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A Citizen's Guide to Wetland Restoration

Approaches to Restoring Vegetation Communities and Wildlife Habitat Structure in Freshwater Wetland Systems

A CITIZEN'S GUIDE TO WETLAND RESTORATION

Approaches to Restoring Vegetation Communities and Wildlife Habitat Structure in Freshwater Wetland Systems

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Adopt a Beach is a non-profit organization that develops stewardship projects along Washington's marine waters and in its associated wetlands.

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A Citizen's Introduction to Wetland Restoration

When we see land as a community to which we belong, we may begin to use it with love and respect. There is no other way for land to survive the impact of mechanized man, nor for us to reap from it the aesthetic harvest it is capable, under science, of contributing to culture. That land is a community is the basic concept of ecology, but that land is to be loved and respected is an extension of ethics.

A Sand County Almanac
Aldo Leopold

Introduction

In the Puget Lowlands over half of the wetlands that existed before European settlement have been lost, and the vast majority of the remaining wetlands have been damaged or impaired. Habitats that have been most affected include estuarine wetlands, forested wetlands, peat wetlands such as bogs and fens, and highly complex wetlands which are sensitive to harmful impacts.

Fortunately, it is possible to restore and heal some of the damage which has occurred. If carefully planned and conducted, restoration projects completed by private citizens can make a significant contribution towards maintaining and improving wildlife habitat and water quality throughout the Puget Lowland. The chapters and format of this guidebook provide a general approach to environmental restoration by describing details that need to be addressed during planning and implementation. Chapters 1 through 4 discuss planning and implementation, Appendices A and B provide specific information on plant growth and selection, and the Reference section provides references for additional information. Appendix C provides a checklist of restoration tasks and issues, and Appendix D provides the common and scientific names of plants mentioned in the text.

Intent of the Guidebook

This guidebook is designed to help citizens restore and improve wetland and riparian habitats within the Puget Lowland (Figure 1). The intended audience is private landowners who have access to a degraded wetland or stream, and wish to improve the function or landscape aesthetics of the site without involving earthwork or altering water flows. As a result, planting vegetation and installing wildlife habitat features are the main restoration techniques described in this guidebook. A

professional biologist experienced in wetland restoration should be contacted whenever substantial movement of soil or any change in the flow or location of water is anticipated. In these cases, the help of other professionals may also be needed, and local, State, or Federal Government permits will probably be required. The Washington Department of Ecology Wetlands Section, many county planning departments, and other local jurisdictions maintain consultant lists and can help with permit requirements.

As used in this guidebook, "restoration" means the process of intentionally returning an ecosystem to a close approximation of its pre-disturbance condition. The goal of restoration is to restore the structure, function, diversity and dynamics to an ecosystem that will operate without continued human management or reliance on engineered structures. The term "restoration" is generally used to describe activities in communities that have been severely degraded by clearing, filling, or invasion by non-native plant species. Successful restoration not only requires knowledge of the type of community that existed prior to disturbance, but also an understanding of the site's existing conditions. When this knowledge is successfully integrated with well thought-out restoration plans, the restored ecosystem will continue to exist and function on the landscape into perpetuity.

Enhancement involves increasing one or more values of all or a portion of an existing wetland. In general, enhancement is the term used when working within a community that is in good shape, but may lack structural features or species that would normally occur there.

The intent of this guidebook is to promote careful and considered actions that will restore functions to existing degraded wetlands or streams, and to avoid adverse impacts to high quality wetlands

and streams. If it ain't broke, don't try to fix it, because to do so will almost always cause damage. For example, many people prefer ponds or open, park-like woodlands to dense thickets of vegetation. As a result, emergent, shrub, or forested wetlands are sometimes converted to ponds, and forest undergrowth is cleared in wetland buffers and along streams. The net result of conversion or clearing is usually the loss of ecologically important functions. As a result, altering any high quality wetland or riparian community in an attempt to enhance a particular attribute or aesthetic qualities is detrimental.

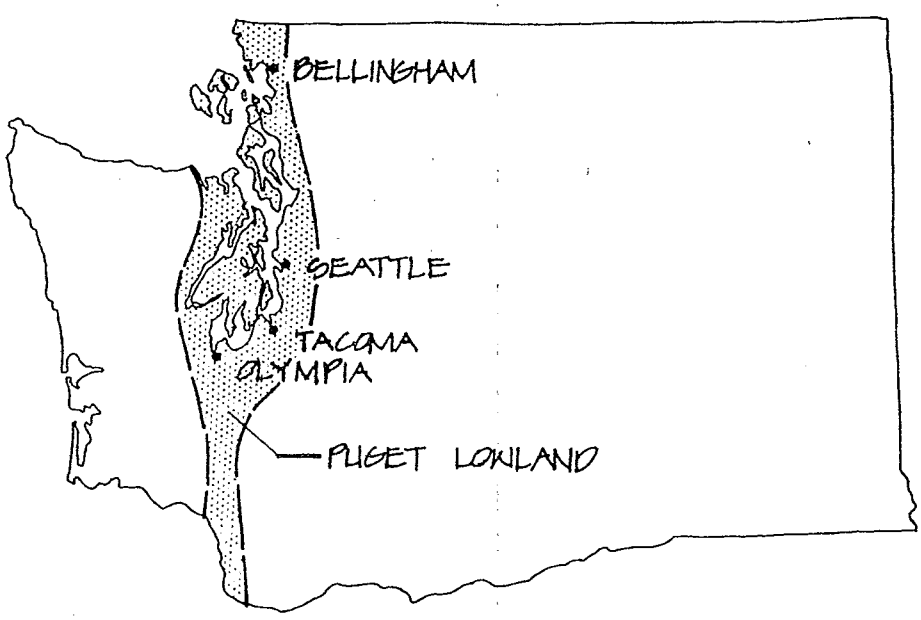


Figure 1: The Puget Lowland includes a large area and a wide range of climates, soils, and biological communities.

This guidebook does not provide the information needed to attempt a wetland *creation* project. Wetland creation, which involves transforming uplands into wetlands, requires considerable expertise and information, and is often unsuccessful. If done haphazardly, attempts to create wetlands can inadvertently damage surrounding natural systems by altering surface or groundwater flows, or result in communities with low functional value. In addition, wetland creation usually requires permits from local, State, or Federal agencies, and more time and money than the restoration and enhancement activities described in this guide.

This guide also does not provide recipes for restoration to apply to various wetland types throughout the region. It does not because each opportunity for restoration you encounter will present a different set of circumstances in terms of hydrology, soils, vegetation, and past disturbances. In each case, the restoration goals you select and the environmental conditions you have to work with will be unique, and will require unique solutions.

Successful restoration is based on an understanding of ecology, the scientific study of the interactions that determine the distribution and abundance of organisms. The term "ecology" is derived from the Greek *oikos*, which means "home" - for humans, plants and animals. The watershed of the wetland or stream to be restored is referred to as a landscape. The ecosystem is a unit within the landscape that includes both plants and animals and the physical and chemical components of the immediate environment. Community ecology deals with the composition or structure of groups of plants and animals that occur together, and their interrelationships.

