Introduction

In recent years wetlands and their management have been receiving increased attention. The needs of a growing population for development sites and forest products have placed pressure on water resources and aquatic habitats. Wetlands in our forest lands provide clean water, regulate streamflows and include some of the most crucial habitat for Washington's wildlife species. Many wetland functions can easily be damaged by poorly conducted management activities.

Recognizing wetlands is not always easy, but is vital for determining the best possible forest management in wetlands and adjacent areas. The first steps in wetland recognition and management are:

1. Applying an appropriate wetland definition
2. Identifying the wetland type
3. Determining the wetland's extent
4. Determining the protection it needs.

The purpose of this guide is to:

1. Provide a brief introduction to the site features that define wetlands, and provide information basic to recognizing different types of wetlands and delineating their boundaries.

2. Illustrate some of the common wetland plants that are most important for recognizing wetlands.

3. Provide background information in support of the Washington State Department of Natural Resources Forest Resource and Habitat Conservation Plans, as they apply to wetlands.

Defining Wetlands[1]

Several legal definitions of wetlands are currently used in the state of Washington. The Department of Natural Resources uses the Forest Practices (FP) definition for regulatory purposes.[2] Most state regulatory agencies use the definition found in the Shoreline Management Act, the Growth Management Act and the Water Pollution Control Act.[3] This definition is very similar to the definition used by federal agencies under the Clean Water Act and the Forest Practices definition (see Glossary under "wetlands" for the complete text of these definitions). For the purposes of this guide, we will focus on the ecologically based criteria these definitions have in common, rather than detail the differences between definitions.

Ecologically, wetlands are recognized by three parameters: wetland hydrology, hydric soils and wetland vegetation. Under most circumstances, at least one positive field indicator of each parameter will be apparent at any given wetland. In the following section, each of these parameters will be examined individually.

1 For a more in-depth, technical treatment of wetland identification, please refer to the *Washington State Wetlands and Delineation Manual, 1997*, and the *Corps of Engineers 1987 Wetland Delineation Manual*. See Literature Cited for complete references. The Washington State Forest Practices Board manual also provides guidelines for wetland delineation, June 1995.

2 An exception to this is in the case of coastal wetlands, where the U.S. Fish and Wildlife Service definition is used (Cowardin, et. al.,1979). This is because the USFWS definition is inclusive of certain non-vegetated wetlands such as mudflats and other tidal areas that are within the jurisdiction of the DNR Division of Aquatic Resources.

3 *Washington State Wetlands and Delineation Manual*, 1997.

Recognizing Wetland Hydrology

Wetland hydrology occurs in areas where the soil is saturated or inundated (flooded) with ground or surface water within 12" of the surface for long enough during the growing season to exclude plants which are not adapted for life in saturated soils.

The growing season is the time in the spring and summer when the soil temperature at 20" is at or above 40° F. While the timing of the onset of the growing season varies with elevation, aspect and geographical area, a generally accepted rule of thumb is that the growing season begins around March 1st in Western Washington.

Soils must be saturated for more than fourteen consecutive days during this period to satisfy the wetland hydrology criterion[4] according to the *Forest Practices Board Manual.* This means that if the soil is saturated between March 1st and March 15th, the hydrology criterion has been satisfied.

FIELD INDICATORS OF WETLAND HYDROLOGY (IN ORDER OF DECREASING RELIABILITY[5]):

1. Visual observation of inundation (surface flooding); or

2. Visual observation of saturation (evidence of periodic saturation within 12" of the surface); or

3. Watermarks or staining on bark of woody vegetation; or

4. Drift lines; "high tide" lines of debris left by previous high water events; or

5. Sediment deposits, including deposits of algae; or

6. Drainage patterns within wetlands.

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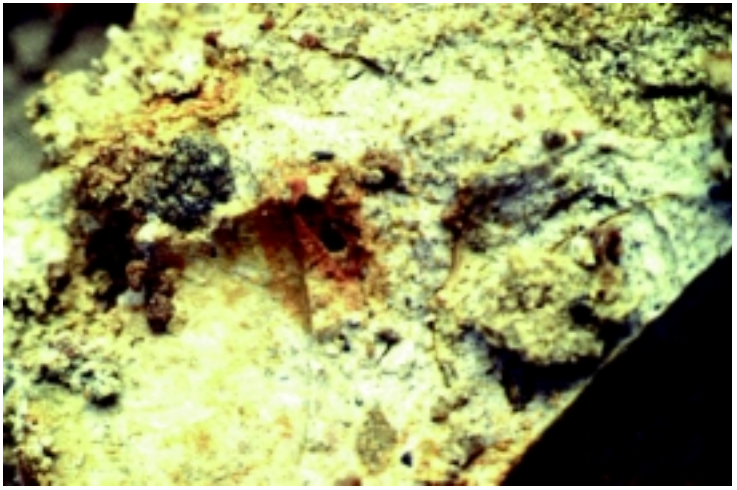
4 An earlier version of hydric soil from the USDA Soil Conservation Service required seven consecutive days of saturation to satisfy the hydrology criterion. This definition is used by both the *Corps of Engineers Wetland Delineation Manual*, 1987, and the *Federal Manual for Identifying and Delineating Jurisdictional Wetlands*, 1989, but has been superceded by a more recent NRCS definition requiring 14 consecutive days of saturation.

5 *Washington State Wetlands and Delineation Manual,* 1997 and *Corps of Engineers 1987 Wetland Delineation Manual*.

In addition,

7. Oxidized root channels in the soil (orange "halos" surrounding the channels of live roots).

Oxidized root channels. The reliability of these features as field indicators of hydric conditions increases greatly if you can identify a live root within the channel. See discussion on page 7.



Cross sectional view. RICHARD BIGLEY.

Longitudinal view. RICHARD BIGLEY.

Recognizing Wetland Soils

Hydric soils are saturated, flooded or ponded long enough during the growing season to develop anaerobic conditions in the upper part.[6] In just a few days to a week, flooding of soil causes a rapid depletion of oxygen and the onset of an anaerobic environment. The diffusion of dissolved oxygen in waterlogged soils is 10,000 times slower than in unflooded soils. If oxygen does make its way into a flooded soil, it is rapidly used by microbes that can use either oxygen or oxidized soil components to support their respiration.

The anaerobic conditions under which hydric soils form can give the soils one or more distinct characteristics, which can often be seen quite easily in the field. Hydric soils can be organic (derived from living organisms) or mostly mineral.

When examining a potential hydric soil, dig a small pit about 20" deep and lift out the soil column for examination in good light. Use moist soils when determining color. Note that small changes in the microtopogrpahy of a site can be reflected in soil characteristics. Such variations should be considered when delineating wetland boundaries.

Of the three criteria that are used to define wetlands (hydrology, vegetation and soils) the defining characteristics of wetland soils are most likely to undergo some revision in the near future. Research on soil color, soil temperature and duration of saturation may eventually yield new guidelines for hydric soil definition.

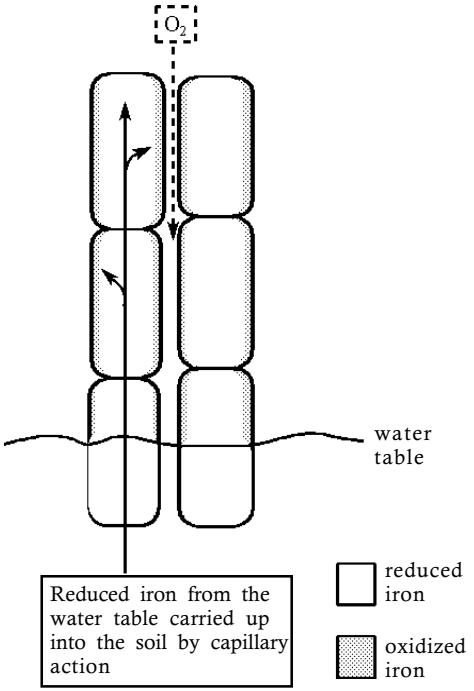
MINERAL SOILS

Soil color is an important diagnostic feature of hydric mineral soils. The anaerobic conditions present in a hydric soil change soil colors when minerals such as manganese and iron become

6 U.S. Department of Agriculture Soil Conservation Service, 1991. *Hydric Soils of the United States.*

reduced.[7] In their reduced state, these minerals become more soluble and are washed from some regions of the soil profile and may accumulate elsewhere in the soil. When these reduced darker minerals are leached from the soil profile, the pale soil matrix left behind is called a depleted matrix.

Figure 1: Formation of soil pore linings



Concentrations of oxidized iron occur on the outside of soil peds when reduced iron is transported by capillary action within an anaerobic ped. This iron becomes oxidized when it comes in contact with oxygen that has diffused through pores. *(Redrawn from Vepraskas, 1992)*

7 Insoluble ferric hydroxide plus hydrogen from the dehydrogenation of organic matter is combined to produce the fairly soluble ferrous hydroxide and water. ($Fe(OH)_3 + e^- + H^+ --> Fe(OH)_2 + H_20$)

Mottling and gleying are two easily observable color features which occur in mineral soils as a result of either periodic or prolonged saturation, respectively. Both occur through a process of chemical reduction, and usually occur within 12" of the surface in hydric soils.

Mottled soils have a matrix of one color with blotches and flecks of other colors, and occur where the water table fluctuates and soils may only be saturated for part of the year. In mottled hydric soils, the matrix color is usually grayish (chroma of 2 or less)[8] and mottles are usually red, brown or yellowish. The mottles result from the reoxidation of iron and other minerals around zones in the soil that contain oxygen such as root channels or macropores. A macropore is a naturally occurring void in the soil. In some cases nodules or concretions of iron or manganese occur within the mottles.

Gleyed soils are usually light grey with a bluish or greenish tint (chroma of 1 or less). They occur under conditions of long term saturation where essentially all the iron and manganese is reduced.

Oxidized root channels: An easily seen feature of hydric mineral soils are "rusty" colored root channels (also called rhizospheres). This rusty color results when plants growing in saturated soils transport oxygen to their roots. Some of this oxygen leaks from the roots and comes in contact with the soil surrounding the roots. The iron in the soil adjacent to such roots oxidizes, leaving a rusty "halo" of reoxidized iron around the root channel.

Similar coloration can sometimes be observed in soil pores and on ped surfaces (a ped is a naturally occurring soil aggregate). The process by which this coloration occurs is described in Fig. 1.

Sandy soils can be difficult to evaluate for hydrologic influence.

8 The color measurements given above are from the *Munsell Soil Color Charts*, a pocket–sized collection of color chips which can be compared with soil colors in the field. The Munsell charts arrange soil colors by their components: hue, which indicates where the color falls among the primary spectral colors; value, which indicates the darkness or brightness of a color; and chroma, which refers to the purity or strength of the color. Soils which remain under saturated conditions for long periods of time usually have low chromas. See appendix B3: soil color notation using the Munsell color charts.

They often do not develop diagnostic coloration, because of their coarse texture. Sometimes vertical streaks of darkly colored organic material can be seen in the profile of sandy soils, and occasionally a lens shaped inclusion of organic material can be found buried.

ORGANIC SOILS

Organic hydric soils are generally wet or saturated year round, and consist chiefly of plant material in various stages of decomposition. Organic soils, also called histosols, often accumulate in thick mats because in anaerobic conditions decomposition is usually slower than accumulation. Organic hydric soils are greater than 16" deep.

Some hydric mineral soils have a surface horizon of organic soil called a histic epipedon. As with organic hydric soils, these surface layers are generally anaerobic and should not be confused with aerated forest floors that are rarely flooded. On non-sandy soils, histic epipedons need to be greater than 8" thick to qualify the soil as hydric. On sandy soils, they need only be 3" thick.

Generally there are two types of organic soils. In muck soils, plant matter has been broken down to the extent that individual plant fragments are not identifiable. Muck soils, when rubbed between the fingers, feel smooth or greasy and will stain the fingers. Peat soils have clearly recognizable fragments of plant matter visible within the soil structure. Acid conditions within peat soils inhibit the microorganisms which help to break down organic material. Sphagnum peat soils form in bogs, and in some places will continue to accumulate for thousands of years if the wetland is left undisturbed.[9]

9 For a more in-depth discussion of hydric soils, please refer to *Washington State Hydric Soils Handbook*, Department of Ecology 1990 and *Washington State Wetlands and Delineation Manual, 1997.*

FIELD INDICATORS OF HYDRIC SOILS[10]:

1. "Rotten egg" odor resulting from hydrogen sulfide, a compound which results from reduction of sulfur in anaerobic conditions, and can be found in both organic and mineral soils that contain sulfur; or
2. Gleying of mineral soil (Munsell color chart chroma of $\leq$ 1); or
3. Mottling of mineral soils (with a matrix chroma of $\leq$ 2); or
4. Deep organic horizon (>8"); or
5. Streaks or lenses of organic material in sandy soils.

10 For more technical guidance in identifying hydric soils, refer to *Field Indicators of Hydric Soils in the United States: a guide for identifying and delineating hydric soils* (see literature cited).

Gleyed matrix. In a gleyed matrix, pale bluish or greenish coloration reflects the presence of reduced iron, which remains in the upper portion of the soil profile. In a depleted matrix, (not pictured), the iron has been removed from the top of the profile, resulting in a pale or light grey matrix. USDA NATURAL RESOURCES CONSERVATION SERVICE.

Spodosol. This upland soil has a pale E (eluviated) horizon, where dark minerals have been stripped by organic acids and heavy rainfall. These minerals have been translocated to a reddish horizon below the E horizon. Upland spodosols can sometimes be confused with hydric soils because of the pale E horizon. For more discussion of spodosols, please see appendix B, pages 134–135. USDA NATURAL RESOURCES CONSERVATION SERVICE.

Mottled mineral soil. Mottles are indicative of a fluctuating water table, and conditions of alternating wetting and drying in the soil. See the discussion on page 6. RICHARD BIGLEY.

Below: Mucky organic soil. Muck soils feel smooth and greasy, and stain the fingers. To make sure the soil is organic, continue rubbing between the fingers until the soil is gone. If there is a powdery residue left on your fingers, it is probably a silt soil (not organic). If all that remains is a stain, it is a muck soil. WASHINGTON STATE DEPARTMENT OF ECOLOGY.

Recognizing Wetland Vegetation

The vegetation criterion in wetland definitions requires an area to have over 50 percent of its dominant species (see "dominant plant species" in Glossary) classified within a broad range of wetland plants (see below: facultative, facultative wetland or obligate wetland). It is important to note that some plants are adapted to both wetland and upland conditions. The mere presence of a particular plant does not indicate wetland conditions unless the vegetation dominance, hydrology and soils criteria explained here are satisfied. Wetland plants are adapted to conditions in which their roots are submerged at least periodically, and the oxygen in the pore spaces of the soil is displaced by water, creating an anaerobic environment. Unfortunately, wet site adaptations are not always recognizable in the field, so it is important to learn to identify some of the most common wetland species in our area. To help people to determine if a plant species is a wetland species, the U.S. Fish and Wildlife Service in cooperation with other agencies has developed the *National List of Plant Species That Occur in Wetlands* (Reed 1993, Reed 1988). The list divides plants into five "indicator status" categories based on their frequency of occurrence in wetlands. When available, the plants wetland indicator status for Washington state is included with its description in the wetland plant indicator section at the end of this guide. Appendix D provides a partial list of Washington wetland indicator plants with indicator status.

The indicator status categories are as follows:

- Obligate wetland (OBL) plants occur almost always under natural conditions in wetlands (more than 99 percent of the time).
- Facultative wetland (FACW) plants usually occur in wetlands (67-99 percent of the time) but are occasionally found in nonwetlands.
- Facultative (FAC) plants are equally likely to occur in wetlands or nonwetlands (34-66 percent of the time).
- Facultative Upland (FACU) plants usually occur in nonwetlands, but are occasionally found in wetlands (1-33 percent of the time).

- Obligate Upland (UPL) plants almost always occur (more than 99 percent of the time) in uplands in the region specified.

A positive (+) or negative (-) sign, when used with indicators, attempts to more specifically define the frequency of occurrence in wetlands. The positive sign indicates "slightly more frequently found in wetlands" and the negative sign indicates "slightly less frequently found in wetlands". An asterisk (*) following an indicator identifies a tentative assignment based on either limited information or conflicting reviews.

FIELD INDICATORS OF WETLAND VEGETATION:

1. OBL species comprise all dominants in the plant community; or
2. OBL species do not dominate each stratum, but more than 50 percent of the dominants totalled from all vegetation strata are OBL, FACW, or FAC species; or
3. A plant community has a visually estimated percent coverage of OBL and FACW species that exceeds the coverage of FACU and UPL species.[11]

Occasionally, other methods of quantifying wetland vegetation such as frequency analyses may be used, but for the vast majority of situations encountered on forest lands in Washington state, estimates of dominance are sufficient to satisfy the vegetation criterion for wetlands. See appendix A for an explanation of vegetation coverage methods.

11 *Washington State Wetlands and Delineation Manual, 1997* and *Corps of Engineers 1987 Wetland Delineation Manual.*

Recognizing the Types of Wetlands

Each type of wetland is created under different conditions, and has different functions and sensitivities to disturbance. In order to match proper management to the wetland sensitivity, identification of wetland type is vital. The major types of wetlands one is most likely to encounter in forest practices activities are bogs, marshes and swamps (which include forested wetlands and scrub-shrub wetlands).[12] These are compared in Table 1 (pp. 16-17).

Bog, Snohomish County, WA. A bog within a forested landscape may or may not have open water, depending on the stage of succession. See figure 2 on page 17. WADNR, WASHINGTON STATE HERITAGE PROGRAM.

12 Kunze (1994) provides a technical classification of specific wetland communities for native, low elevation wetlands in western Washington. Crowe and Clausnitzer (1997) classify wetland plant associations in NE Oregon.

Forested wetland, King County, WA. Forested wetland with overstory of Oregon ash and understory of slough sedge. Tree bases show evidence of extensive antler rubbing. RICHARD BIGLEY.

Scrub-shrub wetland, King County, WA. Scrub-shrub wetland with *Spiraea douglassi* (foreground). *Spiraea* often increases with wetland disturbance, reducing plant diversity. RICHARD BIGLEY.

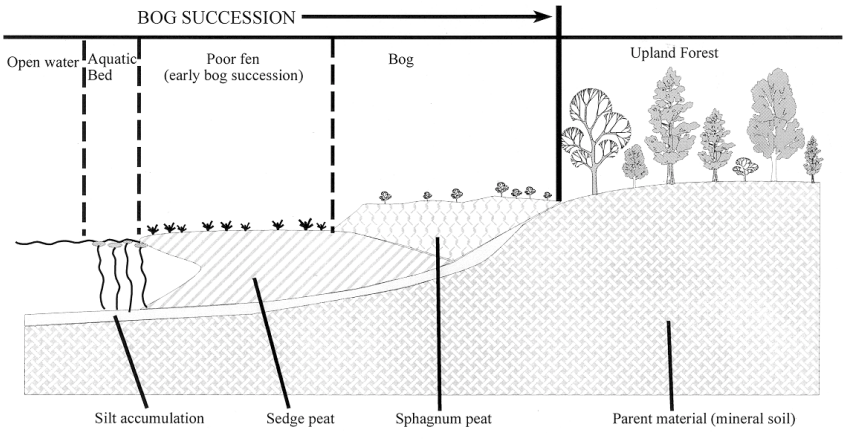
Marsh, King County, WA. Marshes in forested areas can receive extensive inputs of down wood from surrounding forest. RICHARD BIGLEY.

Table 1. General characteristics of the three major types of wetlands.

Characteristics	Sphagnum Bogs	Marshes	Swamps (Forested and Scrub-shrub Wetlands)
Hydrology	Still water or saturated soil without major inflow	Flowing to standing water or saturated soil subject to seasonal flooding	Flowing to standing water or saturated soil subject to seasonal flooding
	Precipitation the major source of water and nutrients for vegetation	Flowing surface or subsurface water seasonally, intermittently or all year	Flowing surface or subsurface water seasonally, intermittently or all year
	Floating vegetation or deep saturation year-round		
	Low levels of available nutrients	Generally high levels of available nutrients	Generally high levels of available nutrients
Vegetation	Unique, restricted	Unique with high species diversity	Frequent occurrence of species that may otherwise be rare in the forest
	Extremely slow growing	Very high herbaceous productivity	Moderate productivity
Soils	Typically has a thick sphagnum peat surface horizon. Forms at extremely low rates: 1" in 60 years in Western Washington, 1" in 100 years in Eastern Washington.	Variable, usually thick organic surface layers (muck or non-sphagnum peat). Strong gleying or mottling on mineral soil.	Variable, usually thick organic surface layers (muck or peat). Strong gleying or mottling on mineral soil.

Characteristics	Sphagnum Bogs	Marshes	Swamps (Forested and Scrub-shrub Wetlands)
Wildlife	If open water is present, high use by many wildlife species	Very high use including fish overwintering, waterfowl migration and elk winter range	Very high use by fishes, forest animals and nesting birds
Relative susceptibility to disturbance	Very sensitive to additions of soil and nutrients. Inputs of stream water or sediments which can alter nutritional and chemical relationships are damaging. Sensitive to water level changes that alter oxygen concentrations.	Sensitive to water level changes including those related to road building, soil disturbance or removal of vegetation.	Sensitive to water diversion, soil disturbance, and changes in vegetation. High soil compaction and displacement hazard. Removal of vegetation may result in an increased water table which delays regeneration.

Figure 2. Cross section of a pond undergoing succession to a bog



Sphagnum bogs are the endpoint of a unique type of wetland succession in which sphagnum peat accumulates and the vegetation root zone becomes hydrologically isolated from outside sources of nutrient rich surface and ground water (Fig. 2). The only source of water for true bogs is precipitation.

Fens are a major successional stage between open water and bogs. Fens generally accumulate sedge peat, are dominated by grasses and sedges and are in contact with relatively nutrient rich ground water. In comparison, bogs are characteristically dominated by plants such as sphagnum moss, bog cranberry, sundew, and Labrador tea, and may also support western hemlock, lodgepole pine, western redcedar or spruce.

Sphagnum bogs are the most ecologically sensitive group of wetlands, because the plants which grow in them are adapted to very acidic, low nutrient growth conditions. The water in bogs has a pH between 6.0 and 4.0 (That's somewhere between the pH of black coffee and vinegar!). Sphagnum moss actually helps to lower pH through an active cation exchange process which releases positively charged hydrogen ions.

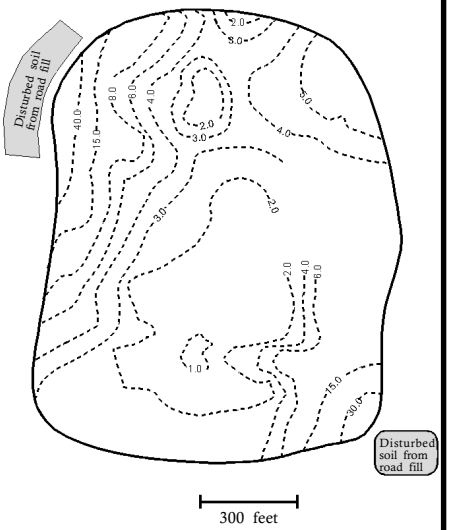
Bogs are extremely sensitive to nutrient and mineral inputs which can change the chemical equilibrium of the bog system. For this reason, bogs are susceptible to disturbances that degrade or change water quality or quantity (Fig. 3). For example, exposing bare soil near bogs can be particularly damaging as resulting soil-laden runoff water alters the chemical character of the bog and can kill living sphagnum. Burning slash near sphagnum bogs is also detrimental due to release of high nutrient ash.

Diverting water from bogs lowers the water table and speeds the decomposition of the peat, sometimes leaving the trees standing on their roots.

Bogs are valuable as habitat because of the unique species they support. Only a fraction of western Washington's original bogs remain undisturbed, and because sphagnum peat soils develop at a rate of only 1" every 60 to 100 years, bogs are irreplaceable within our lifetimes.

