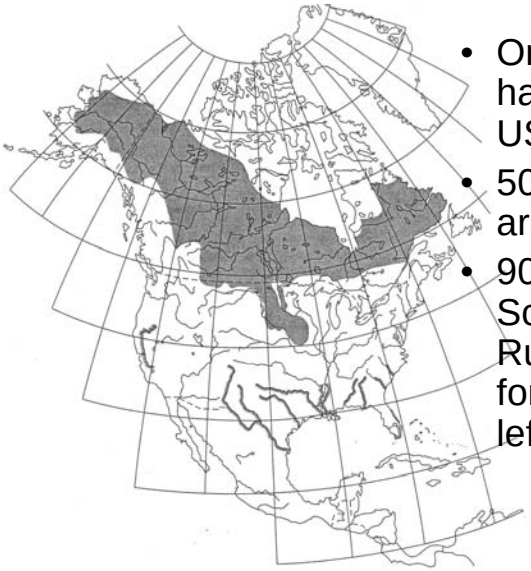
Riparian and Wetland Ecology

Reading: Knight, Ch. 4

Clean Water Act: “no net loss”

- If wetlands are disturbed or destroyed, mitigation must restore old wetlands or create new ones
- National Research Council recently reported that current wetland policy is a “failure” (www.nap.edu/books/0309074320/html)
- Half of wetlands now gone due to drainage (“reclamation”)
- Only 11% of Iowa wetlands are left (in 1984)

Wetland distribution



- Originally >90,000,000 ha of wetlands in the US
- 50% of world's wetlands are in Canada
- 90% in Canada, Scandinavia, and Russia; peatlands formed in depressions left by glaciers

3

Definition of a wetland

- Ecotone or transition zone between upland and continuous water
- Legal definition is important; areas must be delineated
- USFWS, Army Corps of Engineers, EPA, and USDA settled on the following definition in 1989:
  - A wetland is any depression where water accumulates for seven consecutive days during the growing season, where certain water-loving plants (hydrophytes) are found, and where the soil is saturated enough with water that anaerobic bacterial activity can take place (hydric soil).

11/2/09

4

More recent EPA/Clean Water Act definition

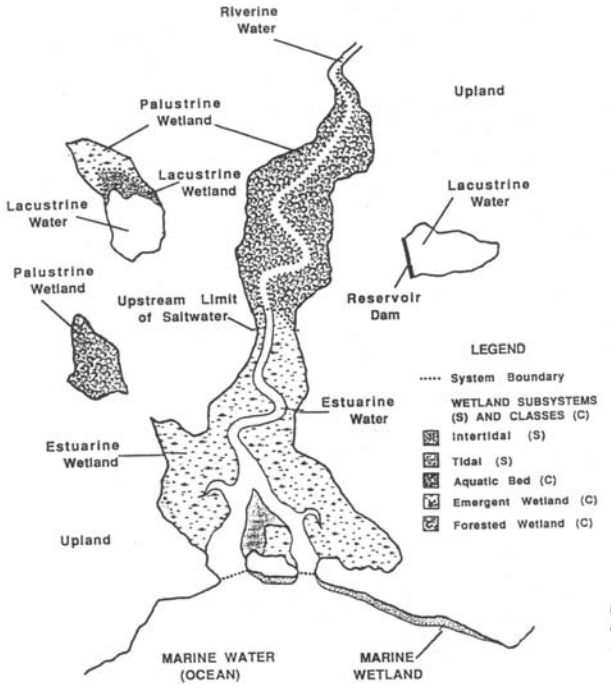
- "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions…" http://www.epa.gov/owow/wetlands/what/definitions.html
- Involves "navigable" waterways and waters that drain into them (this is the contentious part!)

