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Wetland Plants: Their Function, Adaptation and Relationship to Water Levels

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Introduction

Wetlands display a wide range of hydrologic conditions, ranging from permanent inundation to merely soil saturation for at least some portion of the growing season. This hydrologic regime produces a reducing environment characterized by the absence of free oxygen within the soil profile. The resulting soils are called “hydric soils”.

Wetland plants (also called hydrophytes) are specifically adapted to reducing conditions in the soil and can; therefore, survive in wetlands. These adaptations can be morphological, reproductive, or physiological and are characteristic of many wetland species. Conversely, species without these special adaptations (i.e., "upland" plants), are intolerant of the absence of oxygen in the soil profile and may not survive under these conditions.

Adaptations to low soil oxygen characterize many wetland species. This is done by a variety of means. Perhaps most prominent is the development of aerenchymous tissue found in many herbaceous wetland species. This tissue is filled with large, connected intercellular spaces allowing free gas flow through the tissues, thus effectively overcoming the reduced environment and allowing rhizomes and roots to be supplied with oxygen. Wetlands and riparian species must also be adapted to the harsh physical conditions presented by the constant movement and fluctuation of water. Some species have evolved with flexible stems and leaves, while others have developed extensive spreading root systems.

Wetland and riparian species are essential to healthy ecosystems, and each species provides specific functions beneficial to the system and to man, and wetland and riparian areas should be designed and managed to incorporate all of these functions. By absorbing the force of strong winds, fluctuating water levels, abating flood peaks, and preventing shoreline erosion, wetlands, and the plants growing in them, protect terrestrial areas from storm and flood damage. The plants in wetlands help to filter chemical and particulate pollutants, and trap sediment in the water column. The trapped sediment gradually develops into mud flats, sand bars, or gradually fill-in creating habitat and food web support for a wide range of organisms. All of these functions add to the stability and health of the wetland and provide useful benefits to the flora and fauna of the wetland and surrounding ecosystems.

Many hydrophytes produce visual clues as to their affinity for wetlands; however, few provide clues to indicate their tolerance to water depths and duration of soil saturation within which they can survive. The US Fish & Wildlife Service has produced a reference on hydrophytes (*National List of Vascular Plant Species that Occur in Wetlands*, http://www.fws.gov/nwi/bha/list88.html) which provides information on a species' frequency of occurrence in wetlands. Caution is raised in using this document since a "frequency of occurrence" is not the same as a "tolerance of depth and duration" of hydrology. The "frequency" information within this document is commonly misconstrued for depth and duration. The primary way of knowing a species' tolerance to wetland condition, including depth & duration, is by knowing the individual tolerances for each species. The remainder of this document contains information on individual species as to the hydrologic conditions where they commonly occur. With this information it will be easier to select species for restoration activities or to identify the hydrologic condition of an area during dryer portions of the year.

This publication is designed to elucidate some of the commonly found wetland and riparian plant types and their relationship to water levels. A typical wetland or riparian zone can be broken into four hydrologic regimes: the area of short-term saturation, the area of long-term saturation, the draw down zone, and the permanently flooded region (figure 1). This figure indicates optimal moisture conditions, although local conditions are the best benchmarks for design. Because of ever-changing water levels these zones are often indistinct and may have broad reaches of transition or overlap. The area of short-term saturation is typically dry but may receive short periods of inundation. Plants in this zone must be both flood tolerant and drought tolerant to survive possible long stretches with or without available water. The long term saturation zone sits above the ordinary high water mark but receives ample water from capillary action through the soil as well as from periodic flooding. This area can, on occasion, be flooded for long periods of time and face high flood water energies, so the plant species found here may have special adaptations such as flexible stems (e.g. coyote willow) or aerenchymous tissues (Nebraska sedge). The draw down zone is the region between the ordinary high and low water marks. Draw down zone water levels are high generally after spring runoff and then drop over the summer as the water soaks into the ground, moves off the site, or is lost to evapotranspiration. This area is frequently flooded or may also be dry for long periods. Plants in this region are suited to withstand sustained periods of inundation, frequently changing water levels and floating debris. The permanently flooded region is, as its name suggests, permanently flooded in the course of an average water year. Plants in this region can be either free floating (duckweed), rooted to the bottom with leaves floating on the surface (lotus) or rooted to the bottom with the vegetation fully submerged in the water column (coontail).

