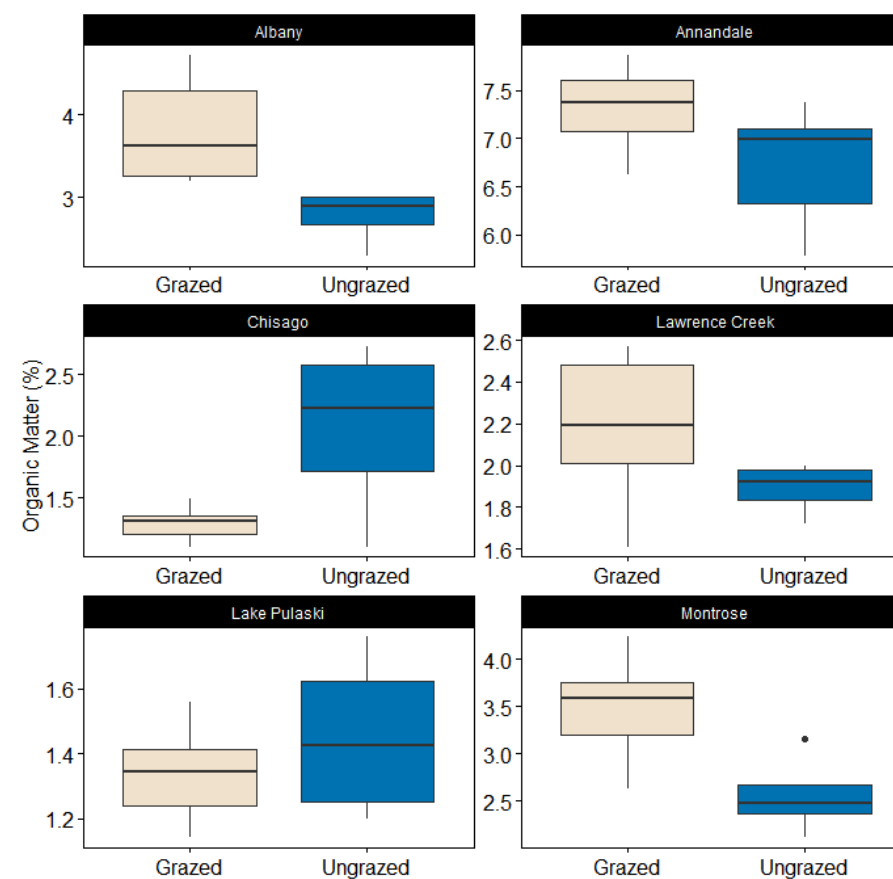




## Organic Carbon (%)