Several ecological concepts pertain to the art of restoration. *Competition* is an interaction in which one organism consumes a resource that would have been available to another; most weeds are successful competitors for light, water, and nutrients. *Predation* occurs when one organism eats or kills another, for example when great blue herons or belted kingfishers prey upon juvenile fish. *Herbivory*, such as geese eating planted vegetation, is another form of predation. Mutually beneficial ecological relationships, termed *commensalism*, in which organisms thrive and benefit each other, are also very important. Mycorrhizal relationships between fungi and flowering plants are one example.

Wetland Functions

One of the most readily apparent functions of wetlands is providing critical habitat for a wide variety of plants and animals, including several threatened, endangered, or sensitive plant and animal species. Plants found uniquely in wetland areas include not only the familiar common cattail and yellow pond lilies, but also cranberry, burreed, many sedges and rushes, and the insectivorous sundews.

A high percentage of wildlife species depend on wetlands for some part of their life cycle. During certain stages of an animal's life cycle, aquatic habitat may be critical for its continued existence. The constant changes wrought by flowing water create "edge effect" - a mingling of plant and animal species between upland, wetland and water. Vegetation diversity, including both numbers of species and structural complexity, contribute to high wildlife diversity. Wetlands provide food, shelter and cover for many terrestrial and amphibious animal species. Wetlands are particularly important

during the breeding and nesting season, when animals are often most vulnerable and need protection.

Wetlands also provide food and shelter for fish. Wetland vegetation growing next to and over streams shades and cools the water. Insects falling from overhanging plants feeds hungry mouths below and downstream. . Dense roots provide bank stabilization and erosion control, keeping banks in place when threatened by waves or flooding. Roots secure streambanks, reducing siltation that covers spawning gravels, but at the same time allowing undercutting so fish have hiding places

Healthy wetlands and streams provide flood storage and lengthen the time between a rain event and peak runoff. In watersheds with healthy wetlands and streams, dense vegetation and floodplain storage slow water velocity and reduce downstream flooding. A watershed's water storage capacity is reduced when wetlands are lost or streams are channelized, resulting in increased flooding of homes and neighborhoods.

Wetlands provide water quality improvement. Dense vegetation slows and filters water, and as the sediment load settles out, so do excess nutrients and pollutants such as fertilizers or pesticides. Many plants can uptake excess water-borne nutrients and convert them to plant tissue, and many contaminants are safely immobilized as a result of chemical binding with organic material and sediments in wetlands. Unfortunately, the presence of pollutants in surface water runoff also makes them available to wetland organisms that may form the base of food webs that include human beings.

Wetlands often provide areas for groundwater discharge or recharge. During flooding or high water flows, water infiltrates from the surface into groundwater aquifers. During low flows,

this water is released slowly, improving water quality and quantity for fish, wildlife, recreation, and plant growth.

Wetlands are also unique and highly productive ecosystems that provide excellent opportunities for aesthetic enjoyment, recreation, education, and scientific research.

Need for Permits

Whenever work is planned in or adjacent to a wetland, local, State, and Federal government agencies should be contacted early in the restoration planning process. There are two reasons for this: 1) opportunities for technical or financial assistance can be identified; and 2) a permit may be needed for the work you propose to do. For example, any work within "Waters of the State" (which includes all marine and fresh waters within the ordinary high water lines and within the territorial boundaries of the state) requires a Hydraulics Project Approval issued by the Washington Department of Fisheries (for salt water and waters supporting salmon) or by the Washington Department of Wildlife (in fresh waters of the state without salmon).

Additional Federal, State, and local permits may be needed if you plan to work within a stream corridor or wetland. Under no circumstances should you excavate, recontour, place soil, mulch, or rock, or use herbicides in or near wetlands or streams without first consulting Federal, State, and local regulatory agencies. Phone numbers for State and Federal agencies are listed at the end of Chapter 3. City and County Planning Departments are listed in your local phone book.

History of Restoration

Over 50 years ago, prairie restoration was initiated in the midwestern United States by a private landowner, Aldo Leopold, who is known as the father of the land ethic and author of *A Sand County Almanac*. Leopold and his family bought a ruined and abandoned farm, repeatedly planted native seeds, and slowly accumulated enough experience so the seedlings grew and flourished. Nina Leopold Bradley, his daughter, writes, "All of us were learning something about ecology in perhaps the only way it can really be learned - in formulating the small question. By making the observations, keeping the records, and performing the experiments, we began to discover the successful combination of plants and animals that constitute a healthy land." Today, people come from all over the country to see the beautiful prairies, wet meadows, and deciduous forests restored by the Leopold family.

The first major restoration ecology project in the United States was initiated at the 1,200-acre University of Wisconsin Arboretum in 1932 (Curtis, 1959). It was determined that the Arboretum was not to be merely a collection of trees, but rather that major emphasis was to be placed upon a collection of *biotic communities*. Native plants and seeds were collected and planted in the same relative abundance in which they occurred in natural plant communities. Eventually, management options such as fire, weed, and pest control were developed. This approach has provided the basis for many other restoration projects.

One of the oldest restoration projects in the Pacific Northwest is the Salmon River salt marsh restoration, located near Lincoln City, Oregon. Begun in 1980, the goal was to return diked pastures to functioning estuarine wetlands. Recent research and

observations indicate the site has been successfully restored to a functioning, natural, salt marsh.

Restoration of freshwater systems in recent years has largely been the result of wetland regulation and a "no net loss" policy adopted by government regulatory agencies. When the no net loss policy was initiated, mitigation for wetland impacts (in the form of wetland creation or restoration) generally required no net loss of wetland *acreage*. More recently, replacement of *wetland functions* is being used to evaluate restoration success, with acre-for-acre replacement a secondary consideration.

Chapter 1
Site Selection

Every restoration site should be selected based on its potential for successful restoration, and should be screened for "red flag" conditions that could prevent its use. Red flag conditions include the presence of hazardous waste, inaccessibility, land covenants, and the presence of rare species. If you suspect your site meets any of these conditions, restoration will require the assistance of trained professionals.

Sites chosen for restoration or enhancement should be obviously degraded by clearing or overgrown by non-native species. Undisturbed, uncommon, or pristine sites are not good choices for enhancement. For example, bogs and forested communities require special treatment, so you may want to enlist the help of someone with experience in dealing with these systems. Seek help whenever you have a question about the type of wetland you are dealing with, a particular phase of a restoration project, or you are unsure about what to do. Help with restoration planning and implementation is available from local, state, and federal agencies. Phone numbers for agencies and organizations that may provide assistance are listed at the end of Chapter 3.

There are many ways to go about restoring a wetland, ranging from large projects that completely change a site's physical characteristics and biological community, to small-scale projects that improve a site's function and value but do not involve earthwork or great expense. Protecting a wetland or stream, restoring or enhancing vegetation, controlling invasive species, and enhancing wildlife habitat are actions that are within the realm of possibility for many homeowners. Each of these strategies are discussed further in Chapter 3.

Restoration success will be best assured if you spend the time and energy needed to understand your site's physical and biological systems before developing plans and taking action. Wetlands are integral parts of the physical features and biological communities that form the landscape, and as a result are influenced by the condition of the surrounding landscape.

For example, it would be a waste of time, energy, and plant material to plant shade-requiring species in an area that receives full sun, or to install nest boxes for birds requiring forest cover when no forest cover exists nearby. Your site's location relative to urban areas and other wetlands, streams, and forests will have a strong influence on the success of your project.

