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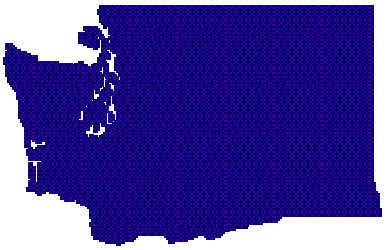
CLEAN WATER FOR WASHINGTON



Wetlands: Nature's Water Purifiers

By Edward B. Adams

Wetlands are living, functioning ecosystems that occur where water meets land. Shorelines of rivers, streams and lakes are wetlands that are familiar to almost everyone. Bogs, marshes and swamps also are typical wetlands. This bulletin describes the functions and value of wetlands in protecting water quality. To be a wetland, a site must have typical wetland hydrology, plants, and soils. If all three of these conditions occur, the area is a wetland.

Hydrology. First, wetlands are wet! Water is at or near the surface of the ground. In most wetlands water periodically covers the soil. Even when a wetland appears dry, waterlogged conditions often occur below the surface of the soil.

Plants. Wetlands have special plant communities of either obligate or facultative wetland plants. Obligate wetland plants must have their "feet" wet and do not live in upland areas. They have roots well adapted to water and saturated soils. Facultative wetland plants can tolerate either wet or somewhat drier conditions.

Soils. Wetlands also have characteristic soils. Wet soils are often deficient in oxygen, slowing decomposition of dead plant material. The soils develop into muck or peat soils. The organic material in muck soils is more decomposed than that in peat soils. These soils are wet, dark, somewhat heavy and high in organic material (15% to 20%). Wetlands may also have hydric (water loving) mineral soils. As the water table moves up and down in a wetland, it may cause the soil to appear mottled with red spots caused by iron deposits.

Wetlands Benefit the Environment

By retaining floodwaters and then slowly releasing the waters later in the season, wetlands help control floods. The heavy organic soils of wetlands act like sponges. Wetlands stabilize shorelines by slowing runoff. The plants and fibrous roots help hold soil and protect shorelines.

Many wetlands have an abundance of wildlife. Wetlands often have a complex food chain that supports many organisms and wildlife species. However, not all wetlands are the same. Wetlands range in complexity from simple wetland pastures, often reed canarygrass, to forested swamps. Complex wetlands with many plant species and wetland zones may be more valuable to the ecosystem.

Wetlands also function in groundwater recharge. Some of the floodwaters that wetlands capture during storms percolates to groundwater. Often, groundwater and the water table are near the surface in a wetland. It is often difficult to separate ground and surface water in a wetland; they interconnect.

Wetlands can provide a major environmental benefit in cleaning up contaminated water. Water managers construct artificial wetlands to purify waste water from sewage treatment plants, from storm water runoff, and even from fish rearing ponds.

Wetlands Trap Suspended and Dissolved Contaminants

Wetlands reduce contaminants in surface water by acting as settling basins. Once the velocity of inflowing water drops, suspended particles begin to settle out and are deposited in the bottom of the wetland. This process also settles out contaminants such as phosphates, pesticides, and heavy metals attached to the particles. Insoluble, plant unavailable phosphate often binds with soil particles and precipitates out of the system in sediment. Additional sediment covers the contaminants, burying them, and removing them from the water. As a result, cleaner water flows from the wetland.

The heavy muck soils of wetlands have high levels of decaying plant organic matter. This organic matter provides many charged particles that attract and hold organic molecules such as pesticides. Thus, the organic material attracts and binds the dissolved pesticides to the wetland soil, removing the pesticides from the water.

Wetland muck soils support immense populations of microorganisms. Some of these microbes can use pesticides and other organic molecules as food.

According to Louise Kulzer, Office of Water Quality for the Municipality of Metropolitan Seattle (METRO), wetland plants are important in purifying water. Certain plants separate heavy metals from the water. Water parsley, hardback, sedges, duckweeds, waterlilies, bulrushes, and cattails (Figure 1) all accumulate heavy metals (Table 1). Rushes and bulrushes (Figure 2) also can help break down organic pollutants.

Wetlands reduce some pathogenic bacteria after only 2 hours of contact with wetland plants (Table 2).

Figure 1. Cattails (*Typha latfolia* L.) provide wildlife fhabitat while removing nitrate, lead, cadmium, cobalt, and zinc from water.

Figure 2. Bulrushes (*Scirpus* spp.) are the workhorses of wetland water purifying plants. They remove bacteria, oil, organics, and nutrients. Rushes (not pictured) also remove heavy metals, including cobalt, copper, manganese, nickel and zinc.

Table 1. Uptake and storage of nitrogen and phosphorus in the standing vegetation of selected wetland plants. (After Kulzer, L. 1990. Water Pollution Control Aspects of Aquatic Plants: Implications for Stormwater Quality Management, METRO, Seattle, WA).

