Puget Lowland Freshwater Wetlands

What is a wetland?

"Wetlands are 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. Wetlands generally include swamps, marshes, bogs, and similar areas." - Definition of wetlands as used by the U.S. Army Corps of Engineers (Corps) and the U.S. Environmental Protection Agency (EPA) since the 1970s for regulatory purposes (USEPA, no date)..

In more common language, wetlands are areas transitional between terrestrial and deep-water habitats, where the frequent and prolonged presence of water at or near the soil surface drives the natural system -- meaning the kind of soils that form, the plants capable of growing there, and the fish and wildlife communities that use the habitat.

The Physical Environment of Wetlands

Hydrology. Wetland hydrology – the source(s), presence, and persistence of water for significant periods of time -- is the key defining characteristic of wetlands. When soil near the ground's surface is saturated with water, oxygen is driven out of the pore spaces between soil particles, creating anoxic – oxygen-free – conditions. Wetland hydrology exists when an area is wet enough for long enough to result in soils that are anoxic for a significant portion of the growing season. This has important implications for soil characteristics and for vegetation communities.

Everyone can recognize a wetland when that wetland is a pond or a lake with permanent standing water. However, many wetlands have a naturally fluctuating hydrology and may be dry at times, making recognition of these wetlands less obvious to the general public. People who identify wetlands for a living learn to use soil characteristics and plant communities as indicators of wetland conditions, even when standing water or squishy soils are not present. [You can, too!]

Soils. Soils that are waterlogged (or saturated) for significant parts of the year develop distinctive characteristics (such as color, texture, and soil chemistry) and are known as *hydric* soils. In saturated conditions water fills the air spaces between soil particles and forces the oxygen out, causing soils to become anaerobic or anoxic (depleted in oxygen). Anaerobic conditions slow decomposition, frequently resulting in an accumulation of undecomposed or partially decomposed dead organic[1] plant material in wetland soils.

Some sites have impermeable layers underneath them formed by bedrock, clay layers, or, in glaciated areas, glacial 'hardpan.' These hard subsurface layers may keep water ponded on the surface much longer than would occur otherwise, resulting in wetland hydrology in unexpected places.

Most wetland soils have high amounts of organic carbon and nutrients compared to nearby upland soils. This relatively high concentration of organics contributes to the significant

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[1] In chemistry, the term *organic* means there is a lot of the element Carbon involved. Soils composed in large part of organic materials are called organic soils. Soils composed primarily of non-plant material are known as mineral soils. Mineral soils are described based on the size of the predominant soil grains -- sand (the largest), silt, and clay (the smallest) – and their proportion in the soil. Sandy soils are the most permeable, allowing water to move through easily. Clay soils are the least permeable and hold onto soil moisture the longest.

biological productivity of wetlands. Organic material provides energy for soil microbes to recycle nutrients and to convert nitrogen to organic forms that encourage plant growth.

Soil scientists can identify hydric soils by their color and structure. Often organic, anaerobic soils are dark grey to nearly black. In more mineral soils, the chemistry of hydric soils affects minerals such as iron and manganese causing distinctive color variations.

Vegetation. All plant roots require oxygen. Wetlands are hostile environments for plant species that have not developed special adaptations to supply oxygen to their roots under anaerobic conditions. Plants which are adapted to these conditions are referred to as *hydrophytes* (hydro- = water; -phyte = plant), and wetland plant communities are often referred to as hydrophytic vegetation. There are many types of hydrophytic plants, including those that float on the water, plants (e.g., duckweed), floating-leaved plants (e.g., pondweed, yellow pond lily), emergent plants (e.g., cattails, bulrushes), submerged plants (eel grass), and others.

Types of Freshwater Wetlands

Open water. Open water wetlands may have no visible vegetation but may have free-floating surface or submerged plants that are not rooted in the substrate (e.g., duckweed [*Lemna minor*]) or unrooted submerged plants (e.g., coontail [*Ceratophyllum demersum*]).

Aquatic-bed. Aquatic beds occur in relatively shallow, permanently inundated areas between marshes and deeper-water environments of ponds and lakes. The plant community is characterized by floating-leaved herbaceous species which are rooted in the substrate. Yellow pond lily (*Nuphar polysepalum*), pondweeds (*Potamogeton* species), and water shield (*Brasenia schreberi*). Unrooted floating species such as duckweed may also be present.