11/2/09 5

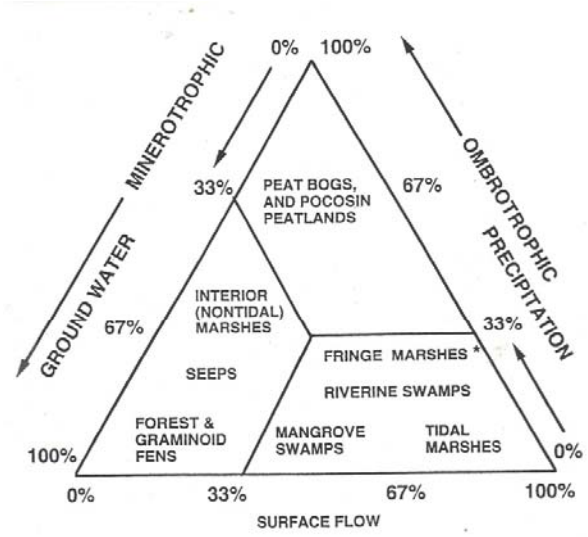
USFWS Classification

- Estuarine, associated with tidal marshes, mud flats, bays, coastal rivers where salt content is between 0.5 and 30 parts per thousand
- Riverine (riparian), associated with lotic (flowing) freshwater streams and rivers
- Lacustrine (lake), situated in lentic (non-flowing) water bodies where emergent vegetation is <30% cover and water <2 m deep
- Palustrine systems (inland marshes, bogs, swamps, etc.) make up >90% of wetlands globally

11/2/09 6



Wetland types have also been categorized based on water source, nutrient status, topography, and ecological similarity



Riparian ecosystems

- Riparian zones are areas immediately adjacent to streams and rivers; considered wetlands or transition zones between aquatic and terrestrial habitats
- High water table, periodic flooding
- Distinct vegetation and soil characteristics
- Extent of riparian zone determined by topography, aridity, presence of floodplain soils
- High productivity, species diversity, species density (plants *and* animals)

Riparian ecosystems

- Mosaics of landforms, communities and environments; patchiness contributes to biodiversity
- "Bosques" in southwest; "bottomland hardwood swamps" in southeast
- Migration corridors
- Vegetation traps sediment, aids in sediment storage; sediment and vegetation filter and clean the water flowing through
- Nearly 3,000,000 ha riparian forest lost in US between 1940-1980

Exchange of energy, nutrients, species between aquatic and terrestrial ecosystems