Figure 3. The impact of upland ground disturbance on bog chemistry

This figure shows calcium concentrations (ppm) in a bog after a road was built on the adjacent upland. Nutrients from the mineral soil used as road fill infiltrate the bog that is naturally very nutrient poor. Concentrations of potassium, sodium and magnesium showed patterns similar to calcium. The calcium concentrations of undisturbed bogs are 1-2 ppm. Although not documented, one would expect a decline in unique bog plants over time in the nutrient enriched areas.



Redrawn after Jull 1983.

Marshes include wetlands with a wide range of hydrologic characteristics. Marshes range from areas which have substantial amounts of standing water throughout the year, and which support aquatic plants such as water lilies, to shallow marshes and wet meadows which may be dry enough to walk through in late summer. Soils may be nonsphagnum peat, muck or mineral hydric soils. However, all marshes are recognizable by their grasslike vegetation of sedges and rushes, as well as many other herbaceous plants. Marshes provide habitat for many creatures. Many species of wildlife depend on marshes for food, shelter and nesting areas. Where marshes are connected to riparian systems, they may provide crucial winter habitat for young anadromous fishes. Marsh vegetation is particularly well suited for filtering sediments and pollutants, making marshes quite important to water quality. When marshes are invaded by exotic plant species

like reed canary grass, their ability to carry out the above function is reduced.

Swamps are wetlands which support 30 percent or greater coverage of woody vegetation such as trees and shrubs. They may have standing water year round or be saturated for only a few weeks during the growing season. Soils may be of any type. There are two major types of swamps:

1. Forested wetlands are dominated by woody vegetation over 20' tall and are some of the most difficult wetlands to recognize, because they often support plants which can grow in upland areas as well as wetlands.

Forested wetlands provide important habitat for many woodland creatures including birds, small mammals and amphibians such as salamanders. Snags (dead trees) in forested wetlands are very important for woodpeckers and the many bird and mammal species that use the cavities left by woodpeckers for nesting sites.

2. Scrub-shrub wetlands are dominated by woody vegetation which is under 20' tall. This can include shrubs such as red-osier dogwood, willow and salmonberry as well as young trees or trees that have been stunted by poor growth conditions. They can be very valuable as habitat for birds, and their tangle of vegetation can provide important browse and shelter for many other creatures as well.

Understanding Wetland Functions and the Role of Buffers

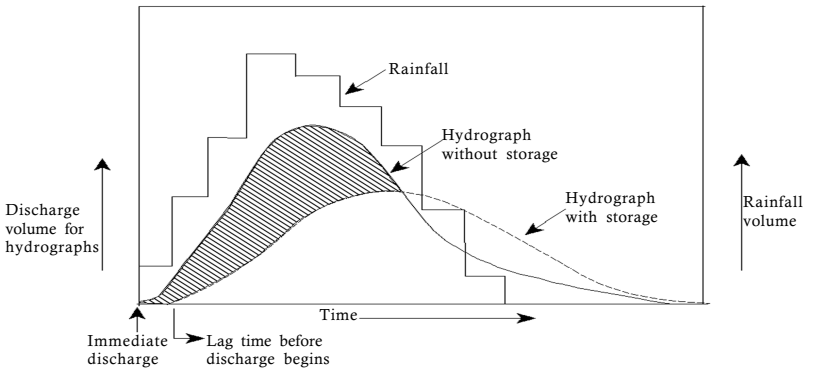
Wetlands are complex ecological systems. A tremendous amount is still unknown about the functions and values of different wetland types, let alone the particular functions served by an individual wetland. Table 2 lists wetland functions and values. A general understanding of what is known of wetland function is very helpful in the design of appropriate wetland buffers.

Here are some examples of wetland functions or values common to many different wetland types:

- Groundwater exchange. Most wetlands serve an important function in transferring surface water into the ground, thereby recharging groundwater supplies. In other areas they provide avenues for groundwater to discharge.
- Sediment trapping. Forested wetlands often contain a disproportionately high concentration of down wood compared to most upland forests. Inundation in wetlands promotes the accumulation of down wood by limiting decay (few decomposers can survive in saturated conditions) and creating snags by flooding surrounding forest. Down wood in wetlands exerts considerable control over water routing, dissipating flow energy, trapping sediments and significantly reducing erosion. The number and size of down logs in a wetland determines the volume of sediment storage capacity behind them. The vegetation of wetlands acts as a filter to trap sediments that are suspended in flowing water.
- Water purification. Wetlands can trap water pollutants. The organic material in wetland sediments has a great affinity for some toxic compounds; in effect, pollutants are drawn out of the water as it flows through the wetland. The extent of this purification capability is dependant upon the size, type and hydrology of the wetland.

- Stormwater detention and seasonal streamflow maintenance. Wetlands have a sponge-like capacity to hold water, and are very important in some areas for slowing down storm water and helping to maintain streamflows during seasonal low flow periods (Fig.4). The wetland absorbs flood waters and then releases them slowly through its outflow, attenuating the flood peak and thus minimizing flooding downstream.

Figure 4: Flood hydrographs for watersheds with and without wetland storage capacity



(after Reppert et al. 1979)

- Fish and wildlife habitat. Many bird, fish, reptile, amphibian, invertebrate and mammal species depend on wetlands for food, shelter, and breeding grounds (Fig. 5). Some animal species spend their whole life cycles in wetlands, while others meet most of their needs in uplands but use wetland areas at critical times in their life cycles, or during periods of extreme weather. For example, deer and elk fawn and calve in wetland and riparian areas. The microclimates within wetlands, especially those of forested wetlands, provide relief from both extreme heat and cold. The soil moisture provides reliable forage and water late in the summer.

The importance of invertebrates in wetlands is sometimes overlooked, however, many insects are dependant on wetlands,

and serve as a vital food source for other animals, both in their larval stages and as adults. For instance, caddisflies, mayflies and dragonflies (including the green darner, Washington's State Insect) spend their whole life cycles in and around wetlands. Butterflies congregate around wet soil to drink and as part of their nuptial behavior. Pollinators such as bees require free water for drinking, and are frequent visitors to wetlands. Mosquitos provide a vital food source in their larval stage to young songbirds early in the spring when few other insects are available.

Wetland size does not necessarily determine the value of a given wetland for wildlife. One study from Puget Sound basin found that wetland size and vegetation structure were poor indicators of amphibian richness.[13] Another study from the Columbia basin found an inverse relationship between wetland size and waterfowl production.[14] See Appendix C for a list of wetland dependent wildlife species.

Figure 5: Coho salmon fry

Wetlands provide primary habitat for four species of salmon or trout throughout Washington. Although several species may use wetlands incidentally, Dolly Varden, bull trout, coho salmon and cutthroat trout include wetlands in their primary distribution. Cutthroat trout may occur in small stream tributaries of up to 20 percent gradient, and above barriers that anadromous fish can not pass. Cutthroat use intermittent tributaries and wetlands extensively. Dolly Varden and cutthroat co-exist primarily in coastal stream systems. Bull trout occur primarily in eastern Washington headwater streams. Coho salmon use off-channel wetlands that are perhaps only seasonally flooded, for winter rearing. JEFF CEDERHOLM.

13 Richter, K.O. and A.L. Azous, 1995.

14 Foster, J.H. et al. 1984.

- Primary productivity. Many wetlands have rates of net primary productivity that are among the highest of any ecosystem in the world, double those of temperate coniferous forests (Fig. 6). The large amounts of biomass created in wetlands support large concentrations of animals in small areas and fuel downstream aquatic systems.

Figure 6: Mean net primary production of various ecosystem types

(after Whittaker and Likens, 1975)

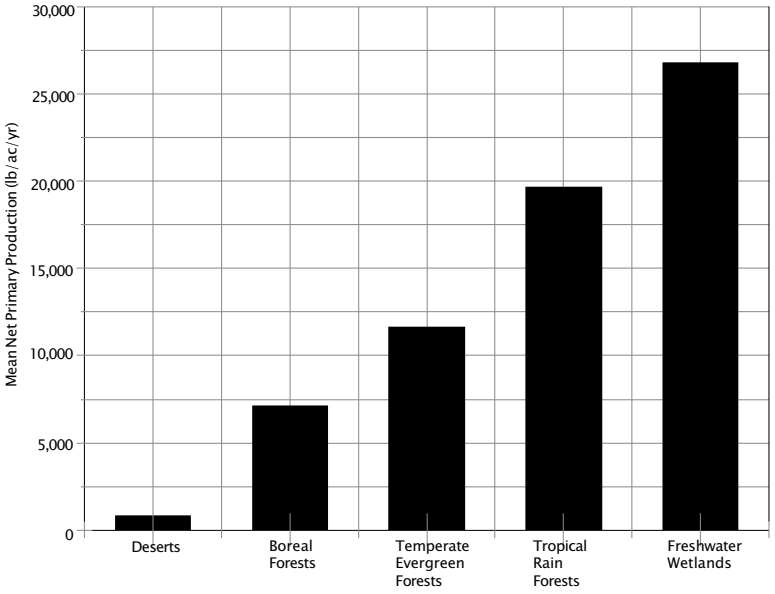


Table 2. Attributes generally given as functions and values of wetland ecosystems

(after Richardson 1994)

Wetland Functions

1. Hydrologic flux and storage
    a. Aquifer (ground water) recharge and discharge
    b. Surface water storage and regulation
    c. Regional stream discharge and recharge regulation

2. Biological productivity
    a. Net primary productivity
    b. Carbon storage
    c. Carbon fixation
    d. Secondary productivity

3. Biogeochemical cycling and storage
    a. Nutrient source or sink on the landscape
    b. Carbon, nitrogen, sulphur, phosphorous, etc. transformations (oxidation/reduction reactions)
    c. Denitrification
    d. Sediment and organic matter reservoir

4. Decomposition
    a. Carbon release (global climate impacts)
    b. Detritus output for aquatic organisms (downstream energy source)
    c. Mineralization and release of nitrogen, sulfur, carbon, etc.

5. Community/wildlife habitat
    a. Habitat for species (unique and endangered)
    b. Habitat for algae, bacteria, fungi, fish, shellfish, wildlife, and wetland plants
    c. Biodiversity

Table 2 (cont.)

Wetland Values[a]
1. Flood control (conveyance), flood storage (1, 2)
2. Sediment control (filter for waste) (2, 3)
3. Waste water treatment system (2, 3)
4. Nutrient removal from agricultural runoff and waste water systems (2, 3)
5. Recreation (1, 5)
6. Open space (1, 2, 5)
7. Visual-cultural (1, 5)
8. Hunting (2, 5)
9. Preservation of flora and fauna (endemic, refuge) (5)
10. Timber production (1, 2)
11. Shrub crops (cranberry and blueberry) (1, 2)
12. Medical (streptomycin) (4, 5)
13. Education and research (1-5)
14. Erosion control (1, 2, 3)
15. Food production (shrimp, fish, ducks) (2,5)
16. Historical, cultural, and archaeological resources (2)
17. Threatened, rare, endangered species habitat (5)
18. Water quality (1, 3)
19. Water supply (1)

a Numbers within parenthesis denote the wetland functions (1–5) which are directly related to the specific wetland value or those functions which can be adversely affected by over–utilization of values.

BUFFER FUNCTIONS

The vegetation, soil and down wood that is left intact in buffer strips around wetlands serves several important functions in protecting wetlands and their values.

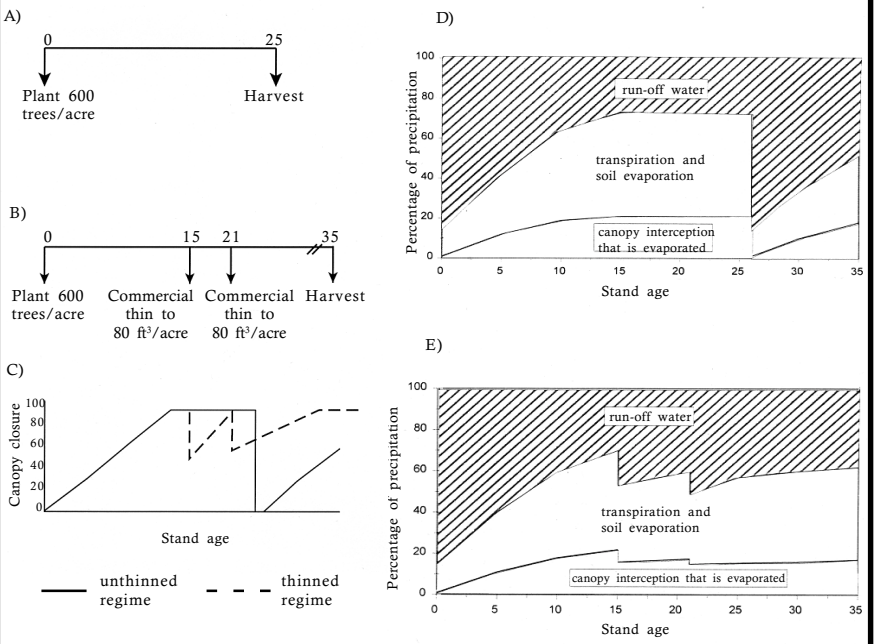
These include:

- High filtration capacity. Vegetation in wetland buffers can protect the wetland from sedimentation and pollution.
- Regulation of flow velocity. Vegetation and undisturbed soil can slow storm waters and reduce erosion.

- Regulation of microclimate. Buffers can help to regulate temperature and moisture fluctuations by providing windbreaks and shading. The control of water temperature is extremely important for fishes and other wildlife, and influences water chemistry (for example, dissolved oxygen). Forested buffers can help to maintain evapotranspiration relationships and the humidities favored by some wetland species.
- Maintenance of wetland hydrology. Understory vegetation and trees in wetland buffers help to maintain wetland hydrology at near natural levels through evapotranspiration (Fig. 7).
- Protection of habitat. Vegetation provides a buffer between human activities and wetlands, thermal cover and browse for wildlife, and valuable edge habitat.

Figure 7: Timber harvest influences on water yields

Simulated water balance of a loblolly pine plantation under two management regimes. These data suggest clearcut harvesting of wetlands resulted in an additional 30 percent runoff. *(Redrawn after McCarthy and Skaggs, 1992)*



(A) Timeline for the unthinned management regime, (B) Timeline for the thinned management regime, (C) Estimates of canopy cover for both regimes over time, (D and E) Changes in the evapotranspiration ratios from the tree canopies and the amount of water yield or runoff from the forest, for unthinned and thinned regimes respectively.

CONSIDERATIONS FOR BUFFER PLACEMENT

The most common disturbances to wetlands as a result of forest management are compaction of soils, alteration of hydrology, siltation from nearby soil disturbance, introduction of invasive plant species and destruction of habitat through the removal of vegetation, snags and woody debris. Regulations are designed to be a compromise in the full range of possible conditions. It is the judgement of a professional forest manager that will determine if considerations in excess of the minimum regulations are required to protect a particular wetland. To help ensure that buffer strips are functional, keep the following in mind:

- The optimal size for a buffer will vary considerably in relation to the characteristics of the individual wetland (know the wetland type: bog, marsh or swamp). Bogs generally require the largest buffers because of their sensitivity to disturbance.
- Areas with steep slopes or unstable soils generally require wider buffers than do areas with gentle slopes and stable soils.
- Where soils are highly compactible, a wider buffer will help to protect the original shape of the wetland, and the structure of soils and vegetation.
- In forested buffers, the maintenance of at least 120 square feet of basal area consisting of the most windfirm trees will increase the likelihood that wetland hydrology can recover to natural levels after harvest.
- Leaving the forest floor intact around wetlands can help reduce overland flow, maintain percolation and reduce siltation.
- Buffers along inflow streams are important to filter water flowing into the wetland and maintain water levels in the wetland.
- In areas where water percolates or seeps into the wetland over a broad slope or swale, a buffer can be used to minimize impact on the hydrology by including the slope or swale.

- Roads and culverts surrounding the wetland should be designed to have minimum impact on wetland water inflow and outflow. Placement and orientation of culverts is critical.
- In basins where over 50 percent of the area above the wetland has been affected by urbanization or forest clearing, consider expanding buffers to manage increased runoff and siltation.
- In wetlands that have not been disturbed by invasive species such as reed canary grass and soft rush, buffers can help prevent introduction of these species. Without a buffer in such areas, logging equipment can introduce seeds of invasive species and prepare the seed bed necessary for their propagation.
- Retaining a complex vegetation structure is crucial for the protection of wildlife diversity, where such diversity exists.

Applying Wetland Criteria and Determining Appropriate Wetland Management

IDENTIFY THE WETLAND

Determining wetland presence, extent and management is an investigative process. Keep in mind that the three wetland criteria (hydrology, soils and vegetation) are interdependent and result from the saturation of soil. Remember that under most circumstances, at least one of the key field indicators should be evident for each of the three criteria. To find wetlands on specific management units:

1. Use existing resources to identify areas that are likely wetlands (National Wetlands Inventory, contour maps, soil surveys and a list of hydric soils).

2. Determine if wetland vegetation is present or evident. If no wetland vegetation is evident, the site has not been disturbed and the site is clearly dominated by upland vegetation, the site is not a wetland.

3. Determine if wetland hydrology is present or evident. Even in the summer when the water table reaches a low point and there is no direct evidence of surface water, you should be able to observe one or more of the key field indicators of wetland hydrology. If you are able to prove the presence or existence of wetland hydrology you can assume the presence of wetland soils, and will not need to make a soil determination. On undisturbed sites where wetland soils and plants are present during dry times of the year, you can infer the presence of wetland hydrology.

4. Determine if wetland (hydric) soils are present.

LOCATE THE WETLAND EDGE

When delineating a wetland remember that it is a water body. Wetlands follow intuitive drainage patterns even though in some locations and times of year the water may be under the surface.

To locate a wetland:

1. Use the relative dominance of wetland vegetation and wetland soils to find the location of the wetland edge (see *recognizing wetland vegetation*, pg. 11 and *recognizing wetland soils*, pg. 5). Check this boundary against topography and clues of hydrologic influence (for example drift lines, areas where floating debris was deposited during recent high water events; silt deposits on vegetation or ground; or algae dried on trees or fence posts).

2. Design the buffer and design management activities. Determine the required buffer to match the specific wetland type and size. *Managing wetlands on state forest lands in Washington* (Bigley and Hull 2000), provides specific guidance under the Forest Resources Plan and DNR Habitat Conservation Plan.

3. Refer to the buffer functions and considerations for buffer placement sections in this publication.

4. Consider the adequacy of the buffer to protect important functions and values, especially how the water flows through the wetland. Consider the objectives for the buffer in terms of function and placement. Do the buffers fall in areas where they will not contribute to the stability of the wetland? Are there significant small isolated wetlands that are not encompassed by the buffer? If the buffer does not encompass small isolated wetlands that you feel may have some importance, consider clumping some leave trees to give the wetlands some protection.

Wetland Indicator Plants

This section illustrates some of the common wetland species that are helpful in recognizing and delineating wetlands. Table 3 provides a quick reference to some wetland indicators (not all of which are illustrated) and their indicator status (see page 12).

For each species there are three types of information given:

1. Common and scientific names of both the plant and plant family. This information should allow for clear communication about plant names and facilitate cross-referencing with other information sources. Previously used scientific names are indicated in brackets for cross referencing.

2. Identification. This section provides a short physical description of the plant, which should always act as a complement to the line drawings. Descriptions of the plant growth form, leaves, flowers and fruit should be read to confirm identifications and avoid confusion with look-alike species.

3. Site type and indication. This section provides information about the geographical range and types of environments in which the plant occurs, and explores what the plant can tell us about the specific growing conditions of the sites on which it is found.

Some wetland determinations may require the identification of wetland or upland plants not contained in this guide. Collecting plants for identification is encouraged unless the species appears to be rare (less than a couple dozen individuals). Never collect one of a kind specimens, just flag them for future reference.

When collecting common herbaceous plants for identification try to get the entire plant including roots and if possible flowers and fruits. For shrubs and trees, a branch should do. Describe the growing conditions where you got the plant and any associated species you recognize.

Please note that the species mentioned here are the most common wetland indicators. Many other species may be found in wetlands, some of which are threatened or endangered. The Department of Natural Resources Natural Heritage Program maintains a database with site-specific information on endangered, threatened

and sensitive plants. The Natural Heritage Program also has a list of endangered, threatened and sensitive plants which is available to the public. Copies of this list and information on the database can be obtained by writing to: Washington Natural Heritage Program, Department of Natural Resources, Business Systems Support Division, 1111 Washington St. SE, P.O. Box 47014, Olympia, WA 98504-7014

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Table 3. Common wetland indicators and their indicator status.

Common Name	Scientific Name[a]	Indicator Status[b]	Page
Trees			
Black cottonwood	*Populus balsamifera ssp. trichocarpa*	FAC	38
Oregon ash	*Fraxinus latifolia*	FACW	39
Red alder	*Alnus rubra*	FAC	40
Western crabapple	*Malus fusca*	FACW	41
Willow sp.	*Salix spp.*	Species specific	42
Shrubs			
Bog laurel	*Kalmia polifolia*	OBL	43
Bog rosemary	*Andromeda polifolia*	OBL	44
Devil's club	*Oplopanax horridus*	FAC+	45
Douglas spiraea	*Spiraea douglasii*	FACW	46
Laborador tea	*Ledum groenlandicum*	OBL	47
Pacific ninebark	*Physocarpus capitatus*	FACW-	48

a Scientific names are from Hitchcock et. al. 1955, 1989, 1961, 1964 and 1969 unless designated with an asterisk.

b Indicator status is from Reed, Porter B., 1988. *National List of Plant Species That Occur in Wetlands: 1988 Washington*; and from Reed, Porter B. et. al. 1993. *1993 Supplement to List of Plant Species that Occur in Wetlands.*

Common Name	Scientific Name	Indicator Status	Page
Prickly currant	*Ribes lacustre*	FAC+	49
Red-osier dogwood	*Cornus stolonifera*	FACW	50
Salmonberry	*Rubus spectabilis*	FAC+	51
Twinberry honeysuckle	*Lonicera involucrata*	FAC+*	52
Herbs			
American speedwell	*Veronica americana*	OBL	53
Arctic starflower	*Trientalis arctica*	OBL	54
Bog St. John's wort	*Hypericum anagalloides*	OBL	55
Buckbean	*Menyanthes trifoliata*	OBL	56
Bunchberry	*Cornus canadensis*	FAC	57
Bur-reed	*Sparganium sp.*	OBL	58
Cattail	*Typha latifolia*	OBL	59
Cow-parsnip	*Heracleum lanatum*	FAC+	60
Creeping buttercup	*Ranunculus repens*	FACW	61
Deerfern	*Blechnum spicant*	FAC+	62
False hellebore	*Veratrum viride*	FACW	63
False-lily-of-the-valley	*Maianthemum dilatatum*	FACU-	64
Field mint	*Mentha arvensis*	FACW-	65
Horsetail	*Equisetum arvense*	FACW	66
Kneeling angelica	*Angelica genuflexa*	FAC	67
Ladyfern	*Athyrium felix-femina*	FAC	68

Common Name	Scientific Name	Indicator Status	Page
Herbs (cont.)			
Marsh cinquefoil	*Potentilla palustris*	OBL	69
Marshmarigold	*Caltha biflora*	OBL	70
Marsh violet	*Viola palustris*	OBL	71
Oregon oxalis	*Oxalis oregana*	no data	72
Peat moss	*Sphagnum capillaceum*	no data	73
Piggyback plant	*Tolmea menziesii*	FAC*	74
Pioneer violet	*Viola glabella*	FACW+	75
Purple loosestrife	*Lythrum salicaria*	FACW+	76
Skunk cabbage	*Lysichitum americanum*	OBL	77
Slender stemmed waterleaf	*Hydrophyllum tenuipes*	no data	78
Small-flowered forget-me-not	*Myosotis laxa*	OBL	79
Starry false Solomon's-seal	*Smilacena stellata*	FAC-	80
Sundew	*Drosera rotundifolia*	OBL	81
Sweet scented Bedstraw	*Galium triflorum*	FACU	82
Three-leaved foamflower	*Tiarella trifoliata*	FAC	83
Touch-me-not	*Impatiens noli-tangere*	FACW	84
Water horsetail	*Equisetum fluviatile*	OBL	85
Water parsley	*Oenanthe sarmentosa*	OBL	86
Yellow iris	*Iris pseudacorus*	OBL	87

Common Name	Scientific Name	Indicator Status	Page
Herbs (cont.)			
Yellow monkey-flower	*Mimulus guttatus*	OBL	88
Yellow pond lily	*Nuphar polysepalum*	OBL	89
Grasslike Plants			
Beaked sedge	*Carex utriculata**	OBL	93
Cottongrass	*Eriophorum spp.*	OBL	94
Reed canary grass	*Phalaris arundinacea*	FACW	95
Slough sedge	*Carex obnupta*	OBL	96
Small fruited bulrush	*Scirpus microcarpus*	OBL	97
Soft rush	*Juncus effusus*	FACW	98
Spike rush	*Eleocharis spp.*	Species specific	99

Wetland Trees

Black cottonwood

Populus balsamifera ssp. trichocarpa

(Populus trichocarpa)

SALICACEAE (Willow family)

Identification:

Deciduous, alternately branched tree, 50 to 60' tall; bark rough and furrowed; buds and leaves very sticky with a sweet smelling resin, dark green above and paler on the undersurface, tear-drop shaped or nearly triangular; male catkins bloom before the leaves appear in spring; small, round fruits and flowers are borne on a long pendulous peduncle. Could be confused with quaking aspen (*Populus tremuloides*). Quaking aspen has smooth bark and small leaves with flattened petioles.