Plant	Uptake		Storage	
	Nitrogen	Phosphorus	Nitrogen	Phosphorus
	lbs/acre		lbs/acre	
Bulrush	111	16	155-270	35-100
Cattail	535-2350	67-360	255-1390	40-335
Reed	200	31	125-385	12-47
Rush	715	100	175-270	35

Table 2. Average reduction of pathogenic and indicator bacteria after 2 hours of contact with wetland plants. (After Kulzer, L. 1990. Water Pollution Control Aspects of Aquatic Plants: Implications for Stormwater Quality Management, METRO, Seattle, WA).

Plant		Bacteria	
	E. coli	*Enterococci*	*Salmonella*
		% Reduction	

Mentha aquatica	90	90	90
Soft Rush	80	80	50
Softstem Bulrush	70	80	60
Reed	70	40	40
Yellow Flag Iris	50	20	10
Combination of *Mentha*, Bulrush and Reed	70	50	50

Wetlands Use up Excess Nutrients

Nitrate. Wetland plants need nitrogen to grow as do other plants. Wetland plant communities are among the most productive of ecosystems, often producing 10 to 1000 times the biomass of nearby upland communities. As a result, wetland plant communities can remove a lot of nitrate from polluted water inputs. Cattails and grasses such as reed canarygrass are excellent users of nitrate (Figure 3).

In addition, microbes that live on the surface of plant roots in a wetland remove 10 times more nitrate than do the plants themselves. These microbes change nitrate nitrogen (NO_3) to ammonia nitrogen (NH_4) in a process called nitrate assimilation.

The ammonia form of nitrogen does not leach. Ammonia may escape instead into the atmosphere. Nitrate nitrogen is very leachable. In groundwater, excess nitrate can cause disease in humans, especially infants, where nitrate converts to nitrite in the stomach. Nitrite accumulation causes a disease called methemoglobinemia, or blue baby syndrome.

Phosphate. Plants, including algae, take up and use plant available phosphate.

Although wetlands generally accumulate nutrients, they sometimes become net exporters of nutrients taken up by plants. Depending on hydrologic conditions, decaying vegetation, and waterfowl use, nutrient cycling within the wetland can redissolve soluble nutrients, which then flow out of the wetland.

Size and Shape for Removing Pollutants

Dr. Rich Horner, University of Washington, studies artificial wetlands. Artificially created wetlands can remove contaminants from stormwater runoff,sewage effluent and other sources. Horner finds that a wetland needs to have certain structural characteristics to remove pollutants effectively. This research shows that wetlands need enough contact time with contaminants in the water to remove them.

A retention time of about 1 week in a wetland removes particulate matter from the water. At this speed, most sediments will settle out of the water. To remove nutrients and other soluble materials, a retention time of more than 2 weeks is desirable.

Figure 3. Reed canarygrass (*Phalaris arundinacea* L.) is an excellent user of nitrate and can aid in the removal of mercury. It grows on the margins of wetlands and in wet pastures. However, it can be a weedy species. Do not use it to mitigate damage to a natural wetland.

A roundabout water path provides longer retention times. A deep and straight channel can cut the mean retention time by channeling a large proportion of the water straight through the wetland. Multiple channels are much better. An inlet near the outlet also can short-circuit the flow through the wetland.

Wetlands need to cover at least 1% of a watershed to purify its water. This works out to 1 acre of wetland per 100 acres of watershed. A much better ratio is 2.5% or 2.5 acres per 100 acres of watershed. Heavy nutrient or other contaminant loading can overpower the ability of a wetland to remove contaminants.

Ideally, more than 50% of a wetland should be 1 to 6 inches deep. Twenty-five percent of the wetland should be 6 to 12 inches deep and the remaining area 2 to 3 feet deep.

If the water is deeper, the area becomes a pond or lake having wetlands around the edge. Do not count the deeper water in the wetland-to-watershed ratio. Deeper water does not support wetland plant types in abundance.

However, deep slack water does promote settling of particulate matter. Damming a river aids in cleaning up polluted water in just this way. The silt of Lake Roosevelt contains chemical contamination (dioxins and furans) attached to these heavier silt particles. Little of this contamination travels

beyond Grand Coulee Dam.

Protect Remaining Wetlands

Settling and developing Washington consumed nearly 75% of the state's native wetlands. People drained wetlands for agricultural use, filled in wetlands for development of cities and roads, or flooded them behind dams. The state needs the few remaining wetlands to continue purifying water supplies, and to provide many other benefits, such as flood control and wildlife protection. Wetlands, among the most productive lands in Washington, deserve all the protection possible.

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