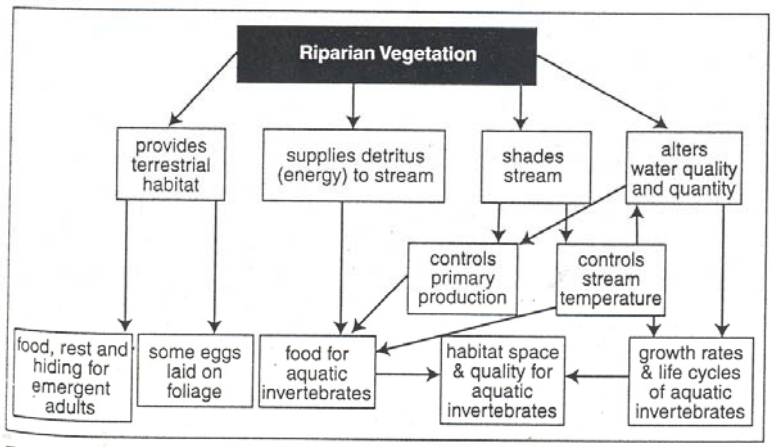


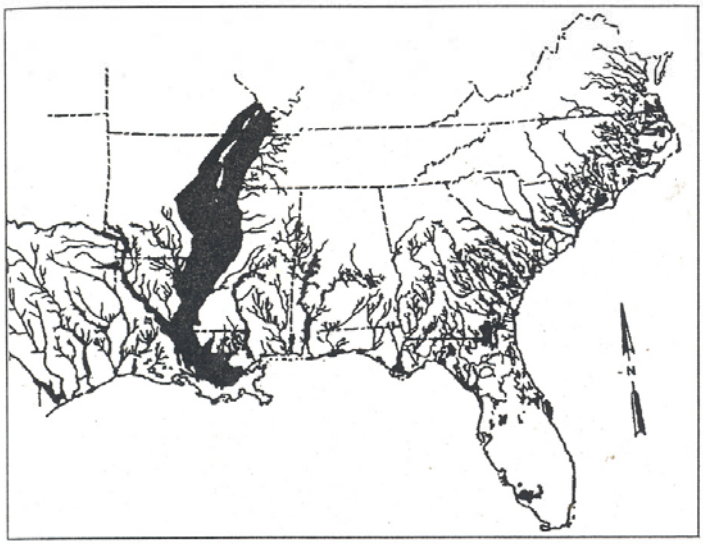
Figure 15-23 Some relationships between riparian vegetation and stream aquatic communities. (*After Knight and Bottorff, 1984*)

Swamps

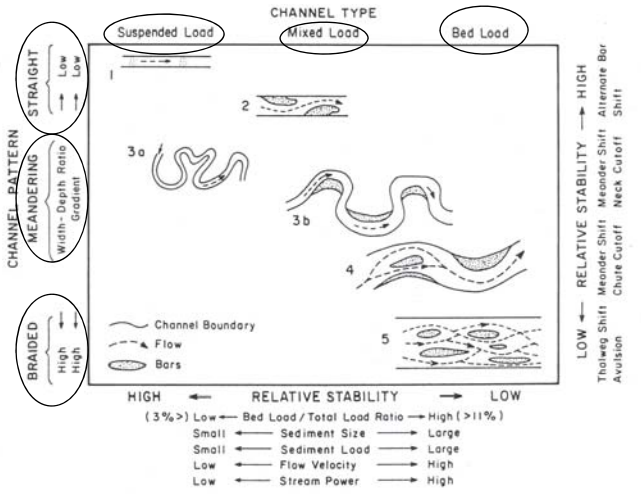
- Basically, marshes with trees
- Freshwater swamps are mostly riparian: Bald cypress in south, White cedar back east
- Saltwater swamps are estuarine: mainly mangrove vegetation

Bald cypress swamp, southern Illinois

Bottomland hardwood swamps prior to European settlement



Riparian ecosystem succession is governed by geomorphology



Low stability leads to dynamic vegetation patterns

Riparian geomorphology

- Braided, meandering, and straight channels have differing levels of resistance to changes in channel location (see figure on last slide)
- Braided channels found high-gradient valleys with coarse sediments
  - Typically in glacial outwash areas
- Meandering channels typically found in old, low-gradient floodplains with fine sediments
  - Thalweg of meandering rivers erodes outside of bends, forcing channel to become more sinuous
  - Point bar is deposited on inside of bend

Riparian geomorphology

- Straight channels may be bedrock controlled, or occur when stream power is high relative to channel stability
- Dams reduce sediment load and increase stream power, leading to erosion of point bars and channel straightening
  - Major consequences for riparian vegetation that is dependent on point bars for establishment