Before beginning your restoration project, observe the surrounding landscape and learn about the types of wetlands that naturally develop in landscape settings comparable to your situation. How your site fits into the greater landscape and its location in the watershed are primary factors in determining the kinds of wetland communities that would naturally occur there. Information concerning locations of comparable wetlands may be available from local Planning or Parks and Recreation Departments, and from the Washington Department of Ecology. Ecology has published a free guide to public-access wetlands, entitled *Wetland Walks, A Guide to Washington's Public-Access Wetlands*. Copies can be obtained by contacting the Washington Department of Ecology Publications Office at (206) 407-7472. Washington State University Cooperative Extension, King County has also published a guide to public access wetlands, entitled *Wetlands of King County*. The King County guide is available through the King County Cooperative Extension office (206) 296-3900).

Visiting local wetlands that have soil and hydrology characteristics similar to those at your restoration site may be helpful in selecting plant species for your site, and will help to identify each species' growth habits, water requirements, and tolerances. Visits to local wetlands will also provide opportunities to observe and learn about wetland plant and animal communities. Developing a basic understanding of wetland ecosystems is necessary for successful wetland restoration.

Sources of Landscape Information:

Information describing the landscape around your site may be available from local, state, and federal sources. This information is often provided free or at nominal cost, and may provide insight into existing or historic conditions, and locations of wetlands or streams that could serve as models for your project. Sources of information include:

US Geological Survey Quadrangle Maps, available from local map stores.

US Department of Agriculture Soil Conservation Service Soil Maps, available from the Soil Conservation Service Olympia office at (206) 753-9448.

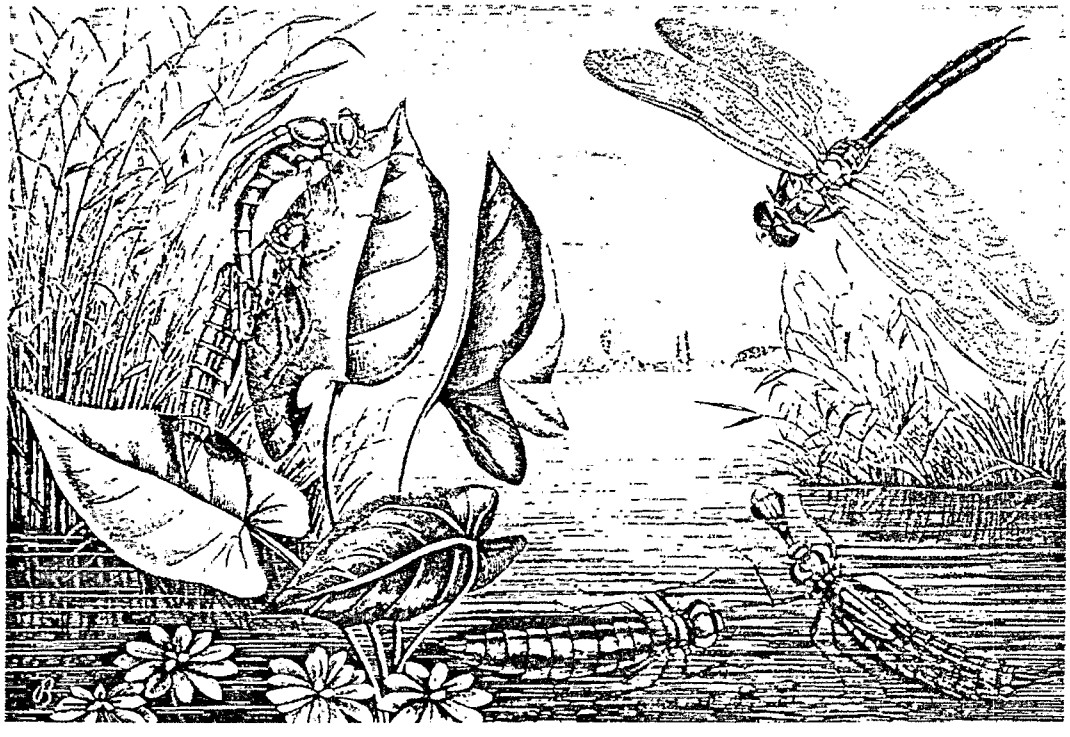
US Fish and Wildlife Service National Wetland Inventory Maps, available from the Washington Department of Ecology's Olympia office at (206) 459-6202.

Local wetland and stream inventory maps and aerial photos available from local planning departments. Information on Puget Lowland wetland and stream inventories is also available from the Washington Department of Ecology Wetland Inventory Coordinator, at (206) 459-6836

Current and historical aerial photos, available from local planning departments, Federal and state agencies such as the US Army Corps of Engineers [(206) 764-3677], Washington Department of Natural Resources [(206) 902-1234], Washington Department of Transportation [(206) 586-1936], and commercial suppliers.

Many of the maps and aerial photographs described above are also be available through local libraries and in the University of Washington Library Map Collection.

Long-term residents can often provide valuable site-specific information on historic conditions such as plant communities that previously grew in the area, seasonal water fluctuations, and wildlife use of a site.



Chapter 2
Analyzing the Restoration Site

An important first step in developing a restoration plan is to assemble some basic information about the hydrology, soils, vegetation, areas and types of disturbance, and wildlife use at your restoration site. *A Field Guide to Wetland Characterization* (Pritchard, 1991), available from King County Cooperative Extension, is a practical citizen's guide to wetland identification and characterization. Characterizing the existing conditions at your site is the key to understanding what restoration activity is needed and determining what activities are feasible. A good way to analyze your site is to answer the question "What is wrong and how can I fix it?" for each of the following topics.

Water

"Hydrology" is the general term used by wetland scientists to describe a site's water regime. A site's water regime includes flow patterns, water depths, inundation and saturation periods, and seasonal fluctuations. Extreme high and low flows may be more significant than normal flows for restoration success, and should be investigated prior to restoration planning and implementation. Ideally, site hydrology should be monitored over a twelve-month (or longer) period before attempting restoration.

If your restoration area is adjacent to a lake or pond, identify the normal high and low water levels. If along a stream, you will need to need to know how the restoration area is affected by high flows during the winter and spring, and by low (or no) flows during the summer. If in a marsh or swamp, you will need to know whether the area is seasonally or permanently flooded or

saturated. Water sources and watershed characteristics largely determine whether a site will have a stable or seasonally fluctuating water level, or water levels that fluctuate frequently and rapidly as a result of runoff from roofs and roads.

More than anything else, how well you understand your site's hydrology will determine the success of your restoration effort. Failure to understand and anticipate hydrologic conditions is one of the most frequent causes of restoration failure, and hydrology is one of the most important considerations when deciding whether certain plants will grow in a specific location. Each species has its own water requirements and tolerances, and the familiar adage "right plant, right place" applies at least as much to landscape restoration as it does to residential landscaping. Perhaps it applies even more so, since once plants are installed at a restoration site they typically are left to fend for themselves without the benefit of the maintenance residential landscapes receive.