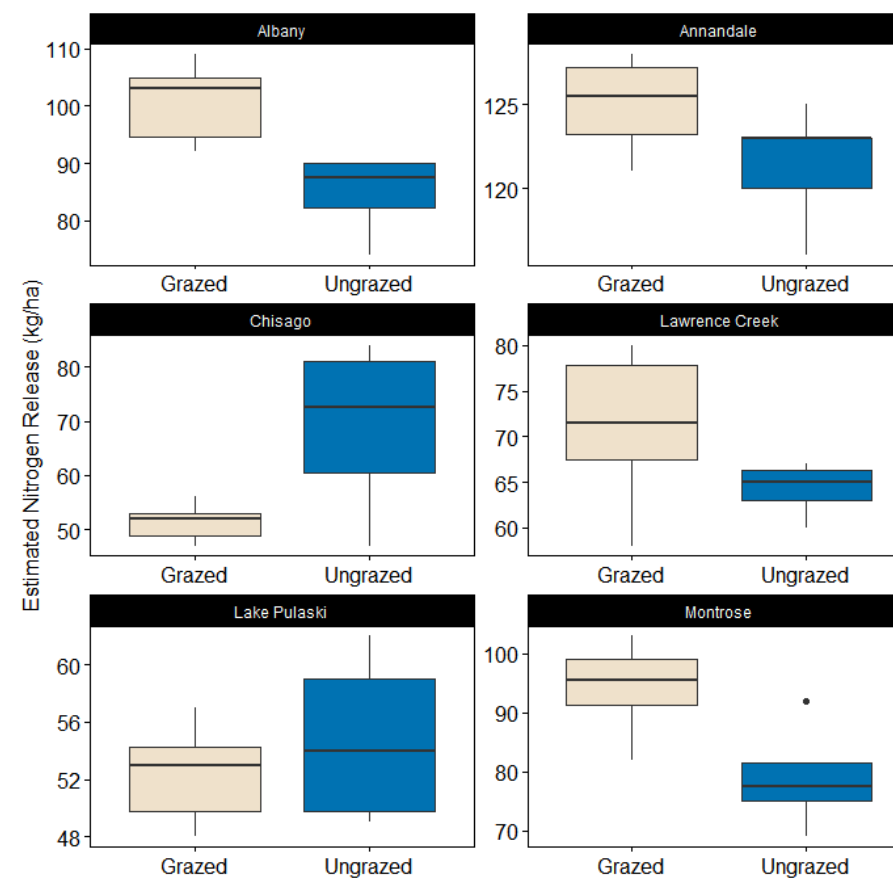
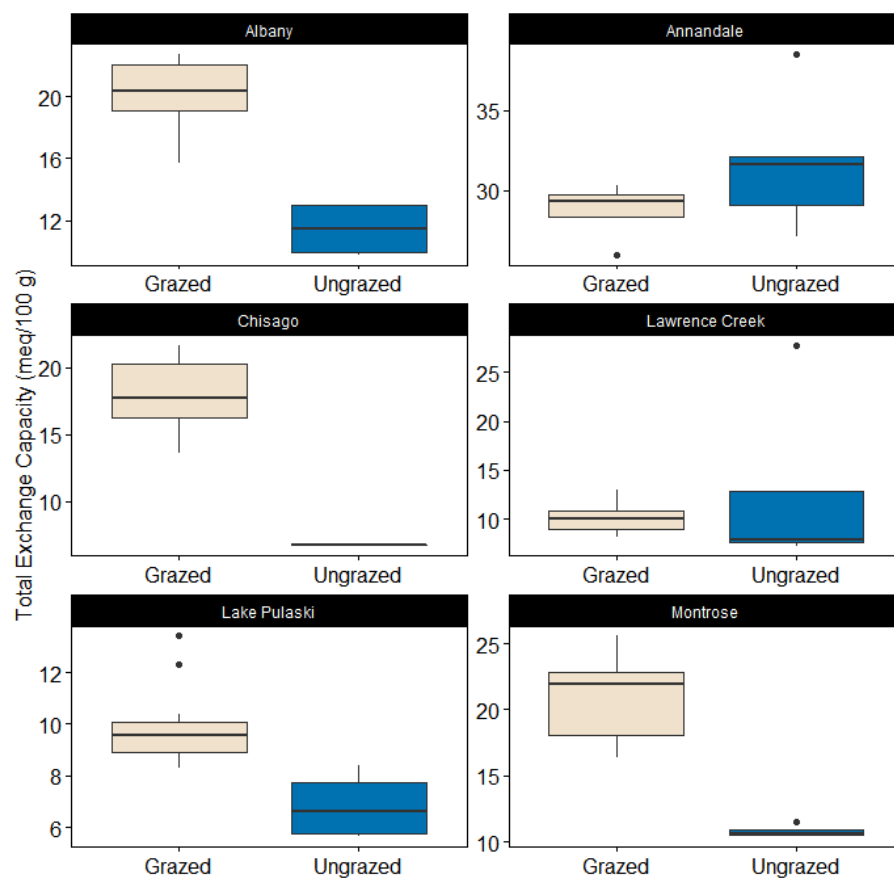