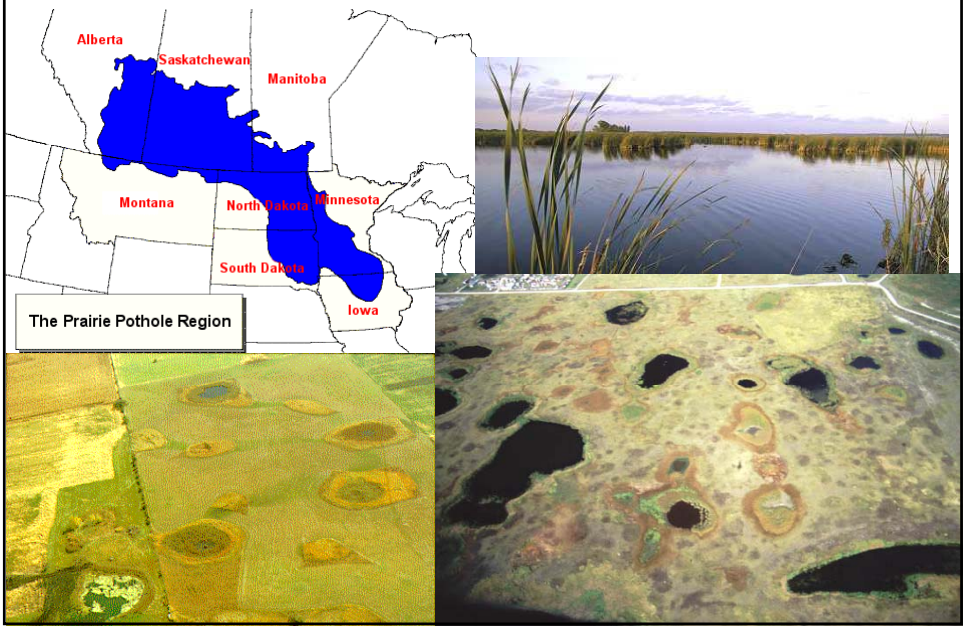
Marshes

- Shallow; light penetrates to the bottom
- Substrate is mostly mineral soil
- Eutrophic (mineral-rich)
- Emergent hydrophytes such as cattails, bulrushes
- Two major types:
  - Inland marshes, including prairie potholes, Everglades
  - Coastal (tidal) marshes

Marshes

- Both types can be freshwater, brackish or saline
  - Very saline (EC>45 deci-Siemens/m)
  - Moderately saline (15-45 dS/m)
  - Saline (2-15 dS/m)
  - Seasonal changes in salinity can occur: EC increased from 1.4 to 10 dS/m from May to September in a Candian prairie pothole
- Prairie potholes formed in kettle depressions, on impermeable till; where marine shales are in till, salts leach to surface during summer

Prairie Potholes

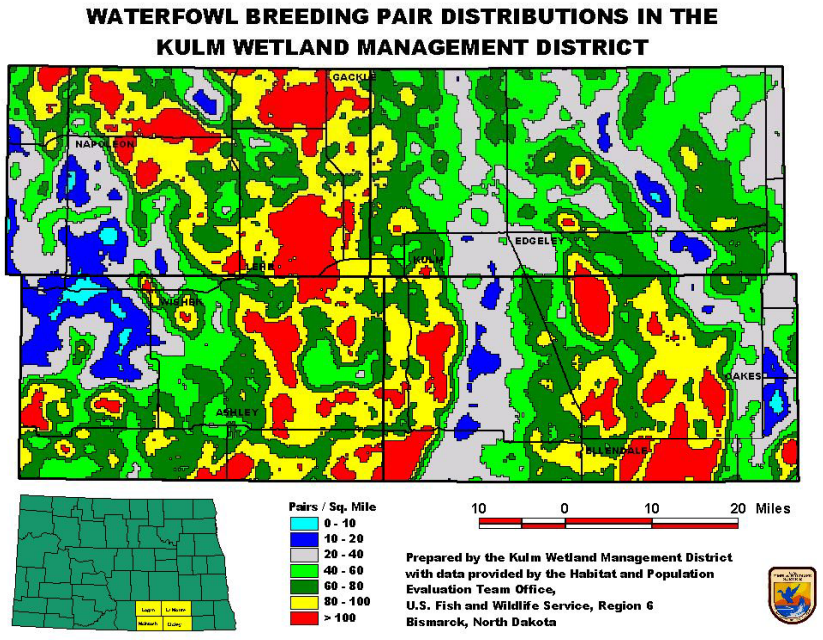


Prairie Potholes

- 300,000 square mile region
- Created by retreating glaciers, ~12,000 years ago
- Mosaic of wetlands scattered across N. Great Plains; up to 60% of area originally in wetlands
- Mixed grass prairie in west, tallgrass prairie in east
- Dynamic hydrology
- Strongly affected by drought