This paper is divided into four sections describing groups of morphologically similar plants that may be encountered within each of the water depth zones. These sections are as follows: 1) emergent plants including dense rhizomatous, shallow water perennials, deep water perennials, bunch-type perennials, broad leafed rhizomatous, emergent woody plants and riparian trees and shrubs; 2) Floating leafed aquatics; 3) submerged aquatics; and 4) free floating aquatics. Again, zones may, and often do, overlap, so species will frequently be found in more than one zone. Also, the plants cited within this paper are examples only. The lists are by no means meant to be exhaustive.

Table of Contents **Page**

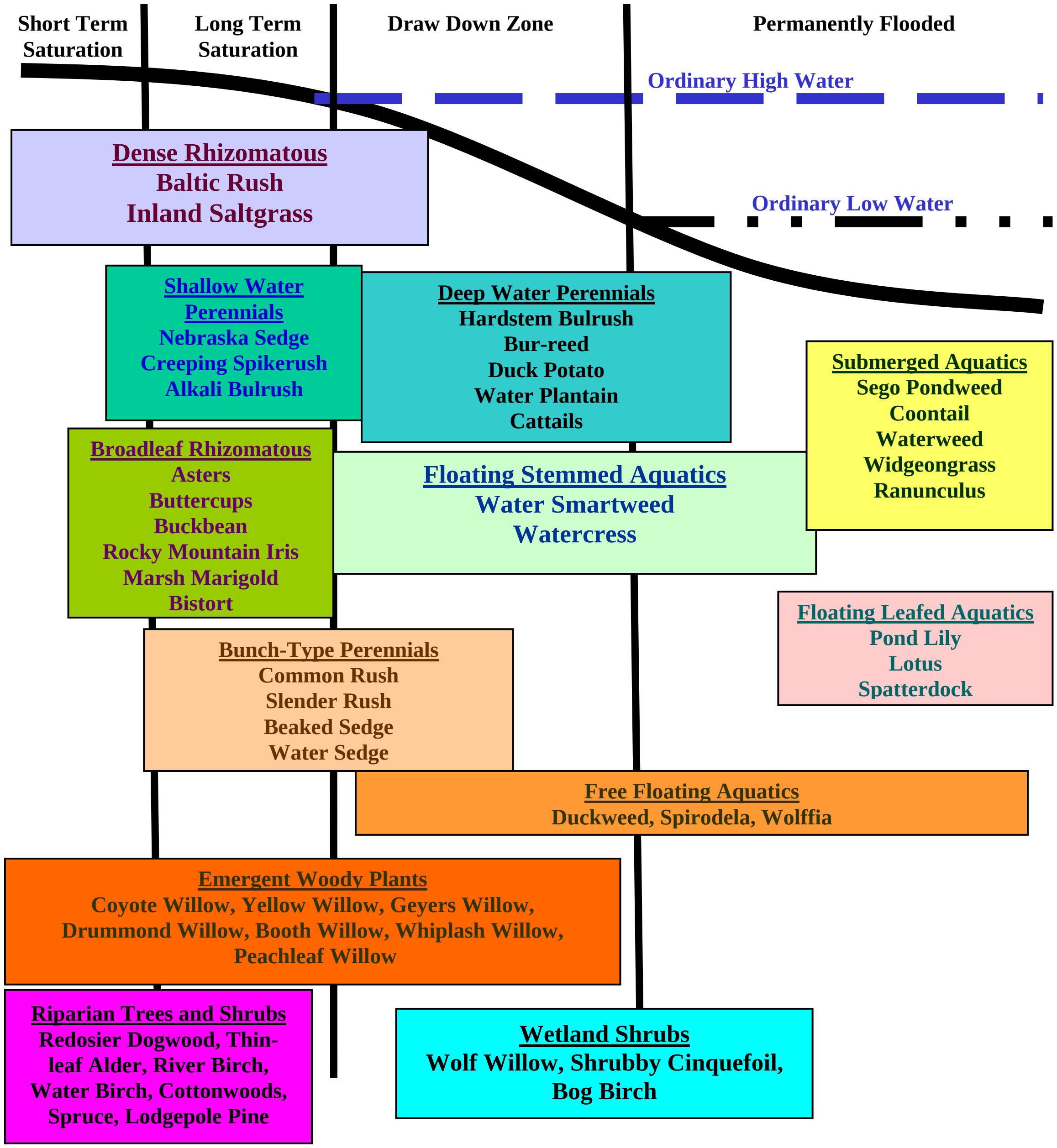


Figure 1: This is a graphic representation of different plant types and their relationship to water depths.

Emergent Plants

1. Dense Rhizomatous

- Found in seasonally saturated areas (prefer soil that is saturated early in the season but later dry out)
- Perennials with heavy, dense rhizomes
- Reproduce by seed and underground rhizome runners
- Spread mainly by rhizomes
- Dense monotypic stands
- Can be quite drought tolerant
- Found at water's edge and even in wet depressions in upland areas
- Examples – Baltic Rush *(Juncus balticus)*, Reed Canarygrass *(Phalaris arundinacea)*, Tufted Hairgrass *(Deschampsia caespitosa)*, Redtop *(Agrostis stolonifera)*, Inland Saltgrass *(Distichlis spicata)*

Baltic Rush

Inland Saltgrass

2. Shallow Water Perennials

- Shoots from rhizomes are produced throughout the growing season and into late fall
- Require annual draw down or maximum water depths of 6 inches during most of the growing season
- In water depths that remain at a one foot or more, they will persist for sometime, but eventually disappear
- Considerable variation in hydrologic regimes tolerated by these species
- Thick root mass that is resistant to compaction, erosion, and herbivory.
