

Abstract

Collaborative Research: Effects of plant species, organic matter quality, and microbial activity on peatland ecosystem function and resilience to climate change

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Statement of Objectives: Our overall goal is to implement a replicated field experiment designed to test soil climate and biotic (plant species, functional identity, and traits; microbial metabolism) controls on peatland carbon cycling over both annual and decadal time frames.

Specific Hypothesis:

- 1) Soil moisture controls plant structure and productivity in peatlands.
- 2) Soil temperature and moisture regimes interact to control short-term (months to years) responses of carbon flux, largely by controlling rates of heterotrophic respiration.
- 3) While heterotrophic respiration initially is controlled by the utilization of substrates from previously saturated soils, soil climatic conditions and plant composition eventually interact to control nutrient availability and substrate utilization during heterotrophic respiration. Shifts in vegetation structure due to altered soil moisture and temperature change the quality of organic matter inputs to soil, with potential positive or negative feedbacks to heterotrophic respiration.

Location of Research Activities: This study will occur in Seney National Wildlife Refuge (SNWR) in the Upper Peninsula of Michigan. Two-thirds of the SNWR is covered by peat (about 25,000 ha), and it includes the largest wetland drainage project in Michigan. The ditches, dug in 1912, are still in place and represent an unparalleled opportunity to examine how drying over different time frames (annual versus decadal) alters peatland carbon cycling.

Brief Methods: Our proposed research will comprise of intensive, replicated field manipulations of water table position (through trenching), soil temperature (through warming via thermal infrared lamps), and water table position x warming interactions. Within this experimental framework, we will perform 1) seasonal field measurements to document relationships between hydrology, soil temperatures, vegetation, and carbon fluxes, 2) field and laboratory studies to address climatic and vegetation controls on nutrient availability, substrate quality and utilization during respiration, and 3) integration into regional remote sensing efforts that will evaluate how changing climate and vegetation conditions influence peatland carbon exchange across the Great Lakes region.

Expected Accomplishments: Our research will (a) improve our understanding of the strength of peatland CO₂ sinks and CH₄ sources in the Great Lakes region, (b) experimentally test controls over the processes contributing to the net fluxes of greenhouse gases in these ecosystems, and (c) improve the ability to predict the response of peatland structure and function over a spectrum of temporal scales.