Prairie Potholes

- "Duck factory"
- 15-20 million birds breed there annually
- 60% of breeding population of mallard, gadwall, blue-winged teal, northern shoveler, northern pintail, redhead, and canvasback
- Low numbers in early 1990's following drought
- Numbers recovered rapidly in mid-90's
  - Drought ended
  - Red fox numbers were low
  - Ag land converted back to perennial grassland: CRP



Vernal pools in California

▲ Orcuttia, a genus of annual grasses endemic to vernal pools in California

Similar to prairie potholes, but not caused by glaciation

Endemic species

Mitigation of wetland loss?

11/2/09 23

Cyclic succession in prairie potholes

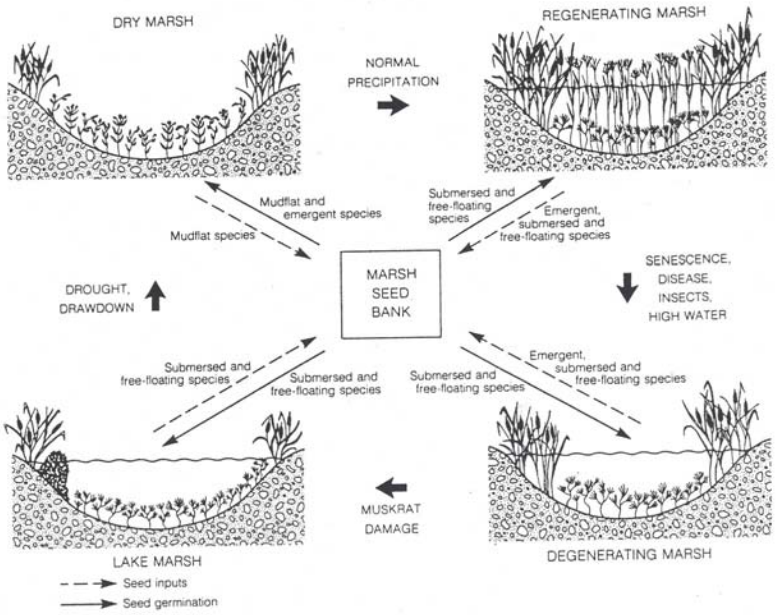
- Traditional view saw climate, and hence water levels, as static (decadal time scales)
- Periodic droughts drive cycles of succession
- Two basic states: flooded & drawdown; different species become established during each state
- Zonation may be important to avifauna

11/2/09 24

Cyclic succession (2)

- Drought may increase species diversity
- Regulation of water levels in wetlands to a constant height may be counterproductive
- Periodic disturbances are important in any ecosystem, for maintaining species diversity, patchiness, nutrient cycling, etc.
- Allogenic factors play a key role over short and very long periods, autogenic factors over intermediate time scales

Dynamics of prairie pothole ecosystems



Prairie pothole restoration

- CRP program pays farmers to return fields to native grasslands
- Potholes also being restored
- Vegetation structure (zonation) returns quickly
- Species composition depauperate
  - Seed banks lack natives
  - Isolation from seed sources
  - Competitive exclusion by invasive species
    - Cattails in hollows
    - Smooth brome in uplands

Peatlands

- Defined as having waterlogged, organic substrate, at least 30 cm of peat; Histosols
- Slow decomposition in waterlogged conditions sequesters carbon in the form of peat
- Two main types: fens and bogs, but there is a spectrum

Bogs

- Ombrotrophic (water source is precipitation)
- Oligotrophic (nutrient poor) and acidic (pH ~4)
- Primary source of nutrients is rain and snow
- Blanket bogs on upland
- Floating edge adjacent to open water
- *Sphagnum* & sedge (*Carex*) make up bulk of peat, but specialized plants such as sundew (*Drosera*), pitcher plant (*Sarracenia*), Labrador tea (*Ledum*) widely distributed (examples in Conservatory)
- Ericaceous shrubs are common (cranberries)
- Called “muskegs” in Canada; trees such as black spruce (*A. mariana*) and tamarack (*Larix laricina*) may be present