Plants

Identify the plants growing at your site and determine their growth habits, including their sun or shade requirements, flooding and drought tolerance; potential for weediness, wildlife value, and aesthetic qualities. Knowing what already grows there can tell you whether you can expect problems with weedy species colonizing your site, and can help you decide what native species are adapted to the site's growing conditions. The existing vegetation at your site may strongly influence your plant choices. Existing vegetation may shade the restoration area, or may provide a seed or propagule source for revegetation. Weedy species growing at or near the site may invade your restoration area and be difficult to control.

Look for areas where native vegetation could be enhanced, and for areas where non-native invasive species could be controlled and replaced by native vegetation. For example, Himalayan and evergreen blackberries form dense thickets near wetlands in many areas, often inhibiting the regeneration of native forest communities (see Appendix D for scientific names of plants mentioned in the text). Although blackberries provide some benefit to wildlife, re-establishing a native shrub or forest community will in many cases result in greater benefits to a wider variety of wildlife.

Soils

The type of soil at your restoration site may also influence your plant choices. Soil texture, pH, nutrient content, and degree of compaction affect plant growth, and may need to be amended to ensure plant establishment. In addition, the amount of organic matter in the soil may help determine which plants are suitable for your site.

Wetland soils fall into either of two major classes: organic soils, and mineral soils. Organic soils are formed from decomposed plants (in which case the soil is called "muck") or undecomposed plants (in which case the soil is called "peat"). Mineral soils are composed primarily of sand, silt, and clay. Sandy soils percolate rapidly, and may need irrigation while plants are becoming established. Compacted glacial tills and clay soils are relatively impermeable, difficult to dig, and may be challenging to the restorationist, but are often most appropriate to sustain wetland hydrology. Soils contaminated with toxic materials require handling by trained professionals.

Topography

Assess the topography of your restoration site to determine whether slopes and water depths are appropriate for planting. Eroding streambanks or bluffs may need to be stabilized or recontoured to create favorable conditions for restoring plant communities. "Bioengineering", which incorporates live plants in erosion control systems, often offers good possibilities for revegetating steep slopes and eroding streambanks. However, slope and streambank stabilization requires a thorough analysis of the erosive forces at work, and usually requires professional assistance. When seeking professional help, be sure the person you select has both expertise and practical experience in soil or streambank stabilization.

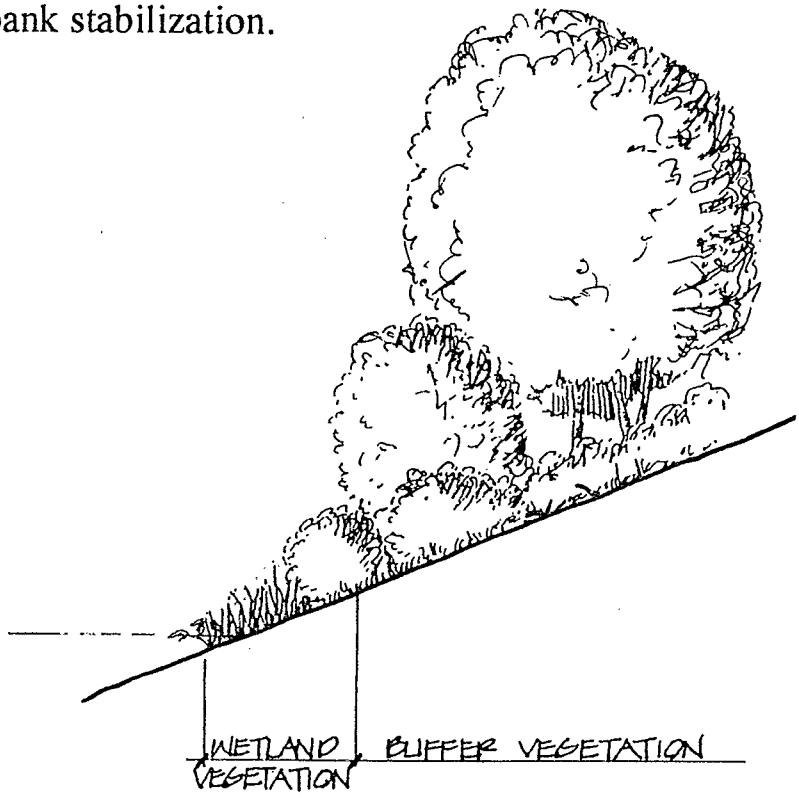


Figure 2: The extent of a wetland area is often controlled by topography. Here, a steep slope restricts the extent of the wetland.

The underwater topography in ponds or lakes will determine whether areas are available for establishing plants that grow in shallow water, such as burreed or spikerush, and plants that require deeper water, such as pondweed and yellow pond lily.

Aspect, which is the direction a restoration site generally faces, is another important consideration related to topography. For example, plant community restoration on sites located on north-facing slopes may require the use of shade-tolerant plants. In contrast, sites on south-facing slopes will often require plants that tolerate full sun and summer drought. Slope, site orientation, and existing vegetation will all influence the microclimates found at your site.

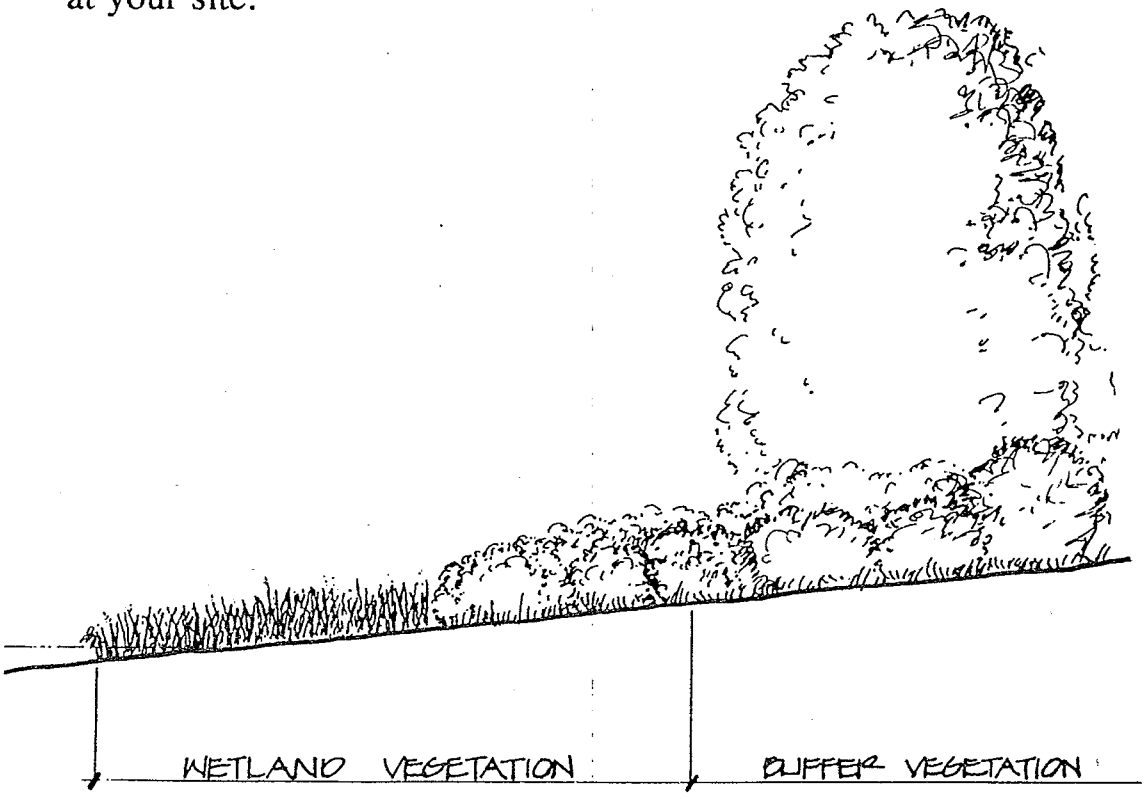


Figure 3: An area with more gentle topography typically permits a broader wetland area to develop.