- Can survive periods where the water table is more than 1 m below the surface
- In riparian areas found on fringe between upland and wetland in toe zone
- Also found in marshy habitats in standing water
- Examples – Threesquare Bulrush *(Scirpus pungens)*, Creeping Spikerush *(Eleocharis palustris)*, Nebraska Sedge *(Carex nebrascensis*), Alkali Bulrush (Scirpus maritimus)

Nebraska Sedge

Creeping Spikerush

Alkali Bulrush

3. Deep Water Perennials

- Require annual draw down or maximum water depths of 12-18 inches during majority of growing season
- They will persist for sometime in water depths up to 3 feet, but eventually will disappear
- They will grow and spread much faster in fluctuating water depths
- Examples – Hardstem Bulrush *(Schoenoplectus acutus* var. *acutus),* Softstem Bulrush *(Schoenoplectus tabernaemontani),* Cattails *(Typha* sp.*),* Bur-reed *(Sparganium* sp.*),* Duck Potato (*Sagittaria latifolia)* , American Water Plantain (*Alisma subcordatum)*

Hardstem Bulrush

Common Cattail

4. Bunch-Type (Caespitose) Perennials

- Prefer flooding in the early portion of the season. Can grow in shallow standing water, but can withstand long dry periods.
- Plants grow in tight clumps forming characteristic mounds or "hummocks"
- Species found in saturated soils and upper draw down zones
- Intolerant of long term inundation
- Examples – Common Rush *(Juncus effusus),* Western rush (*Juncus occidentalis*), Beaked Sedge *(*Carex *rostrata),* Water Sedge (*Carex aquatilis)*

5. Broad Leafed Rhizomatous

- Prefers seasonally flooded areas that dry out later in the year.
- Tolerant of short lived inundation
- Usually rhizomatous
- Monotypic stands in saturated soils
- Spectacular show of wild flower colors
- Attract pollinators which provide food for fish, birds and other larger animals
- Examples – Asters *(Aster* sp.*)*, Rocky Mountain Iris *(Iris missouriensis), Yellow* Marsh Marigold *(Caltha palustris)*, Meadow Bistort *(Polygonum bistorta),* Buttercups *(Ranunculus sp.)*

