Visions West Presentation Nov 8, 2023, by Lewis Heaton & Beckie Phillips, Ecoinsights@protonmail.com

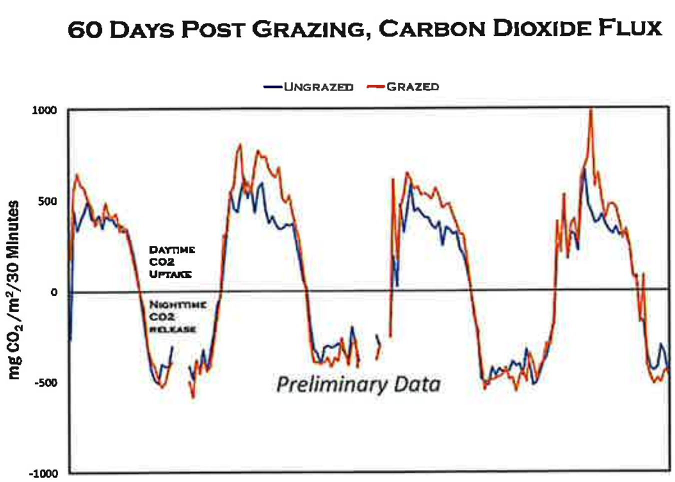
Managing Rangelands for Natural Carbon Capture

Research to quantify the annual amount of carbon dioxide captured and sequestered under managed grazing at a pasture scale is being performed at Lewis Heaton's ranch in McKenzie, North Dakota. Several partners and stakeholders are engaged in this research, which is being led by the North Dakota Natural Resources Trust, with science support from Ecological Insights Corporation. The goal of this project is to show ranchers and the public how intensive grazing, followed by rest and recovery, can be used to regenerate rangeland ecosystems by enhancing natural carbon capture. Data collected here is needed to help ranchers understand how they might benefit from emerging carbon markets and farm programs. Lewis Heaton has dedicated 150 cow-calf pairs and over 100 acres (split into two 50-acre pastures) to this ground-breaking research, which may be the first of its kind—nationally and internationally.

Jesse Beckers at the North Dakota Natural Resources Trust has formed partnerships and garnered support from the North Dakota Industrial Commission, Hess Oil Corporation, the North Dakota Petroleum Council, the National Fish and Wildlife Foundation, the North Dakota Game and Fish Department, the North Dakota Stockmen's Association, and the Badlands Advisory Group.

Field work was initiated in May 2023 with instrument deployment and testing by Ecological Insights scientist Dr. Rebecca Phillips. The first year of data, consisting of 17,520 data points and over 100 variables, will be evaluated to test for effects of managed grazing on carbon uptake, or net ecosystem production. The full carbon balance, which includes carbon in forage exported by grazers and carbon in animal waste deposited, will tell us if the grazed pasture produced more forage and/or sequestered more carbon. A statistical model with covariates such as soil temperature, leaf area, soil moisture, relative humidity, rainfall, and photosynthetically active will help us predict carbon uptake under variable weather conditions.

Unique to this project is the scale of data collection, where carbon dioxide uptake is measured in real time over 50-acre pastures. Studies that collect above and below ground carbon data at specific points in space and time may not spatially and temporally represent the rangeland of interest. Here, we collect atmospheric carbon and water flux data every half-hour from a 50-acre pasture under managed grazing and a 50-acre ungrazed control on a working ranch.



An example of daily carbon uptake two months post-grazing is illustrated by this graphic of preliminary data. Carbon dioxide uptake during the day is shown as values above zero and carbon release at night as values below zero. The blue line represents the ungrazed control, and the orange line represents the grazed paddock. During the day, plants are regrowing, and the difference in carbon uptake is evident. This is an example of four days of data.

We continue to observe this trend, although the pattern changes with weather and time since grazing. Results at the Heaton Ranch will be used to model natural carbon capture at the Rider Ranch near Williston, where weather and forage data are being collected. We hope to include satellite imagery at some point, so the model can be used to estimate carbon uptake for many rangelands in North Dakota. We expect this approach to yield more accurate measures of carbon uptake than soil carbon measurements, which are currently used for carbon verification.

Methane is also a carbon-based gas that is a by-product of the fermentation process. New methane sensors, designed to measure pasture-scale methane uptake, are becoming available in late 2024. Rangelands are important methane sinks, yet few studies publish natural methane uptake at high spatial and temporal resolutions. Grazing management may reduce methane emissions from grazers (Zubieta et al. 2021) while increasing methane uptake at the soil surface (Wang et al. 2015). The addition of a methane sensor to the current instrument setup would allow us to address the question: How is natural methane uptake in rangelands affected under managed grazing? We hope to encourage additional support necessary to include methane uptake measurements.

In summary, additional support for this project will facilitate:

1. Continued measurement of natural carbon capture beyond two growing seasons—leading to greater understanding of how grazing management (including altering season of use) impacts carbon uptake and forage production under a wider range of environmental conditions, including drought.
2. Application of modelled carbon capture to other ranches, with rates of carbon uptake that would help ranchers negotiate with carbon buyers.
3. Addition of methane flux to suite of measurements at McKenzie site, so we can determine if rates of methane uptake by soil organisms increase in the presence of grazers.
4. Utilize measurements to illustrate the ecological values (carbon sequestration, grassland health, habitat management) of grazing systems and ranchers to a wider audience.

