Hydric Soil Functions

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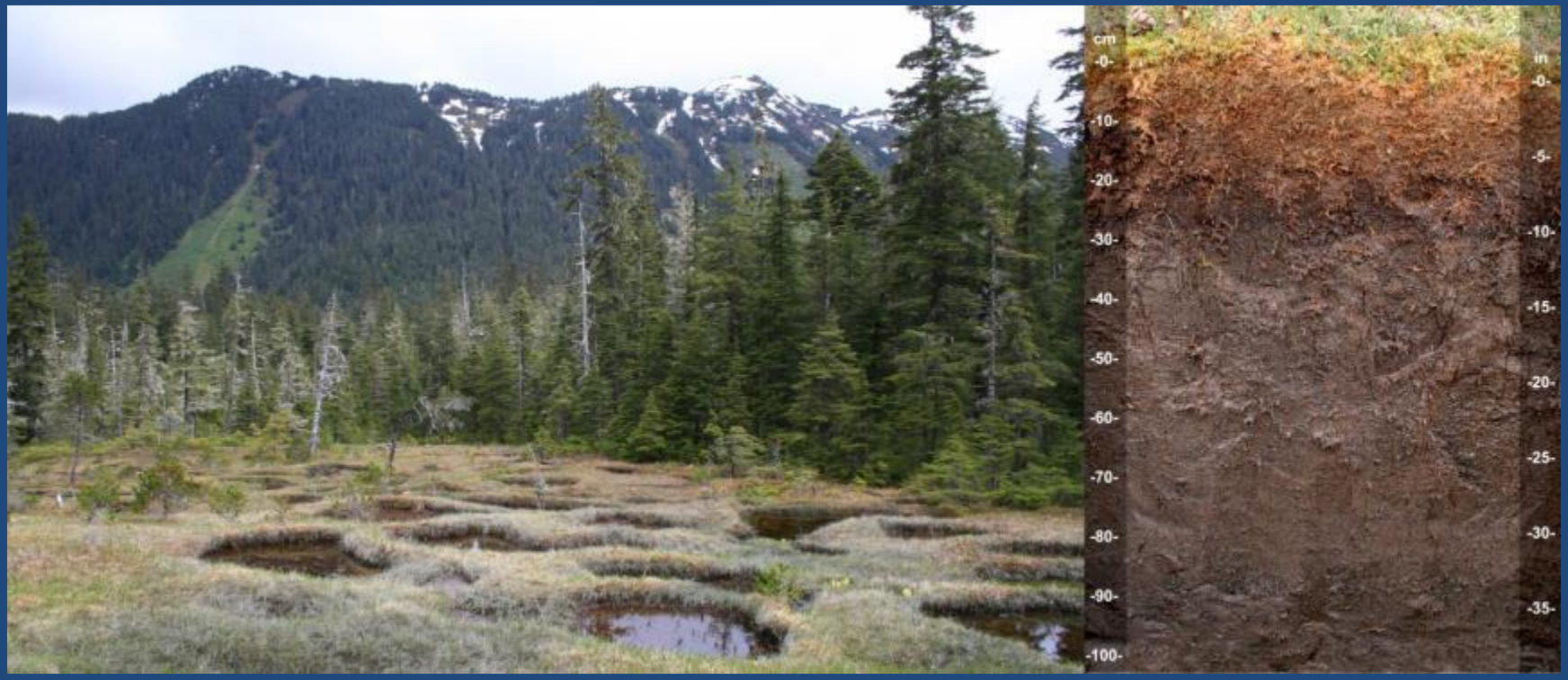


Photos courtesy of John A. Kelley; USDA, NRCS

Wetland Functions

- Wetland functions are the biological, chemical, and physical processes that occur in wetlands.
- Wetland functions are frequently classified as hydrologic, biogeochemical, or those functions that pertain to food webs and wildlife habitat.
- This module concentrates on wetland functions that are directly attributable to the soil component of wetlands-hydric soils.

