

WETLANDS ON THE LANDSCAPE

Wetland Soil Carbon

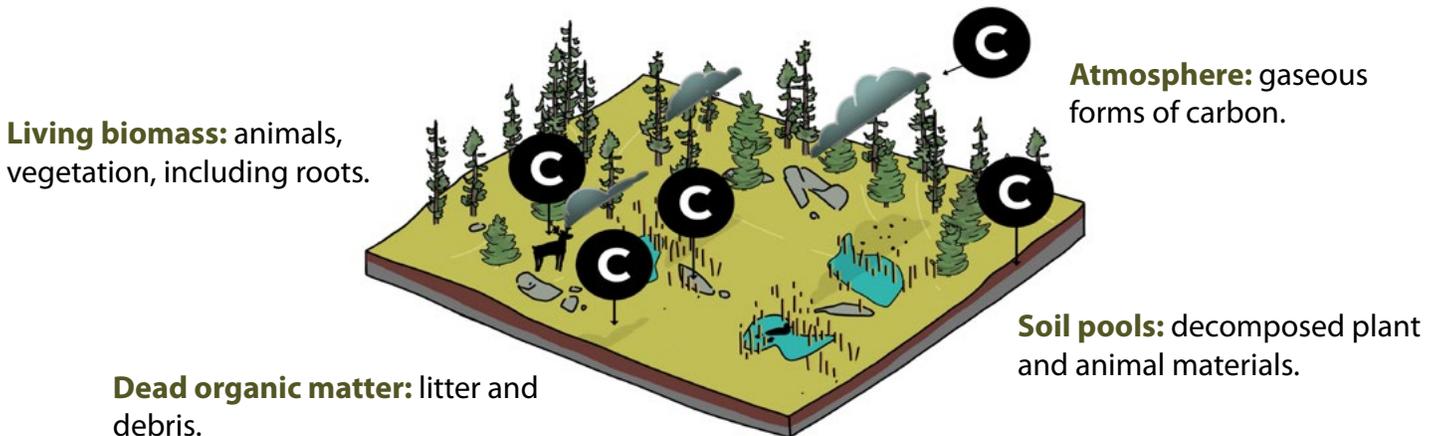
Wetlands are vital to the global carbon cycle, serving as significant reservoirs of organic carbon by extracting it from the atmosphere and storing it in their soils and vegetation.

Organic wetlands are one of the most carbon-dense ecosystems globally, covering **only 3% of the Earth's surface yet storing approximately one-third of the global soil carbon stock.**¹ Canada alone contains 25% of global organic wetlands, storing approximately 150 billion tonnes of land-based carbon.² However, carbon storage can be affected by natural and anthropogenic disturbances, such as wildfires, forest harvest, and linear disturbances. As government policy, industry certification, and consumer preferences increasingly emphasize carbon accounting and management, understanding the role of wetlands in carbon storage becomes essential in a whole landscape approach to ecosystem-based management.



What is Carbon?

Carbon, a naturally occurring element, serves as a fundamental constituent of all organic compounds and is prevalent in:



Canada's wetlands store more carbon than upland forests, despite upland forests covering a larger land area.³ This is because wetlands sequester most of the carbon below ground in their soils, with approximately 98.5% of organic wetland carbon stored in soils rather than above ground vegetation.

Carbon Sequestration

Wetlands extract significant amounts of carbon dioxide from the atmosphere and store it in the soil through a process called **sequestration**. Wetland ecosystems sequester carbon dioxide through photosynthesis, transforming it into live plant biomass.⁴ Carbon is integrated into soil through the incorporation of live biomass, including roots and plant litter, while soil fauna, such as fungi and microbes, further enhance soil organic carbon through their biological activities.^{5,6} In organic wetlands, thick layers of dead plants build up over thousands of years under wet conditions, forming deep, carbon-rich, organic soil deposits, known as peat.

