

WETLANDS ON THE LANDSCAPE:

Wetland Hydrology

Wetland hydrology refers to the distribution, movement, and management of water in wetlands. It is the most critical determinant of a wetland's structure and role within a watershed. Wetlands are in part defined by the presence of water (*Factsheet #3*) and wetland hydrology influences water quality, connects adjacent ecosystems, and transports water between across the landscape (*Factsheet #2*). Because of these connections, understanding wetland hydrology at local and regional scales is crucial for a whole landscape approach to ecosystem-based management.

Wetland Ecohydrology

Wetland hydrology has a strong relationship with wetland ecology (i.e. living things and their interactions with each other and with their physical surroundings). This relationship is called ecohydrology and can determine:

- **Vegetation Composition:** moisture regimes influence the types of plants that grow in a wetland, and how fast they grow.¹ Wetland plants can also impact water movement. For example, *Sphagnum* moss can move water vertically through a wetland.
- **Water Storage:** different wetland types have the potential to store different quantities of water based on the plant species present.¹
- **Accumulation of Organic Material:** organic wetlands accumulate greater amounts of organic material compared to mineral wetlands due to their ecohydrological regime.¹
- **Nutrient Cycling and Availability:** different wetland types are more nutrient rich than others based on water inputs, which can in turn influence plant diversity.^{1,2} Plants can also influence the wetland water quality, for example, *Sphagnum* moss can acidify water chemistry.



Controls on Wetland Hydrology

The western boreal forest is characterized by a sub-humid, relatively dry climate and diverse soil properties, creating a favorable environment for forest ecosystems that store large amounts of water. Wetlands are often associated with low lying areas, but in the western boreal forest, wetlands often form on relatively flat areas due to deep organic soil deposits. This results in a landscape featuring a mosaic of wetlands and uplands.

A water balance is the hydrology accounting system and can be used to understand how water moves and is stored in wetlands. The water balance (Figure 1) takes into account inputs, including precipitation (P), groundwater (G_{in}), and surface inflow (S_{in}) and outputs including evapotranspiration (ET), groundwater (G_{out}), and surface outflow (S_{out}).

The main drivers of wetland hydrology, function and formation in the western boreal forest are:

1. Climate

The western boreal forest operates at a moisture deficit, where evapotranspiration exceeds precipitation.³ Seventy percent of precipitation occurs during the growing season (May to September), resulting in significant amounts of water lost to evaporation. Most water is accumulated from rain and snowfall in the non-growing season (October to May) due to lower evapotranspiration rates from dormant vegetation.³ This moisture deficit creates greater drought potential in the region.⁴

The amount of water a wetland stores, receives, and releases varies throughout the growing season (May to October). We refer to these temporal patterns of wet and dry periods as a **wetland hydroperiod**. Monitoring wetland hydrology can provide information about:

- **Duration of Inundation:** How long a wetland remains flooded or saturated with water. Some wetlands may have a permanent water presence, while others might experience seasonal flooding or periodic inundation.
- **Frequency of Flooding:** Some wetlands might flood annually during the rainy season, while others might only flood once every few years during major storm events.
- **Seasonality:** The wetland hydroperiod can be highly seasonal, with distinct wet and dry periods throughout the year. The timing and duration of wet and dry phases can influence the types of plant and animal species.
- **Variability:** Climate variability, precipitation patterns, water management, and land use change can cause year-to-year variability in a wetland's hydroperiod.