Disturbed Areas

Identifying disturbed areas in a wetland, along a stream, or within a wetland or stream buffer will usually be the first step in determining the scope and feasibility of a restoration project. Look for areas where native vegetation has been removed or replaced by a non-native plant community, areas where livestock has unrestricted access to the wetland or stream, or areas where buffer vegetation could be enhanced to screen a wetland or stream from human noise or activity.

Identifying the type and extent of disturbance is also important because successful restoration depends on eliminating or controlling the disturbance. Often, restricting access by cattle and people will be the single most effective restoration action, and no additional work may be needed. Native plant communities will often recover without additional plantings once a chronic disturbance is eliminated. In cases where eliminating the disturbance is impossible, understanding the nature of the disturbance will help determine potential control actions.

It is also important to identify areas where restoration success may be limited by existing vegetation, hydrology, soils, or other conditions. For example, attempting to restore native vegetation within an area dominated by reed canary grass may be futile. Similarly, attempts to restore vegetation may fail in wetlands or streams whose natural water regimes have been drastically altered. In this situation, pre-disturbance wetland hydrology may have to be restored before native vegetation can be established. Alternately, native plants that are adapted to the existing water regime could be selected.

Wildlife

Wildlife use of a site is largely determined by the habitat resources that are present, and connections with adjacent habitats. Wildlife will use sites where food, water, cover, and breeding areas are available, as long as they have a corridor of suitable habitat that allows them to reach the site. In areas without suitable connections to nearby habitats, lack of travel corridors may limit the numbers or types of wildlife using the site. In these cases, it may be best to work towards establishing connections between the isolated habitat, similar habitats nearby, and adjacent upland habitats.

Physical and biological features that have particularly high value for wildlife nesting, cover, or feeding are often referred to as "habitat features." Habitat features often lacking in urban or suburban areas include snags (standing dead trees), and logs. Assess your wetland or stream to determine whether snags and logs are absent or in short supply. Snags provide feeding areas for insect-eating birds such as pileated woodpeckers and northern flickers, nest sites for cavity-nesting birds such as black-capped chickadees and tree swallows, and perch sites for a wide variety of birds.

Logs provide perch sites for birds, and loafing and hunting sites for mammals and reptiles. Frogs and salamanders attach their egg masses to submerged branches, and logs also provide substrate for plant growth. Although logs in streams are sometimes perceived as barriers that impede flows and fish passage, they perform functions that are necessary for a healthy stream. Logs provide cover for fish, substrate for invertebrates and algae, and direct water flow.

Additional Information

Additional considerations in or near a restoration site that may influence your project include the location of overhead or underground utility lines, property boundaries and ownership, and road or utility easements. Trees should not be planted where they will interfere with utility lines. Choose your planting area in a site where chances are good the plants will remain undisturbed. In the interest of maintaining good relations, discuss your plans with your neighbors before planting shrubs or trees that may block trails or views.

Also identify and assess off-site influences. Be aware of sources of pollutants in the surrounding watershed. Stormwater runoff, point source discharges, and road and agricultural runoff may contribute pollutants, nutrients and potentially toxic substances such as pesticides or heavy metals. Noise pollution, glare, high amounts of human traffic, offroad automobile or bicycle use and heavy littering also influence a site's potential for restoration.

Chapter 3
Developing a Conceptual Restoration Design

The information you gather during the Site Analysis phase described in Chapter 2 will be used to develop your restoration goals and tasks. Developing goals and tasks is the first step in creating your plan. Your goal is a statement of the overall action you hope to achieve. Tasks are the major actions that need completing to reach your goal. For example, after getting to know your site and identifying the types of disturbances that have affected the site, you may decide your goal is to increase the area's value to wildlife. Several potential tasks may be appropriate, including protecting the area from physical impact, enhancing existing vegetation, controlling invasive species, and installing habitat features. The actions you choose should be based on your understanding of the physical and biological characteristics of the area, and the types of impacts that have affected the site.

Tasks also serve as milestones to help you keep track of your progress towards the overall goal. For example, your goal may be to restore a native forest community in a stream or wetland buffer area 100 feet long and 50 feet wide. The major tasks associated with this goal may include visiting nearby natural areas to identify appropriate buffer zone communities, shrubs, and trees, developing a planting plan and schedule, removing non-native vegetation, installing native plants, and controlling weeds.

Once your goals and tasks are defined, the next step is to decide upon specific actions and methods for accomplishing them. Specific methods are described in Chapter 4, Developing and Planting the Restoration Design.

Protecting a Wetland

Sometimes the best way to restore a wetland or stream involves actions that do not directly involve the area. Wetland and stream buffers are undeveloped areas of natural vegetation that filter sediments and pollutants in surface water runoff, slow the flow of surface water runoff, provide habitat and connections between habitats for wildlife, and screen wetlands or streams from the noise and activity of adjacent areas. Restoring or enhancing buffer vegetation can make a wetland more attractive to wildlife, and at the same time may provide opportunities to increase plant diversity and enhance aesthetics.

In areas where livestock have unrestricted access to a wetland or stream, fencing the site to exclude livestock may be the best and only action needed. Once livestock are excluded, native vegetation will often recover on its own. Otherwise, planting native trees, shrubs, and herbs will help the area recover. Consider fencing off not only the wetland or stream, but also an adjacent buffer of upland vegetation. The quality and functions of the wetland or stream should determine the buffer width, and your local planning or public works department or the Department of Ecology can advise you on the recommended width for your particular situation.

The type of fencing used may affect wildlife use of the area. Barbed wire fencing is often used since it is relatively inexpensive, requires little maintenance, and effectively excludes livestock while allowing unrestricted access to native wildlife. Woven wire or solid wood fences may impede or prevent access for some species of wildlife. Any type of fence will require a long-term maintenance commitment.

Both the U.S. Soil Conservation Service and the U.S. Fish and Wildlife Service sponsor programs that provide assistance to property owners wanting to install fencing to exclude livestock from wetlands or streams. Phone numbers for western Washington offices for both agencies are provided at the end of this chapter.

Restoring or Enhancing Vegetation

In areas where native vegetation has been degraded or removed, restoring or enhancing buffer zone, streamside, or wetland vegetation can provide many benefits. In cases where adjacent areas or sites elsewhere in the same system provide models of high-quality communities, restoring the vegetation at your site may be a matter of mimicking the model community. To have the greatest chance of success, look for model communities that occupy areas with hydrology, soils, topography, and aspect similar to your restoration area.

In addition to basing your plant species selection on model communities, limit your choices to native species. Ornamental species and varieties are not appropriate for use in native community restoration, as they have the potential to out-compete native vegetation and contaminate native gene pools.