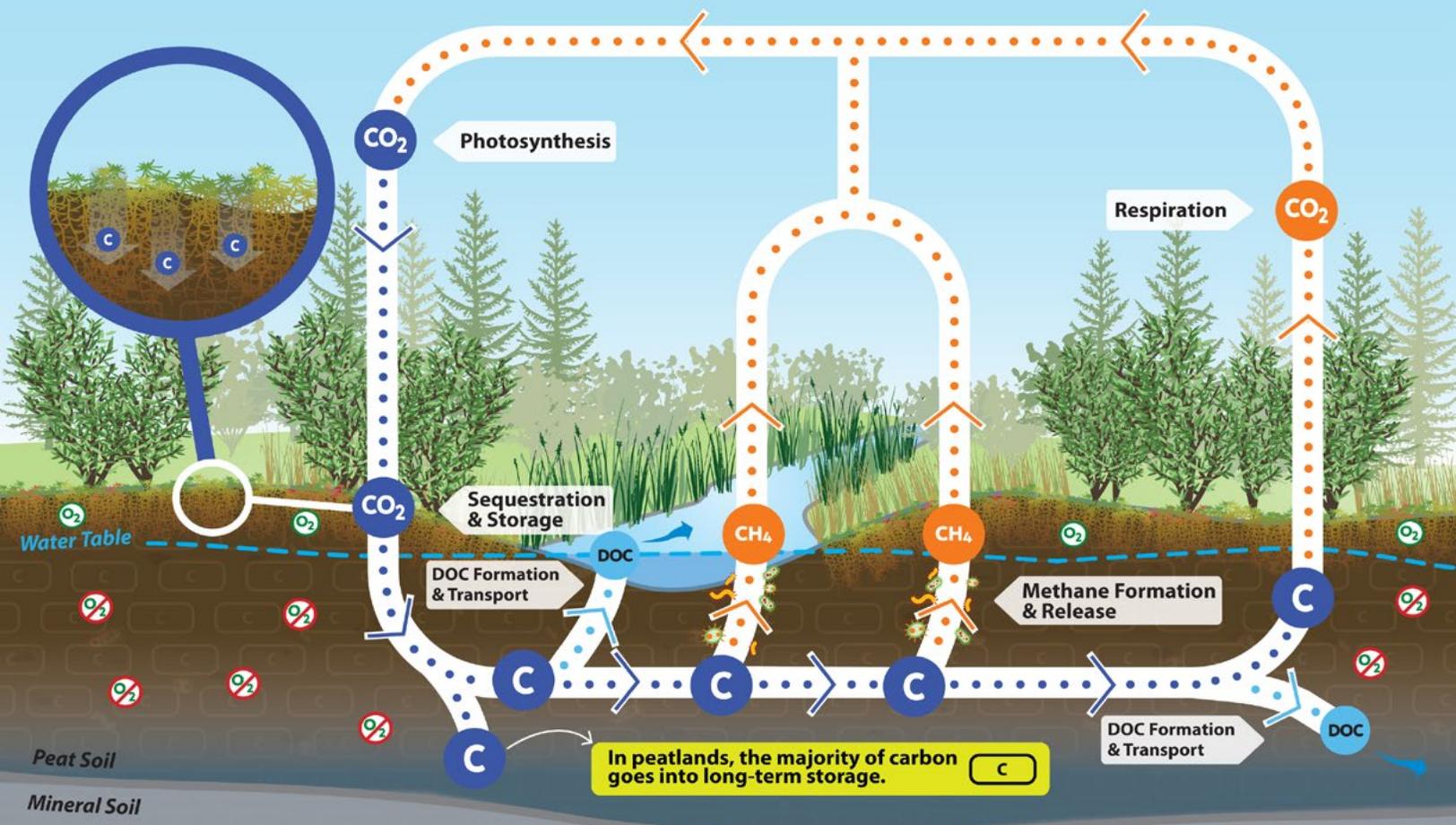
Carbon Accumulation

Carbon accumulation occurs over **thousands of years** and is largely influenced by wetland hydrology which governs gas diffusion rates, oxygen levels, nutrient dynamics, and vegetation composition.⁷ In organic wetlands, the vast majority (greater than 98%) of the carbon that is sequestered is stored in the organic soil as peat.⁸

Figure 1. Boreal organic wetland (peatland) carbon cycle.⁹

THE CARBON CYCLE OF A BOREAL PEATLAND

In boreal peatlands, carbon is sequestered and stored in organic soils (peat) over thousands of years, owing to their cool climates and waterlogged, oxygen-depleted conditions. It is estimated that Canada's peatlands store over 150 billion tonnes of carbon.



Created by Ducks Unlimited Canada through the Forest Management Wetland Stewardship Initiative.

PHOTOSYNTHESIS

Carbon Dioxide (CO₂) is absorbed by plants and used to create plant biomass such as leaves. Carbon is also transported to the roots and soil.