Hydric Soil Definition

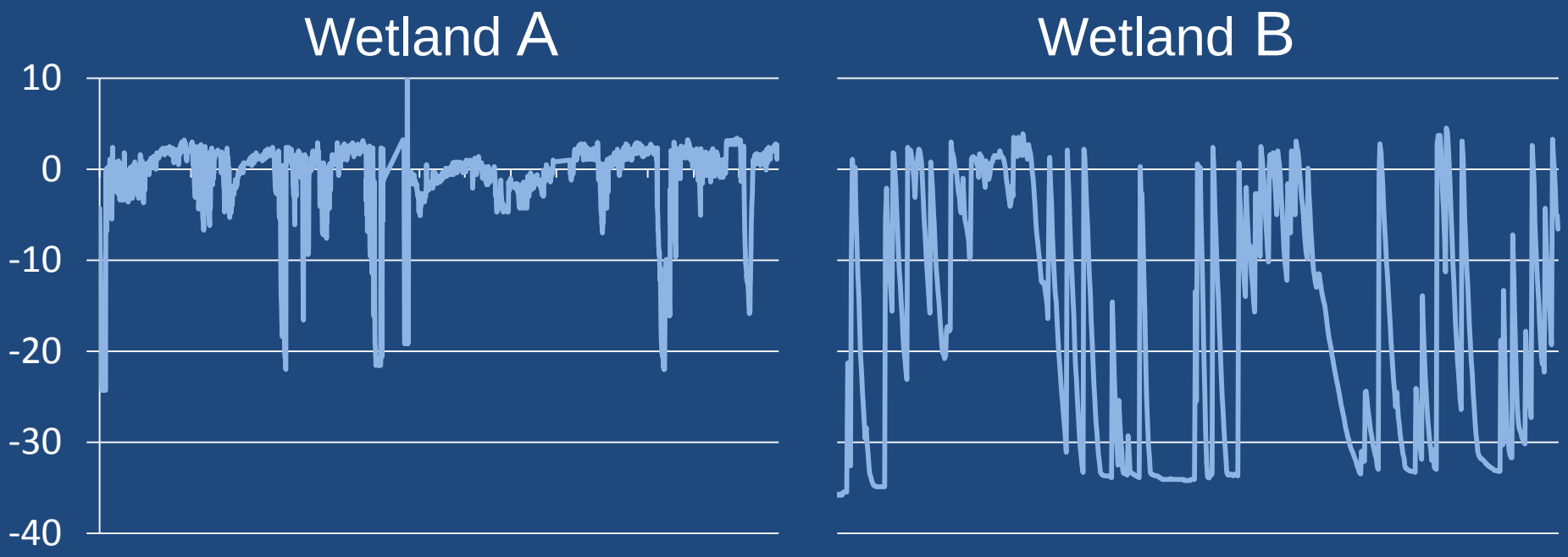
A hydric soil is a soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part.
(59 Fed. Reg. 35680, 7/13/94)

- Anaerobic: free oxygen is absent
- Aerobic: free oxygen is present

Hydric Soil Functional Capacity

- Landscape position & surface shape
- Hydroperiod: seasonal pattern of water table depth
- Hydrodynamics: energy and direction of water flow
- Residence time: time it takes a given amount of water to enter, move through, & exit a wetland
- Soil physical & chemical characteristics

Hydroperiod: seasonal pattern of water table depth (inches) in a wetland




With Respect to Functions,
Not All Wetlands Were Created Equal

Hydrologic Functions

- Hydric soils facilitate & regulate the flow of water between groundwater systems & surface water systems.
- Recharge: movement of water from surface water to groundwater.
- Discharge: release of groundwater to soil surface.
- Baseflow: portion of streamflow that comes from subsurface flow.