Purple loosestrife, reed canary grass, and several additional non-native species often limit restoration success. In each case, these species are invasive, pernicious weeds that out-compete native vegetation. Weedy plant competition can be a serious problem at restoration sites, so much so that competition from weedy species is second only to misjudging site hydrology as a source of restoration failure (Bill, 1990).

Purple loosestrife should not be used under any circumstances. Despite the fact that water gardening books often suggest using it to add color to the landscape and it is still available from out-of-state mail order nurseries, it is illegal to plant it in Washington State. Purple loosestrife has invaded hundreds of thousand of wetland acres throughout the northern United States, and is being reported with increasing frequency throughout the Puget Lowland. As a result of its invasive growth habit, Washington State has banned its sale or use.

Yellow iris is another non-native species that is often introduced in wetlands and along streams for its showy flowers. As a result of its ability to spread by seed and uprooted rhizomes, yellow iris has become naturalized and is so common that many people think it is native to our area. In some settings it can form large, dense stands. As a result, many biologists consider yellow iris a contaminant in native communities, and inappropriate for use in wetland or riparian restoration projects.

Certain native species also cause problems due to their aggressive growth habits when introduced for restoration or enhancement. Our native common cattail, despite its popular status as the unofficial symbol of wetlands, can quickly grow into a large, dense stand in which few other plants will grow. The preferred habitat of common cattail is at a lake or pond margin, from the water's edge to depths of about 2 feet. If your restoration area doesn't already have cattails, it may be best to leave well enough alone and plant hardstem bulrush instead. Although hardstem bulrush occupies similar habitat to common cattail, it is less aggressive, and still provides food and cover for many species of wildlife. Douglas' spiraea, also called hardhack, is another native species that can cause trouble at restoration sites by prolifically seeding onto areas of bare soil and forming dense thickets.

Species that can cause problems or are otherwise unsuitable for native community restoration include:

- common cattail
- common reed
- creeping buttercup
- Douglas' spiraea
- narrow-leaved cattail
- purple loosestrife
- reed canary grass
- soft rush
- yellow iris
- yellow loosestrife
- all non-native ornamental herbs, shrubs, and trees

Throughout the Puget Lowland many wetlands that were originally shrub or forested swamps have been converted to pastures. These sites sometimes also contain a stream whose buffer vegetation has been removed. If a site's hydrology has not been altered by ditching or draining, these sites often provide a good opportunity for restoration. If the site will continue to be used for pasture, providing an off-channel watering pond, fencing off the stream, and restoring streamside vegetation can provide significant water quality benefits. Information on off-channel pond design and construction is available from the Soil Conservation Service.

Controlling Invasive species

Communities dominated by non-native species are prime candidates for restoration. Weeds such as reed canary grass, blackberries, and purple loosestrife have unfortunately taken over many of our riparian and wetland communities because they are

strong competitors, and humans have altered natural hydrology, vegetation, or soils in ways that favor these weeds. Controlling invading species and eventually replacing them with native communities requires not only persistence, but also identifying and modifying the habitat conditions that favor the weeds. Conditions that favor the growth of weedy species include activities that destroy existing vegetation and create areas of bare soil, widely fluctuating water levels, and the presence of weed seed sources upstream or within the soil seed bank. Once weedy species have become established, it can be very difficult to replace them with native species.

Every effort to control weeds will require a long-term commitment, since all weeds are successful reproducers, and often use more than one method to colonize new areas. Potential weed control techniques include burning, flooding, weed whacking or mowing, herbicides, and immediate revegetation of disturbed sites with native species. Long-term control methods include establishing a canopy of trees to shade out weedy species that require full sun. Each method has its own advantages and disadvantages, and your selection will depend on the species you are attempting to control, the physical and biological conditions at the restoration site, and your long- and short-term goals.

Herbicide use near wetlands and along streams is discouraged due to the potential for contamination. In addition, herbicides must be applied by a state-licensed applicator within a wetland or stream corridor. Help in designing and implementing a weed control plan is available through a variety of sources, including County Extension Agents, the Washington Department of Agriculture, the Washington Department of Ecology, and private consultants.

Enhancing Wildlife Habitat

While restoring native plant communities by itself is a significant form of wildlife habitat enhancement, non-living habitat features such as logs, snags (standing dead trees), and artificial nesting structures can also be installed to enhance wildlife values. If during your site assessment you determine wildlife habitat features such as logs or snags are lacking or exist only in limited numbers or sizes at your site, installing them may increase wildlife use.

Although installing tall, large-diameter snags requires heavy equipment, small snags (less than about ten feet tall and 12 inches diameter at breast height) can often be installed by hand. Snags can be planted like oversized fenceposts, buried about one-third of their length (a 15-foot log would make a 10-foot tall snag when installed). Snags intended for use as perches should have several branches and should be located where a bird's approach is not obstructed by vegetation. Snags on which nest boxes will be mounted must be tall enough and located properly for the birds for which the nest boxes are intended.

Logs and stumps can also be installed to provide cover and perch sites, and have the added benefit of providing sites for the growth of mosses, herbs, shrubs, and trees as the wood slowly decays. Logs that extend from the shore into open water provide perch sites for waterfowl, reptiles, and amphibians, and cover for fish. Logs located in areas of saturated soil or in buffer communities also provide perch sites and cover for a wide variety of wildlife. Logs or stumps located in areas where they could float away should be anchored with cables attached to buried concrete blocks. For a "natural" appearance and to increase habitat diversity, logs should be buried about one-third to one-half their diameter. The bases of stumps should also be buried if feasible.

Ideally, it is best to provide a variety of snags, logs, and stumps in various sizes and states of decay. As a general rule, the greater a snag's or log's length and diameter, the greater its value to wildlife.

If nest boxes and other structures are properly sized, located, and maintained, they can be an effective means of enhancing wildlife habitat. However, In areas where raccoons, domestic cats, or other nest predators are common, the tree or post holding the nest box should be wrapped with sheet metal at least 36 inches long. If nest boxes are not properly constructed, installed, and maintained, they may be a net detriment to the targeted species. Much information regarding nest box design, construction, installation, and maintenance is available from the US Fish and Wildlife Service, the Washington Department of Wildlife, The Audubon Society, and in publications available in bookstores and libraries.

Other factors that will affect whether wildlife use the structures include how well your restoration site meets a target species' other habitat requirements, and whether the habitat feature is in limited supply at the site. If natural sites are already available, or if the habitat at your site is not otherwise suitable for the target species, your efforts may be wasted.

Isolated remnants of habitat within an urban landscape may be of limited use for many wildlife species, as there may simply be no way for animals to reach these areas. Amphibians, small mammals, and regionally rare species with limited distributions or restricted habitats are particularly limited in their dispersal abilities. In areas with artificially fluctuating water tables or poor water quality, wildlife use may be even more limited.

Free-roaming cats and dogs can reduce populations of small mammals and ground-feeding or nesting birds. Deer mice, meadow voles, flying squirrels, and songbirds are common prey items of domestic cats that are allowed to roam. To reduce predation by domestic animals, create dense buffers of native vegetation, and use predator guards when installing nest boxes or other habitat features.

