Wetlands[1]

Definition – Areas where water is the primary factor controlling the environment and associated plant and animal life. These transitional habitats occur between upland and aquatic environments where the water table is at or near the surface of the land, or where the land is covered by shallow water that may be up to 2 meters deep. Most wetlands are dominated by hydrophytes, or wetland plants; these can tolerate various degrees of flooding or live in frequently saturated areas. Most wetlands are characterized by fluctuating water levels and by soils that are distinctly different from those of dry upland areas. Rivers, streams, lakes, and ponds are often associated with wetlands.

Perhaps the most comprehensive was adopted by the U.S. Fish and Wildlife Service in 1979: "Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered with shallow water…wetlands must have one or more of the following characteristics: (1) at least periodically, the land supports predominately hydrophytes, (2) the substrate is predominately undrained, hydric soils, and (3) the substrate is saturated with water or covered with shallow water at some time during the growing season of each year. Can you envision some problems with interpretation of this definition?

Wetland systems
Marine &
Estuarine:
Coastal, saltwater (and brackish) systems (tidal marshes, mangrove swamps)
Lacustrine,
Riverine, &
Palustrine:
Freshwater systems – accounting for 90% of US wetlands. Lacustrine systems are associated with lakes; riverine with rivers; palustrine systems are marshes, swamps, bogs.

Marshes
Support soft-stemmed herbaceous plants (e.g., sedges and grasses) known as emergents (partly in, partly out). Deeper marshes support floating vegetation such as water lilies and carnivorous bladderworts. Some marshes dry out completely on an annual basis or less often. (Everglades, Prairie Pothole region)

Swamps and Floodplain Forests (bottomland hardwoods)
Dominated by woody plants (i.e., trees and shrubs). Cypress forests, gum swamps, willow and alder thickets and swamp chestnut oak forests are examples. Pocosins are found in the Carolinas, boggy shrub wetlands with hollies, bay trees, and stunted pond pine, and are often underlain with peat.

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[1] Some of this information from: Niering, W.A. 1985. Wetlands. The Audubon Society Nature Guides. Alfred A. Knopf, Inc., New York, NY.

Bogs
Usually found in previously glaciated areas (though Kentucky has a few), are underlain with peat, and without mineral soils. Conditions are usually very acidic. Peat is formed by the build up and slow decomposition of plant material in places of high acidity and poor drainage where bacteria cannot survive. Sphagnum moss is often the dominant ground cover. Laurel shrubs, orchids, pitcher plants, larch, tamarack, and Atlantic white cedar are often found here.

Rivers and Streams
The nature of these systems is largely dependent upon water flow. Anchored plants and animals often are associated with fast-moving streams; large amounts of organic matter accumulation often characterize slow-moving rivers.

Lakes and Ponds
Standing water usually persists throughout the year – the former are larger and deeper, the latter smaller and shallower. Greater temperature gradations are associated with lakes. Higher latitude lakes are usually less productive due to colder temperatures. These are oligotrophic (like Lake Tahoe). Warmer lakes can accumulate nutrients and become mesotrophic and, eventually eutrophic (like Lake Okeechobee). Eutrophication is often caused by sewage and other artificial inputs of organic material and nutrients such as nitrogen and phosphorus. Their origins may be glacial, erosion (such as karst), volcanic, and human-made. Lakes may turn into marshes or other wetlands with sufficient time and the buildup of silt, sediments, and organic matter. Reservoirs built in stream systems fill up unusually quickly with sediments.

Wetlands Management

Wetlands mitigate flooding, provide habitat for waterfowl, filter pollutants, and stabilize the biosphere (oxygen production, nitrogen cycling, methane sinks - helps in regulating the ozone layer).

Dredging for boat traffic, draining for agriculture, diversion for drinking water, channeling for flood control, diking for flood control, flooding for mosquito control, poisoning from acid mine drainage, siltation from farming and clearcutting, mining for peat, cultivating cranberry bogs, temperature change from loss of forest canopy, flow interruption from hydroelectric and other dams, degradation from untreated sewage, pollution from industry and suburbia, intense recreation, acid rain, mineral and oil runoff from highways, introduction of exotic species (>70 fish species established in North America)....
What else has impacted wetlands negatively?

In the 1800s wetlands were viewed by the U.S. Congress as things to be “reclaimed.” Thus, they passed the Swamp Wetland Acts that gave 65 million acres of land to 15 states for draining. Less than 50% of the wetlands that existed 400 years ago remain. In the 1600s the U.S. had 215 million acres; by the 1970s only 99 million acres remained.

Increasingly, wetlands are viewed as integral parts of larger systems including wetlands. The quality of a wetland is by no small measure determined by the activities on adjacent uplands.
Barry Commoner's 4 laws of ecology are particularly relevant to wetlands:
1) Everything is connected to everything else;
2) Everything must go somewhere;
3) Nature knows best; and
4) There is no such thing as a free lunch

Wetland Processes:
Energy Flow - the food chain often begins with microscopic organisms floating in water (phytoplankton is fed on by zooplankton which are fed on by small fish and insect larvae, etc.). In the Everglades: plants - apple snails - snail kites.
Nutrient Cycling - Detritus is produced by feeding activities of bacteria, worms, and aquatic insects. This process releases nutrients and organic compounds that help sustain the wetland ecosystem.
Productivity - Wetlands are among the most productive ecosystems in the world - because of their ability to capture large amounts of the sun's energy and store it as chemical energy, and because wetlands are often efficient recycling systems (maybe not so much in bogs and fast-moving rivers and streams). What about wetland "crops"? Rice, sugar cane, waterfowl, crayfish, catfish, muskrat, beaver.
Groundwater Recharge - Wetlands act as natural filter and reservoirs for human water supplies.