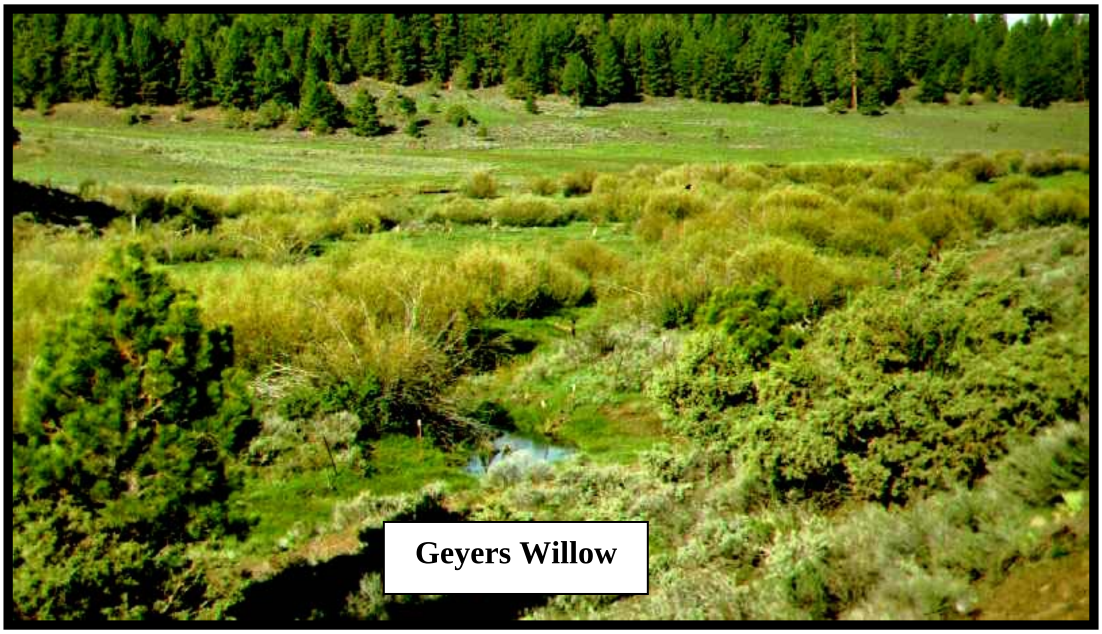
Yellow Marsh Marigold

Rocky Mountain Iris

Meadow Bistort

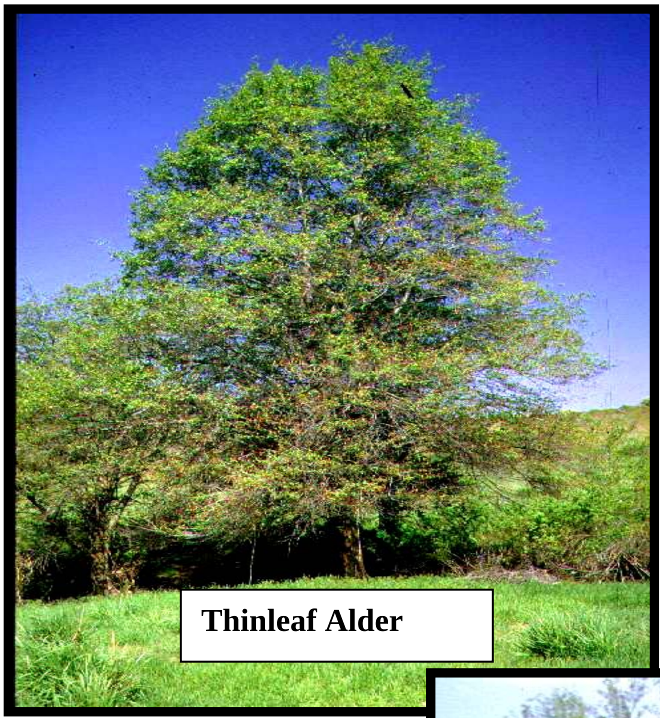
6. Emergent Woody Plants

- Tolerant of long to permanent inundation; Some species had withstand deep water for 4-6 months and sprout when their tops are finally exposed
- Produce adventitious roots to aid in obtaining oxygen for the water column
- Generally found in upper portions of the zone
- Useful for stabilizing streambanks due to spreading nature and numerous flexible stems that reduce water flow energies in flood situations
- Examples – Coyote Willow *(Salix exigua),* Yellow W*illow (Salix lutea),* Geyers Willow *(Salix geyeriana),* Drummond Willow *(Salix drummondiana),* Booth Willow *(Salix boothii),* Peachleaf Willow *(Salix amygdaloides)*