Marsh. A marsh is a wetland dominated by herbaceous vegetation such as cattail (*Typha latifolia*), grasses, sedges (*Carex* spp.), bulrushes (*Scirpus* spp.) and rushes (*Juncus* spp.). Marshes may or may not be permanently inundated.

Swamp. A swamp is a wetland dominated by woody vegetation. There are two kinds of swamps:

Scrub-shrub wetland (aka. shrub swamp) – A wetland dominated by woody vegetation less than six meters (20 feet) tall. The characteristic vegetation of scrub-shrub wetlands includes willows (*Salix* spp.), Douglas spiraea (*Spiraea douglaii*), red-osier dogwood (*Cornus sericea*), Pacific ninebark (*Physocarpus capitatus*), and other species. A variety of sedges, grasses, and forbs may be present under the shrubs.

Forested wetland – A wetland with a canopy of trees greater than six meters (20 feet) tall. The canopy may include red alder (*Alnus rubra*), black cottonwood (*Populus trichocarpa*), Oregon ash (*Fraxinus latifolia*), western red cedar (*Thuja plicata*), Sitka spruce (*Picea sitchensis*), Pacific crabapple (*Malus fusca*), or a few other tree species. An understory of shade tolerant shrubs and herbs may include salmonberry (Rubus spectabilis), red-osier dogwood (*Cornus sericea*), skunk cabbage (*Lysitchiton americanum*), Pacific water parsley (Oenothera *sarmentosa*), slough sedge (*Carex obnupta*), and other species.

Bog. Bogs differ from other wetlands in that they generally have no significant inflow or outflow, and are thus nutrient-limited. The classic bog dominated by *Sphagnum* moss develops an acidic water chemistry that, along with the nutrient limitations, promotes development of a highly specialized flora including such bog-specialists as Labrador tea (*Rhododendron groenlandicum*), bog laurel (*Kalmia microphylla*), bog cranberry (*Vaccinium oxycoccus*), sundew (*Drosera* spp.), and a few others.

Adaptations of Wetland Plants

Wetland habitats are not like other habitats in that their soils are waterlogged for significant portions of the growing season. As mentioned before, when soils are waterlogged – or saturated – the air that occurs within pores in the soil is driven out, resulting in oxygen-free or anoxic conditions in the rooting zone. Anoxic conditions are hostile, and frequently lethal for most terrestrial plants. Hydrophytes possess specialized adaptations for survival in wetland habitats, especially anoxic soils. Of course there are tradeoffs, and extreme hydrophytes may perform poorly (or fail completely!) in drier areas.

Wetland stresses resulting from anoxic soil conditions

- Anaerobic respiration is grossly inefficient compared to aerobic respiration, leading to rapid depletion of stored energy (carbohydrate reserves).
- Anaerobic respiration produces toxic metabolic byproducts that can be harmful to the plant.
- Inefficiencies and depletions lead to slowdown/shutdown of key metabolic processes, (photosynthesis, transpiration, nutrient uptake), exacerbating energy depletion.
- Anoxic soils produce chemically reduced forms of iron, sulfur, and manganese which are toxic to plants.

Adaptations to Anoxic Environments

anaerobic respiration – Anaerobic respiration is cellular respiration in the absence of oxygen. When possible, aerobic respiration provides far more energy at far less cost in reserves. But when oxygen is lacking, anaerobic respiration at least allows an organism to function – for a while.

aerenchyma – Large air spaces in roots, stems, and leaves allow the diffusion of oxygen from the aerial portions of a plant into the roots. Unlike the natural porosity of upland plants (2-7 %), up to 60% of the plant body of wetland plants may consist of aerenchyma.

adventitious roots – '*Adventitious'* means coming from another source and not inherent or innate; or, arising or occurring sporadically or in other than the usual location. In wetland plants, this refers to roots produced by stem or (in some species) leaf tissue which lie just above saturated soil or standing water. Adventitious roots are able to function normally in an aerobic environment while a plants 'normal' roots are in an anoxic environment.

Wet-season dormancy. Deciduous species in wetlands may avoid some or all of the period of soil anoxia by being dormant during the wettest part of the year. Evergreen species don't have this option.