## Organic Matter (%)





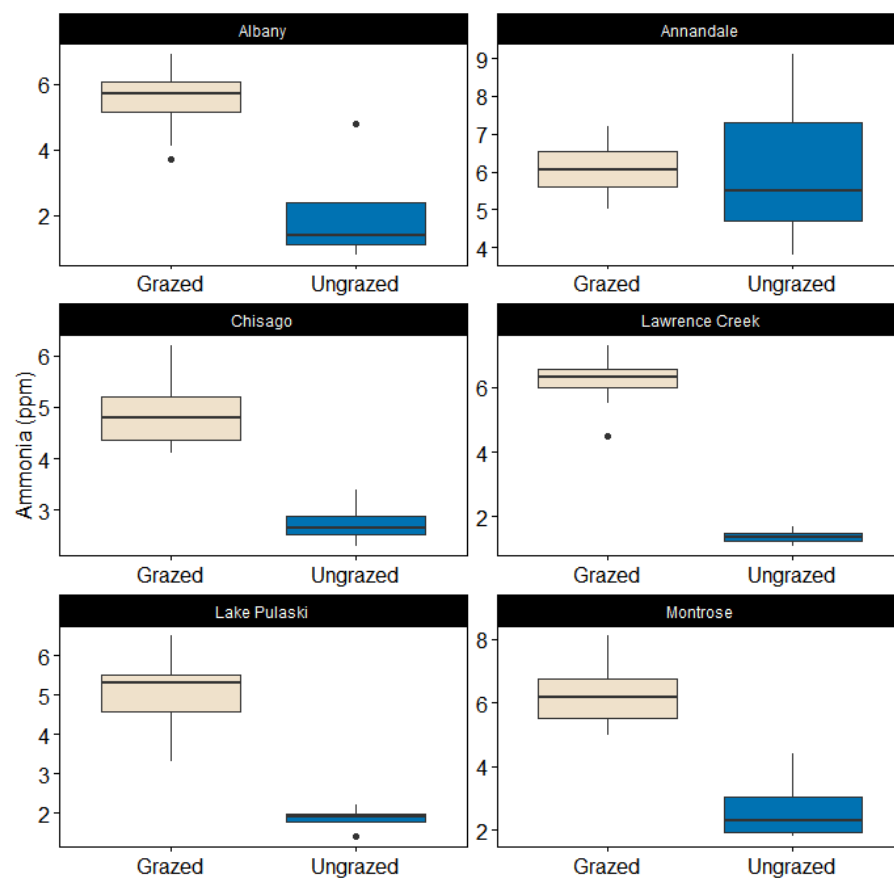
## Total Exchange Capacity (meq/100g)      Estimated Nitrogen Release (kg/ha)