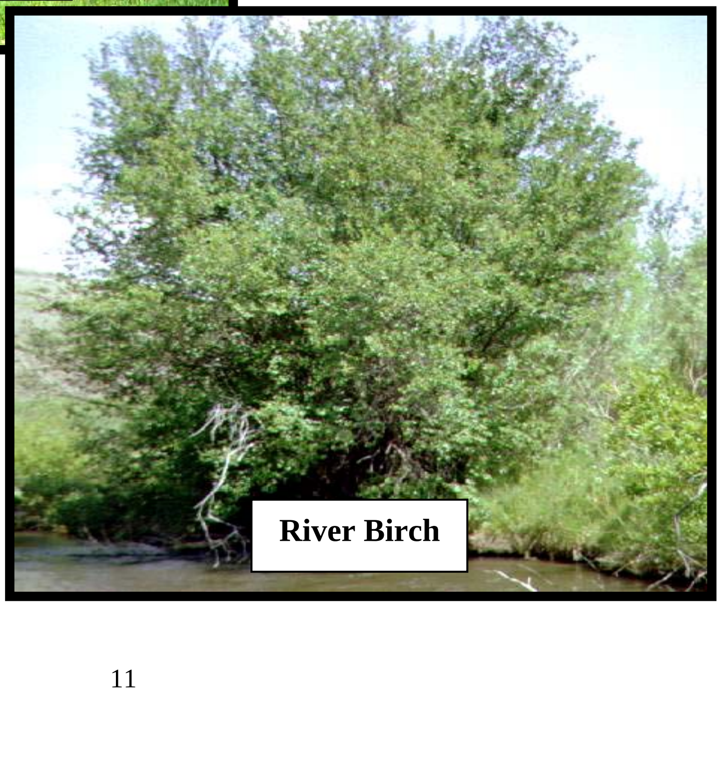


7. Riparian Trees and Shrubs

- Tolerant of short term, seasonal inundation and soil saturation
- Do not survive long term inundation or permanent soil saturation
- Have large deep growing root systems
- Provide shade and organic matter to the ecosystem
- Important for a wide variety of wildlife species in terms of habitat nesting, roosting,
- Examples – Redosier Dogwood *(Cornus sericea)*, Thinleaf Alder *(Alnus incana)*, River Birch *(Betula nigra)*, Cottonwoods *(Populus sp.)*, Spruce (*Picea* sp.*)*, Elderberry *(Sambucus* sp.*)*, Chokecherry *(Prunus virginiana)*, Hawthorn *(Crataegus* sp.*)*, Lodgepole Pine *(Pinus contorta)*