Site Type and Indication:

A facultative species (FAC) found in forested wetlands, riparian communities and on islands within marshes. Found mostly at low elevation in western Washington, extending up river drainages. Black cottonwood can establish on drier sites during wet years and continue to survive because of its deep rooting habit. It is a good indicator of forested wetlands, easy to see on aerial photographs. Commonly provides nesting sites for birds. The rapid growth and large size of black cottonwood make it a valuable contributor to downed wood in streams and wetlands.

Oregon ash

Fraxinus latifolia

OLEACEAE (Olive family)

Identification:

Deciduous, oppositely branched tree, 30 to 65' tall; leaves pinnately compound, leaflets 5 to 7, 1 to 4" long; fruits 1 to 2" long with a single blade-like wing, hanging in clusters. Fruits are a good aid to identification because they are persistent through the winter.

Site Type and Indication:

A facultative wetland species (FACW), found in forested and scrub-shrub wetlands, especially those adjacent to marshes or in moist riparian areas. A good indicator that a high water table will discourage growth of most conifers. Provides nesting for many forest birds. Boles used by deer for antler rubbing. Provides covered winter habitat for fish. Occupies low elevations, west of the Cascades.

Red alder

Alnus rubra

BETULACEAE (Birch family)

Identification:

Shrub or tree up to 80' tall; alternately branched; leaves rusty-gray beneath, broadly elliptic with wavy inrolled margins; flowers are male catkins and female cones which bloom before the leaves come out. Catkins are several inches long and green with yellow stamens; cones are green becoming brown, 0.5 to 0.75", and around half as broad as long, oblong to ovoid. In eastern Washington could be confused with Sitka alder (*Alnus sinuata*, FACW) which has double-toothed leaves; mountain alder (*Alnus incana*, FACW), with leaves that are not rusty-gray beneath or inrolled; or white alder (*Alnus rhombifolia*, FACW).

Site Type and Indication:

A facultative species (FAC), found in forested and scrub-shrub wetlands, in riparian areas and on the margins of ponds, marshes and wet meadows. Common on uplands, a poor indicator of wetland edge. Heavy utilization by resident birds like kinglets and chickadees and migrating warblers. Provides nesting and rookery sites for great blue herons.

Western crabapple

Malus fusca

(Pyrus fusca)

ROSACEAE (Rose family)

Identification:

Shrub or small tree, 9 to 40' tall; alternately branched, young twigs somewhat hairy; leaves ovate-lanceolate to ovate oblong, often with a prominent lobe at the base on either or both sides, serrated, usually narrowing to a sharp tip, 1.5 to 3.5" long, dark green on upper surface; flowers white to pink; fruit yellow to purplish-red. Could be confused with escaped domestic fruit trees.

Site Type and Indication:

A facultative wet species (FACW), common on stream banks, in swamps, bogs and moist woods. Western crabapples are eaten by deer, bear and many bird species.

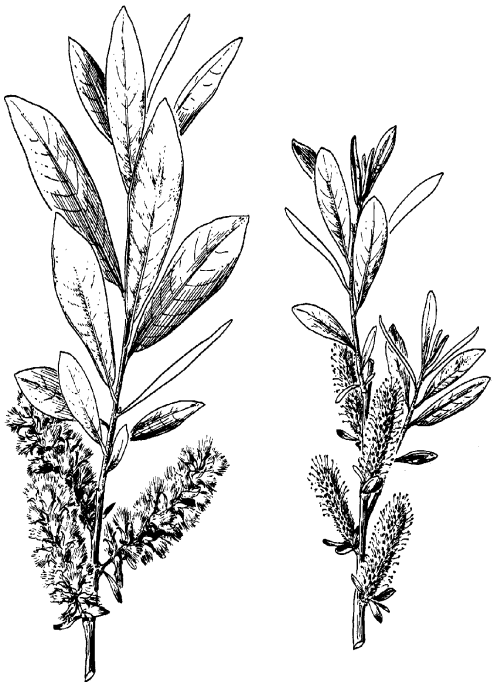
Willow

Salix spp.

SALICACEAE (Willow)

Identification:

Small trees or shrubs with alternate branching and considerable vegetative and floristic variation between species. Bark smooth; leaves lanceolate, oblanceolate, ovate or elliptic, often with pointed tips. Flowers in erect or (rarely) drooping catkins which generally bloom very early in the year. Common species include Hooker's willow (*Salix hookeriana*) FACW, on western Washington coast; Scouler's willow (*Salix scoulerina*) FAC, throughout Washington; and Sitka willow (*Salix sitchensis*) FACW, primarily west of the Cascade crest, but known from protected Eastern Washington sites.



Site Type and Indication:

Common in swamps and on the margins of ponds and streams, also found in moist upland areas. There are probably close to 300 species world wide, over 30 of them found in the Pacific Northwest. Site indication for wetlands ranges from poor to excellent depending on species. This plant also sprouts vigorously after cutting, and is extremely useful for bank stabilization, revegetation and erosion control. Do not assume indicator status without correct identification.

Wetland Shrubs

Bog laurel

Kalmia polifolia

(*Kalmia occidentalis*)

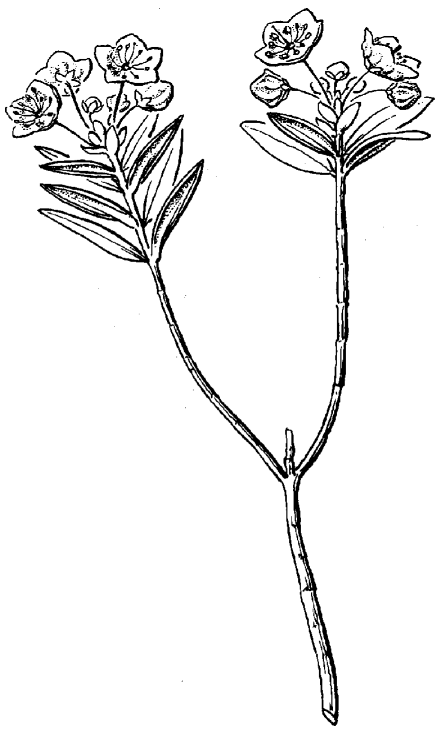
ERICACEAE (Heath family)

Identification:

Low evergreen shrub 1 to 3' tall, leaves leathery with grey fuzz on the underside, oblong to elliptic, margins strongly recurved; flowers light to deep pink; fruit a dry capsule. Often confused with Labrador tea (p. 47).

Site Type and Indication:

An obligate wetland species (OBL), found generally in sphagnum bogs, but also occurs in some nutrient poor scrub-shrub wetlands. This species is widespread in tundra and boreal climates where it competes for nutrients with conifers on nutrient poor sites.



Bog rosemary

Andromeda polifolia

ERICACEAE (Heath family)

Identification:

Low spreading evergreen shrub, 4 to 30" tall; leaves alternate, narrow, elliptic to almost linear, 0.5 to 1.5" long; flowers pinkish and urn-shaped, borne in small terminal umbels.

Site Type and Indication:

An obligate wetland species (OBL), found in bogs. Found in cold peat accumulating sites throughout the Northern hemisphere.

Devil's club

Oplopanax horridum

(Oplopanax horridus)

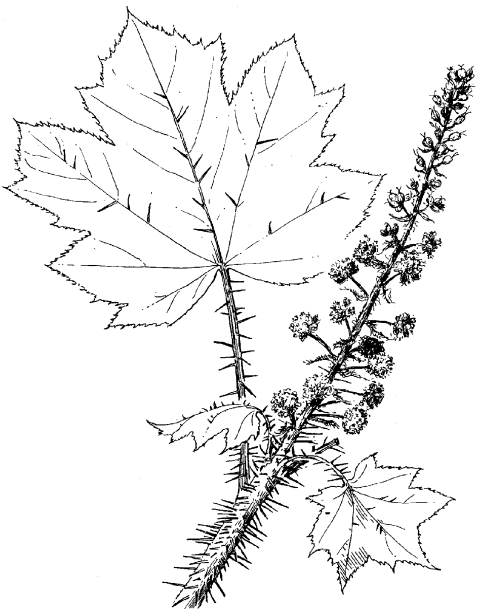
ARALIACEAE (Ginseng family)

Identification:

Tall 4-10' spiny deciduous shrub; leaves 4-14", palmately lobed and spiny; berries in red terminal clusters in the autumn. The genus name was in part derived from the Greek *haplon* meaning weapon. Once you've met this plant, the species name will need no explanation.

Site Type and Indication:

A good indicator of sites which have wet or saturated soils most of the year; a facultative (FAC+) wetland species. Sites generally have moderate productivity. More than a few plants indicates major potential windthrow and engineering limitations because of the wet soils. Devil's club sites are very susceptible to compaction, fire susceptibility is low. Unlike skunk cabbage (p. 77), devil's club prefers aerated soil conditions. Areas with devil's club usually present a major brush competition potential. Regeneration plans in devil's club areas should anticipate overtopping shade from salmonberry and other deciduous shrubs. Devil's club is a preferred forage for elk. Coastal areas with devil's club are notorious for mountain beaver. Common associates include ladyfern, swordfern, three-leaved foamflower, and salmonberry.

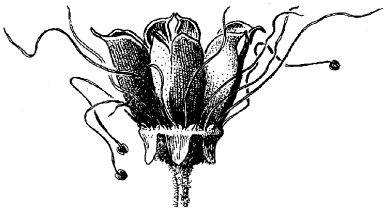


Douglas spiraea

Spiraea douglasii

ROSACEAE (Rose family)

Identification:



Erect deciduous twiggy shrub, 3 to 6' tall, alternately branched; branches green when young, becoming smooth and brown with age. Leaves 1 to 3" long, oblong and ovate to elliptic, serrated half the length from the tip back, usually smooth textured but sometimes with soft wooly hairs. Flowers tiny and pink in conical plumes, 2 to 8" long, which can persist through the winter in a dark brown, dried out form. Could be confused with shiny-leaf spiraea (*Spiraea betulifolia var. lucida*). Shiny-leaf spiraea is very common in eastern Washington and occurs on open dry hillsides to some wet sites.

Site Type and Indication:

A facultative wetland species (FACW) found in marshes, bogs, scrub-shrub and occasionally forested wetlands from sea level to the subalpine. A very good indicator of areas where most conifers will grow poorly. Douglas spiraea has low browse palatability and is sensitive to trampling. Resprouts rapidly from rhizomes and buds at the base of the stem. Spiraea increases cover with disturbance.

Labrador tea

Ledum groenlandicum

ERICACEAE (Heath family)

Identification:

Evergreen shrub 1.5 to 6.5', twigs dotted with glands and with tiny soft hairs; leaves ovate to elliptic-oblong, with thick rust colored fuzz underneath, leaf edges curled under; flowers white, around 0.5 to 0.75" in diameter.

Site Type and Indication:

An obligate wetland species (OBL), found in most bogs east and west of the Cascades, and occasionally found in marshes. A good indicator that the rooting medium (sometimes peat or rotting logs) is very nutrient poor.

Pacific ninebark

Physocarpus capitatus

ROSACEAE (Rose family)

Identification:

Erect, deciduous shrub up to 16' tall with alternate branching, bark shredding in thin layers; leaves palmately three-lobed, 1 to 3" long; flowers tiny, white, in 1 to 3" spherical clusters. Could easily be confused with mallow ninebark (*Physocarpus malvaceus*) which is an upland species common in dry forests of eastern Washington.

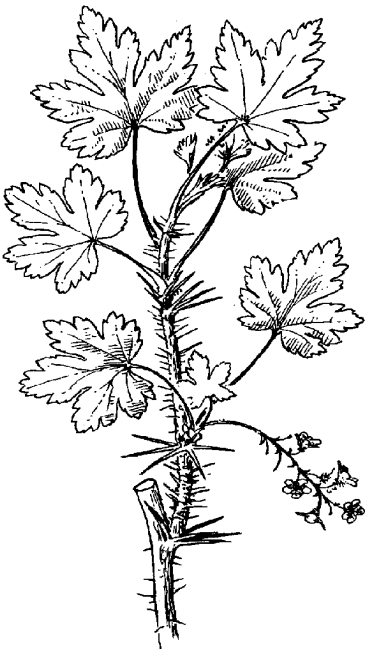
Site Type and Indication:

A facultative wetland species (FACW-), found in western Washington at low elevations in moist uplands, in saturated soils of scrub-shrub or forested wetlands and on the margins of marshes and streams. Most common on nitrogen-rich wet soils. Tolerates fluctuating water tables and strongly gleyed soils.

Prickly currant

Ribes lacustre

GROSSULARIACEAE (Currant family)

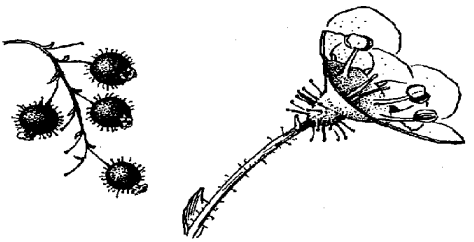


Identification:

Erect to trailing shrub to 4' tall; stems covered with fine hairs and bristly prickles; larger spines protrude at the nodes of stems and branches. Leaves are mostly five lobed, 1 to 3" in diameter and shiny green. Yellow-green flowers are borne on racemes at the nodes. Fruits are dark purple glandular berries. One of over 30 currant species known from the northwest. Common species include stink currant (*Ribes bracteosum*) FAC, mostly in western Washington; black currant (*Ribes hudsonianum*) OBL, in eastern Washington; and golden currant (*Ribes aureum*) FAC+, in eastern Washington.

Site Type and Indication:

A facultative species (FAC), equally likely to occur in wetlands or nonwetlands. Common in riparian areas throughout Washington.



Red-osier dogwood

Cornus stolonifera

(Cornus sericea)

CORNACEAE (Dogwood family)

Identification:

Erect, multistemmed deciduous shrubs, 6 to 20' tall, oppositely branched, the young branches red to purplish; leaves 2 to 4" long, ovate or elliptic-ovate, leaf veins curve toward leaf apex. In the variety that is widespread in Western Washington, the undersides of the leaves are hairy; flowers tiny and white in flat topped clusters; fruit a white berry. Could be confused with Pacific dogwood (*Cornus nuttallii*). Both species have a white, viscous, milky, latex sap in their leaf veins.

Site Type and Indication:

A facultative wetland species (FACW), common in riparian areas, scrub-shrub wetlands, forested wetlands, and very moist shady forests, often in association with red alder. The fruits and foliage are eaten by many wildlife species. The branching and rooting habits of red-osier dogwood make it a viable species for bank stabilization.

Salmonberry

Rubus spectabilis

ROSACEAE (Rose family)

Identification:

Deciduous shrub 1 to 8' tall; stems armed with a few straight prickles or unarmed, brown; leaves trifoliate, not too prickly; flowers pink; berries salmon-colored.

Site Type and Indication:

Common in the Washington western hemlock zone on moisture receiving sites, wetlands, and stream banks; a facultative (FAC+) indicator. Scattered occurrence on wetter sites in the Pacific silver fir zone, absent from higher elevation dry sites. Because of the high moisture and fine soils on many salmonberry sites, ground equipment should be avoided. Salmonberry is a valuable browse species. The cover of salmonberry increases with disturbance. Because it is aggressive and tolerant of seasonal flooding, salmonberry can be a serious competitor for conifer re-establishment after harvest in forested wetlands. Salmonberry can form stable "shrub fields" in areas that were once forested. Salmonberry sites are often good mountain beaver habitat.

Twinberry honeysuckle

Lonicera involucrata

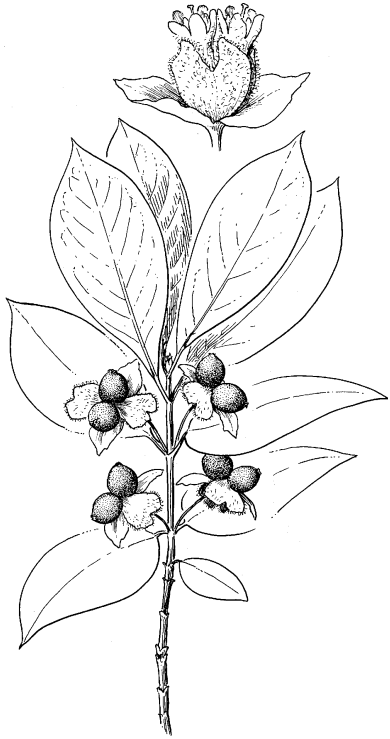
CAPRIFOLIACEAE (Honeysuckle family)

Identification:

Deciduous shrub, 3-10' tall; leaves opposite, elliptic and entire (no teeth on the margins); flowers yellow and paired; berries black, in pairs, loosely enclosed by dark red bracts.

Site Type and Indication:

Most common on warm, moist sites which are nitrogen rich. A facultative (FAC+*) species that is just as likely to be in an upland forest as a wetland. Twinberry honeysuckle tolerates fluctuating water tables, is persistent on clearcuts and can delay conifer establishment on harvested wetlands. Associated with piggy-back plant, devil's club, salmonberry and stink currant.



Wetland Herbs

American speedwell

Veronica americana

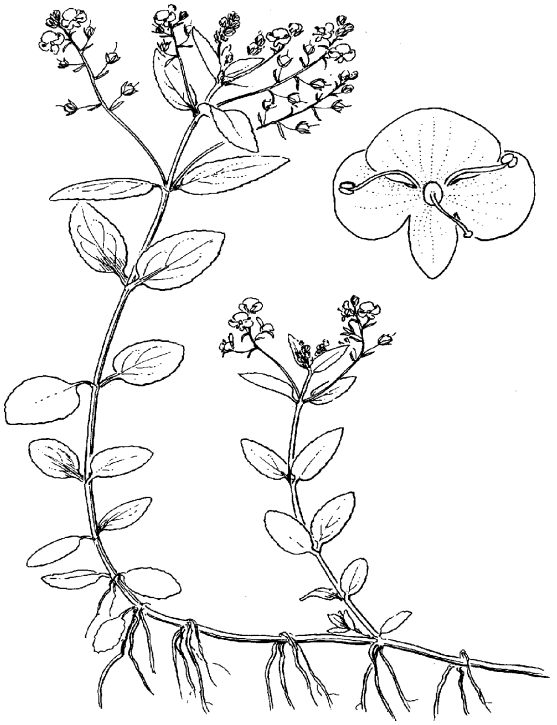
SCROPHULARIACEAE (Figwort family)

Identification:

Rhizomatous herbs, 4 to 38" tall; leaves opposite with short petioles, more or less serrated, lanceolate or lance-ovate, 0.5 to 3" long by 0.25 to 1" wide, flowers blue in axillary racemes of 10 to 25 flowers each. Looks similar to skullcap speedwell (*Veronica scutellata*) which has generally narrower leaves.

Site Type and Indication:

Both of the common speedwell species are obligate wetland species (OBL), found on streambanks, in marshes, and in other wet areas. Fibrous root systems make them valuable for bank stabilization in streams and after wetland disturbance.



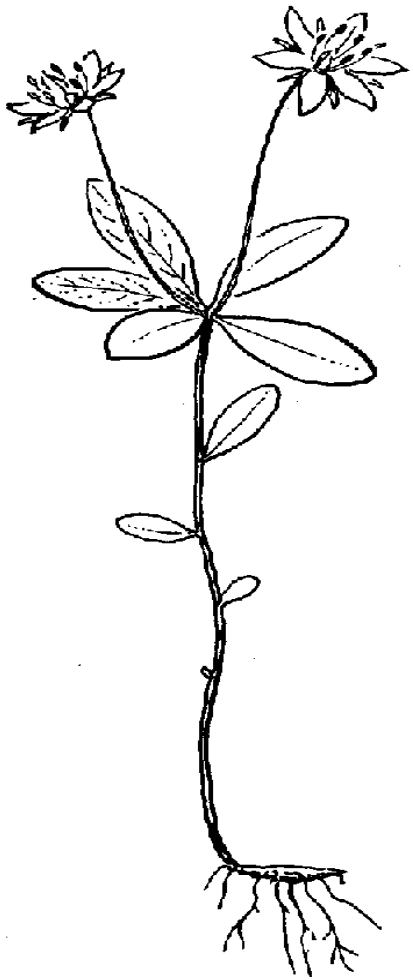
Arctic starflower

Trientalis arctica

PRIMULACEAE (Primrose family)

Identification:

Delicate plants up to 8" tall, from short horizontal tubers. Flowers usually white, though sometimes pinkish, starshaped on long slender axillary pedicels. Lower leaves small compared to upper leaves. Upper leaves (3 to 8) are elliptic to obovate, 0.5 to 2" long, born in whorls or whorl-like clusters. Fruit is reminiscent of a tiny soccer ball. Could be confused with broad-leaved starflower (*Trientalis latifolia*, FAC-).



Site Type and Indication:

An obligate (OBL) species, common in swamps and bogs, tolerant of acidic conditions. Found throughout the state.

Bog St. John's wort

Hypericum anagalloides

HYPERICACEAE (St. John's Wort family)

Identification:

Small prostrate herb with stems that freely root at the nodes, some erect stems 2 to 6" tall; leaves ovate elliptic or obovate, up to 0.5" long with sharp odor. Flowers in leafy clusters with yellow petals and many stamens.

Site Type and Indication:

An obligate wetland species (OBL), found in shallow marshes, bogs and wet meadows throughout Washington.

Buckbean

Menyanthes trifoliata

MENYANTHACEA (Buckbean family)

Identification:

Fleshy herb, up to 15" tall, rhizomatous, the rhizome covered with the dead bases of old leaves; leaves trifoliate, the leaflets elliptic-ovate to elliptic-obovate, 1.5 to 5" long, the petioles 4 to 12" long. Inflorescence a raceme about 3" long. Flowers whitish with purplish tinged petals, the peduncle 3 to 12" long.

Site Type and Indication:

An obligate wetland species (OBL), common in bogs, marshes, ponds and lakes. Occasionally in seasonal wetlands. Very shade intolerant.

Bunchberry

Cornus canadensis

CORNACEAE (Dogwood family)

Identification:

Small rhizomatous herb 3-8"; leaves whorled at top of a wiry stem; flowers terminal, in a condensed white head subtended by 4 whitish to pinkish bracts which at first glance may be mistaken for petals. Fruits in a single cluster of bright orange to red berries.

Site Type and Indication:

A facultative (FAC) species, which occupies a wide range of sites from very wet to dry, typically with the greatest coverage on cool, well drained to moist sites. No matter what the moisture of the site, bunchberry suggests low nutrient availability. Associated with stepmoss, beargrass, and oregongrape.

