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Soil Organic Carbon Accumulation in Restored Native Prairies Over Time

Samrin Shahnaz
University of Northern Iowa

Kenneth J. Elgersma Ph.D.
University of Northern Iowa

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Biology

Samrin Shahnaz, Dr. Kenneth Elgersma
Department of Biology, University of Northern Iowa

Background

With the recent focus on the effects and causes of climate change, the relationship between agriculture and climate change is an important concern. Traditional farming maximizes crop production at the expense of ecosystem services like soil carbon storage. As the human population grows, it is vital to develop practices that balance crop production and ecosystem services.

We investigated organic carbon accumulation in restored prairie soil over the course of a decade. Our goal was to find out how organic carbon levels and soil bulk density changed over time, and how that change was influenced by species diversity and soil depth.

Research Questions

How much organic carbon accumulates in restored prairie soil over a decade?

How does plant species diversity affect soil organic carbon levels?

How does soil depth affect organic carbon accumulation?

How does soil bulk density change over the course of a decade in restored native prairies?

Methods

Study location

- Cedar River Ecological Research Site (CRERS)
- Soil type: Flagler sandy loam
- 4 soil treatment types (1-species switchgrass, 5-species, 16-species and 32-species mix)
- 16 total plots (4 soil treatments, with 4 repetitions)

Bulk density and organic carbon

- Soil coring was performed using a manual core and a trailer-mounted core on fields A, B and C, to 15-cm depth
- Each sample was divided into 2 layers of 7.5 cm each
- Stones (>2mm) were removed by sieving, then weighed and their volumes measured for bulk density
- Dried soil to find % moisture
- Combusted organic carbon in a muffle furnace at 500^oC for 200 minutes and measured weight loss to find Loss on Ignition (LOI)

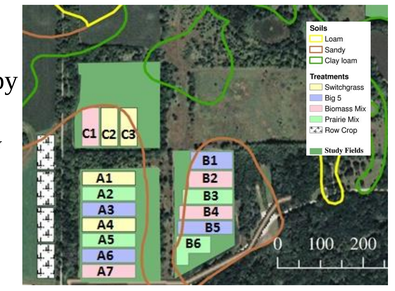

Figure A: Cedar River Ecological Research Site (CRERS).

Figure B: 32-species mix (left) VS 1-species switchgrass (right)

Figure C: Extracting soil from manual core

Results

Figure D demonstrates LOI over time. Carbon concentration increased more rapidly in years 6-12 than years 1-5. For all 4 treatments, the deeper layer stored lower amounts of organic carbon, especially in the first 5 years.

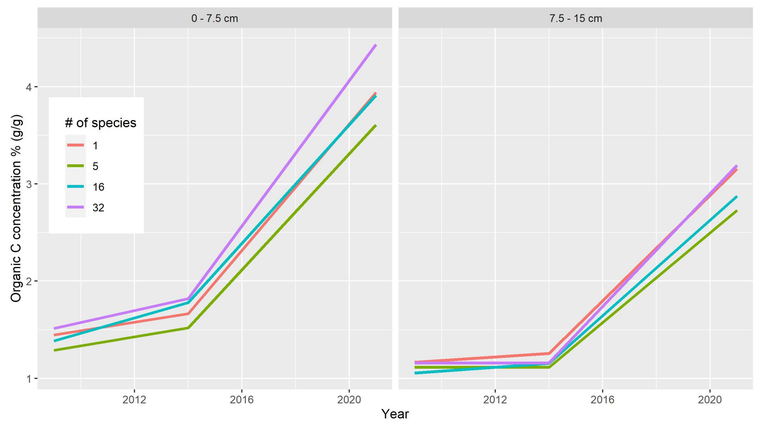

Figure D: Graphs of LOI (g C/g of soil) against time (2009, 2014, 2021). 0-7.5 cm (left), 7.5-15 cm (right).

Bulk density changed little during the first 5 years, but strongly declined in years 6-12 (Fig. E). This demonstrates a reduction in soil compaction as prairie roots loosened the soil.