Hydrodynamics: energy and direction of water flow

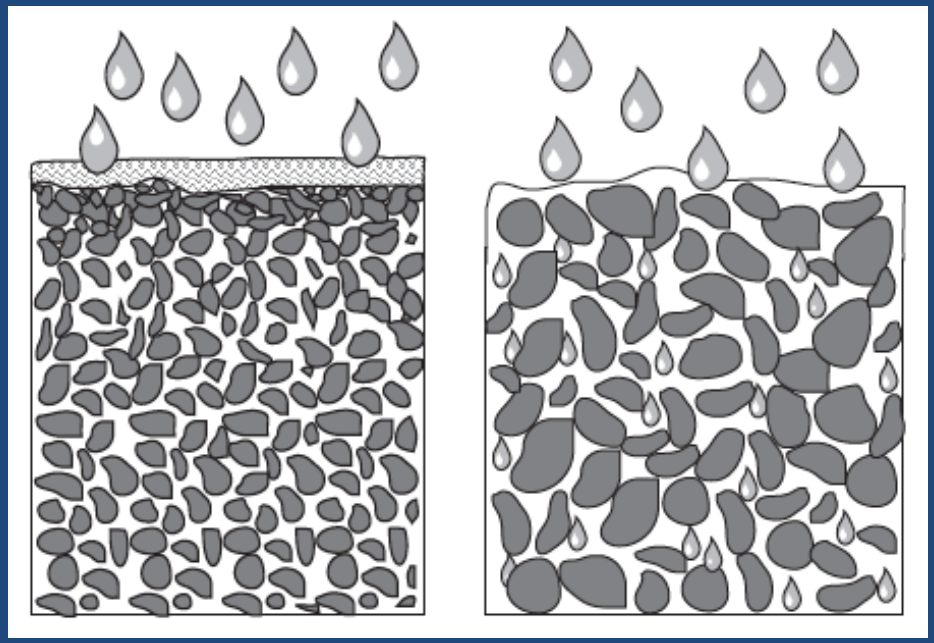
Hydrologic Function: Energy Dissipation

- **Reduction in the velocity of moving water**
- **Promotes sedimentation & infiltration**

Infiltration: movement of precipitation & surface water into soil

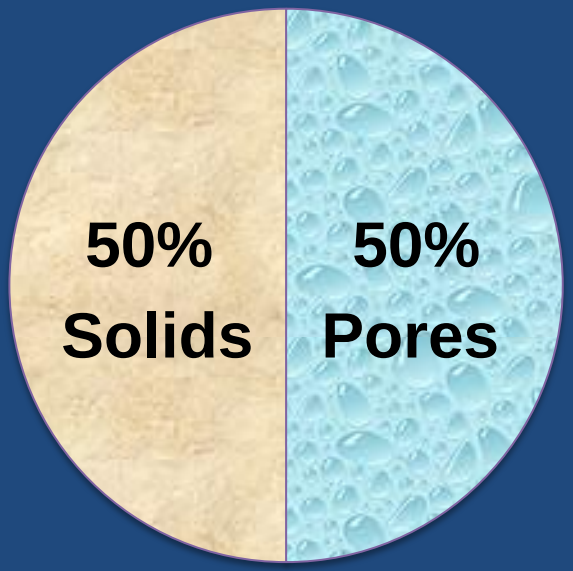
Surface factors that affect infiltration rate (inches/hour)

- Slope & surface shape
- Micro-topography & surface roughness
- Surface horizon characteristics: porosity & aggregate stability



Soil Factors That Affect Water Infiltration & Retention

- Porosity: % soil volume comprised of pores
- Bulk Density: soil dry wt. per unit volume



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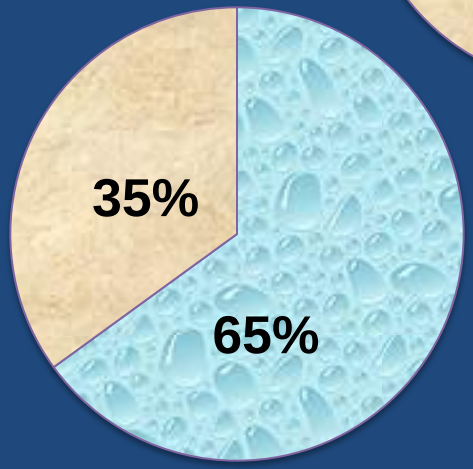