Bur-reed

Sparganium spp.

SPARGANIACEAE (Bur-reed family)

Identification:

The Sparganiums are easily recognized by their flowers, which are borne on terminal or axillary stalks and are clustered in spherical heads, the staminate (male) heads above the pistillate (female). Plants can be erect or lax and floating; the leaves are alternate, usually fleshy and sheathed at the base. The most common bur-reed is simple-stem bur-reed (*Sparganium emersum*).

Site Type and Indication:

The bur-reeds of Washington are all obligate wetland species (OBL), and are common in marshes; some species will be found in standing water, others in saturated soils.

Cattail

Typha latifolia

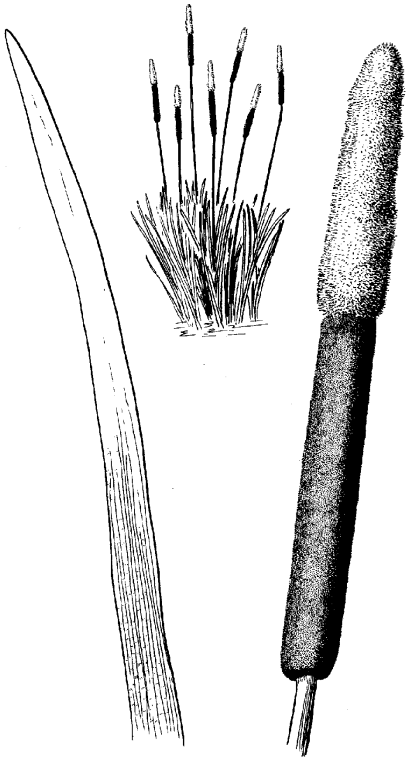
TYPHACEAE (Cattail family)

Identification:

Tall plants, 3 to 6'; leaves strap-like, nearly as long as the flowering stems, 0.5 to 1" wide; inflorescence a dense brown spike, round in cross-section, 4 to 8" long and 1" in diameter.

Site Type and Indication:

An obligate wetland species (OBL), found in marshes, and along the margins of streams and ponds. Spongy, air conducting tissue in the shoots and roots allows cattails to grow well in anaerobic soils.



Cow parsnip

Heracleum lanatum

(*Heracleum maximum*)

UMBELLIFERAE (Parsley family)

Identification:

Very large robust plants, up to 11' tall, from taproots or clusters of fibrous roots. Flowers in white compound umbels, the terminal umbel up to 8" in diameter. Leaves ternate, the leaflets palmately lobed (loosely resembling maple leaves) up to 15" in diameter. Undersides of the leaves and stems near the inflorescence fuzzy to woolly. Flattened petioles sheath the stems. The entire plant has a memorable foul smell. When growing on drier sites cow parsnip may only reach 2' tall and could be confused with coltsfoot (*Petasites frigidus*).

Site Type and Indication:

This facultative (FAC+) species is common in riparian areas and moist low ground and can be rather shade-tolerant.

Creeping buttercup

Ranunculus repens

RANUNCULACEAE (Buttercup family)

Identification:

Many stemmed herb, creeping or sometimes erect; sparsely to copiously hairy, up to 40" long, freely rooting at the nodes. Basal leaves with a petiole up to 16" long, compound with 3 leaflets, more or less triangular in outline, 1 to 3" wide, leaflets lobed and toothed. Stem leaves petiolate toward the base, becoming sessile and deeply lobed toward the top. Flowers yellow and five petalled with many stamens.

Site Type and Indication:

A facultative (FACW) wetland species, found in shallow marshes and wet meadows. A very widespread weedy species introduced from Europe. Several other species of buttercups which might be confused with creeping buttercup occur in western Washington. Always check for other wetland species and features when delineating wetlands with buttercup species.

Deerfern

Blechnum spicant

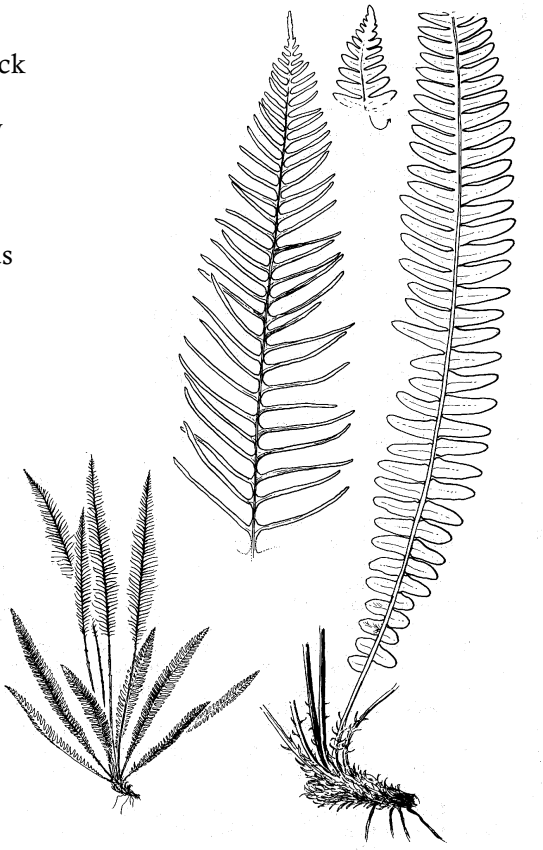
POLYPODIACEAE (Common fern family)

Identification:

Leaves once-pinnate forming a crown from a short creeping rhizome; dimorphic, the sterile leaves 8-32", fertile leaves with very narrow elongated pinnae and sori very close to leaf border.

Site Type and Indication:

A facultative species (FAC+) which occurs throughout the Sitka spruce, western hemlock and Pacific silver fir zones. Common at low elevations on nitrogen poor, moist sites. On nitrogen rich sites, deerfern (like salal) has a habit of rooting on rotting logs.



False hellebore

Veratrum viride

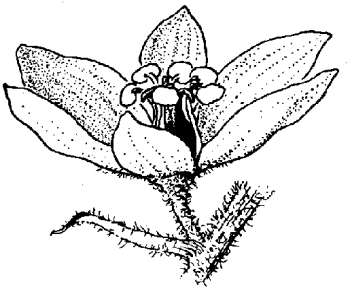
LILIACEAE (Lily family)

Identification:

Fleshy plant, 3 to 5' tall, leaves heavily ribbed, up to 12" long, oblong-elliptic, becoming smaller toward the top of the plant; flowers drooping in narrow, yellow-green branching panicles.

Site Type and Indication:

A facultative wetland species (FACW), previously classified as an obligate wetland species. Found in forested and scrub-shrub wetlands, marshes, and lowland to montane meadows. Don't base wetland determinations solely on this species. Use in combination with other wetland indicators.



False lily-of-the-valley

Maianthemum dilatatum

LILIACEAE (Lily family)

Identification:

Small (4-14") rhizomatous herb; leaves parallel-veined and heart shaped; flowers tiny and white in a terminal spike. Berries are red, persistent through the autumn, and poisonous.

Site Type and Indication:

Occurs on a wide range of sites but does poorly (small leaves, low stature) on areas which are cool or subject to summer drought. When false lily-of-the-valley cover is extensive (over 50%) or is in combination with other wet site indicators, soil compaction, brush competition, and wind throw are potential problems. A facultative (FAC) wetland indicator. Common associates include deerfern, skunk cabbage, swordfern and devil's club.

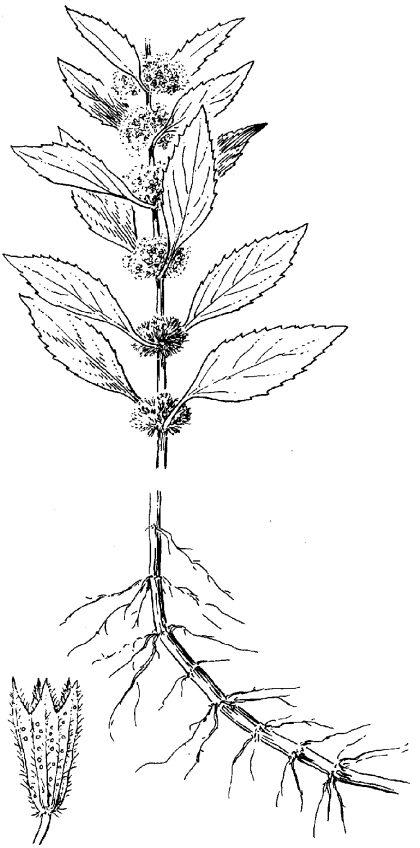
Field mint

Mentha arvensis

LABIATAE (Mint family)

Identification:

Perennial plants from creeping rhizomes. Up to 31" tall, stems square in cross section and somewhat hairy, sometimes the hairs limited to the angles. Leaves 0.75" to 3" long, on short petioles, elliptic, serrated, and sharp pointed. Flowers bilabiate, white, light purple or pink, borne in dense clusters in the axils of the upper leaves.



Site Type and Indication:

A facultative wetland species (FACW-), common in riparian areas from sea level to mid elevations in the mountains.

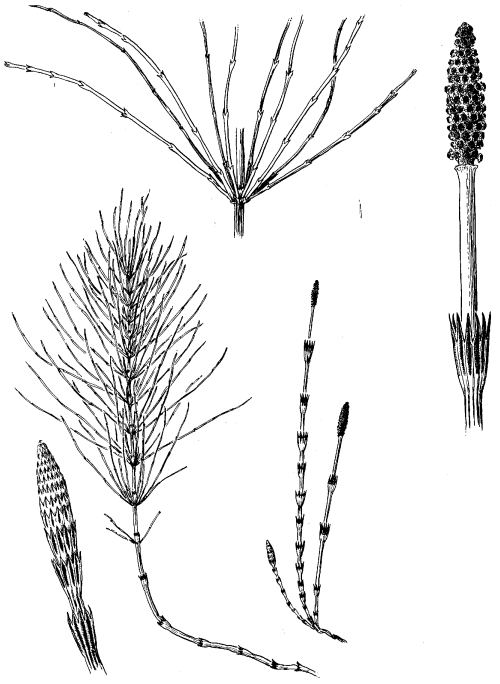
Horsetail

Equisetum arvense

EQUISETACEAE (Horsetail family)

Identification:

Erect plants, 6 to 24" tall; sterile and fertile fronds quite different in appearance: sterile fronds are green with a straight, narrow, sometimes branched stem and whorls of wiry branches radiating out and upward. Stems of fertile fronds are pale brownish to whitish with a cone shaped tip which is the reproductive structure. Tiny upward pointing teeth on the nodes of both the fertile and the sterile stems are reduced leaves, made superfluous by the photosynthesizing abilities of the green stem and branches of the sterile fronds. Beware of several look-alike species which may have a different indicator status, including fall scouring-rush (*Equisetum hyemale*) FACW, on nutrient rich sites; wood horsetail (*Equisetum sylvaticum*) FACW, on nutrient poor sites; and giant horsetail (*Equisetum telmateia*) FACW, on nutrient rich sites.



Site Type and Indication:

A facultative species (FAC), found in wet and sandy soils, in marshes, forested and scrub-shrub wetlands and wet meadows. Very aggressive on disturbed soils.

Kneeling angelica

Angelica genuflexa

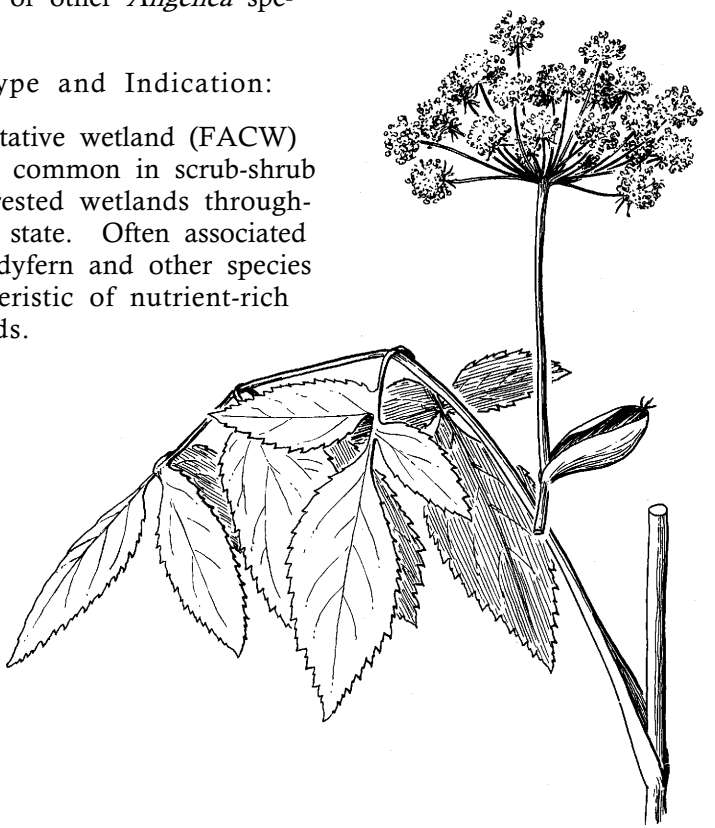
UMBELLIFERAE (Parsley family)

Identification:

Robust perennial plants from simple rootcrowns, stems leafy, often with a whitish (glaucous) cast. Leaves pinnately compound, bent downward at the first leaflets, as if genuflecting. Leaflets elliptic, ovate or lanceolate, serrate, 1.5 to 4" long and 0.5 to 2" wide. Flowers in several white to pinkish compound umbels. Could be confused with sweet cicely (*Osmorhiza chilensis*) which has no wetland indicator value; or water parsley (*Oenanthe sarmentosa*) an obligate wetland species; or other *Angelica* species.

Site Type and Indication:

A facultative wetland (FACW) species, common in scrub-shrub and forested wetlands throughout the state. Often associated with ladyfern and other species characteristic of nutrient-rich wetlands.



Ladyfern

Athyrium filix-femina

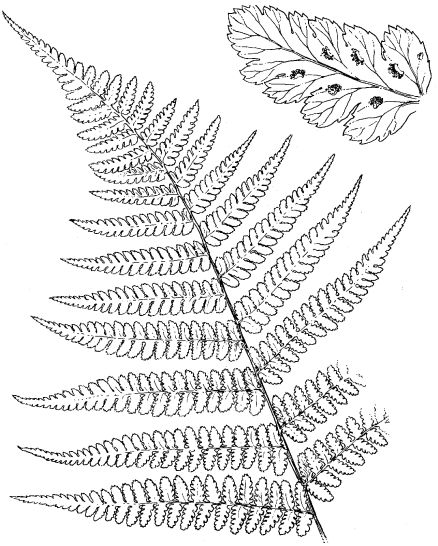
POLYPODIACEAE (Common fern family)

Identification:

Fronds up to 6' tufted at the top of an erect, stout rhizome; fronds 2-3 times pinnate, lance-shaped, tapering both ways from middle (widest at mid-length).

Site Type and Indication:

A facultative (FAC) species, characteristic of moist to wet nitrogen-rich sites in the Sitka spruce, western hemlock and Pacific silver fir zones. When abundant, suggests soil compaction and wind throw hazard. Often occurs in forested wetlands. Associated with enchanter's nightshade, Oregon oxalis, piggy-back plant, swordfern, devil's club, and skunk cabbage.



Marsh cinquefoil

Potentilla palustris

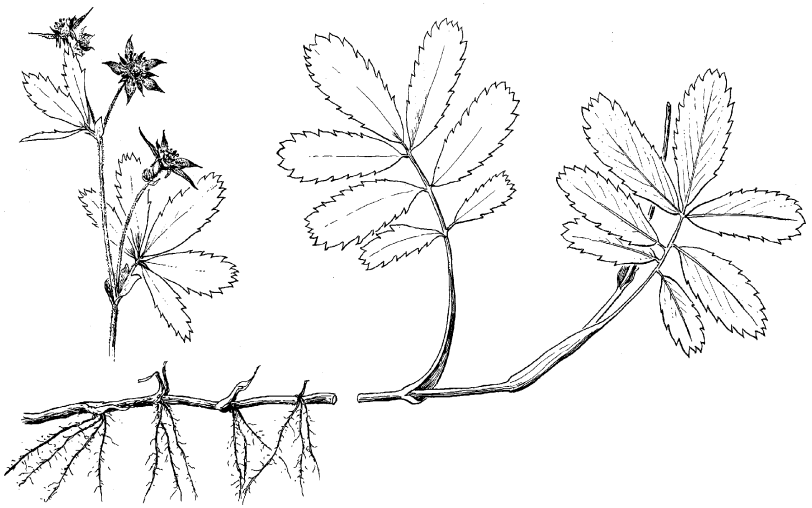
ROSACEAE (Rose family)

Identification:

Rhizomatous plants with creeping or ascending stems which often root at the nodes. Stems are up to 40" long, usually reddish, becoming purplish and hairy on the upper surfaces. Leaves pinnately compound with 5 to 7 serrated leaflets, light green on top and much paler glaucous and white fuzzy to silky underneath. Flowers dark red to purple, borne in cymes. Beware of similar species with different indicator status. For example, northwest cinquefoil (*Potentilla gracilis*, FAC), which has red flowers and largeleaf avens (*Geum macrophyllum*, FACW+), with a big, fat terminal leaflet.

Site Type and Indication:

An obligate (OBL) species usually found in the standing water of bogs, wet meadows, marshes and riparian areas.



Marshmarigold

Caltha biflora

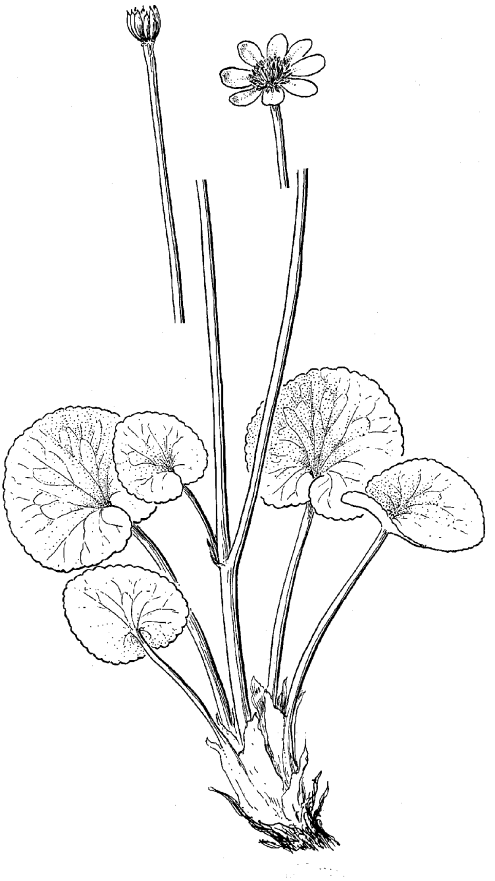
RANUNCULACEAE (Buttercup family)

Identification:

Fleshy hairless perennial plants with round cordate leaves on long petioles. Flowers white with many stamens.

Site Type and Indication:

An obligate (OBL) species, common in the open water of bogs and marshes.



Marsh violet

Viola palustris

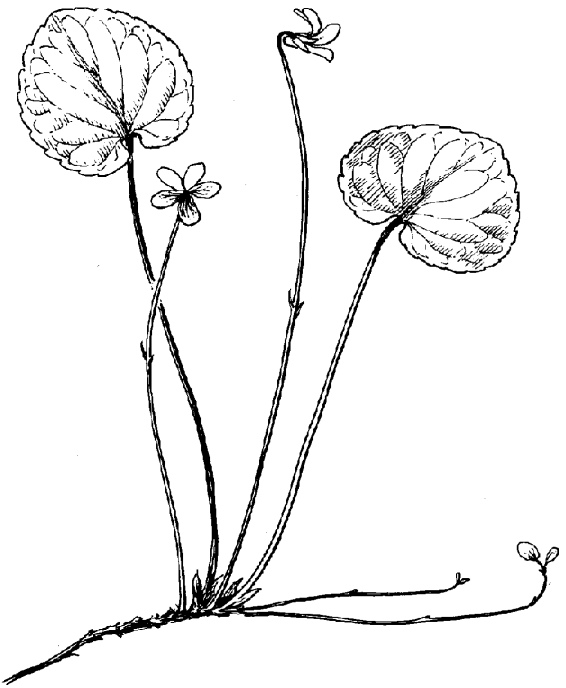
VIOLACEAE (Violet family)

Identification:

Perennial plants from rhizomes and creeping stolons. Petioles up to 6" long. Flowers white with purple lines on lower petals, or lower petals lilac tinged. Flowers about 0.5" long. Could be confused with early blue violet (*Viola adunca*, FAC), with purple flowers mainly east of the Cascade crest; or with many other violet species when they are not in flower.

Site Type and Indication:

An obligate species (OBL) of riparian areas, marshes and wet meadows. When not in flower, this species can be difficult to distinguish from other violets. Don't base a wetland delineation on this species alone without confirmation of identification.



Oregon oxalis

Oxalis oregana

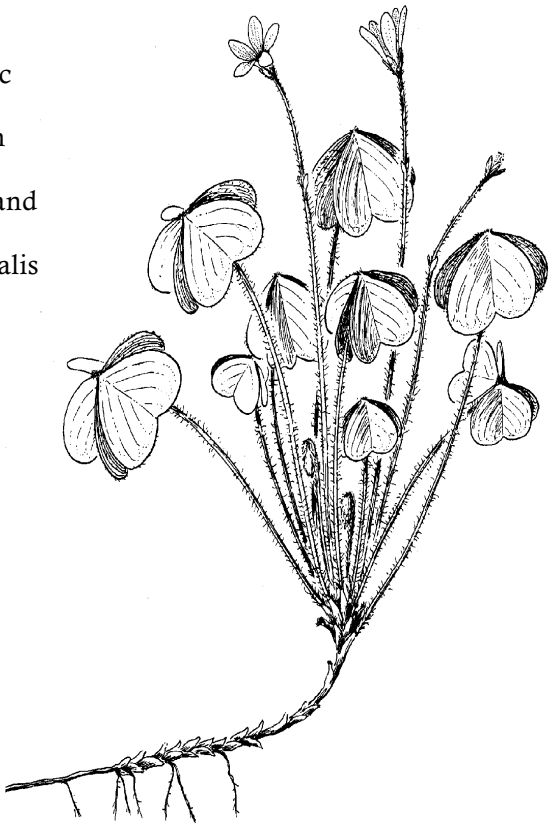
OXALIDACEAE (Oxalis family)

Identification:

Small herb 2-7" high; leaves trifoliate, clover-like with 2-lobed leaflets; flowers are 5-petaled, white with pink veins.

Site Type and Indication:

Characteristic of relatively warm, mesic to wet, nitrogen rich sites in the Sitka spruce, western hemlock and Pacific silver fir forest zones. When common, a good indicator of deep rich soils in the Sitka spruce and western hemlock zones. Restricted to moist or wet sites in the Pacific silver fir zone in our area. Associated with ladyfern, swordfern, Alaska huckleberry, and salal. The wetland indicator status of oxalis has not been defined.



Peat moss

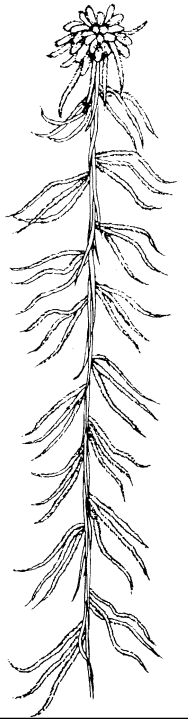
Sphagnum capillaceum

Identification:

Mat forming moss, branches in clusters of 3 to 5 per bundle; shoot apex generally a tight cluster of branches; leaves lacking mid vein; colors various (whitish green to red). Could be confused with several other species of sphagnum moss.

Site Type and Indication:

Characteristic of bogs. Sometimes found in marshes and forested wetlands or rotting logs. A good indicator of very nutrient poor, acidic soil conditions. Associated with deerfern, Labrador-tea, and Douglas' spiraea.