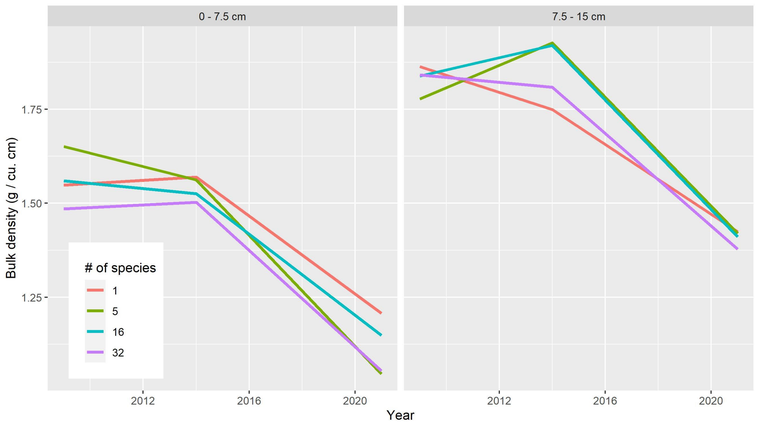

Figure E: Graphs of bulk density (g soil/cm^3 of soil) against time (2009, 2014, 2021). 0-7.5 cm (left), 7.5-15 cm (right).

Figure F show that carbon content on an aerial basis increased over time and accelerated in years 6-11. Lines for each species treatment are not very different. The graph for 0-7.5 cm (from the top) of soil is steeper than for 7.5-15 cm of soil, indicating more soil C sequestration in the top soil.

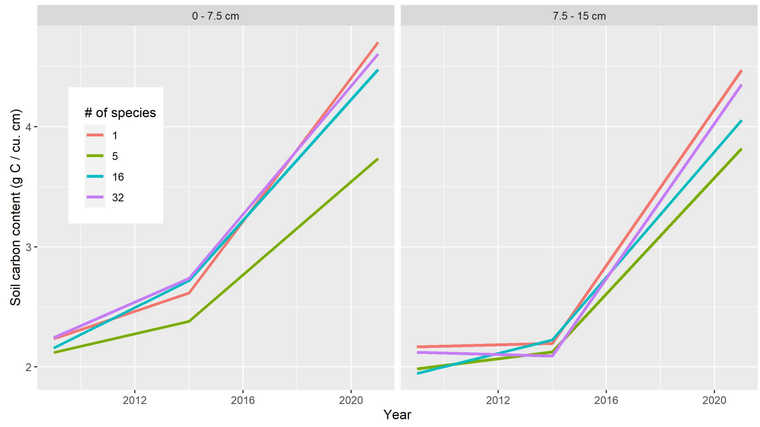

Figure F: Graphs of soil organic carbon on an aerial basis (g C/cm^3 of soil) against time (2009, 2014, 2021). 0-7.5 cm (left), 7.5-15 cm (right).

Soil C content summed across the soil layers shows rapid soil C sequestration in years 6-12 in all diversity treatments, although soil C storage is lower in the 5-species grass mixture (Fig. G).

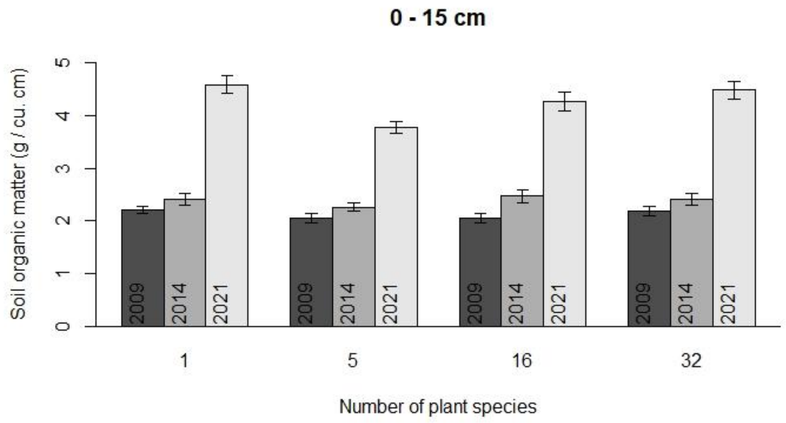

Figure G: Bar graph of soil organic carbon on an aerial basis (g C/cm^3 of soil) against species treatment for 0-15 cm of soil depth.

Conclusions

- Plant species diversity does not have a strong effect on soil organic carbon levels
- More organic carbon is accumulated in restored prairie soils over time
- Soil compaction is not diminished initially but does improve in later years

Acknowledgements

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