Introducing animals to wetlands or streams to establish or increase populations is not a good idea. In the worst cases, introducing non-native species results in the loss of native species. Bullfrogs, crappie, and largemouth bass all eat juvenile cutthroat trout and other native fish, as well as the tadpoles of our native frogs and larval stages of native salamanders. As a result, populations of the introduced species have reduced or replaced native fish and amphibian populations in wetlands and lakes throughout the Puget Lowland.

Sources for help with restoration design, implementation, and permitting:

U.S. Army Corps of Engineers, Seattle District, Regulatory Branch (206) 764-3495

U.S. Fish and Wildlife Service, Washington State Ecosystems Conservation Program (206) 753-9440

U.S. Environmental Protection Agency, Wetlands Section (206) 553-1226

U.S.D.A. Soil Conservation Service (206) 753-9448

Washington State Department of Fisheries, Habitat Management Division (206) 902-2534

Washington Department of Wildlife, Habitat Management Division (206) 753-3188

Washington State Department of Natural Resources, Aquatic Lands Division (206) 902-1100

Washington State Department of Ecology, Shorelands Division, Wetlands Section (206) 407-7272

Washington State Department of Agriculture, Plant Services Division (509) 757-2106

King County Surface Water Management Division, Basin Planning Program or Ecological Support Unit (206) 296-6519

Local Conservation District Offices:

Clallam County	(206) 457-5091
Clark County	(206) 696-7631
Cowlitz County	(206) 425-1880
Grays Harbor County	(206) 249-5980
Island County	(206) 678-4708
Jefferson County	(206) 385-4105
King County	(206) 226-4867
Kitsap County	(206) 876-7171
Lewis County	(206) 748-0083
Mason County	(206) 427-9670
Pierce County	(206) 536-2945
San Juan County	P.O. Box 38, Friday Harbor, WA 98250 (no telephone)
Skagit County	(206) 428-4313
Snohomish County	(206) 335-5634
Thurston County	(206) 754-3588
Wahkiakum County	(206) 795-8240
Whatcom County	(206) 354-2035

Local Washington State University Cooperative Extension Offices:

Clallam County	(206) 452-7831
Clark County	(206) 696-8411
Cowlitz County	(206) 577-3014
Grays Harbor County	(206) 249-4332
Island County	(206) 679-7327
Jefferson County	(206) 385-9158
King County	(206) 296-3900
Kitsap County	(206) 876-7157
Lewis County	(206) 748-9121 (ext. 121)
Mason County	(206) 427-9670
Pierce County	(206) 591-7180
San Juan County	(206) 378-4414
Skagit County	(206) 336-9322
Snohomish County	(206) 338-2400
Thurston County	(206) 786-5445
Wahkiakum County	(206) 795-3278
Whatcom County	(206) 676-6736

Adopt-A-Stream Foundation (206) 388-3487

Chapter 4
Preparing and Planting Your Design

Once you have decided what you want to do to restore or enhance your wetland or stream, the next steps include preparing a detailed plan, locating materials, preparing the site, and installing the plants and habitat features. The following sections take you through each step, describing key elements that need to be considered. Although you may be anxious to dig in and get your hands dirty, planning your actions first will usually result in a more successful project.

Developing a Restoration Plan

Working your design out on paper will allow you to determine plant spacings and numbers, wildlife habitat feature locations, and to estimate costs. You will need an accurate base map of your site at a scale of 1 inch = 10 feet or less, showing topography at 1-foot contour intervals and the locations of property lines, utility corridors, existing vegetation, view corridors, wildlife use areas, water features, and other details that will affect your design.

After completing your base map, use the information you gathered during site visits to nearby wetlands and the growth habit information provided in Appendix A and other references to develop a plan that shows the plants and habitat features in their desired locations. While deciding which species to use, consider also that only a few specialty nurseries provide native wetland and riparian trees, shrubs, and herbs, and even at these nurseries species and numbers are often limited. Phone calls to potential suppliers at this stage will help to minimize last-minute substitutions during planting. In addition, finding out early that a

particular species you want to use is unavailable may allow you some time to collect seeds or cuttings and grow the plant yourself.

The planting plan you prepare should allow you to determine the numbers of each species you want to use. You will also need to decide on the sizes of the plants you want. Trees and shrubs are often available in sizes ranging from seedlings to plants so large they require heavy equipment to move; herbs may also be available in a range of sizes. Plants are also typically available in containers, balled and burlapped, or bare root, depending on the season. Whatever the case, because wetland and stream restoration by the general public is relatively new, most retail nurseries do not stock a wide variety of suitable native plants.

Recommended plant spacings are given in Appendix A. For many species a range is given, with the shorter distance representing the spacings that will usually achieve relatively dense cover quickly. Wider spacings can be used in areas where solid cover by a single species is not desired. When locating plants, avoid an artificial look by placing plants in a random manner, rather than in straight lines or other geometric patterns such as those seen in many conventional landscape plantings.

The amount of maintenance you plan to provide once your area is planted will also affect your plant size selection. Seedlings will generally require more maintenance than larger plants to minimize competition with other plants until the seedlings grow large enough to successfully compete for water, nutrients, light, and space.

Restoration Scheduling

Plan your restoration effort so that the tasks follow each other in a logical sequence and minimize impacts to existing habitats. For example, to avoid trampling newly-planted areas, place snags and other habitat features before planting the site.

To maximize chances for plant survival, plantings should be installed during the early spring or late fall. Fall is an excellent time since the ground is still warm and fall rains ensure adequate moisture. Many plants may continue to grow roots through the winter if the weather is mild, thus giving them "leg up" on the following growing season. In contrast, trees and shrubs installed in the spring are more likely to require irrigation through the following summer.

Nest boxes should be installed during the summer and fall to be ready for the nesting season the following spring, and to avoid disturbing the current year's nesters. Although snags, logs, and other habitat features can be installed any time of year outside of the breeding season (approximately March 1 to August 1), scheduling work within wetlands or streams during the dry season (generally August and September) will minimize water quality impacts.

Native Plant Sources

Since native wetland and riparian plants are not yet staple items in most retail nurseries, you may have to go to several sources to obtain the plants you need. In addition to purchasing plants from commercial nurseries, other potential sources of plants include salvaging plants that would otherwise be destroyed during logging, home building, or road construction and maintenance, and setting up your own nursery beds to grow the needed plants.

Removing plants from natural wetlands is not appropriate. Nothing is gained if we destroy or damage one wetland to enhance another.

Whatever your plant sources are, be sure the plants have been grown under environmental conditions similar to those at your restoration site, and from seeds or cuttings collected close to the restoration site. Local plants are most likely to be adapted to local growing conditions, and using local plants will help to preserve local races (also called "genotypes"). The forestry industry has long recognized the advantage of using local genotypes, and grows trees for specific areas only from seed collected in those same areas. Although the same principle should be applied to any habitat restoration project, the general unavailability of native wetland plants has sometimes resulted in the importation of plants from nurseries located in the midwestern or eastern United States. Resist the temptation to do this if the species you want are not locally available. Instead, collect seeds or cuttings from local wetlands and grow your own plants.

Hortus Northwest, a Pacific Northwest plant directory that lists native plant nurseries and the plants they sell, is an excellent place to begin your plant search. Copies can be purchased by contacting the publisher in Canby, Oregon, at (503) 266-7968. The Conservation Committee of the Central Puget Sound Chapter of the Washington Native Plant Society also maintains a list of native plant nurseries. A copy of the list can be obtained by writing to the Washington Native Plant Society at PO Box 576, Woodinville, WA 98072-0576.