Piggy-back plant

Tolmiea menziesii

SAXIFRAGACEAE (Saxifrage family)

Identification:

Small herbs 1-2' tall; leaves with 5-7 shallow lobes; small chocolate colored flowers with hair-like petals on loose racemes; reproduces vegetatively by buds at base of leaf blades. Can be confused with coolwort foamflower.

Site Type and Indication:

A facultative (FAC*) species that is a good indicator of mesic to moist (wet) soil conditions and high nitrogen availability. Occurs from the coast to mid elevations on the west side of the Cascades. When common, suggests potential soil compaction and windthrow hazard and poor response to nitrogen fertilization. Associated with swordfern, three-leaved foamflower, salmonberry, ladyfern, and devil's club.

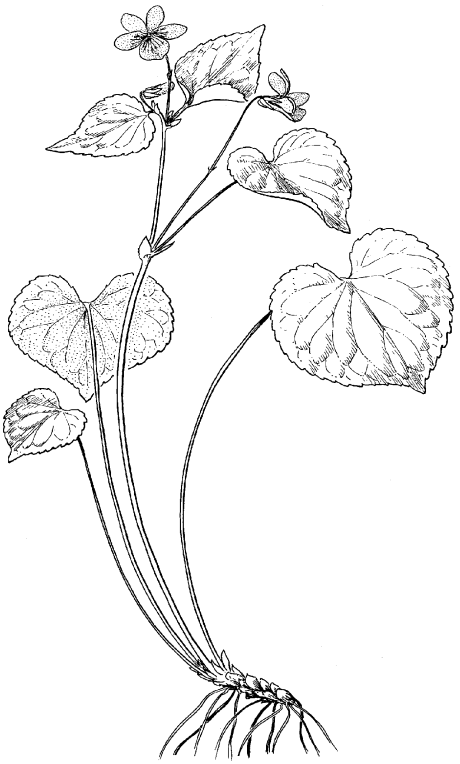
Pioneer violet

Viola glabella

VIOLACEAE (Violet family)

Identification:

Small herb, 3 to 10" tall; branching at the top; leaves heart-shaped and toothed, flowers yellow pencilled with purplish or brownish streaks.



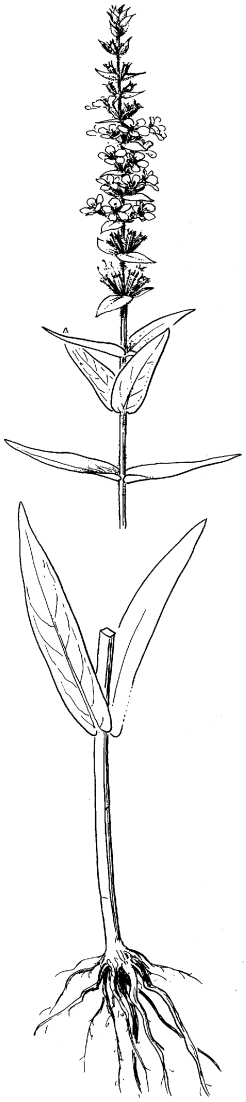
Site Type and Indication:

A facultative wetland species (FACW+), common in forested wetlands and nitrogen rich moist forests throughout Washington. When pioneer violet is not flowering, it is difficult to distinguish from several other violet species. Don't base a wetland delineation on this species alone, check for other wetland species and features.

Purple loosestrife

Lythrum salicaria

LYTHRACEAE (Loosestrife family)

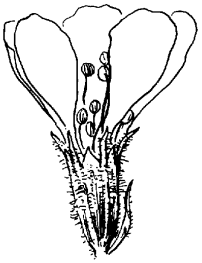


Identification:

Rhizomatous perennial herb 1 to 6' tall; leaves opposite, long and thin, heart shaped at the base; flowers showy, reddish-purple in terminal spikes. Could be confused with fireweed (*Epilobium angustifolium,* FACU-), or willow weed (*Epilobium ciliatum*, FACW-)

Site Type and Indication:

An facultative wetland species (FACW+), found in marshes and swamps. An aggressive European species characteristic of disturbed marshes. The introduction and spread of this plant should be aggressively discouraged.

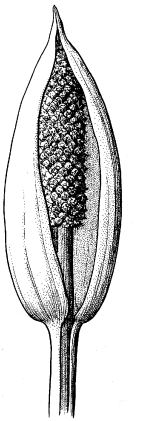


Skunk cabbage

Lysichitum americanum

(*Lysichiton americanus*)

ARACEAE (Arum family)



Identification:

Plant 6 to 24" high; leaves large, green and fleshy, up to 3' long and 1' wide; flower a large yellow spathe (or sheath) with a thick spadix (club-like inflorescence) inside. Plant blossoms early in the spring before the leaves come out. Herbage and flower give off a pungent odor, as the name suggests.

Site Type and Indication:

An obligate wetland species (OBL), most common at low elevation and wetland sites that collect water. Tolerant of anaerobic rooting conditions, and is consequently often one of the only plants in saturated organic muck soils. Flowering heads and leaves are extensively browsed, the fruits are a favorite food of bear. A good indicator of potential engineering problems. Skunk cabbage always suggests that special considerations will be needed for regeneration. Even though large Douglas-fir and other flooding intolerant conifer species may occur on sites with skunk cabbage, they are usually restricted to mounds within the wetland and are difficult to re-establish.

Slender stemmed waterleaf

Hydrophyllum tenuipes

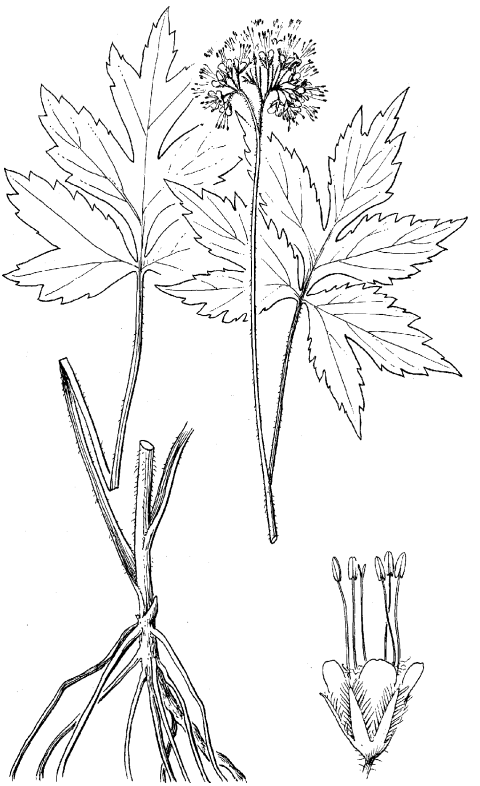
HYDROPHYLLACEAE (Waterleaf family)

Identification:

Rhizomatous herb, 8 to 30" tall, leaves up to 6" long, barely longer than wide, toothed and compound, with a pair of distinct leaflets below a larger palmately 3 lobed leaflet; flowers in loose greenish-white, cream colored or bluish heads, the stamens extending far beyond the petals.

Site Type and Indication:

Found in moist woods and forested wetlands throughout western Washington. This species tolerates considerable drying in the growing season, but soils where it grows are generally wet in the winter. A good indicator of moist or wet areas which are not necessarily wetlands. Wetland indicator status for slender stemmed waterleaf has not been defined.



Small-flowered forget-me-not

Myosotis laxa

BORAGINACEAE (Borage family)

Identification:

Short-lived, fibrous-rooted plants with weak slender stems, up to 16" long. Leaves narrow, oblanceolate to elliptic or lanceolate, 0.5 to 3" long and up to 0.5" wide. Tiny blue flowers in loose racemes terminate the flowering stems.

Site Type and Indication:

An obligate (OBL) species found in moist soil or shallow water of marshes and riparian areas.

Starry false Solomon's-seal

Smilacina stellata

(*Maianthemum stellatum*)

LILIACEAE (Lily family)

Identification:

Rhizomatous herb, 1 to 2' high; leaves elliptic, 2 to 5" long and arranged alternately, the stem sometimes zigzagging between nodes. Flowers small and white in a loose raceme; fruit is bright red berries.

Site Type and Indication:

A facultative species (FAC-), found in moist woods and forested wetlands. A poor indicator of wetland edge because of its wide distribution in upland forests. Associated with other indicators of nitrogen-rich soils such as bleeding heart (*Dicentra formosa*) and ladyfern (*Athyrium filix-femina*).

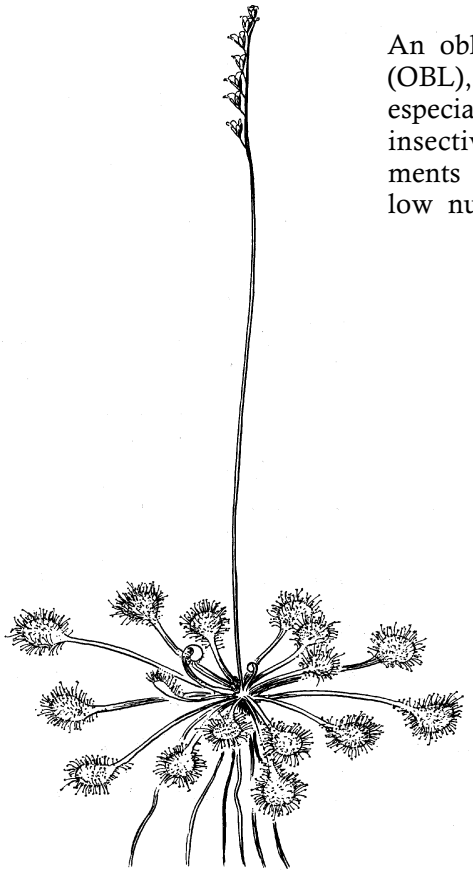
Sundew

Drosera rotundifolia

DROSERACEAE (Sundew family)

Identification:

Small herbs with a flowering stalk up to 10" tall; leaves round, <0.25 to 0.5" in diameter with stout, spreading petioles, 0.5 to 2.5" long, leaves covered with sticky stalked glands which catch and digest small insects; flowers white, 2 to 8, borne on one side of a tall stalk.



Site Type and Indications:

An obligate wetland species (OBL), common in swamps and especially bogs, where its insectivorous habit supplements its nitrogen intake in the low nutrient bog environment.

Sweet-scented bedstraw

Galium triflorum

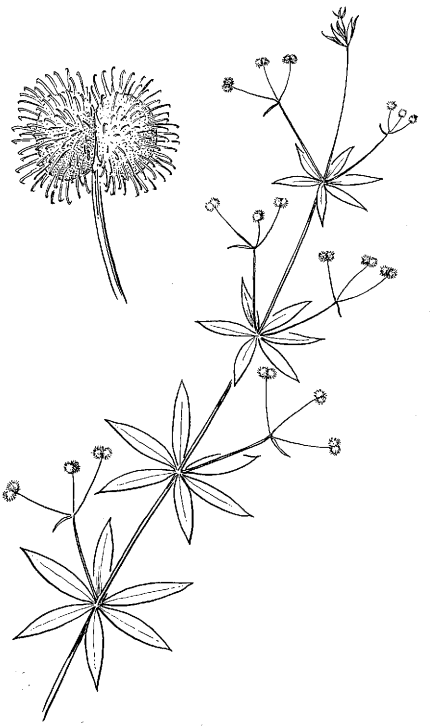
RUBIACEAE (Madder family)

Identification:

A rhizomatous plant with rough four-angled stems; leaves whorled, mostly 6 to a whorl, vanilla scented and sharp pointed with one central vein; flowers have four very small white petals; fruit are mostly 2 lobed and covered in hooked bristles, and are generally born in 3's at the ends of axillary peduncles. Several other *Galium* species are common in our area.

Site Type and Indication:

Widespread on moist, lower elevation site types. A facultative upland (FACU) species, associated with ladyfern, swordfern, and three-leaved foamflower. Often found in great abundance on the margins of wetlands. Indicates that soils are moist and nitrogen levels high.



Three-leaved foamflower

Tiarella trifoliata

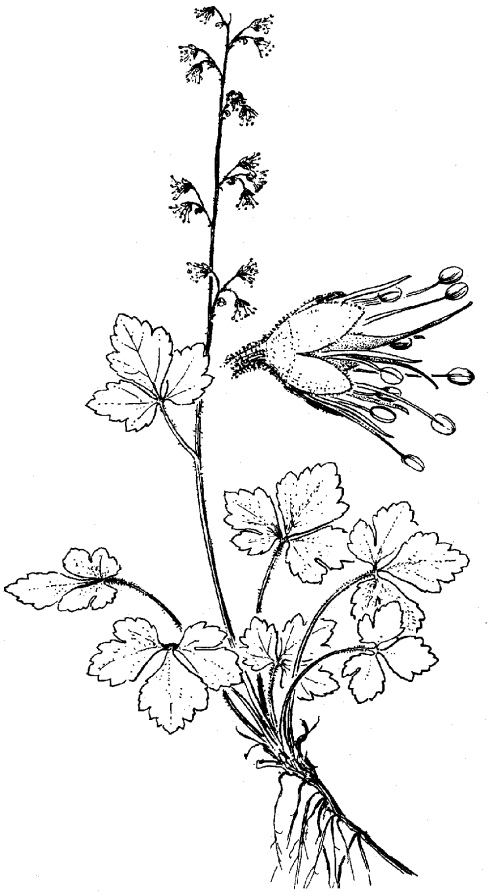
SAXIFRAGACEAE (Saxifrage family)

Identification:

Herbs 5-20" high; leaves trifoliate, covered with soft hairs, all but one growing from the base of the stem, flowering stem with solitary leaf; flowers white in a terminal panicle. Could be confused with the less common coolwort foamflower (*Tiarella trifoliata, var. unifoliata*).

Site Type and Indication:

A facultative species (FAC), common on cool, moist to wet, nitrogen rich sites in the Sitka spruce, western hemlock and Pacific silver fir zones. Commonly associated with vanillaleaf, ladyfern, salmonberry, and swordfern. Coolwort foamflower is more common at higher elevations.



Touch-me-not

Impatiens noli-tangere

(*Impatiens occidentalis*)

BALSAMINACEAE (Balsam family)

Identification:

Succulent annual herb, 7 to 23" tall; leaves alternate, elliptic-ovate, 1 to 4.5" long, with somewhat coarsely rounded teeth, each of which is tipped with a slender sharp point; flowers irregular, orange with brown spots; fruit a dry capsule which dispenses its seeds explosively when touched.

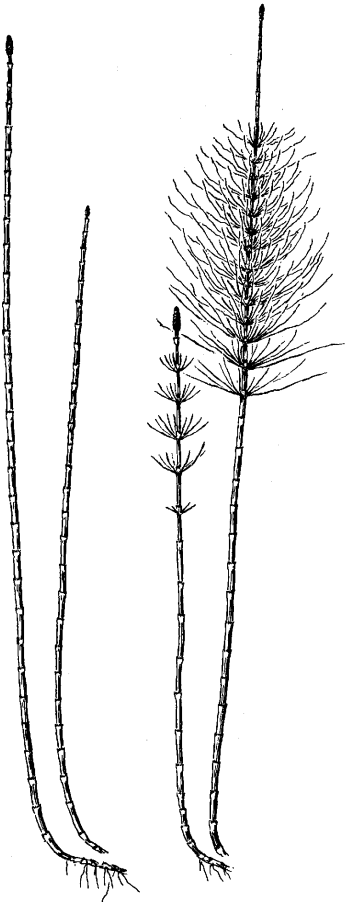
Site Type and Indication:

A facultative wetland species (FACW), which prefers moist shady areas in swamps and on streambanks. Common throughout the state, often found in abundance.

Water horsetail

Equisetum fluviatile

EQUISETACEAE (Horsetail family)

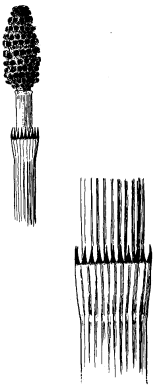


Identification:

Annual plants up to 40" tall, not differentiated into fertile and sterile stems as in common horsetail (*Equisetum arvense*). Plant green, branched or unbranched, with green sheaths up to 0.25" long, with narrow black or blackish teeth along the upper edge. Stems are hollow, the cavity about three quarters of the diameter of the stem itself. This species can be distinguished from common horsetail by the cones at the tips of the stems.

Site Type and Indication:

An obligate (OBL) species, found in shallow water or mud, in marshes and bogs.



Water parsley

Oenanthe sarmentosa

Umbelliferae (Carrot family)

Identification:

Soft, generally reclining herb with lax, freely branched stems, up to 40" long. Leaves 4 to 14" long, compound, two to three times pinnate, the leaflets toothed to cleft. Flowers tiny and white, borne in umbels.

Site Type and Indication:

An obligate wetland species (OBL), found in shallow marshes, wet meadows, scrub-shrub and forested wetlands. Widespread in Western Washington and along the Columbia River to Klickitat County. In forested wetlands this species suggests that the soil is near saturation most of the year.

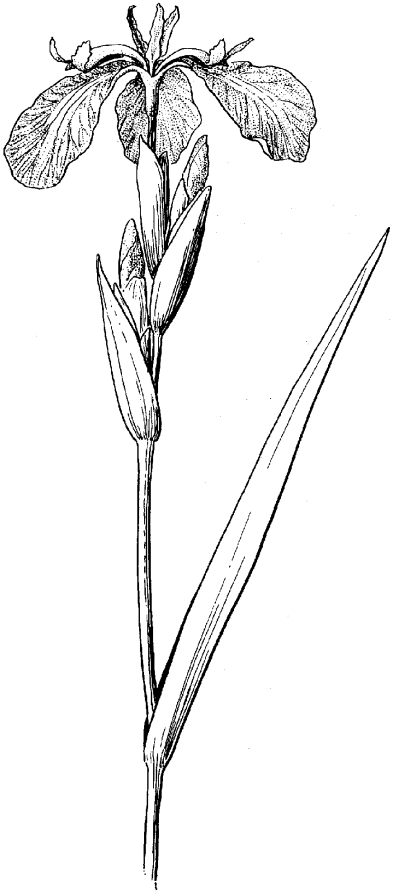
Yellow Iris

Iris pseudacorus

IRIDACEAE (Iris family)

Identification:

Stout plants in dense clumps up to 3' wide; leaves strap-shaped, stiff, about 0.5" wide and up to 35" long; flowering stems up to 14" tall; flowers yellow with purple lines, very showy.



Site Type and Indications:

Obligate wetland species (OBL), common in marshes and on the margins of lakes and ponds. An introduced European species, the spread of which should be discouraged.

Yellow monkeyflower

Mimulus guttatus

SCROPHULARIACEAE (Figwort family)

Identification:

Plants variable in rooting habit and stature. Sometimes annual from fibrous roots, perennial from stolons or occasionally perennial from rhizomes. Can be up to 39" tall, or just a few inches tall with small leaves. Leaves opposite, can be smooth or hairy, but always soft and often succulent. Leaves with irregular teeth, ovate to almost round, sometimes with heart shaped bases, the leaf veins always starting at the same point at the base of the leaves (palmately veined). Lower leaves with petioles, upper leaves smaller and sessile, sometimes clasping the stem. Flowers yellow with maroon markings in the throat, strongly bilabiate, < 0.5 to 1.5" long. Can bloom from March through September.

Site Type and Indication:

An obligate (OBL) wetland species of wet places and riparian areas. Yellow monkeyflower occurrence and distribution can be helpful in determining the extent of seasonal high water.

Yellow pond lily

Nuphar polysepalum

(*Nuphar luteum ssp. polysepalum*)

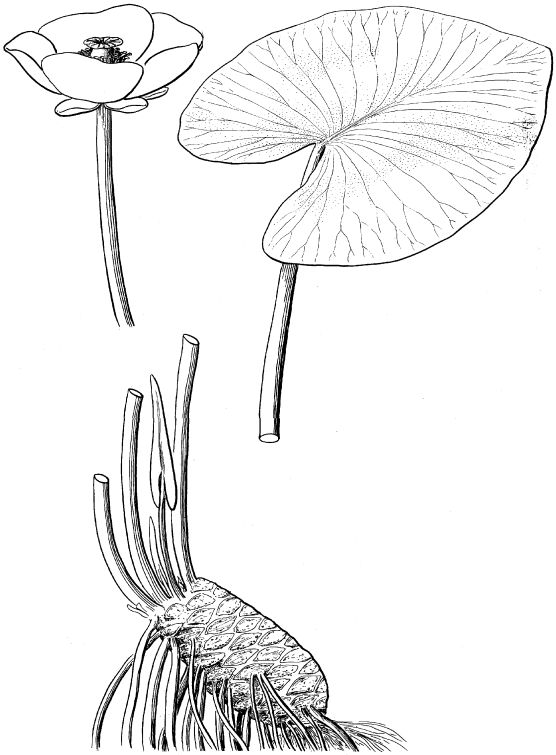
NYMPHACEAE (Waterlily family)

Identification:

Large leathery aquatic herb; leaves heart shaped, 4 to 15" long, sometimes submerged, sometimes standing well above the surface of the water on stout petioles; flowers stout, yellow, 2 to 5" in diameter.

Site Type and Indication:

An obligate wetland species (OBL), restricted to deep marshes and the edges of ponds.



Wetland Grasses and Grass-like Plants

The understories of many marshes and forested wetlands are dominated by grasses or grass-like plants. Many non-wetland areas can also be dominated by similar looking species. Identification of the plants is the best way to make interpretations as to past disturbance and current site conditions.

Table 4 makes it easy to differentiate between the major groups of grass-like plants. Check the Glossary for definitions of the more technical terms.

Slough sedge. A very common wetland indicator for wetlands in forested areas on the west side of the Cascades. See page 96. WADNR, WASHINGTON STATE HERITAGE PROGRAM.

Table 4. General features of major groups of grasses and grass-like plants

	Sedges *Carex*	Bulrushes *Scirpus*	Rushes *Juncus*	Grasses
Leaves	3 rows on a stem; strap shape, sometimes "W"-shaped in cross-section, sheath closed	3 rows on a stem; strap shaped, sheath closed	1 row per stem if round, two rows if flattened	2 rows on a stem; strap shaped; sheath open
Stem shape	Round or triangular in cross section	Round or triangular in cross section	Round or flattened in cross section	Round in cross section; jointed
Stem interior	Solid	Solid	Spongy	Hollow
Inflorescence	Spike	Spikelets borne in heads, or panicle-like or umbel like inflorescence	Usually cymose and and either paniculate or in dense heads	Spikelets borne on a jointed stem
Flower	Each flower subtended by a bract; male and female flowers usually borne on the same spike, one above the other; female flowers usually with 2 or 3 styles, male flowers usually with 2 or 3 stamens	Spirally arranged on a spikelet, borne in the axils of scales; 2 to 6 bristles take the place of petals; stamens 1 to 3	6 brownish or purplish, undifferentiated petals and sepals; stamens usually 3 or 6	Florets borne on spikelets, which are surrounded by 2 bracts known as the palea and lemma

	Sedges *Carex*	Bulrushes *Scirpus*	Rushes *Juncus*	Grasses
Fruit	A dry, 1-seeded fruit (achene) enclosed in a sheath or sack (perigynum)	Achene, not enclosed in a perigynum	Many seeds enclosed in a capsule	A dry, 1-seeded fruit (caryopsis) in which the outer covering (pericarp) is bonded to the fruit on all sides

Northwest beaked sedge

*Carex utriculata**

CYPERACEAE (Sedge family)

Identification:

Rhizomatous plants 12 to 46" tall, stems arising singly or a few clustered; leaves up to 0.5" wide, grass like; spikes elongate, erect and cylindric, the staminate (male) spikes born above the pistillate (female) ones. Female spikes with stiffly spreading achenes. The shell-like sack (perigynium) which surrounds the achene is larger than the achene in this species, and somewhat inflated.

Site Type and Indication:

An obligate wetland species (OBL), found in shallow water on firm substrate in marshes and bogs and the margins of ponds and lakes. One of the most common sedge indicators of forested wetlands.