Oxidation of the rhizosphere (aka. 'leaky roots'). Oxygen transported into the roots from aboveground 'leaks' out into the surrounding soil, creating a thin oxygenated layer around roots. Oxidation of the rooting zone (rhizosphere) promotes aerobic metabolism and also promotes the oxidation of reduced, toxic compounds in the root environment.

Stem / petiole elongation. This adaptation of floating-leaved plants is a result of cell *lengthening*, not cell replication. Stem or petiole elongation is triggered by inundation and helps maintain a connection between atmospheric oxygen and below-water organs of plant such as yellow pond lily.

Lenticels. Lenticels are pores that form in the bark of some woody species that assist in oxygen transfer into the stem. Lenticels frequently have their greatest concentration near the water or soil surface.

There are other adaptations!

Functions and Values of Wetlands

Although wetlands cover only about 2 percent of Washington, the physical and biological functions they perform far exceed the fraction of the land base they occupy. The following are just a few examples:

Hydrology

- Maintaining streamflows.
- Slowing and storing floodwaters.
- Stabilizing streambanks and shorelines.
- Recharging groundwater.

Water quality

- Maintaining stream temperatures
- Filtering sediments.
- Absorbing certain excess nutrients, and toxic compounds.

Fish and wildlife habitat

For a vast and diverse array of wildlife, including invertebrates, fish, amphibians, reptiles, birds, and mammals, wetlands are *essential* habitats for feeding, nesting, cover, or breeding. More than 315 species of wildlife use Washington's wetlands as primary feeding or breeding habitat. Wetlands are vital nursery and feeding areas for anadromous fish such as salmon and steelhead trout. Wetlands are critical habitats for a large number of the State's threatened or endangered wildlife species.

Aesthetics and recreation

- Attractive and diverse scenery.
- Sites for recreation, education, and scientific study.

Status, Condition, & Trends of Puget Lowland Wetlands

According to a 1988 inventory, wetlands cover about 939,000 acres in Washington. Freshwater wetlands account for most of this acreage. Estimates of pre-settlement wetland acreage in Washington range from 1.17 to 1.53 million acres. The 1988 study estimated that 20 to 39 percent of Washington's wetlands had been lost during the past two centuries. Other estimates have placed the total loss as great as 50 percent, and some urbanized areas of the Puget Lowland have experienced losses of from 70 to 100 percent. Estimates of continuing wetland loss range from 700 to 2,000 acres per year.

Agricultural development and the siting of ports and industrial facilities are considered the principal historical causes of wetland loss. Continuing losses of wetland acreage are associated primarily with urban and exurban expansion.

Along with the outright loss of total acreage, many of the State's remaining wetlands (especially in the lowlands) have been degraded, often to a significant degree, by one or more of the following factors:

- Hydrological alterations such as water diversions or impervious surfaces.
- Fragmentation.
- Road construction and inadequate maintenance.
- Excessive and unfiltered runoff.
- Excessive nutrient and chemical inputs from agricultural, industrial, and home-and-garden chemicals.
- Unsustainable forestry practices.
- Overgrazing by livestock.
- Invasive plants and animals.

The Wetland Indicator Rating System

Some plants have highly specialized adaptations to wetlands and grow almost exclusively in these habitats. These hydrophytes are often also referred to as *obligate* wetland species. On the other end of the spectrum, there are plants that completely lack wetland adaptations and for which wetland environments are lethal. These species (almost?) never occur in wetlands, and are referred to as *upland* species. In between these extremes ecologists recognize a gradation of tolerance and occurrence to wetland conditions (Table 1).

Table 1. Wetland indicator status: Definitions (Lichvar et al. 2012)

- **Obligate** (OBL) — Almost always occur in wetlands.
- **Facultative Wetland** (FACW) — Usually occur in wetlands, but may occur in non-wetlands.
- **Facultative** (FAC) — Occur in wetlands and non-wetlands.
- **Facultative Upland** (FACU) — Usually occur in non-wetlands, but may occur in wetlands.
- **Upland** (UPL) — Almost never occur in wetlands.

Indicator values for rated species are published and updated periodically in the National Wetland Plant List (Lichvar et al. 2014).

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Washington Department of Ecology. **Functions and Values of Wetlands.** [Webpage] *Links at the bottom of the page might be interesting to you, but are not required reading.* http://www.ecy.wa.gov/programs/sea/wetlands/functions.html

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