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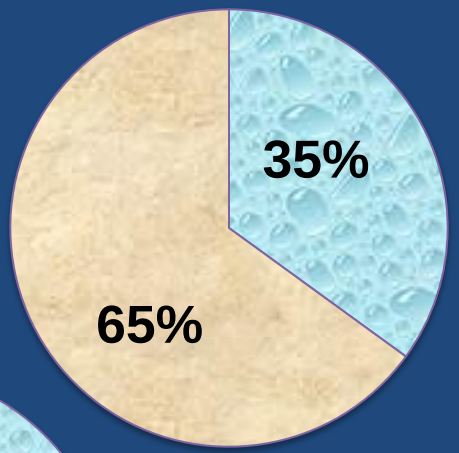

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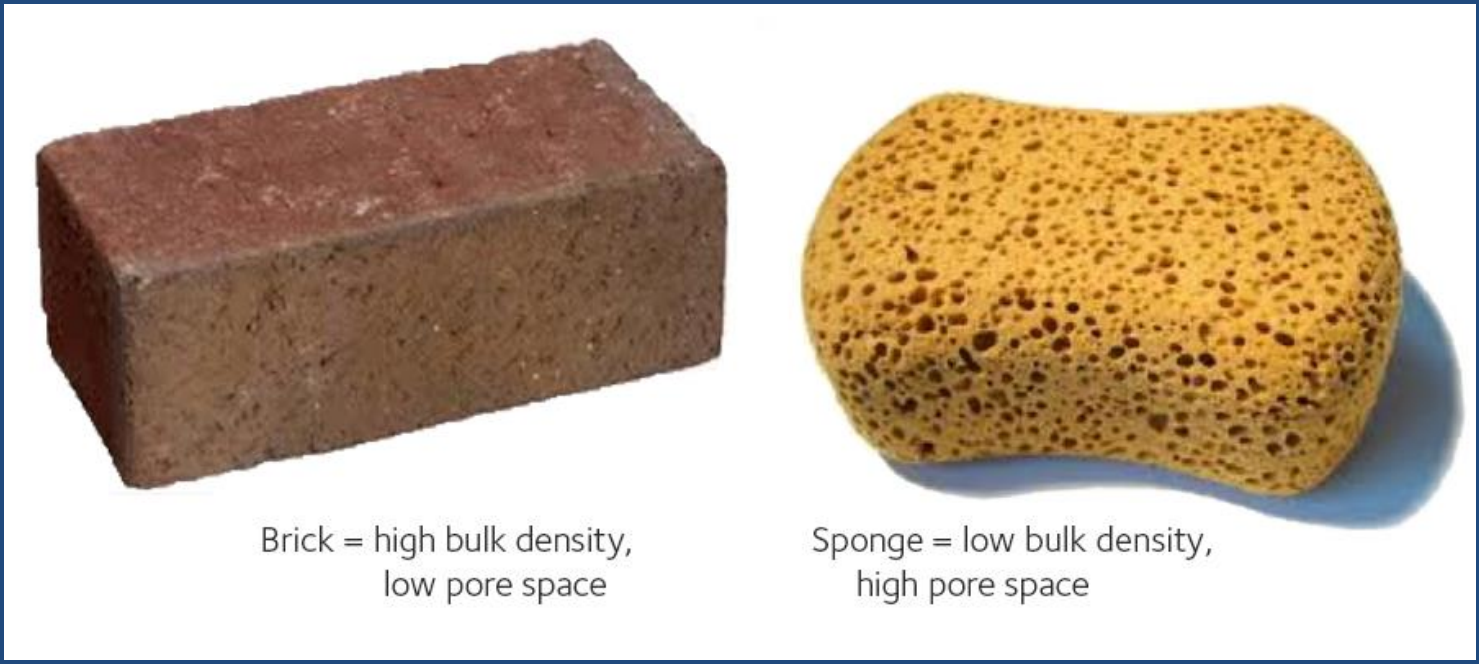
Hydrologic Functions: Water Absorption, Retention & Transmittal



Porosity: % soil volume comprised of pores
Bulk density: soil dry wt. per unit volume

Hydric Soil Characteristics That Impact Surface & Subsurface Water Retention

- Surface factors: slope, shape, micro-topography
- Soil thickness
- Depth to a confining layer
- Soil Porosity
- Hydroperiod


Hydrologic Functions: Subsurface Water Retention
& Groundwater Recharge

Hydrologic Functions: Surface Water Retention & Groundwater Recharge

Hydrologic Functions: Groundwater Discharge & Stream Baseflow Maintenance

Biogeochemical Functions

The efficiency of wetlands in biogeochem. cycling is directly linked to:

- the close proximity of aerobic and anaerobic zones
- the cycles of wet and dry periods in hydric soils.