*Note:

C. utriculata keys to *C. rostrata* in Hitchcock et. al. (1973). *Carex* specialists now agree that *C. rostrata* is a rare east side species, known in Washington from only a few sites, with specialized habitat of quaking or floating bog mats. Plants of this description found on the west side or on the east side on firm substrate are most likely *C. utriculata*.

Cottongrass

Eriophorum spp.

CYPERACEAE (Sedge family)

Identification:

Colonial plants from creeping rhizomes; 12 to 28" tall. Leaves grasslike, mostly arising from the base of the plant. Solitary spikelet of flowers at the tip of the stem, with a dense head of cottony reddish to white bristles, for which these species are named.

Site Type and Indication:

Obligate plants (OBL) of mostly cold, wet areas in the mountains, but also present at sea level near the coast. Flowering heads are persistent and make mapping of wet meadows easy.

Reed canary grass

Phalaris arundinacea

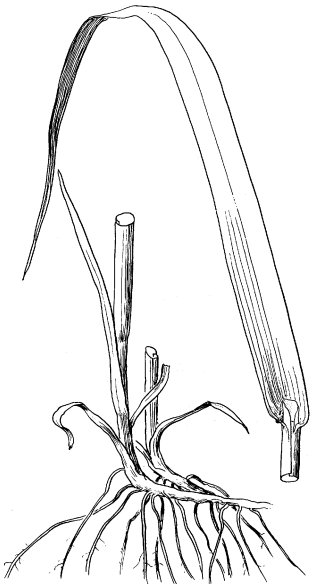
GRAMINEAE (Grass family)

Identification:

A tall, robust, rhizomatous grass, from 3 to 6' in height, leaves flat, up to 0.75" wide, smooth or minutely hairy. Inflorescence 3 to 6" long, compact but spreading as the fruits mature. Reportedly can be cut for hay.

Site Type and Indication:

A facultative wetland species (FACW), found commonly in ditches, wet meadows and shallow marshes; invasive and very hardy. This widespread native weed commonly chokes culverts, is of low use by wildlife and displaces native plant species in disturbed wetlands. The introduction of this species to undisturbed wetlands should be avoided.



Slough sedge

Carex obnupta

CYPERACEAE (Sedge family)

Identification:

Densely tufted, rhizomatous species up to 3' high; leaves narrow and strap shaped, no more than 0.25" wide. Flowers in 4 to 8 light to dark brown nodding spikes, subtended by several leafy bracts, the largest of which is at least as long as the inflorescence, and usually longer.

Site Type and Indication:

An obligate wetland species (OBL), which is common in standing water or saturated soils in marshes or along rivers or ponds. In forested wetlands, the wetland boundary can sometimes be located at the transition from swordfern to slough sedge. Seeds are eaten by waterfowl.

Note: Not all sedge species are wetland indicators. It is well worth learning the particular sedges common to your local area to avoid errors in wetland identification.

Small fruited bulrush

Scirpus microcarpus

CYPERACEAE (Sedge family)

Identification:

Robust, coarse plants from 2 to 5' tall, growing singly or in loose clumps of several together; stems more or less triangular; leaves strap-shaped, about 0.5" wide, alternately arranged along the stem; sheaths sometimes purplish tinged. Flowers in an umbel-like terminal cluster of small dark brown to blackish spikelets which spread and nod loosely on long green peduncles. The inflorescence is subtended by several large leafy bracts, the largest of which is usually 4" long or more.

Site Type and Indication:

An obligate wetland species (OBL), found in marshes and the mucky margins of lakes and ponds.

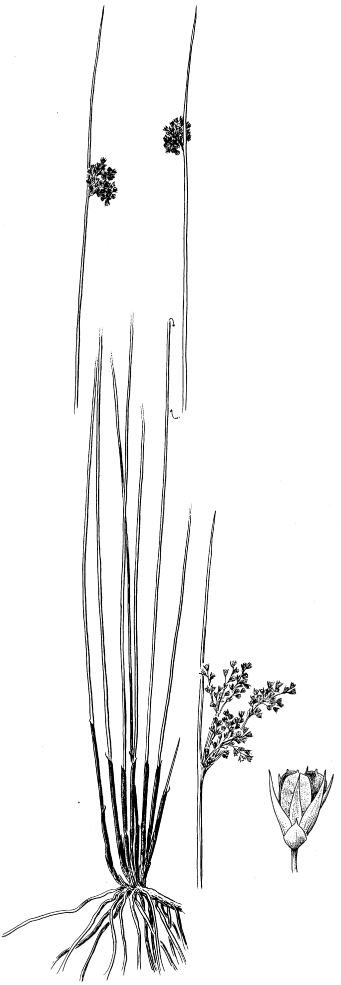
Soft rush

Juncus effusus

JUNCACEAE (Rush family)

Identification:

Tufted, rhizomatous plants with stems which are round in cross-section, 8 to 39" tall, with pale to dark brown sheaths which clasp the stems from the base to a height of 2 to 5". Inflorescence sprouts in a loose panicle from the stem, a bit more than two-thirds of the way from the base.



Site Type and Indication:

A facultative wetland species (FACW), found in shallow marshes and saturated ground in wet meadows. Although this is a native species, it is highly invasive, and is a good indicator of wetland disturbance. In uplands, it often occurs where ground traffic has damaged soil pore structure and created anaerobic conditions.

Spike rush

Eleocharis spp.

CYPERACEAE (Sedge family)

Identification:

Plants in the genus *Eleocharis* have a solitary spikelet at the very top of a long stem; all basal leaves are reduced to inconspicuous scales or sheaths.

Site Type and Indication:

All but a few species in this genus are obligate wetland species (OBL), and are commonly found in marshes and swamps.

Glossary

Achene
: A one seeded, dry fruit which doesn't split at maturity.

Alternate
: Leaves or branches positioned individually at nodes, alternating sides along the stem; not in opposite pairs or whorls.

Anaerobic conditions
: Conditions that occur in the absence of oxygen.

Anther
: The pollen bearing part of a stamen, located at the apex of the filament.

Apex
: Tip or end.

Axil
: The angle between the leaf and the stem; axillary = in or arising from the axil.

Basal
: Situated at the base.

Basal area
: A measure of tree density, referring to the cross-sectional area of tree trunks measured at breast height. Basal area can be measured with several different instruments, including specialized prisms and relaskops.

Bilabiate
: "Two lipped". Refers to irregular flowers such as those in the pea family (See Glossary illustrations, p. 112).

Bi-ternate
: Two times ternate; with 3 groups of three.

Bog

A wetland with peat soils, acidic conditions and vegetation that is hydrologically isolated from outside sources of nutrient rich ground and surface water. Bogs receive their water and nutrients from precipitation, and support specially adapted flora. Sphagnum moss is the most common peat forming vegetation in northern bogs.

Bract

A modified leaf associated with a flower or flower cluster which may look like a petal or scale.

Canopy cover

The area included in a vertical projection of a canopy which is usually expressed as a percentage of a fixed area. In practice, imagine a convex polygon encompassing the canopy and project that onto the ground.

Capsule

A dry fruit which splits open at maturity to release its seeds.

Caryopsis

A dry, one seeded fruit in which the outer part of the fruit (pericarp) is firmly bonded to the seed, as in a grain of wheat.

Catkin

An elongate, usually drooping, scaly spike of flowers.

Compound leaf

Divided into two or more distinct leaflets.

Conifer

Mostly evergreen, cone bearing trees and shrubs including such trees as western larch (which is not evergreen) and Pacific yew (which has berry-like fruits called arils instead of cones).

Cyme

A branched inflorescence in which the central, terminal or uppermost flowers bloom earliest.

Cymose
: Having or resembling a cyme.

Deciduous
: Having leaves which fall in the autumn, as opposed to evergreen leaves which persist through several seasons.

Distal
: At or toward the tip or far end.

Dominant plant species
: Dominance as used here refers to the spacial extent of a plant species, as it is discernible or measurable in the field wetland determination.

  To determine dominance, estimate the percent canopy cover of each species in each stratum (trees, saplings, vines, shrubs, and herbs). Rank the species in each stratum in descending order of abundance. The dominant species are those whose combined coverage equal over 50 percent, plus any single species whose coverage equals 20 percent or more. To determine if the vegetation of a given area meets the vegetation criterion for wetland identification, refer to the 1988 List of Plants that Occur in Wetlands (Reed, 1988) and the 1993 supplement to List of Plants that Occur in Wetlands (Reed, 1993) or to Appendix D. If over 50 percent of the dominant species are classified as OBL, FACW or FAC, the area supports wetland vegetation.

Elliptic
: In the shape of an ellipse; widest in the middle with the two ends equal.

Entire
: Leaf margin without teeth or lobes.

Evapotranspiration
: Loss of moisture through a combination of evaporation from land and water surfaces and transpiration by plants.

Facultative (FAC)
: Plants which are equally likely to occur in wetlands or nonwetlands (estimated probability 34 percent to 66 percent).

Facultative Upland (FACU)
: Plants which usually occur in nonwetlands (estimated probability 67 percent to 99 percent) but are occasionally found in wetlands (estimated probability 1 percent to 33 percent).

Facultative Wetland (FACW)
: Plants which usually occur in wetlands (estimated probability 67 percent to 99 percent) but occasionally are found in nonwetlands.

Fen
: A type of wetland that usually has sedge peat soils and is in contact with nutrient rich ground and surface water. A seral stage of bogs.

Field indicator
: A characteristic that provides evidence for an environmental condition and is observable in the field. For instance, saturated soil is a field indicator of wetland hydrology.

Filament
: The stalk of a stamen which supports the anther.

Frond
: A compound leaf, usually of a fern or palm.

Glabrous
: Smooth, not hairy or glandular.

Gland
: Organ which secretes a greasy or sticky substance, or a similar non-secreting organ.

Gleyed Soil

A soil which is light grey, greenish or bluish colored as a result of prolonged saturation. Gleying occurs by the process of gleization.

Head

An inflorescence of flowers clustered closely together at the tip of the peduncle.

Hydric

Wet, available soil moisture is above climatic inputs because of topographic and/or soil features.

Hydric soil

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.

Hydric soil criteria:[13]

1. All Histosols except Folists, or
2. Soils in Aquic suborders, great groups, Albolls suborder, Aquisalids, Pachic subgroups or Cumulic subgroups that are:

a. Somewhat poorly drained with a water table equal to 0.0 foot (ft.) from the surface during the growing season, or

b. poorly drained or very poorly drained and have either:

(1) water table equal to 0.0 ft. during the growing season if textures are coarse sand, sand or fine sand in all layers within 20 inches (in.) or for other soils, or

(2) water table at less than or equal to 0.5 ft. from the surface during the growing season, if permeability is equal to or greater than 6.0 in./h. in all layers within 20 in., or if permeability is equal to or greater than 6.0 in./hour (h) in all layers within 20 in., or

(3) water table at less than or equal to 1.0 ft. from the surface during the growing season, if permeability is equal to or greater than 6.0 in/h. in any layer within 20 in., or

13 USDA, NRCS, 1998.

3. Soils that are frequently ponded for long or very long duration during the growing season or
4. Soils that are frequently flooded for long or very long during the growing season.

Indicator plant
: A plant considered to be indicative of a particular habitat or environmental condition.

Inflorescence
: A flower cluster; the arrangement of flowers on the stem.

Lanceolate
: Lance-shaped, several times longer than broad, broadest at the base and tapering toward the tip.

Layering
: Rooting of aerial branches when they remain in contact with soil for sufficient time to develop roots.

Lemma
: The lower of two bracts which with the palea enclose the individual flowers in a grass spikelet.

Linear
: (Pertaining to leaf shape) narrow with the sides parallel; of equal or nearly equal width throughout its length, like a Douglas-fir leaf or a blade of grass.

Macropore
: A naturally occurring void in the soil.

Mesic
: Moist, neither wet nor dry. Available soil moisture reflects climatic inputs rather than topographic or soil conditions.

Montane
: Of or growing in mountain areas.

Net primary productivity
: The total amount of energy that a plant captures through photosynthesis over a given period of time, minus the energy required for respiration.

Node
: The place on a stem where leaves are normally attached.

Oblanceolate
: Several times longer than wide, broadest at the apex, tapering toward the point of attachment.

Obligate plant (OBL)
: Plants which are almost always found in wetlands under natural conditions (probability >99 percent).

Obovate
: Egg shaped in outline, attached at the narrow end.

Opposite
: Leaves or stems borne in opposite pairs on either side of a stem; situated in pairs at each node.

Organic soil
: To be classified as organic, a soil horizon must have at least 30 percent organic matter if the mineral fraction is more than 50 percent clay, and only 20 percent with less clay. The absence of a gritty feeling when rubbing the soil between your fingers is a fairly reliable indicator of organic soil.

Ovate
: Egg shaped in outline, attached at the broad end.

Ovoid
: Egg shaped (3 dimensional).

Palea
: The upper of two bracts which, with the lemma, enclose the individual flowers in a grass spikelet.

Palmate
: Three or more leaflets, veins or lobes which attach at the same point (as fingers arise from a palm).

Panicle
: A branched inflorescence where the youngest flowers are at the apex or center.

Paniculate
: Having or resembling a panicle.

Ped
: A small naturally occurring soil aggregate.

Pedicel
: The stalk of an individual flower within an inflorescence.

Peduncle
: The stalk of an inflorescence or solitary flower.

Percent cover
: The percentage of the area of a vegetation plot covered by a particular plant species. See vegetation coverage appendix.

Pericarp
: The wall of a fruit that surrounds the seed such as the outer wall of a grain of wheat or the fleshy part of a cherry.

Perigynium
: The specialized bract or shell which encloses the achene in sedge species.

Petiole
: The stalk of a leaf.

Pinna (plural: pinnae)
: A primary division of a pinnately compound leaf.

Pinnate
: Arrayed along opposite sides of a common axis such as a stem or a midrib, like barbs on a feather.

Pinule
: The smallest leaflet or lobe of a pinna.

Pistillate flower
: A flower with pistils, but no stamens; a female flower.

Raceme
: A long, unbranched inflorescence of flowers on pedicels.

Recurved
: Curved back, out, or down.

Reduction
: A chemical transformation when electrons are accepted to decrease in positive valence or increase in negative valence. For example ferric iron Fe^{+++} is reduced to ferrous iron Fe^{++} by accepting electrons.

Rhizome
: A creeping underground stem, which usually roots at the nodes and sends up new shoots from its apex.

Riparian
: Relating to the banks of rivers or streams.

Sepal
: A member of the outermost ring of flower leaves, situated below the petals; usually green or greenish and leafy in texture.

Seral
: A species or community that is replaced by another as succession occurs.

Sere
: The entire sequence of plant community development leading to a climax or stable condition.

Serrate
: With forward pointing teeth.

Sessile
: Without a stalk; attached directly to the base.

Sheath
: A plant part which clasps or surrounds another plant part, as in the sheath of a grass leaf which encloses the stem.

Sinuate
: With a very wavy margin.

Sorus (plural: sori)
: A cluster of sporangia (reproductive structures) as in ferns, on the underside of the fertile leaves.

Spadix
: A club-like inflorescence, enclosed by a spathe.

Spathe
: A large bract which subtends or encloses a spadix.

Spike
: A long unbranched inflorescence with sessile flowers, on which the uppermost flowers are the youngest.

Spore
: A one-celled reproductive structure of non-flowering plants such as ferns, fungi, and mosses.

Stamen
: The male pollen-bearing portion of a flower's reproductive organs, consisting of a filament and an anther.

Staminate flower
: A flower that has stamens but no pistils; a male flower.

Stoloniferous
: Having a long stem which creeps along the surface of the ground and roots at the nodes and the apex.

Stoma (plural: stomata)
: A tiny pore in the epidermis of leaves or stems, through which gasses pass.

Stratum
: Vegetation strata are the growth forms (or layers) of plants on a site. They include trees, saplings, lianas (vines), shrubs and herbs.

Style
: The stalk of a pistil (the female reproductive organ of a flower) which connects the stigma (pollen-receiving structure) to the ovary.

Subtend
: To underlie, to be beneath and include or enclose.

Succulent
: A plant or plant part that is fleshy and full of juice.

Sucker

A new shoot arising from underground, usually from an old root or rhizome.

Ternate

In 3's, as in a palmately compound leaf with 3 leaflets.

Trifoliate

Having 3 leaves or leaflets.

Umbel

A flat-topped or rounded inflorescence of flowers on stalks of approximately equal length which are attached together at the apex of the peduncle.

Wetland

Four definitions are in use in Washington.

1. The Corps of Engineers (CE) (Federal Register 1982), the Environmental Protection Agency (EPS) (Federal Register 1985), the Shoreline Management Act (SMA) and the Growth Management Act (GMA) all define wetlands as: 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. Wetlands generally include swamps, marshes, bogs, and similar areas. In addition, the SMA and GMA definitions add: "Wetlands do not include those artificial wetlands intentionally created from nonwetland sites, including, but no limited to, irrigation and drainage ditches, grass-lined swales, canals, detention facilities, wastewater treatment facilities, farm ponds, and landscape amenities, or those wetlands created after July 1, 1990, that were unintentionally created as a result of the construction of a road, street, or highway. Wetlands may include those artificial wetlands intentionally created from nonwetland areas to mitigate the conversion of wetlands."

2. Forest Practices definition: "'Wetland' means those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and under normal circumstances do support a prevalence

of vegetation typically adapted for life in saturated soil conditions, such as swamps, bogs, fens, and similar areas. This includes wetlands cleared, restored, or enhanced as part of a mitigation procedure. This does not include constructed wetlands or the following surface waters of the state intentionally constructed from wetland sites: irrigation and drainage ditches, grass-lined swales, canals, agricultural detention facilities, farm ponds and landscape amenities."

3. U.S. Fish and Wildlife Service definition: "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 by shallow water. Wetlands must have one or more of the following attributes:

1. At least periodically, the land supports predominantly hydrophytes (wetland plants);

2. The substrate is predominantly undrained hydric soils; and

3. The substrate is nonsoil and is saturated with water or covered by shallow water at sometime during the growing season of each year."

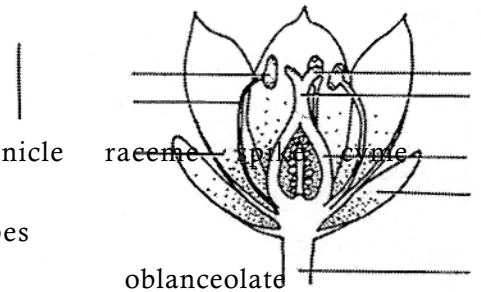
4. U.S. Army Corps of Engineers Clean Water Act definition: "The term "wetlands" means those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas."

Whorl

Three or more leaves or other structures radiating from the same point on a stem or some other common axis.

Glossary Illustrations

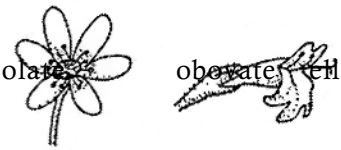
Inflorescences



panicle raceme spike cyme umbel

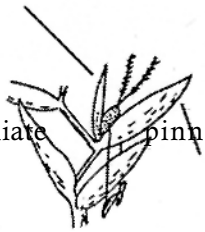
Leaf Shapes

oblanceolate

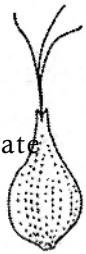


linear lanceolate obovate elliptic ovate

Leaf Arrangements

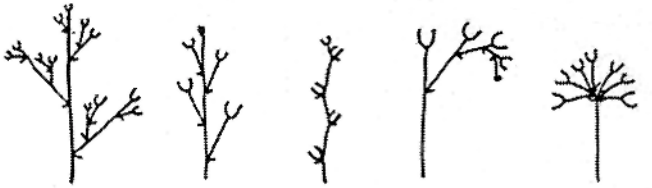


trifoliate pinnate palmate ternate

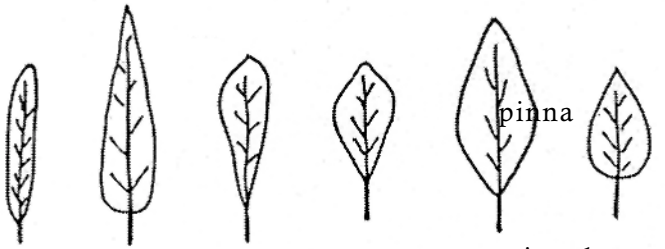


entire serrate

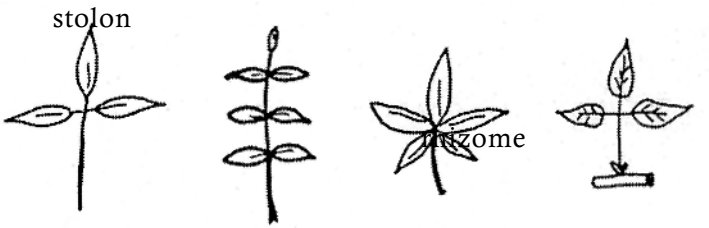
Leaf Arrangements



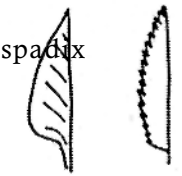
opposite alternate whorl



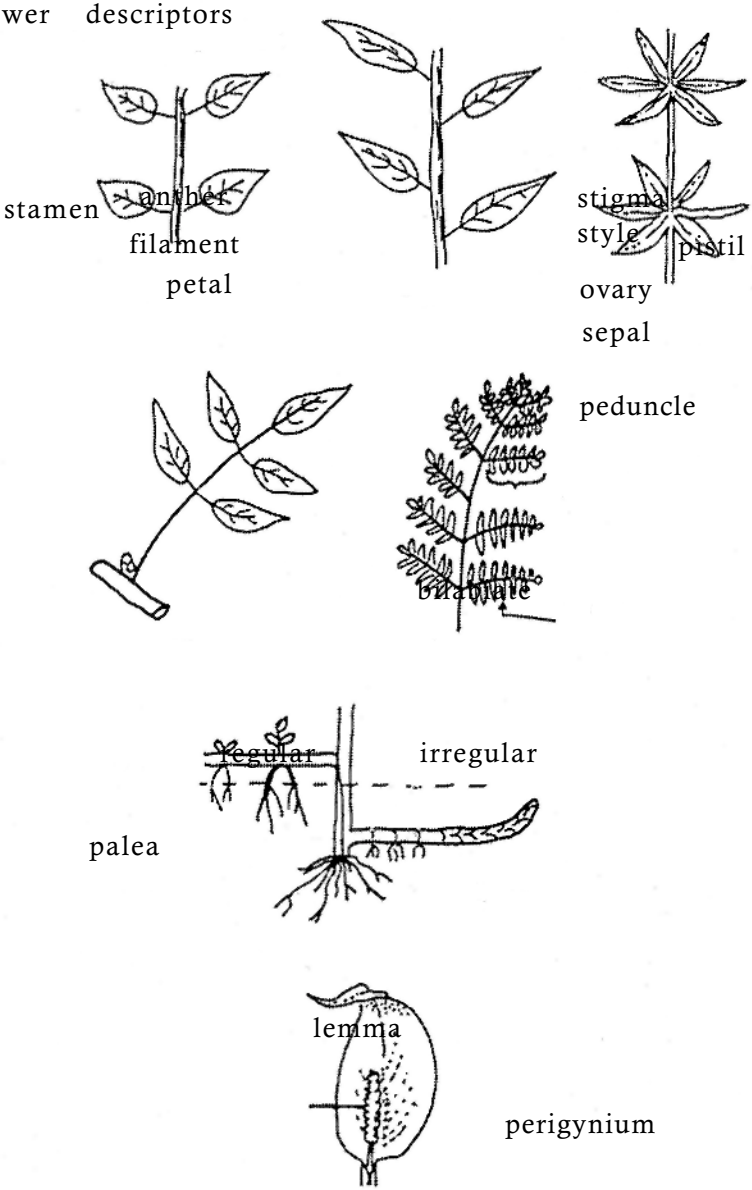
compound leaf frond



spathe



Flower descriptors



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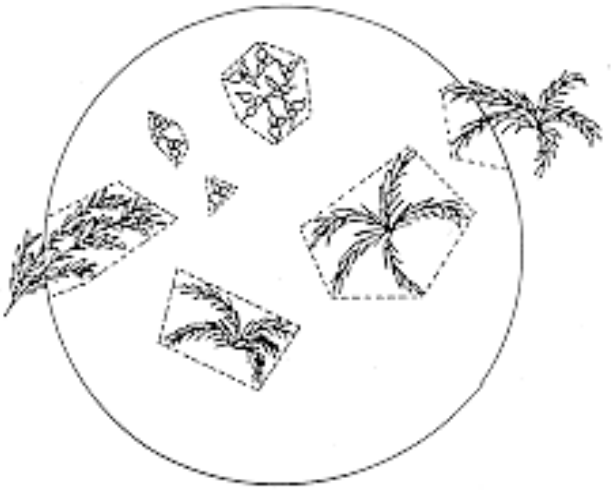
Appendix A: Methods for Vegetation Sampling

APPENDIX A1: ESTIMATING VEGETATION COVERAGE

For the purposes of determining whether a site has wetland vegetation, tree, sapling, shrub and herb coverage will be measured on a tenth acre plot, or within the boundaries of the suspected wetland, if it is smaller than a tenth acre. In some non-forested areas, smaller plots called quadrats should be used, as described below. Within species, overlap does not count, so for a given species, coverage can never be more than 100 percent. For all species combined however, the coverage can easily be over 100 percent.