SEQUESTRATION & STORAGE

Plant biomass such as leaf litter and peat (*Sphagnum*) mosses are broken down, buried and mixed into the soil. In peatland soils, plant biomass accumulates over thousands of years, creating a carbon sink.

DOC FORMATION & TRANSPORT

When soil carbon interacts with the water table, some carbon molecules are dissolved and transformed into Dissolved Organic Carbon (DOC). As water moves through a peatland, DOC is transported and exported to downstream ecosystems.

METHANE FORMATION & RELEASE

In waterlogged soils, stored carbon is decomposed and transformed by soil microbes into methane. Methane can be emitted from waterlogged soils, plants and pools of water.

RESPIRATION

Carbon is emitted back to the atmosphere as CO₂ through respiration from soils, plants and animals. In dry soils, respiration is the leading source of carbon emissions.

Carbon Loss

Despite their role as carbon sinks, organic wetlands are susceptible to emitting significant amounts of carbon in response to climate and land use changes.¹⁰ **With anticipated increases in the frequency, extent, and intensity of disturbances in the western boreal forest, organic wetlands ability to act as carbon sinks may be constrained, with some wetlands potentially transitioning into carbon sources.**

Carbon can be lost from a wetland through:

- **Dry Condition Respiration:** Under dry conditions, soils become oxygenated and decomposition increases resulting in the release of carbon into the atmosphere. When wetlands dry out or are drained, they can release massive amounts of carbon dioxide (CO₂) into the atmosphere.
- **Wet Condition Respiration:** Under wet conditions, decomposition slows and carbon accumulates, but soil microbes still transform soil carbon into methane (CH₄), which can be released through standing water in wetlands. When wetlands are poorly managed or flooded, massive amounts of methane can be released into the atmosphere.
- **Water Movement:** As carbon interacts with the water table, it can be transformed into dissolved organic carbon and can be transported out of the system dissolved in surface and ground water.
- **Wildfire:** Organic wetlands, especially treed wetlands, have the potential for crown fires and for below ground fires though smouldering, releasing significant amounts of carbon. Learn more about peatland fire in *Factsheet #8*.

Changes to a wetland's hydrology, through both natural and anthropogenic disturbances, can significantly impact a wetland's carbon emissions, and therefore, maintaining the natural hydrology of wetlands, can minimize carbon losses.^{11,12} For example, road construction that blocks the natural flow of water can result in one side of the road drying out and flooding on the other side of the road. The dry side will experience greater decomposition rates, resulting in carbon release, and the flooded side is likely to experience greater amounts of methane release. The dry side will also become more susceptible to wildfire ignition and burning, resulting in further carbon loss. A range of anthropogenic activities can result in drying (e.g., drainage for peat harvest) or flooding (e.g., hydro dams) and are furthered explored in *Factsheet #15*.

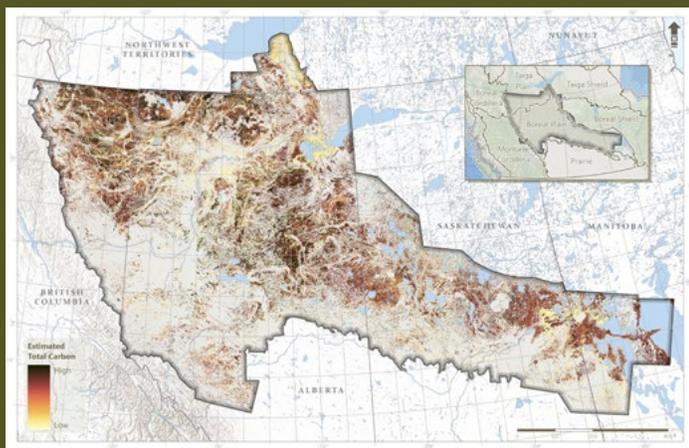


Figure 2. Soil organic carbon in Boreal Plains wetlands.

BOREAL WETLAND SOIL CARBON MAPPING

While estimates of carbon storage are readily available for managed forests, comprehensive assessments for boreal wetlands are often lacking or incomplete. To bridge this gap, Ducks Unlimited Canada (DUC) developed a first-generation map of wetland soil organic carbon for the boreal plains ecozone.

This was achieved by aggregating wetland soil organic carbon densities across various wetland classes and integrating them into DUC's Enhanced Wetland Classification maps.

Resources:

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- [Can-Peat Projects](#)
- [Wetlands: A Powerful Carbon Sink video](#)
- [WWF Interactive Carbon Map](#)
- [Peatlands and Carbon Video Series](#)



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