Citations

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HISTORICAL BISON HERDS PRODUCED METHANE COMPARABLE TO CATTLE IN THE GREAT PLAINS

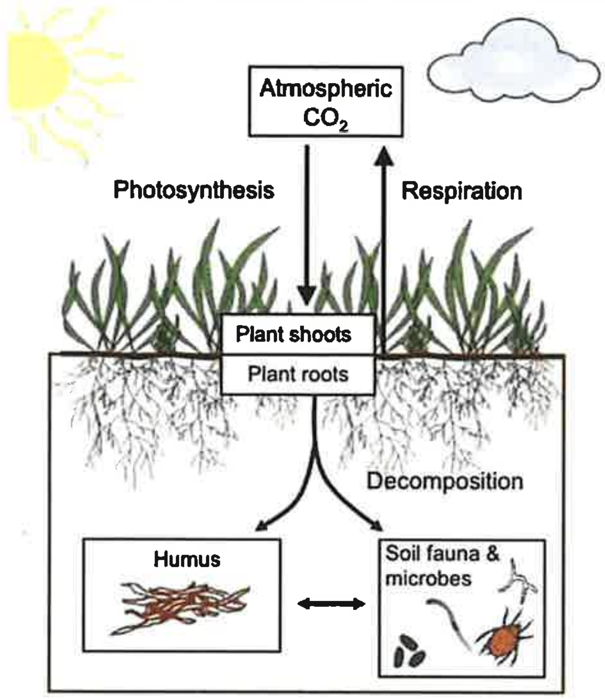
By Rebecca L. Phillips, Ph.D., Ecological Insights Corporation; Jerry Doan, ND Grazing Lands Coalition;
Lucy Britton, Michael Bush and Meghan Carter, Audubon Dakota
May 29, 2020

Methane emissions by cattle in the Great Plains, while substantive, are comparable to historical bison emissions. These results were published by Kelliher and Clark in the journal *Agricultural and Forest Meteorology*. Results beg the question of whether ruminant methane is a contemporary environmental issue or a natural part of the grazing land ecosystem. In this article, we discuss how emissions of methane from ruminant grazing animals (such as bison, cattle, sheep, or deer) is integral to the recycling and conservation of carbon from air, into plants, then animals, and back into grassland soils.

Ruminant grazing animals can acquire nutrients from grasses by fermenting them in a specialized stomach, called a rumen. Microbes in the rumen produce enzymes that break down plant material in the absence of oxygen and produce methane as a fermentation by-product. Ruminants are unique in their capacity to extract energy from grassland plants. This conversion cannot occur without removing hydrogen gas through reaction with carbon to form methane. Methane is common wherever fermentation occurs; landfills emit more methane per unit area than any other single source. Here, we focus on ruminant methane because some suggest that elimination of ruminants like cattle will solve the climate change problem. However, ruminants over geological time emitted methane. Can we really single out cattle as the problem? Aren't grazers just one component to the grassland ecosystem?

Prior to European settlement, the 10-state region of the Great Plains (2.9 million square kilometers) was inhabited by 30 million ruminant bison. The historical bison herd met their energy requirements through enteric fermentation, which released 2.2 million metric tons of methane per year, or 11 pounds of carbon as methane per acre per year over the Great Plains region. Today, bison grazers in the Great Plains have largely been replaced by 40 million ruminant cattle. These cattle meet their energy requirements through enteric fermentation, which releases 2.5 million metric tons of methane per year, or 13 pounds of carbon as methane per acre per year. This historical context is important as we try to understand the role cattle play in current debates about methane.

Methane, like carbon dioxide (CO_2), is a carbon-based molecule. Carbon is the backbone of the food web that moves through organisms in various molecular forms and states. The figure at left illustrates how gaseous carbon is removed from the atmosphere by plants and transferred to soils through roots or herbivores through grazing. The metabolism of carbon compounds is not 100% efficient. Some carbon in plants, soils or grazers is returned the atmosphere as carbon dioxide or methane. Grassland plants take more carbon from the atmosphere than they use for aboveground growth—some of which is stored as soil organic matter. Storage of carbon in soil as organic matter is commonly referred to as carbon sequestration. Long-term studies by the National Aeronautics & Space Administration and the U.S. Geological Survey report that grasslands of the Great Plains conservatively sequester an average of 24 tons per square kilometer per year (Zhang et al 2011) or 220 pounds per acre. This amount of carbon stored greatly exceeds the amount of carbon emanating from the rumen in cattle (see bison discussion above), which is one reason ruminant methane cannot be fully evaluated as an isolated factor independent of the ecosystem. Grazers co-adapted with grassland species over time, and different forms of carbon (including methane) move through the entire ecosystem to serve energy and habitat requirements for its multiple inhabitants. Greater rates of soil carbon sequestration can be achieved through regenerative practices, such as adaptive grazing management (http://www.fao.org/3/x5304e/x5304e03.htm; https://www.drawdown.org/).



So, what is the connection between carbon and methane in grasslands? Ruminant grazers co-adapted with grasslands to optimize the use of carbon as it moves through the ecosystem. Some of the carbon in plants must be released as methane in the process of converting plant material to energy in the rumen. The carbon stored belowground in grazing lands dwarfs the carbon lost as methane. We summarize with three key points: 1) all ruminants produce methane; historically, bison emissions were comparable to cattle emissions today, 2) amounts of carbon stored as organic matter in Great Plains grasslands exceed amounts emitted as methane , and 3) ruminants indirectly improve grassland soils over time by participating in the process of building soil organic matter.

Well-Managed Cattle Sequester Carbon

Regenerative practices, such as moving cattle frequently to fresh pasture, encourage transfer of carbon from atmosphere to plants to storage in soil organic matter. [1,2]

1. http://www.fao.org/3/x5304e/x5304e03.htm
2. https://www.drawdown.org/