Examine each species on the plot individually. Begin by mentally drawing a convex, straight line polygon around the outer portion of the crown of the plant that you wish to measure, or around the crowns of closely spaced plants of the same species. Do not subtract for areas between leaves or branches. The area of the polygon is the coverage of the plant(s) (see below). Sum this area with the coverages of other plants of the same species, using the coverage table to determine the percent cover (page 121).



Ask yourself if the plant species covers more or less than half of the plot, or more or less than a quarter or three quarters of the plot. If the species covers more than 75 percent, try estimating the area of the plot not covered. If the species covers less than 75 percent, measure the actual area of large plants or clumps either by measuring the square footage or by measuring the typical diameter and figuring the area using the vegetation coverage table (see below). For instance, if a clump of salmonberry has a diameter of 16.6', look at the coverage table to find that the clump has a coverage of 5 percent.

If the species for which you are estimating coverage consists of many overlapping individuals, draw your polygon around the outside of all of them. If the individuals do not touch or overlap, you may mentally herd them together and estimate the area that they would cover if they did touch.

If you have several individual plants of the same species that are close to the same size (skunk cabbages for instance), estimate the cover of a typical one, then count all the individuals and multiply the number of individuals by the typical coverage. If the one had a coverage of 0.5 percent and there were six individuals, the coverage would be three percent.

Check your estimates by:

1. Measuring canopy dimensions and calculating the area using the coverage table.

2. Comparing your estimate to one for a different species.

3. Comparing estimates done on the same species by different methods.

4. Comparing your estimates with another person's.

Make a point to re-calibrate your eye to different coverages by using the following procedure frequently while you are learning the coverage estimation techniques. Choose a point anywhere within a plot, and place a temporary stake there. Using the coverage table as a guide, mark concentric circles or squares of one and five percent with flagging on the ground. Mentally superimpose the circles on different plant species until you feel confident that you are estimating accurately.

APPENDIX A2: DETERMINING COVERAGE AND DOMINANCE IN FORESTED WETLANDS

Estimating vegetation coverage in a tenth-acre plot

% of 1/10th acre	Side of a square	Radius	Diameter	Square feet
100%	66’	37.2’	74.4’	4356
10%	21’	11.8’	23.6’	435.6
5%	14.8’	8.3’	16.6’	217.8
2%	9.3’	5.3’	10.5’	87.1
1%	6.6’	3.7’	7.4’	43.6

1. Using a tenth acre plot (or the boundaries of the wetland if the wetland is smaller than a tenth acre), make a list of all the plant species on the plot, including each plant category (trees, saplings, shrubs and herbs).

2. Estimate the percent coverage of each species, and rank them by coverage in descending order (see examples).

3. Add all the coverages to determine total coverage (note that total coverage can often be well over 100 percent, due to overlapping species).

4. Begin adding the ranked species in descending order by cover percent until the total immediately exceeds 50 percent of the total coverage. The dominant species are those whose combined coverage equals over 50 percent of the total coverage, plus any single species whose coverage equals 20 percent or more of the total.

5. Determine the wetland indicator status of the plants you have determined to be dominants. If 50 percent or more of the dominants are OBL, FACW, or FAC, your plot supports wetland vegetation, and meets the wetland vegetation criterion.

Example 1

In this instance, the dominants are salmonberry, skunk cabbage and western redcedar. Because 100% of these dominants are OBL, FACW or FAC, this site satisfies the hydrophytic vegetation criterion. If the soils and hydrology criteria are also met, this site is a wetland. This wetland is a forested wetland because trees that are 20' tall (or would be 20' tall at maturity) occupy a minimum of 30% cover.

Herbs	Ind. Value	% Cover	Rank
skunk cabbage	OBL	15	3 *
slough sedge	OBL	6	5
deerfern	FAC+	5	6

Shrubs	Ind. Value	% Cover	Rank
salmonberry	FAC+	25	1 *
trailing blackberry	FACU	2	7
salal	FACU	1	8
devil's club	FAC+	1	9

Trees	Ind. Value	% Cover	Rank
western hemlock	FACU-	10	4
western redcedar	FAC	20	2 *

Total coverage: 85%

Dominance threshold equals 50% times total coverage: 42%

20% times total coverage equals: 17%

"*" in the rank column means this species is a dominant plant species on this site.

Example 2

Even though obligate wetland plants occur on this site, it is not a wetland because the dominant plants are not all OBL, FACW or FAC.

Herbs	Ind. Value	% Cover	Rank
deerfern	FAC+	12	3 *
swordfern	FACU	20	2 *
skunk cabbage	OBL	1	7
three-leaved foamflower	FAC	2	6

Shrubs	Ind. Value	% Cover	Rank
salmonberry	FAC+	5	5
trailing blackberry	FACU	10	4
salal	FACU	22	1 *
devil's club	FAC+	1	7

Trees	Ind. Value	% Cover	Rank
western hemlock	FACU	10	4
Douglas fir	FACU *	5	5
western redcedar	FAC	2	6

Total coverage: 90%

Dominance threshold equals 50% times total coverage: 45%

20% times total coverage equals: 18%

"*" in the rank column means this species is a dominant plant species on this site.

Example 3

On this site, the dominance threshold is met by one species, the slough sedge. The soft rush, with its coverage of 44 percent, exceeds 20 percent of the total coverage, and for this reason can be included as a dominant species. "*" and "**" in the rank column means this species is a dominant plant species on this site.

The salal in this example is rooted in rotting logs, not in the saturated soil of the wetland. This site meets the hydrophytic vegetation criterion. This site would be considered a forested wetland if it was anticipated that the alder would reach a minimum height of 20' and a canopy cover of at least 30 percent.

Herbs	Ind. Value	% Cover	Rank
slough sedge	OBL	56	1 *
soft rush	FACW	44	2 **

Shrubs	Ind. Value	% Cover	Rank
salal	FACU *	2	4

Trees	Ind. Value	% Cover	Rank
red alder	FAC	8	3

Total coverage: 110%

Dominance threshold equals 50% times total coverage: 55%

20% times total coverage equals: 22%

APPENDIX A3: DETERMINING COVERAGE AND DOMINANCE IN NON-FORESTED WETLANDS

In non-forested wetlands such as marshes, seasonally wet meadows and bogs, the tenth acre plot method may not be appropriate, because of the scale and morphology of the vegetation being sampled. In such cases, it may make more sense to estimate the vegetation coverages using small plots called quadrats. For our purposes, quadrats are small square or rectangular plots, with an area of one- tenth to one meter squared, depending on the dimensions of the vegetation to be sampled. For herbs, small shrubs and grasses up to one meter in height, a tenth- meter squared quadrat (10" X 15.5") is usually sufficient. For larger vegetation, use a larger quadrat size. Rectangular shaped quadrats have been shown to more accurately reflect clumped vegetation, and so should be used in the case of clumped grasses or grasslike plants. The number of quadrats sampled depends on the homogeneity of the site, and can be determined in the course of sampling , as described below.

Here is one method for sampling meadows, marshes and similar areas:

1. Stretch a measuring tape (at least 150' or 50 m long) from the center of the suspected wetland area to the suspected wetland edge. If the area is too big to be sampled along the length of one measuring tape, measure the distance between the suspected center and the suspected edge; you will distribute your samples along this distance.

2. Based on vegetation type, choose the appropriate quadrat size, and lay out 10 equally spaced quadrats, beginning your sampling at the center of the suspected wetland.

3. In each quadrat, estimate the percent cover of each species present.

4. After sampling 8 quadrats, use the following procedure to determine if enough quadrats have been sampled:

---

[1] Mueller-Dombois et al. 1974.

[2] Daubenmire, 1968.

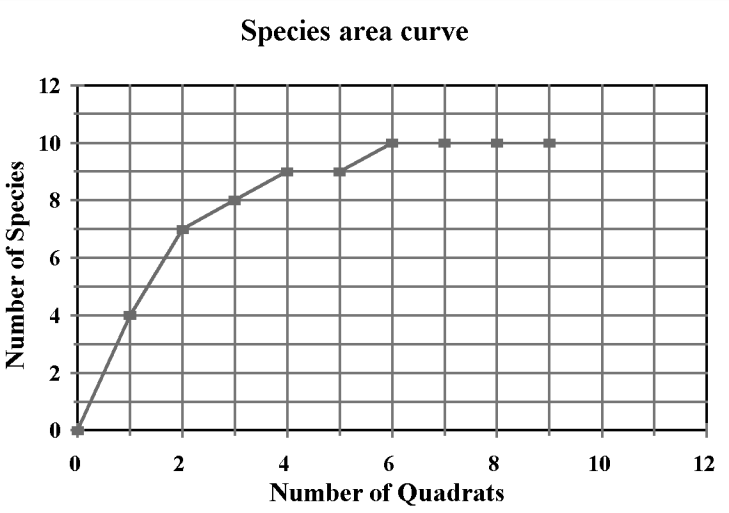
a. Create a graph with quadrat numbers along the X axis, and number of species sampled per quadrat on the Y axis.

b. Plot the cumulative number of species against each quadrat. For instance, if quadrat 1 has four species, and quadrat 2 has any, all or none of the species found in quadrat 1 plus three new species, then seven cumulative species should be plotted for quadrat 2. (See figure)

c. The number of quadrats sufficient to adequately survey the understory will correspond to the point on the curve where it levels out and remains more or less level.

5. If, after plotting eight quadrats, the species area curve has not leveled out, continue sampling and plotting results until the species area curve indicates that you have sufficient samples to characterize the understory.

6. After you have determined that enough quadrats have been sampled, determine dominance using the same procedure as that described for forested areas above.



Appendix B: Soils

APPENDIX B1: POTENTIAL HYDRIC SOILS OF WASHINGTON

See <http://www.statlab.iastate.edu:80/soils/hydric/wa.html> on the world wide web for updates

Ahtanum
Typic Duraquolls

Alvor
Cumulic Endoaquolls

Bellingham
Typic Epiaquepts

Blainegate
Typic Argiaquolls

Bossburg
Histic Vitraquands

Bow
Typic Vitraquands

Bridgeson
Fluvaquentic Haplaquolls

Briscot
Aeric Fluvaquents

Buckley
Typic Humaquepts

Caples
Mollic Fluvaquents

Carrolls
Typic Psammaquents

Cocolalla
Mollic Andaquepts

Colville
Fluvaquentic Haplaquolls

Conboy
Thaptic Endoaquands

Coupeville
Typic Haplaquolls

Cove
Vertic Haplaquolls

Coveland
Aquic Palexeralfs

Custer
Typic Endoaquods

Deckerville
Aquandic Humaquepts

Dupont
Limnic Medisaprists

Earlmont
Typic Fluvaquents

Edmonds
Andic Duraquods

Eliza
Sulfic Fluvaquents

Emdent
Typic Vitraquands

Everson
Aquandic Humaquepts

Fishtrap
Terric Medisaprists

Godfrey
Typic Fluvaquents

Gooseflats
Aeric Halaquepts

Gumboot
Aquandic Humaquepts

Halbert
Histic Placaquands

Hallenton
Typic Haplaquepts

Hockinson
Mollic Fluvaquents

Hoodoo
Typic Vitraquands

Hovde
Aeric Haplaquents

Joseph
Aquic Xerofluvents

Kittitas
Fluvaquentic Haplaquolls

Klaber
Typic Glossaqualfs

Koch
Aquandic Humaquepts

Konert
Typic Argiaquolls

Konner
Cumulic Haplaquolls

Kosmos
Typic Endoaqualfs

Kydaka
Aquandic Humaquepts

Labounty
Typic Umbraqualfs

Lacamas
Typic Glossaqualfs

Lemolo
Typic Humaquepts

Lummi
Fluvaquentic Endoaquolls

Mckenna
Typic Epiaquepts

Mcmurray
Typic Medihemists

Minniece
Typic Umbraqualfs

Mountsolo
Aquic Xerorthents

Mukilteo
Typic Medihemists

Munset
Ultic Palexeralfs

Natal
Umbric Endoaqualfs

Nemah
Vertic Endoaquepts

Nookachamps
Typic Fluvaquents

Norma
Aquandic Humaquepts

Nuby
Typic Fluvaquents

Ocosta
Sulfic Fluvaquents

Odne
Aquandic Epiaqualfs

Okanogan
Cumulic Haploxerolls

Orcas
Typic Sphagnofibrists

Oridia
Aeric Fluvaquents

Pangborn
Typic Medisaprists

Pasco
Cumulic Haplaquolls

Peoh
Cumulic Haplaquolls

Peone
Andaqueptic Fluvaquents

Puget
Aeric Fluvaquents

Pywell
Typic Borosaprists

Ralsen
Fluvaquentic Haplaquolls

Ratlake
Typic Halaquepts

Reed
Vertic Argiaquolls

Rennie
Vertic Fluvaquents

Renton
Mollic Fluvaquents

Saltese
Typic Medisaprists

Salzer
Vertic Endoaquepts

Samish
Typic Fluvaquents

Sammamish
Fluvaquentic Humaquepts

Sanpoil
Cumulic Haplaquolls

Sauvie
Fluvaquentic Haplaquolls

Scamman
Aquic Palexeralfs

Schooley
Aquandic Fluvaquents

Seastrand
Terric Medihemists

Seattle
Hemic Medisaprists

Segidal
Typic Sideraquods

Sekiu
Typic Humaquepts

Semiahmoo
Typic Medisaprists

Shalcar
Terric Medisaprists

Skagit
Typic Fluvaquents

Skokomish
Aquandic Fluvaquents

Snohomish
Thapto-histic Fluvaquents

Stallard
Duric Endoaquolls

Stimson
Typic Humaquepts

Sumas
Aquandic Fluvaquents

Tacoma
Sulfic Fluvaquents

Tanwax
Limnic Medisaprists

Tealwhit
Vertic Endoaquepts

Tisch
Typic Endoaquands

Tonata
Andic Cryaquepts

Toppenish
Fluvaquentic Haplaquolls

Track
Fluvaquentic Haplaquolls

Tukwila
Limnic Medisaprists

Uncas
Histic Vitraquands

Viola
Umbric Ochraqualfs

Wamba
Typic Haplaquolls

Wanser
Typic Psammaquents

Wapato
Fluvaquentic Endoaquolls

Weirman
Torrifluventic Haploxerolls

Wenas
Cumulic Haplaquolls

Whitehorn
Typic Umbraqualfs

Woldale
Typic Haplaquolls

Woodinville
Aeric Fluvaquents

Woodlyn
Typic Sideraquods

Yaquina
Aquentic Haplorthods

Yost
Typic Pelloxererts

Zillah
Fluvaquentic Haplaquolls

APPENDIX B2: INTERPRETING SOIL PROFILE DESCRIPTIONS

The purpose of this appendix is to illustrate selected portions of some soil profile descriptions that indicate the presence or absence of hydric characteristics. Soils within a named soil series exhibit a range of characteristics, and often differ from the soil profiles described in soil surveys. Soils that are listed as potentially hydric may not specifically meet the hydric criteria once examined in the field, and upland soils can sometimes appear similar to hydric soils. Areas of hydric soil frequently exist as subunits within upland soil mapping units at locations where saturated conditions prevail.

The potential hydric soils listed in appendix B1 provide a starting place to determine if a specific location may meet wetland criteria, but there is no substitute for digging a hole and observing the particular characteristics of the soil in question first hand. This is the only way to ascertain whether the soil meets the field criteria for hydric soils. Results of direct field observation always supercede data provided on maps.

Each of the soil descriptions below is provided with a wetland interpretation, which is intended to apply only to the profile as described here; there may well be soils of the same series that would have different wetland interpretations in other locations.

The original profile descriptions are taken from the USDA Natural Resources Conservation Service's web site.[1] We have edited them extensively to conserve space and focus on information directly relevant to specific soil characteristics. We have omitted all information on dry color, consistence, pH, structure, number and type of roots and pores and horizon boundary, unless needed to illustrate a particular point.

The colors in the profile descriptions are for moist soil unless otherwise noted. All textures are from field estimation.

Because hydric soil characteristics by definition occur in the rooting zone of the soil profile, these profile descriptions are also abbreviated in terms of depth; most of them include only the A and B horizons.

1 http://www.statlab.iastate.edu:80/soils/osd/

Soil classification is provided for those readers who have knowledge of soil taxonomy. Space limitations have precluded definitions of taxonomic terms. For information pertaining to soil classification, please refer to Soil Taxonomy, second edition, 1999, and Keys to Soil Taxonomy, 1998.

Described here are three examples of upland soils with characteristics that might be misinterpreted as hydric indicators, and two examples of hydric soils, one mineral and one organic.

Upland soils:

Clallam- a soil with prominent mottles

Klaus- soil with a pale eluviated horizon that could look like soil with a gleyed horizon.

Tokul- a forest soil of western Washington with seasonally high watertables

Hydric soils:

Kosmos- Strongly gleyed soil of southwest Washington

Mukilteo- Deep organic soil

CLALLAM SERIES

The Clallam series as described here consists of moderately deep, moderately well drained upland soils formed in glacial till over very compact glacial till. There is very slow permeability in the compact glacial till. A perched water table as high as 1.5 to 5 feet above the compacted till can occur at times from January to April. These soils are on glaciated hills, have slopes of 0 to 30 percent and are found extensively on the northeastern Olympic Peninsula. Soils in the Clallam series are classified as Loamy-skeletal, mixed, mesic Vitrandic Xerochrepts. Such a taxonomic classification does not imply a hydric soil.

Native vegetation is predominantly Douglas-fir with some western hemlock, grand fir, western redcedar, red alder, and Pacific madrone. Understory species include salal, evergreen huckleberry, red huckleberry, Oregongrape, oceanspray, twinflower, rose and western swordfern (plants that are not considered diagnostic of wetlands). Wetland indicator plants are rare.

TYPICAL PROFILE DESCRIPTION: Clallam gravelly sandy loam

0i- 2 1/2 to 1 inch; needles, leaves, and twigs.

0- 1 inch to 0; partially decomposed needles, leaves and twigs.

To qualify as a hydric soil on the basis of organic horizon, the O horizon would need to be greater than 8 inches thick and composed of peat or muck. If the soil were very sandy, a horizon of peat or muck of 3 inches would enable it to qualify as a hydric soil.

A- 0 to 1 inch; dark brown (10YR 4/3) gravelly sandy loam, light brownish gray (10YR 6/2) dry.

Note that the A horizon has a chroma of 2 when the soil is dry. To assure consistency, color determination should be made when the soil is in a moist, not dry condition.

Bw1- 1 to 10 inches; brown (10YR 5/3) gravelly sandy loam, common medium distinct dark yellowish brown (10YR 4/4) mottles.

These mottles should not be confused with mottles in hydric soils. To be a hydric soil the mineral soil within 12 inches of the surface would need to have a grayish matrix (chroma 2 or less) combined with mottles.

Bw2- 10 to 28 inches; 10 to 28 inches; brown (10YR 5/3) very gravelly sandy loam, common medium distinct dark yellowish brown (10YR 4/4) mottles.

Cd1- 28 to 37 inches; light brownish gray 2.5T 6/2); common medium distinct strong brown (7.5YR 5/6) mottles, reddish yellow.

Low chroma and mottles are common at this depth in the soil profile in upland soils, where the water table may reside periodically, or for much of the year. If these features were within 12 inches of the soil surface, this would qualify as a hydric soil.

KLAUS SERIES

The Klaus series as described here consists of moderately deep, well drained upland soils that form in material high in volcanic ash overlying glacial outwash. Klaus soils are on terraces and terrace escarpments from 700 to 1400 feet. Slopes range from 0 to 65%.

The Klaus series is classified as sandy-skeletal, mixed, mesic ortstein Typic Haplorthods (an ortstein horizon is a weakly

cemented "spodic" horizon containing illuvial organic material and aluminum).

Vegetation is Douglas-fir and western hemlock with an understory of vine maple, salal, western swordfern and mosses.

Wetland soil interpretation:

This is an upland soil. The grey coloration of the E horizon could be confused with horizons having a depleted matrix. E horizons are very common in soils of temperate coniferous forests. They result from a process called podzolization. In this process, with the help of copious rainfall, dark minerals are leached or stripped (eluviated) from the E (or eluvial) horizon by organic acids from the forest floor. While some podzolized soils (also called spodosols) can be hydric, this one is not, and can be distinguished from a hydric soil or a soil with a depleted matrix by the presence of an orange, reddish or brown band of higher chroma in the horizon directly below the E horizon. A hydric mineral soil will maintain the low-chroma coloration throughout the lower horizons of the profile.

TYPICAL PROFILE DESCRIPTION: Klaus loamy sand-forested.

Oi- 2-1/2-1-1/2 inches; undecomposed forest litter and moss.

Oa- 1-1/2 inches to 0; black (10YR 2/1) soft decomposed litter and moss bound by roots.

E- 0 to 2 inches; grayish-brown (2.5YR 5/2) loamy sand (volcanic ash).

This is an example of a pale horizon called an E (eluviated) horizon, which can resemble a depleted matrix.

Bhs- 2 to 7 inches; dark reddish-brown 2.5YR 3/3) sandy loam.

While some spodosols are hydric, this one is not. E horizons of non-hydric spodosols generally have a bright orange, reddish or brown band of soil directly below them, unlike the low-chroma wetland soils. We know that this is not a hydric soil because the Bhs horizon below the E horizon has a chroma of 3.

Bs- 7 to 16 inches dark brown (7.5YR 3/4) gravelly sandy loam.

2BC- 16 to 28 inches; brown (10YR 4/3) very gravelly sand.

TOKUL SERIES

The Tokul series as described here is an example of upland soil consisting of moderately deep moderately well drained soils formed in glacial till, loess, and volcanic ash. Tokul soils are on till plains and glacially modified hills and mountains and are common on the West slopes of the Cascade Mountains in Northwestern Washington.

Tokul soils are moderately well drained with slow to rapid runoff; moderate permeability above the pan and very slow in the pan. A perched water table is as high as 1.5 to 3 feet at times from November through May.

Soils in the Tokul series are classified as Medial, mesic Aquic Vitrixerands (an Andisol with a near surface water retaining layer).

Native vegetation is Douglas-fir, western hemlock, western red cedar, bigleaf maple, and red alder. Understory consists of western swordfern, salal, vine maple, huckleberry, trailing blackberry, Pacific trillium, western brackenfern, salmonberry, deerfern, ladyfern, and Oregon-grape.