Fens

- Similar to bogs because they have peat, but dominated by sedges, grasses, and forbs
- Not acidic; pH is 6 or higher; tend to be minerotrophic rather than oligotrophic
- Water flows through mineral soils, from springs or seepage; picks up nutrients
- Can be on gentle slopes
- Everglades is a large example (originally 900,000 ha); alkaline but oligotrophic; peat formed from sawgrass (*Cladium jamaicense*); more than half has been converted to agriculture and urban use

Boreal peatlands

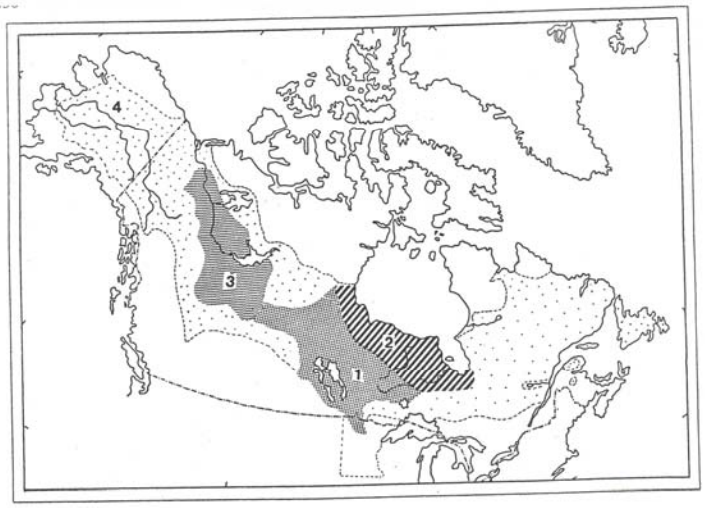
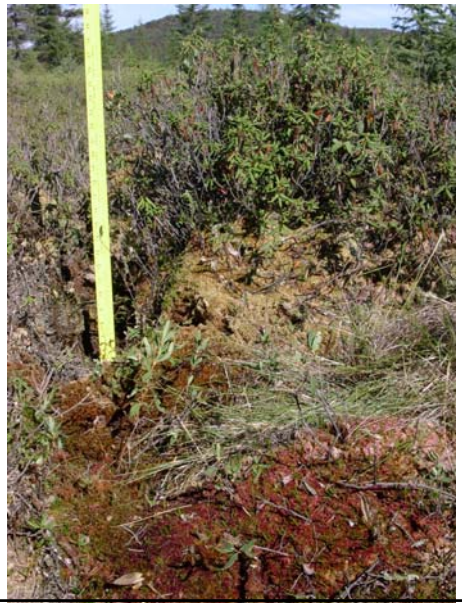


Figure 12.6. Major boreal peatlands of North America: (1) Glacial Lake Agassiz region, (2) Hudson Bay lowlands, (3) Great Bear/Great Slave Lake region, and (4) interior of Alaska, for which detailed peatland maps are not available. The lightly stippled area marks the boreal region (from Viereck and Little 1972; Rowe (1972); Glaser 1987; Zoltai and Pollett 1983).