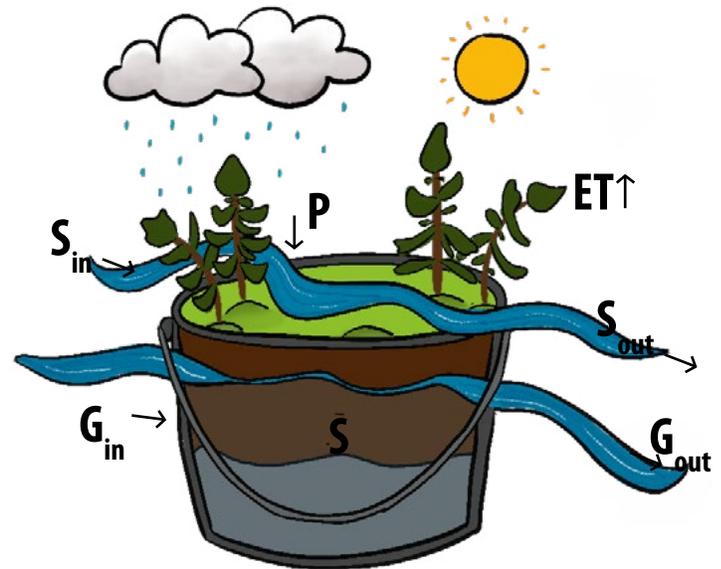


Figure 1. A wetland water balance can be described using a bucket analogy. S , represents the bucket and how much water the wetland stores, P , G_{in} and S_{in} represent inputs into a wetland, and ET , G_{out} and S_{out} represent outputs from a wetland.

2. Surficial Geology

The subsurface geology of wetlands influences how soils and sediment have layered (e.g. mineral or organic) and defines the potential storage, groundwater flow, and runoff processes.^{3,5}

3. Topography and Drainage Networks

Topography has little influence on wetland development in the western boreal forest.^{3,6} Wetlands tend to form in flat, gently undulating, to hummocky areas and are often associated with riverine systems. This topography creates drainage network that is not well-defined, trapping water and allowing for the formation of wetland complexes. Surficial topography greatly influences groundwater flow and functions as groundwater recharge.

4. Soil Type and Depth

Soil type and moisture regimes determine how much water can be stored within wetlands. Soils with higher clay content tend to retain more water compared to sandy soils. Organic wetlands, or peat, have the ability to store large amounts of water, resulting in high water tables and the establishment of water tolerant vegetation such as *Sphagnum* moss and black spruce. Soil depth influences wetland hydrology by affecting water infiltration and retention. Deeper soils may retain more water and allow water to remain in the wetland for a longer period of time.

Water Flow Pathways

How water flows in and out of wetlands depends on **wetland type**. Water can flow in and out of wetlands, particularly in organic wetlands, as surface water, sub-surface water, or groundwater. The movement, quantity, and speed of water through organic wetlands depends on:

- **Porosity:** pore space in soil that can be occupied by water or air. For example, increased peat porosity results in faster water movement through the peat profile.
- **Peat Composition:** Peat can be composed of decomposed mosses, sedges, or woody material, depending on peatland type. Different types of peat result in different levels of conductivity.
- **Decomposition:** Less decomposed soils have greater conductivity due to higher porosity (more/ bigger gaps between solids), while more decomposed soils have reduced conductivity due to lower porosity (fewer/ smaller gaps between solids).

In the western boreal forest, groundwater flow governs the flow dynamics, as surface runoff is less common due to the limited amounts of excess water.³ In organic wetlands, surface runoff occurs as a result of influxes of water input into the system (i.e. increased precipitation) and periods of **high-water tables**.⁵ Whether there is a surplus of water that can move around the landscape is dependent on groundwater storage capacity at different times of the year. For instance, if a wetland's storage is full, a slight rainfall may produce a more significant response, resulting in increased runoff. However, a significant rainfall event may not produce a large response if a wetland's storage is low.

NOT ALL PEAT IS THE SAME:

Not all peat is *Sphagnum*-dominated. Peat forms due to high water tables, low soil temperatures, and slow decomposition of plant materials.⁷ While *Sphagnum* moss is a dominant moss species found in peatlands, some peatlands can have sedge peat, woody peat, or mossy peat. The peat type is dependent on the vegetation communities present and can influence a peatland's hydrologic regime, such as the pH and water conductivity. Peat with high *Sphagnum* content usually has a lower pH than woody peat, and woody peat has lower water conductivity than mossy peat.



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