WETLAND SOIL INTERPRETATION

Tokul soils have been confused with hydric soils because of the surface water that is present in slight surface depressions during storm events and the occurrence of plant species like deerfern and ladyfern. The occurrence of hard pans (slowly permeable B-horizons) in this soil slow or retard downward percolation of water from the surface, but the soils typically do not remain flooded for a sufficient duration to become anaerobic. The color of the Bs horizon has hue of l0YR or 7.5YR, and value of 3 through 6 moist. The bright (high) chroma indicates that the soil is aerobic most all of the time.

TYPICAL PROFILE DESCRIPTION: Tokul gravelly loam

0i- 1-1/2 inches to 2 inches; forest litter of leaves and twigs.

0a- 2 inches to 0; black (10YR 2/1) decomposed litter.

A- 0 to 3-1/2 inches; dark brown (7.5YR 3/2) gravelly loam.

The low chroma in this narrow horizon of soil is due to staining from the organic material mixing from the O horizon, and in this case does not indicate saturated conditions. One reason we know this is that this horizon is subtended by horizons with higher chromas. If this was a hydric soil, every horizon below this would have the same or lower chroma. One exception to this might be in the case of disturbed soil.

Bs1- 3-1/2 to 7 inches; dark brown (7.5YR 4/4) gravelly loam.

The chroma of 4 tells us that this is not a hydric soil.

Bs2- 7 to 15 inches; dark yellowish brown (10YR 4/4) gravelly loam, common medium distinct yellowish brown (10YR 5/8) mottles.

This soil is mottled, but the matrix chroma is too high to indicate saturated conditions. The mottles tell us that this horizon developed under conditions of alternating wetting and drying, but the chroma of 4 tells us that the aerobic condition (non-hydric) predominates.
If lots of gray mottles were extending to within 6 inches of the surface, and a low chroma matrix (less than or equal to 2) occurred within 12 inches of the soil surface, this could be classified as a hydric soil.

BC- 22 to 31 inches; light olive brown (2.5Y 5/4) gravelly fine sandy loam, common fine distinct yellowish brown (10YR 5/8) mottles.

2Bsm- 31 to 60 inches; dark grayish brown (2.5Y 4/2) gravelly sandy loam, common medium distinct yellowish brown (10YR 5/8) mottles; Massive; hard, extremely firm, weakly cemented extremely hard in places.

The coloration at this depth is indicative of at least periodic saturation, but is too deep in the profile for this to qualify as a hydric soil.

This hard pan accounts for a perched watertable from November to May at some locations.

KOSMOS SERIES

The Kosmos series as described by this profile are very deep, somewhat poorly drained hydric soils formed in glaciofluvial material on terraces at elevations of 300 to 400 feet. Depth to a perched seasonal water table is from the surface to within 2 feet of the surface from November to May. Soils in this series are classified as fine-loamy, mixed, mesic Typic Endoaqualfs. This classification would be considered hydric.

Native vegetation is Douglas-fir on high spots, Oregon ash, western redcedar, red alder, and black cottonwood, with an understory of salal, western hazel, vine maple, western brackenfern, western swordfern, rose, evergreen blackberry, willow, red elderberry, Oregon-grape, and salmonberry.

WETLAND SOIL INTERPRETATION: Diagnostic features are a gleyed, ochric epipedon (a pale surface horizon containing little organic matter) from the surface to12 inches and an argillic horizon (an illuvial horizon that contains significant accumulations of clay) from 12 to 47 inches, containing distinct mottles.

TYPICAL PROFILE DESCRIPTION: Kosmos silt loam

Ag1- 0 to 7 inches; dark gray (10YR 4/1) silt loam.

This soil is gleyed through a process of chemical reduction has made them soluble. Many upland soils on the westside have a pale horizon called an E horizon, which can resemble a gleyed or depleted matrix. See the description for the Klaus series for an example of an E horizon.

Ag2- 7 to 12 inches; gray (10YR 5/1) silty clay loam, common fine distinct reddish brown (5YR 4/4) mottles (Combined thickness of the Ag horizon is 9 to 14 inches).

These mottles are typical of those formed in hydric soils, where the water table fluctuates. The matrix color has a low chroma (less than or equal to 3), and the mottles themselves are a higher chroma reddish brown.

Btg1- 12 to 17 inches; gray (5Y 5/1) silty clay loam, many medium prominent reddish brown (5 YR 4/4) mottles.

MUKILTEO SERIES

The Mukilteo series as described here is an example of a classic organic hydric soil consisting of deep, very poorly drained organic deposits. Mukilteo soils are found mainly in depressional areas on glacial uplands and river valleys throughout the Puget Sound Basin. The fiber content of rubbed soils averages from 16 to 60 percent. Soils of the Mukilteo series are classified taxinomically as dysic, mesic Typic Medihemists, a hydric classification.

The vegetation on sites with Mukilteo muck is variable depending on the history of disturbance. Some areas have been cleared and drained and are used for hay, pasture, and blueberries. Native vegetation is red alder, western redcedar and western hemlock, with an understory of willow, Douglas spirea, cattail, sedges, rushes, trailing blackberry, red elderberry and devilsclub. Some ponded areas are not wooded and grow willow, cattail, rushes, sedges, and Douglas spirea.

TYPICAL PROFILE DESCRIPTION; Mukilteo muck

Oa1- 0 to 2 inches; dark yellowish brown (10YR 4/4) sapric material; about 20 percent fibers, 10 percent rubbed; very strongly acid (pH 4.5).

Oa2- 2 to 6 inches; dark reddish brown (5YR 2/2) sapric material; about 50 percent fibers, 6 percent rubbed; very strongly acid (pH 4.5).

Oe1- 6 to 11 inches; dark reddish brown (5YR 3/2) hemic material; about 80 percent fibers, 20 percent rubbed; very strongly acid (pH 4.6).

Oe2- 11 to 42 inches; dark reddish brown (5YR 3/2) hemic material; about 65 percent fibers, 20 percent rubbed.

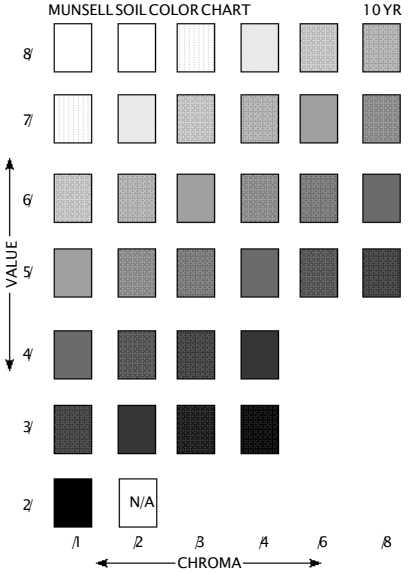
This is a deep organic soil. Because it has a surface horizon of muck or peat greater than 8 inches deep, it is a hydric soil. The materials here are sapric (muck), which means that the plant fibers are so decomposed that less than 1/3 of them are identifiable as some kind of plant material in their unrubbed condition. Note the chroma of 4. In a mineral soil, this color would mean that it was not a wetland soil, but organic soils are considered hydric by virtue of the thickness of their organic layers, not by their colors.

The acidic conditions are brought about by the large quantity of organic (i.e. humic) acids leaching from the dead plant matter. These acids (in combination with the saturated condition) inhibit the microbes that would ordinarily decompose the organic material, slowing decomposition. This is why such large accumulations of muck are possible.

Hemic material (mucky peat or peaty muck) is between 1/3 and 2/3 identifiable fibers. Decomposition slows further down in the soil profile, and conditions are slightly more acidic.

APPENDIX B3: SOIL COLOR NOTATION USING THE MUNSELL COLOR CHARTS

(Text in quotes is from USDA Handbook 18- soil survey manual, as quoted by Munsell color charts.)



Soil color is described using three variables; hue, which is the relation of the color to red, yellow, green, blue and purple; the value, which indicates lightness or darkness, and the chroma, which indicates the purity of the color. The hue designation is shown in the upper right hand corner of each individual color chart and applies to all colors on that chart. "The symbol for hue is the letter abbreviation of the color of the rainbow (R for red, YR for yellow-red, Y for yellow) preceeded by numbers from 0-10. Within each letter range, the hue becomes more yellow and less red as the numbers increase." "The notation for value consists of numbers from 0 for absolute black, to 10 for absolute white."

"The notation for chroma consists of numbers beginning at 0 for neutral grays and increasing at equal intervals to a maximum of about 20, which is never really approached in soil."

The notation for a color with a hue of 10YR, a value of 4 and a chroma of 2 would be expresses 10YR 4/2.

Appendix C: Wildlife

The following table is compiled from data provided by the Washington Department of Wildlife.[1] It includes amphibians, reptiles, birds and mammals that depend on wetlands for some or all of their habitat needs. Many of the species listed have specific habitat requirements that are beyond the scope of this document to detail. For instance, several of the amphibian species breed within specific parameters of water temperature or depth, or require dense aquatic or emergent vegetation. Many bird species require tree cavities in or near wetlands for nesting.

The second column of the table provides the habitat types in which the species is known to occur: Herbaceous Wetlands (HW), Eastside Riparian Wetlands (ERW), Westside Riparian Wetlands (WRW), Open water (OW), and Montane Coniferous Wetlands (MCW).

Wetland dependent wildlife

Birds	Habitats				
	HW	WR-W	MC-W	ER-W	OW
American Avocet	X				X
American Bittern	X				
American Black Duck	X	X	X	X	
American Coot	X				X
American Dipper		X		X	X
American Redstart				X	
American White Pelican					X
American Wigeon	X				
Baird's Sandpiper	X				

1 Johnson, D.H., and T.A. O'Neil. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press.(in press.)

Birds (cont.)	Habitats				
	HW	WR-W	MC-W	ER-W	OW
Bald Eagle					X
Band-tailed Pigeon		X			
Bank Swallow				X	X
Barn Swallow	X	X		X	X
Barrow's Goldeneye					X
Belted Kingfisher		X		X	X
Black Phoebe		X			
Black Tern	X				
Black-bellied Plover					X
Black-billed Magpie				X	
Black-crowned Night-heron	X			X	X
Black-necked Stilt	X				X
Black-throated Gray Warbler		X			
Blue Grouse				X	
Blue-winged Teal	X				
Bufflehead	X		X		X
Bullock's Oriole		X		X	
California Gull					X
Canada Goose	X				X
Canvasback	X				X
Caspian Tern	X				X
Cattle Egret	X				
Cedar Waxwing				X	
Cinnamon Teal	X				

Birds (cont.)	Habitats				
	HW	WR-W	MC-W	ER-W	OW
Clark's Grebe	X				X
Cliff Swallow		X		X	X
Common Goldeneye					X
Common Loon	X				
Common Merganser		X		X	X
Common Snipe	X				
Common Yellowthroat	X	X		X	
Cordilleran Flycatcher				X	
Double-crested Cormorant				X	X
Dunlin	X				X
Eared Grebe	X				X
Eurasion Wigeon					X
European Starling		X		X	
Evening Grosbeak			X		
Forster's Tern	X				X
Fox Sparrow				X	
Franklin's Gull	X				
Gadwall	X				X
Glaucous Gull					X
Golden-crowned Kinglet				X	
Gray Catbird				X	
Great Blue Heron	X	X		X	X
Great Egret	X			X	X
Greater Scaup					X

Birds (cont.)	Habitats				
	HW	WR-W	MC-W	ER-W	OW
Greater White-fronted Goose	X				X
Greater Yellowlegs	X				X
Green Heron	X	X			
Green-winged Teal	X				
Harlequin Duck		X		X	X
Herring Gull					
Hooded Merganser		X		X	X
Horned Grebe	X				X
Lazuli Bunting				X	
Least Sandpiper	X				
Lesser Goldfinch		X			
Lesser Scaup	X				X
Lesser Yellowlegs	X				X
Lincoln's Sparrow	X	X		X	
Long-billed Dowitcher	X				
Long-eared Owl				X	
Mallard	X	X		X	
Marbled Godwit					X
Marsh Wren	X				
Mew Gull					X
Mourning Dove		X		X	
Mute Swan	X				X
Northern Pintail	X				X
Northern Rough-winged Swallow	X	X		X	X

Birds (cont.)	Habitats				
	HW	WR-W	MC-W	ER-W	OW
Northern Shoveler	X				X
Northern Waterthrush		X		X	
Osprey					X
Pacific Golden-Plover					X
Pectoral Sandpiper	X				
Pied-billed Grebe	X				
Purple Finch		X			
Purple Martin					X
Pygmy Nuthatch				X	
Red-eyed Vireo		X		X	
Redhead	X				X
Red-naped Sapsucker				X	
Red-necked Grebe	X				X
Red-winged Blackbird	X				
Ring-billed Gull					X
Ring-necked Duck		X			
Ring-necked Pheasant				X	
Ross's Goose	X				X
Ruddy Duck	X				X
Ruffed Grouse		X		X	
Sandhill Crane	X				
Semipalmated Plover					X
Semipalmated Sandpiper					X
Sharp-tailed Grouse				X	

Birds (cont.)	Habitats				
	HW	WR-W	MC-W	ER-W	OW
Short-eared Owl	X				
Snow Goose	X				X
Snowy Egret	X			X	X
Snowy Plover					X
Solitary Sandpiper	X	X		X	
Sora	X				
Stilt Sandpiper					X
Swamp Sparrow	X	X			
Thayer's Gull					X
Tree Swallow	X	X		X	X
Tricolored Blackbird	X				
Trumpeter Swan	X				X
Tundra Swan	X				X
Vaux's Swift					X
Veery				X	
Virginia Rail	X				
Warbling Vireo		X		X	
Western Grebe	X				X
Western Sandpiper	X				X
Western Screech-owl		X		X	
White-faced Ibis	X				
Willet	X				
Willow Flycatcher		X		X	
Wilson's Phalarope	X				X

Birds (cont.)	Habitats				
	HW	WR-W	MC-W	ER-W	OW
Wilson's Warbler		X			
Wood Duck		X		X	X
Yellow Rail	X				
Yellow Warbler		X		X	
Yellow-breasted Chat		X		X	
Yellow-headed Blackbird	X				
Reptiles and Amphibians					
Bullfrog	X	X		X	X
Cascade Torrent Salamander		X			
Cascades Frog					X
Columbia Spotted Frog	X			X	X
Columbia Torrent Salamander		X			
Common Garter Snake	X	X	X	X	
Cope's Giant Salamander		X			
Great Basin Spadefoot	X			X	X
Long-toed Salamander	X	X	X	X	X
Northern Leopard Frog	X			X	X
Northwestern Salamander	X	X	X		X
Olympic Torrent Salamander		X			
Oregon Spotted Frog	X	X			X
Pacific Chorus (Tree) Frog	X	X	X	X	X
Pacific Giant Salamander		X			
Painted Turtle	X				X
Red-eared Slider Turtle	X				X

Reptiles/Amphibians (cont.)	Habitats				
	HW	WR-W	MC-W	ER-W	OW
Red-legged Frog	X	X			X
Rough-skinned Newt	X	X	X		X
Snapping Turtle	X				X
Southern Torrent Salamander		X			
Tailed Frog		X		X	
Tiger Salamander	X			X	X
Western Pond Turtle	X	X			X
Western Toad	X	X	X	X	X
Woodhouse's Toad	X			X	X
Mammals					
American Beaver	X	X		X	X
Big Brown Bat			X	X	
Bushy-tailed Woodrat				X	
Deer Mouse	X	X	X	X	
Dusky-footed Woodrat		X			
Fisher		X			
Fog Shrew		X			
Long-legged Myotis				X	
Long-tailed Vole	X	X	X	X	
Meadow Vole	X			X	
Mink	X	X		X	X
Montane Vole	X				
Moose	X				X
Mountain Beaver		X			

Mammals	Habitats				
	HW	WR-W	MC-W	ER-W	OW
Muskrat	X	X		X	X
Northern Bog Lemming	X				
Northern River Otter	X	X		X	X
Nutria	X	X			X
Pacific Jumping Mouse		X	X	X	
Pacific Shrew		X			
Pacific Water Shrew		X			
Pallid Bat	X			X	X
Raccoon	X	X		X	
Snowshoe Hare			X	X	
Southern Red-backed Vole		X	X	X	
Townsend's Big-eared Bat					X
Townsend's Vole	X				
Water Shrew		X	X	X	
Water Vole		X	X	X	
Western Harvest Mouse	X			X	
Western Jumping Mouse				X	
Western Pipistrelle				X	X
Western Small-footed Myotis				X	X
White-footed Vole		X			
White-tailed Deer (Eastside)				X	
Yuma Myotis	X	X	X	X	X

Appendix D: Wetland indicator status of selected plants

Abies amabilis[1]	FACU	*Bidens cernua*	FACW+
Abies grandis	FACU-*	*Blechnum spicant*	FAC
Abies lasiocarpa	FACU	*Boykinia elata*	FAC
Acer circinatum	FAC-	*Calamagrostis canadensis*	FACW+
Acer macrophyllum	FACU	*Caltha leptosepala*	OBL
Achillea millefolium	FACU	*Caltha palustris*	OBL
Actaea rubra	NI	*Calypso bulbosa*	FAC+
Adiantum pedatum	FAC	*Camassia quamash*	FACW
Agrostis capillaris	FAC	*Campanula scouleri*	NI
Alisma gramineum	OBL	*Cardamine breweri*	FACW+
Alnus rubra	FAC	*Carex amplifolia*	FACW+
Alnus sinuata	FACW	*Carex deweyana*	FACU*
Amelanchier alnifolia	FACU	*Carex feta*	FACW
Andromeda polifolia	OBL	*Carex hendersonii*	FAC
Angelica genuflexa	FAC	*Carex mertensii.*	FAC
Arnica latifolia	FAC-	*Carex obnupta*	OBL
Asarum caudatum	FACU*	*Carex praticola*	FACW
Aster chilensis	FAC	*Carex utriculata*	OBL
Athyrium filix-femina	FACW	*Ceratophyllum demersum*	OBL
Betula glandulosa	OBL	*Chamaecyparis nootkatensis*	FAC

[1] Reed, 1988 and Reed et al. 1993

Circaea alpina	FACW	*Festuca rubra*	FAC+
Claytonia sibirica	FACW	*Fraxinus latifolia*	FACW
Coptis aspleniifolia	FAC	*Galium aparine*	FACU
Cornus canadensis	FAC	*Galium triflorum*	FACU
Cornus nuttallii	NI	*Gaultheria humifusa*	FAC+
Cornus sericea	FACW	*Gaultheria shallon*	FACU*
Corylus cornuta	FACU	*Gentiana sceptrum*	OBL
Crataegus douglasii	FAC	*Geum macrophyllum*	FACW-*
Deschampsia cespitosa	FACW	*Glyceria elata*	FACW+
Deschampsia elongata	FACW-	*Gymnocarpium dryopteris*	FAC
Dicentra formosa	FACU*	*Hippuris montana*	FACW+
Digitalis purpurea	FACU*	*Holcus lanatus*	FAC
Downingia elegans.	OBL	*Hypericum anagalloides*	OBL
Drosera rotundifolia	OBL	*Impatiens noli-tangere*	FACW
Dryopteris austriaca	NI	*Iris pseudacorus*	OBL
Eleocharis acicularis	OBL	*Juncus articulatus*	OBL
Elymus glaucus	FACU	*Juncus balticus*	FACW+
Empetrum nigrum	FAC	*Juncus bufonius*	FACW
Epilobium angustifolium	FACU+	*Juncus effusus*	FACW
Equisetum arvense	FAC	*Juncus oxymeris*	FACW+
Equisetum fluviatile	OBL	*Juncus patens*	FACW
Equisetum hyemale	FACW	*Juncus tenuis*	FAC
Equisetum telmateia	FACW	*Kalmia polifolia*	OBL
Eriophorum angustifolium	OBL	*Larix occidentalis*	FACU+
Erythronium grandiflorum	FAC-	*Ledum groenlandicum*	OBL
Festuca idahoensis	FACU*	*Linnaea borealis*	FACU-

Listera caurina	FACW	*Oxalis oregana*	NI
Listera cordata	FACW	*Pedicularis groenlandica*	OBL
Lonicera involucrata	FAC+*	*Petasites frigidus*	FACW-
Lonicera utahensis	FAC	*Phalaris arundinacea*	FACW
Luzula multiflora	FACU	*Physocarpus capitatus*	FACW-
Luzula parviflora	FAC-	*Picea engelmannii*	FAC
Lycopodium annotinum	FAC	*Picea sitchensis*	FAC
Lysichitum americanum	OBL	*Pinus contorta*	FAC
Lythrum salicaria	OBL	*Plantago lanceolata*	FAC
Maianthemum dilatatum.	FAC	*Plantago major*	FACU+
Malus fusca.	FACW	*Poa annua*	FAC
Mentha arvensis	FACW-	*Poa pratensis*	FAC
Menyanthes trifoliata	OBL	*Polygonum hydropiper*	OBL
Menziesia ferruginea	FACU+	*Polygonum punctatum*	OBL
Mimulus alsinoides	OBL	*Polystichum munitum*	FACU
Mimulus guttatus	OBL	*Populus balsamifera*	FAC
Mitella breweri	FAC*	*Populus tremuloides*	FAC+
Mitella nuda	FACW	*Potamogeton amplifolius*	OBL
Moehringia lateriflora	FAC	*Potamogeton foliosus*	OBL
Montia parvifolia	FACW-	*Potamogeton natans*	OBL
Myosotis laxa	OBL	*Potentilla gracilis*	FAC
Myrica gale	OBL	*Prunus emarginata*	FACU*
Nuphar luteum	OBL	*Prunus virginiana*	FACU
Oemleria cerasiformis	FACU	*Pyrola asarifolia*	FACW-
Oenanthe sarmentosa	OBL	*Pyrola minor*	FACU+
Oplopanax horridus	FAC+	*Ranunculus alismifolius*	FACW

Ranunculus flabellaris	OBL	*Senecio triangularis*	FACW+
Ranunculus flammula	FACW	*Sparganium androcladum*	OBL
Ranunculus occidentalis	FACW	*Sparganium erectum*	OBL
Ranunculus repens	FACW	*Sparganium eurycarpum*	OBL
Rhododendron albiflorum	FACU	*Spiraea betulifolia*	FAC*
Rhynchospora alba	OBL	*Spiraea douglasii*	FACW
Ribes bracteosum	FAC	*Stachys cooleyae*	FACW
Ribes divaricatum	FAC*	*Stachys mexicana*	FACW
Ribes hudsonianum	FACW	*Stachys palustris*	FACW+
Ribes lacustre	FAC+	*Stellaria calycantha*	FACW
Ribes viscosissimum	FAC	*Symphoricarpos albus*	FACU
Rosa gymnocarpa	FACU	*Taxus brevifolia*	NI
Rosa nutkana	FAC	*Thuja plicata*	FAC
Rosa woodsii	FACU	*Tiarella trifoliata*	FAC
Rubus parviflorus	FAC-	*Tolmiea menziesii*	FAC*
Rubus pedatus	FAC-	*Trautvetteria caroliniensis*	FAC
Rubus spectabilis	FAC+	*Trillium ovatum*	FACU*
Rubus ursinus	FACU	*Tsuga heterophylla*	FACU-
Salix geyeriana	FACW+	*Tsuga mertensiana*	FACU
Salix hookeriana	FACW-	*Typha latifolia*	OBL
Salix scouleriana	FAC	*Urtica dioica*	FAC+
Salix sitchensis	FACW	*Vaccinium cespitosum*	FAC*
Sambucus racemosa	FACU	*Vaccinium membranaceum*	FACU+
Scirpus acutus	OBL	*Vaccinium myrtilloides*	FACU
Scirpus microcarpus	OBL	*Vaccinium ovalifolium*	NI
Scutellaria lateriflora	FACW+	*Vaccinium oxycoccos*	OBL

Vaccinium parvifolium	NI
Vaccinium scoparium	FACU-
Valeriana sitchensis	FAC
Veratrum viride	FACW
Veronica americana	OBL
Viburnum edule	FACW
Vicia americana	FAC*
Viola adunca	FAC
Viola glabella	FACW+
Viola palustris	OBL