Photos courtesy of John A. Kelley; USDA, NRCS

Sedimentation

- Sedimentation is the removal of particulate matter from a water column.
- Sedimentation is a relatively irreversible process that improves water quality by:
  - removing pollutants and pathogens adsorbed to the suspended solids
  - removing a source of turbidity
  - decreasing biochemical oxygen demand (BOD)—the quantity of oxygen (O) required to decompose organic matter and oxidize inorganic compounds such as sulfides

Soil Organic Matter Accretion

- Soil organic matter accretion (& soil C storage) is governed by 2 processes.
  - Primary productivity (C inputs)
  - Decomposition (C losses)
- Wetlands typically have higher rates of primary productivity than uplands-high C inputs.
- Periodic anaerobic conditions in hydric soils lowers decomposition rates-low C outputs.
- Hydric soils typically have higher levels of organic matter than geographically-associated upland soils.

Carbon (C) Sequestration

- Soil C sequestration describes the removal of atmospheric CO_2 & long-term storage of the C in soil.
- Soil C may be mineral (e.g., carbonates) or organic.
- Soils are the largest C reservoir in the terrestrial C cycle

Carbon Export

- Carbon export is the loss of C from soil.
- Atmospheric export-C losses as methane (CH_4)
- Hydrologic export-transport of particulate and dissolved organic matter down a hydrologic gradient
  - Surface water: supports aquatic macroinvertebrate food chain
  - Groundwater: drives redox processes in biogeochemical cycling

Cycling of Redox Sensitive Elements

- Molecular form of nitrogen, phosphorous, sulfur, & many metals is affected by soil chemical conditions and oxygen levels.
- Anaerobic conditions increases solubility of phosphorous, iron, manganese, arsenic, copper, nickel
- The *combination of aerobic & anaerobic conditions* found in hydric soils promotes the cycling of plant nutrients & the removal of pollutants from the water column.

Nitrogen (N) Removal

- Primary pathways for N removal are plant assimilation & denitrification (microbial conversion of nitrate to gaseous forms of N).
- Denitrification is dependent on organic carbon.
- Denitrification is promoted by alternating periods of aerobic & anaerobic conditions.
- Therefore, seasonally-saturated wetlands may be more efficient at removing N than permanently inundated wetlands.

Phosphorous (P) Removal

- Primary processes for P removal
  - Sedimentation
  - Plant & microbe assimilation
  - Adsorption to iron & aluminum minerals in soil
  - Complexing with free iron & aluminum
  - Hydrologic export in particulate or dissolved form
- In many cases uplands or upland/wetland mosaics are better at removing P.
- An upland buffer between wetlands and surface water will increase P removal.

Functions Pertaining to the Food Web & Wildlife Habitat

Saturation→Anaerobiosis→Shade intolerant plants→Unique habitats

Hydric Soils & Wildlife Habitat

- Long-term inundation
  - Open-canopy wetlands
  - Low bulk density soil: burrowing
- Seasonal inundation-vernal pools
- Shallow water tables promote tree throws-vernal pools.

Hydric Soil Biogeochemical Functions Support Aquatic Macroinvertebrates

- Hydrologic export of organic matter: food source for many aquatic macroinvertebrates
- Removal of pollutants: many aquatic macroinvertebrates (e.g. larvae of mayflies & stoneflies, & gilled snails) can't tolerate polluted water.

Summary

1. Hydric soils facilitate & regulate the flow of water between groundwater systems & surface water systems.
2. Biogeochemical cycling is dependent on the combination of aerobic & anaerobic conditions in hydric soils.
3. The capacity of hydric soils to retain water & develop anaerobiosis promotes specific plant communities & unique wildlife habitats.

Many field-observable soil features can be used as metrics in functional assessment of wetlands.