# Measuring the Carbon Storage of Rangelands

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Rangelands, specifically grass and shrub-dominated landscapes, comprise over 40 percent of Alberta's land area. They provide a variety of important goods and services, including fodder for grazing animals, habitat for a diverse array of species, and carbon storage. They are also subject to disturbance, including periodic drought or overgrazing, which diminish their capacity to provide these essential goods and services. Good management can help maintain the essential functions of rangelands, ensuring productive and sustainable resources for future generations.

To better understand the role of grazing management in a variable climate, ongoing work at Mattheis Ranch is determining the capacity of the mixed-grass prairie, typical of southern Alberta's rangelands, to take up and store carbon dioxide through photosynthesis. Measurements utilize "eddy covariance," a method of measuring whole-ecosystem exchange of carbon dioxide and water vapor over large landscapes (Figure 1). Measurements of the net exchange of carbon dioxide can be used to derive estimates of "gross primary production" (GPP), a measure of the photosynthetic productivity of the ecosystem that provides a good estimate of biomass yield used as fodder. Eddy covariance is considered the "gold standard" for measuring the carbon dioxide exchange between terrestrial ecosystems and the atmosphere, and is used to monitor the health and function of large regions of the Earth's terrestrial biosphere. Data from Mattheis Ranch are now contributing to a growing global database of such measurements taken around the world.

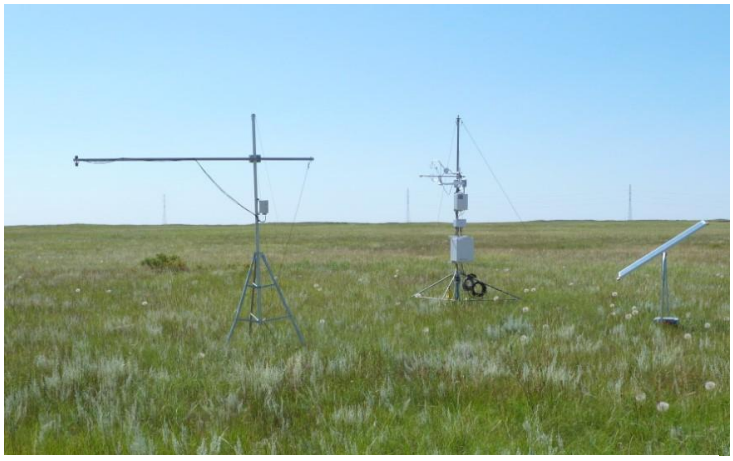

Figure 1. Eddy covariance measurements and surface reflectance measurements at the Mattheis Research Ranch. Photo from Ran Wang.

To extend these estimates to larger areas, eddy covariance is compared to satellite measurements of surface reflectance, providing an essential calibration for satellite-derived estimates of yield and productivity. Figure 2 compares a time series of primary productivity (GPP) measured by eddy covariance to NASA's MODIS satellite surface reflectance in various wavebands, expressed as "vegetation indices" depicting the relative productivity of the landscape. Together, these measurements reveal clear year-to-year variation in productivity (associated with changing temperature and rainfall patterns), and show a

strong association between satellite-derived vegetation indices and eddy covariance measurements. This agreement between satellite data and ground-based measurements provide a foundation for large-scale monitoring of rangeland health and productivity.

Current work is extending this approach to include year-round measurements (allowing for annual budgets of carbon uptake and storage) and allowing comparisons to new satellite sensors, providing a basis for long-term analyses of rangeland conditions over time. In these studies, Mattheis Ranch is proving to be a valuable addition to a growing global database of rangeland health and productivity, under changing weather and climate conditions, as a basis for sustainable management of Alberta's rangelands.

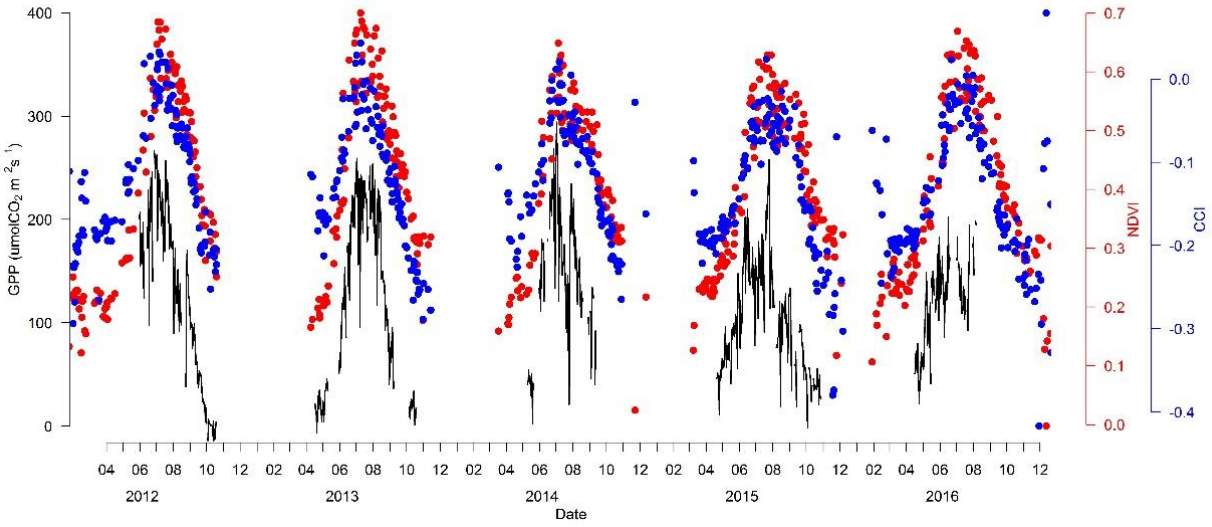


Figure 2. Five-year time-series of gross primary productivity (GPP, black line – measured with eddy covariance) and MODIS vegetation indices (NDVI and CCI) measured at site E3, Mattheis Ranch. NDVI (Normalized Difference Vegetation Index) has been used to detect green vegetation using satellite and ground remote sensing equipment. CCI (Chlorophyll/carotenoid index) monitors the seasonal changes in photosynthetic rates of evergreen species and showed a strong relationship with grassland productivity at the Mattheis Ranch sites.

This research has been published:

Wang, R., Gamon, J.A. 2019. Remote sensing of terrestrial plant biodiversity. Remote Sensing of Environment 231: DOI: 10.1016/j.rse.2019.111218.

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