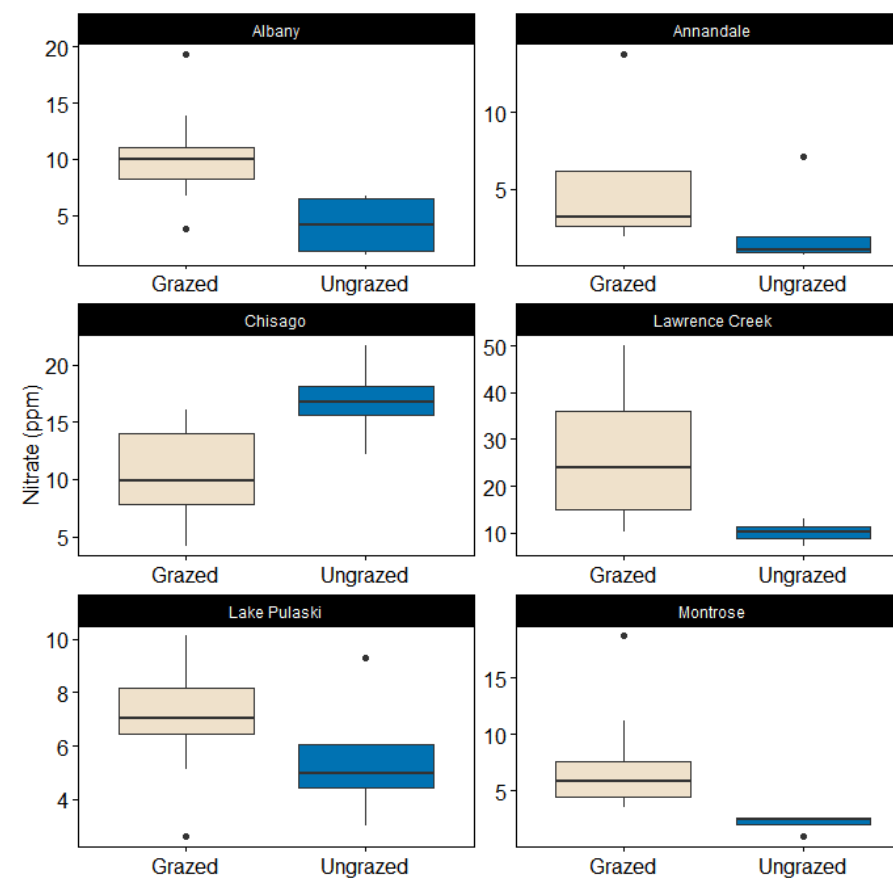




## Ammonia (ppm)



## Nitrate (ppm)

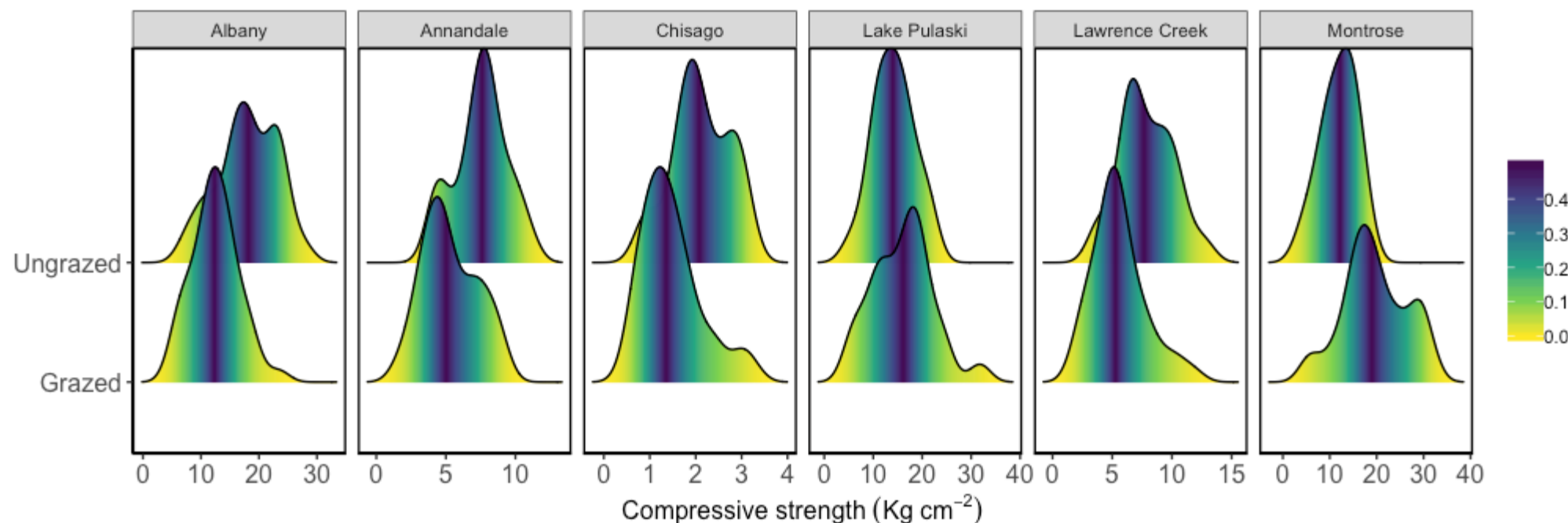


Similar increase was seen in other nutrients at grazed sites, including Mg, Na, K, P, Ca, S



# 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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