Bloomingdale Bog, NY

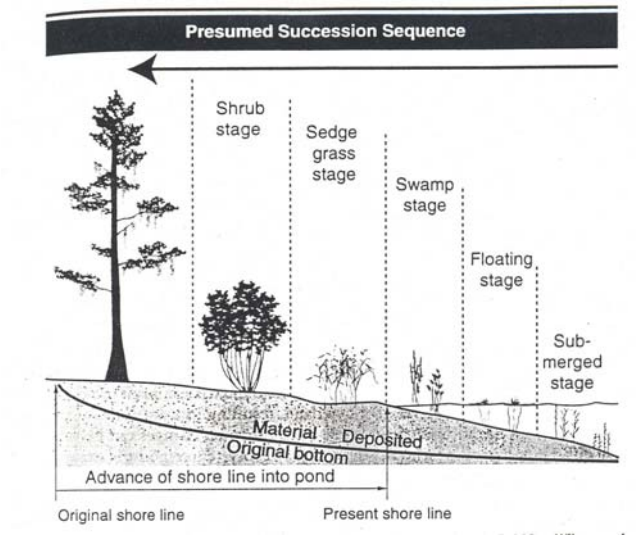
Hummock-hollow topography



Wetland Succession

- Wetlands are classic examples of succession, viewed as stages within a sere from pond to forested upland (hydrarch succession)
- Most bogs and fens have been developing over the last 10,000 to 12,000 years
- Note that dynamics in riparian wetlands is very different than in bogs or marshes

Classic hydrarch succession



Hydrarch succession

- Concentric zonation around a pond or marsh has been traditionally viewed as succession, but may not necessarily indicate succession
- May be a toposequence rather than a chronosequence
  - Different micro-environments and soils from the shore toward the deeper water
  - For example, deeper water has more silt, shallow water more sand
- Zonation may develop over time

Ombrotrophic bog succession

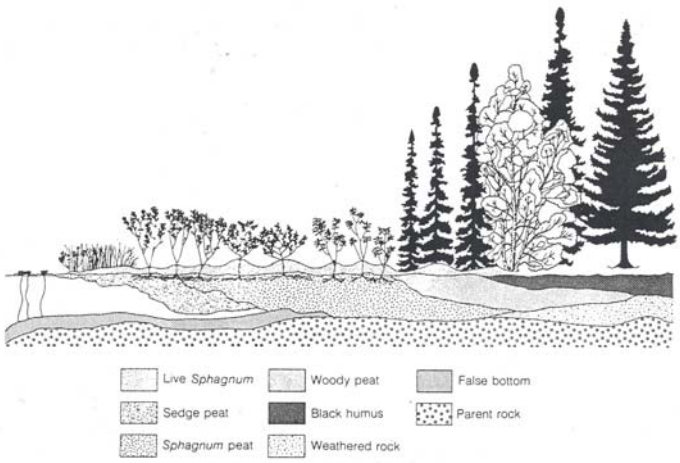
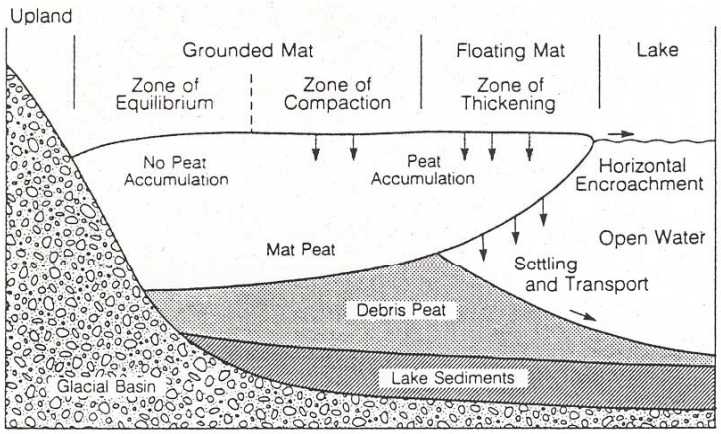


Figure 10.9 Transect through a typical bog in the boreal forest region of Canada showing the characteristic zonation generally attributed to successional development. (After Danserau and Segadas-Vianna, 1952.) (Reproduced with permission from P. Danserau and F. Segadas-Vianna, Ecological study of the peat bogs of eastern North America I. Structure and evolution of vegetation, *Canadian Journal of Botany*, 1952, **30**, 499.)

Ombrotrophic bog succession



Beavers as keystone species in wetlands

Succession of macrophytes in beaver ponds in Minnesota peatlands