Thinleaf Alder



River Birch

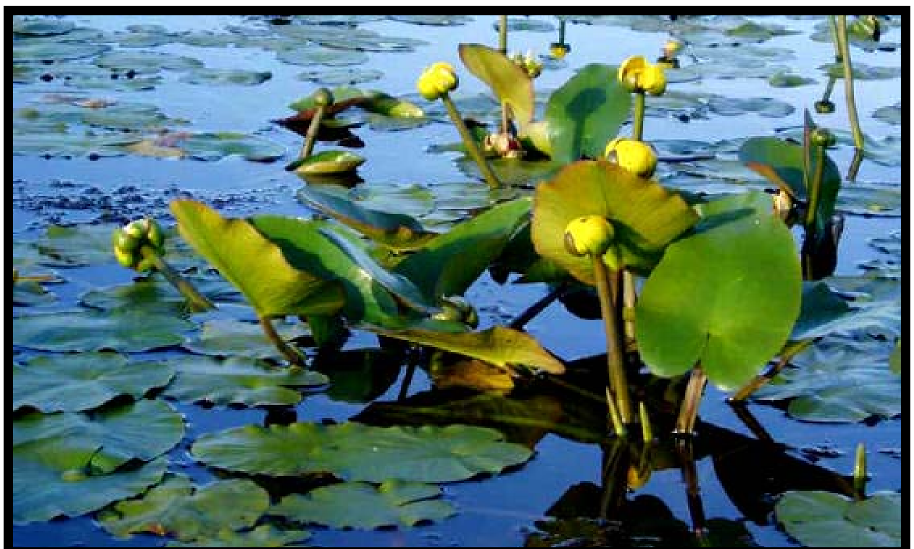
8. Wetland Shrubs

- Tolerant of soggy or marshy conditions most of the year
- Can be excessively wet in the winter, spring, and after heavy rain, but often is dry in the summer
- Generally wet, neutral to calcareous soils in the shrubby margins of bogs and wooded swamps
- Problems with over-shading by other woody species as a result of succession
- Forms dense colonies at the margins of fens and neutral bogs
- Examples - Wolf Willow *(Salix wolfii),* Shrubby Cinquefoil *(Dasiphora fruticosa* ssp. *floribunda),* Bog Birch *(Betula pumila)*

Floating Leaves

1. ***Floating Leafed Aquatics***

- Structured to reach higher points and receive more sunlight
- Plants rooted in deeper water and send their leaves to the surface where they float
- Leaves are filled with aerenchyma to allow them to float on the water surface and to carry gasses to the roots below
- All stomata are found in the upper epidermis of the leaves since the lower portion is always submerged
- No photosynthetic structures in the water column
- Leaves tend to be broader without major lobing; remain flat on the surface; maximize surface area and make use of full sunlight
- Chloroplasts found on the top of leaves
- Usually rhizomatous
- Examples – Fragrant Water Lily *(Nymphaea odorata),* American Lotus *(Nelumbo lutea),* Spatterdock *(Nuphar luteum),* Floating Pondweed *(Potamogeton natans)*



American Lotus

Submerged

1. ***Submerged Aquatics***

- Typically found in deep water (3 feet plus) that never or rarely draw down
- Submersed leaves receive low levels of sunlight because light energy diminishes rapidly while passing through a water column
- Rooted in the bottom, tops float in the water. Air spaces within the tissues to keep the plant buoyant so that its leaves can reach the top of the pond, maximizing the amount of sunlight received
- Can form dense stands or mats underwater
- Examples – Sago Pondweed (*Stuckenia pectinata)*, Coontail (*Ceratophyllum demersum)*, Waterweed *(Elodea canadensis)*, Widgeon Grass (*Ruppia maritime)*

Free Floating

1. Free Floating Aquatics

- These plants are very simple, lacking a stem or leaves, but consisting of a small blade-like structure floating on or just under the water surface, with or without simple rootlets
- Reproduction is mostly by budding
- The fruit is a *utricle,* a sac containing air and a seed designed to float
- Hair on its leaves trap air
- The plants can provide nitrate removal (if cropped) and cover for fry
- The plants are used as shelter by pond water species, such as bullfrogs and bluegills
- The duckweeds are important in the process of bioremediation because they grow rapidly, absorbing excess mineral nutrients, particularly nitrogen and phosphates. A cover of duckweed will reduce evaporation of water compared to an open surface
- Roots hang down into the water column and are not connected to the bottom
- All the nutrients come from the water column
- Generally very small in size
- Examples – Common duckweed *(Lemna minor),* Giant Duckweed *(Spirodela polyrrhiza)*