Management History – disdain and repulsion for wetlands permeated the views of most western Europeans. Terms like "bogged down" and "swamped" have negative connotations and reflect such negative attitudes. As such, wetlands in the U.S. and most of Europe have been systematically drained and filled where economically and technically feasible. For example, George Washington owned a part of the Great Dismal Swamp Company in Virginia that attempted to drain this now greatly diminished bald cypress-tupelo swamp in southeastern Virginia. Many cities, such as San Francisco, Washington D.C., and Chicago, are largely built atop former wetlands.

Some of the earliest and most vocal advocates of wetland protection were waterfowl hunters. Beginning in the early 20th century, hunters begin to purchase wetland habitat in an attempt to stave off declining populations of waterfowl. The political cartoonist **Jay "Ding" Darling** helped popularized wildlife conservation, particularly that for waterfowl and their habitat by publishing scathing cartoons that portrayed political and industrial institutions and leaders as wanton destroyers of nature. Further, Darling designed and made popular the **Federal Duck Stamp** of which the sale of for hunting purposes has generated millions of dollars for waterfowl and wetland protection.

However, these efforts did little to protect wetland ecosystems not particularly important to waterfowl. It wasn't until the 1970's that wetland protection increased significantly as scientists began to understand their ecological and utilitarian importance. Whereas federal policies had once encouraged the destruction of wetlands, they now began to focus on protecting them. The **Army Corp of Engineer**s (ACOE) was granted the authority under section 404 of the Clean Water Act in a court case (*Zabel v. Tabb*) to establish a permit system to regulate the dredging and filling of materials in the "waters of the U.S." ACOE interpreted this narrowly, and applied such powers only to navigable waters. However, 2 important federal court decisions (1974-75) mandated that ACOE expand its dredge-fill permitting authority to include non-navigable waterways, including wetlands. As such, **wetland delineation**, or the determination of whether a property is a wetland based on certain distinguishing characteristics, became necessary to determine whether a landowner had to apply for an ACOE permit if land development was desired.

President Jimmy Carter issued 2 important executive orders; one (11990) that required all federal agencies to consider wetlands protection as a part of their policy, and one (11988) that established similar protection for floodplains and discouraged destructive agency activity in these areas.

In 2001, the U.S. Supreme Court ruled (5-4) that ACOE only had jurisdiction over navigable waterways. This ruling essentially left isolated wetlands with no federal protection and vulnerable to be dredged and filled by the landowner. Soon afterwards, the Bush administration began to retool its interpretation of the Clean Water Act and wetland policies that would eliminate most oversight over isolated wetlands and weaken existing protections. However, public outcry from hunters, conservationists, and others recently caused the administration to temporarily halt initiatives to reinterpret wetland policies. Still today, **there is no specific national wetlands law**.

Current Status of Wetlands - Today, over 53% of all wetlands in the U.S. have been drained, including over 80% of that once found in Kentucky.

Wetland Values (Mitsch and Gosselink 1995)

1. Animal and plant habitat – a number of invertebrates (e.g., shellfish, crayfish), fish (e.g., salmon, catfish), herps (e.g., Alligator, salamanders, water snakes), rodents (e.g., muskrat, beaver), large mammals (e.g., moose, otter), and birds (50% of all U.S. breeding birds) rely on wetlands; about 50% of all U.S. endangered species depend on wetlands.
2. Timber and Vegetation Harvest – (e.g., Bald cypress trees for lumber, peat for energy)
3. Flood Mitigation – Wetlands influence regional hydrological regimes by intercepting and storing storm runoff, thereby slowing discharge into the surrounding landscape.
4. Storm Abatement – Coastal wetlands can buffer inland areas from storms.
5. Aquifer Recharge – Some wetlands can recharge underground water aquifers

6. Water Quality – Wetlands can remove inorganic and organic nutrients and toxic materials from water that flows through them.
7. Nutrient Cycling – wetlands can significantly alter nitrogen, carbon, and other nutrient cycling.
8. Aesthetics – wetlands serve as visually rich environments that people can enjoy and recreate in (e.g., Everglades National Park).
9. Subsistence – some cultures depend on wetlands (Marsh people of Iraq).

Wetland Restoration and Construction

1. **Wetland restoration** – rehabilitation of wetlands that may be degraded or hydrologically altered; often involves vegetation replacement.
2. **Wetland creation** – refers to the construction of wetlands where they did not exist before; often involves alterations to existing soils and hydrology.

Section 404 of the Clean Water Act is largely enforced by the Army Corp of Engineers (ACOE). Since 1988, the U.S. has largely adopted a policy of "no net loss" that requires developers to restore existing, or more usually create new wetlands of similar acreage to that destroyed during the development process. These **mitigation wetlands** are built with the intent of replacing the wetland function and usually in the same or adjacent watershed.

Wetland construction is a commonly used tool by ecological engineers to: 1) create pond or marsh habitat for consumptive or non-consumptive plants and animals 2) create conditions to reforest valuable riparian hardwoods 3) treat waste water 4) control acid mine drainage 5) to buffer coastal or flood-prone river areas

Calculating a water budget - What processes make a wetland wet? Wetland hydrology is the summation of hydrologic inputs and outputs into the system and can be calculated as follows:

$$\Delta V/\Delta t = P_n + S_i + G_i - ET - S_o - G_o \pm T$$

Where $\Delta V/\Delta t$ = change in volume over time (m^3/day), P_n = net precipitation (precipitation – intercepted precipitation); S_i = surface inflow; G_i = groundwater inflow; ET = evapotranspiration; S_o = surface outflow; G_o = groundwater outflow; and T = tides