Be sure to ask the nurseries you contact about the origins of their plants, and whether the plants were collected from the wild or nursery-grown. Plants with local origins are preferable to those

from outside the Puget Lowland, and nursery-grown plants are mandatory because collection from the wild damages our native wetlands.

A relatively inexpensive and particularly satisfying method of obtaining plants is to salvage plants that would otherwise be destroyed during land development. Salvaging requires contacting the landowner to receive permission to collect the plants, and permits may be required from Federal, State, or local governments. Salvaging is best done during the late fall, winter, and early spring, when plants are dormant. Once growth begins in the spring, transplant success diminishes rapidly. Unless the salvage occurs when your site is ready for planting, the plants will need to be stored in a holding area until the site is ready. A simple and inexpensive method for holding dormant plants is to heel them into moist soil or sawdust in a shady area. Red alder, Oregon ash, and all of our native conifers transplant well when dormant, as do many shrubs and herbs, including salmonberry, red elderberry, vine maple, cascara, Indian plum, sword fern, and lady fern.

Propagating and growing your own plants can be a rewarding experience and in some cases may be the only way to get the species and numbers of plants you need for your project. Basic plant propagation information is available in *The Sunset New Western Garden Book* (Editors of Sunset Books, 1979), which also contains descriptions and growth habit information for several native species. *Gardening with Native Plants of the Pacific Northwest* (Kruckeberg, 1982) provides cultural and growth habit information for many of the species mentioned in this guide. Additional publications containing wetland and riparian plant propagation information are listed in the "References and Further Reading" section of this guide.

While species used for riparian and buffer plantings can be propagated and grown under normal garden conditions or with traditional container methods, many wetland plants require saturated soils. An easy way to maintain saturated soil is to build a wooden frame (any length, but not more than four feet wide; see Figure 4), on level ground that has been cleared of rocks and sticks, line the frame with 10 mil or thicker black plastic sheeting (or as thin as four mil if only temporary), fill the frame with potting soil or individual containers, and flood the bed. Many commercial potting soils are essentially sterile, so you will need to add fertilizer to your wet bed or to the individual containers. Compost or timed-release fertilizer can be added to the soil when you prepare the bed, or add liquid fertilizer when you water. Follow the manufacturer's directions to avoid over-fertilizing.

Site Preparation

Preparing your site and assembling the tools and materials you will need before starting work will help your project proceed smoothly and efficiently. Site preparation may include identifying the limits of the work area, identifying areas or individual plants within the work area that are to remain undisturbed, identifying specific locations for plantings (these three items are requirements if anyone other than yourself will be doing the work), clearing unwanted vegetation, providing an adequate water supply, and preparing holding areas for plants.

The limits of the work area and piants or areas that are to remain undisturbed can be marked with brightly-colored surveyor's flagging. Be sure to tell workers what the flagging means so it isn't ignored or mistaken for something else. Individual planting locations can be identified with wooden or wire stakes. Surveyor's flagging and wooden or wire stakes are available from

local building supply stores or by mail order from the suppliers listed at the end of this chapter.

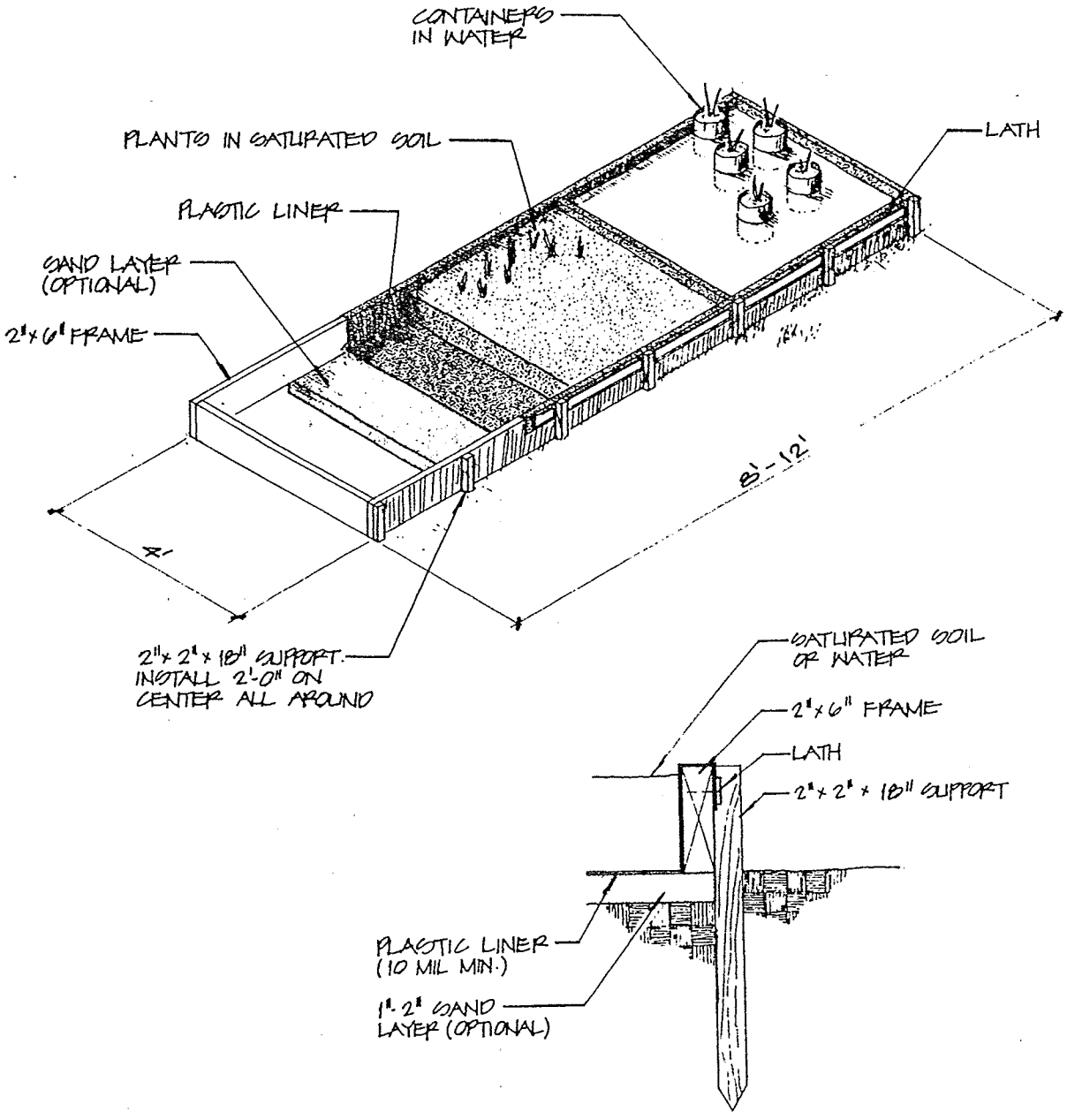


Figure 4: For propagating vegetation requiring saturated soils, the utilization of a wet bed is recommended.

To be effective, clearing invasive species such as blackberries or reed canary grass means digging out the roots, for unless the roots are removed, most weedy plants will grow back in a short time.

The plants you install may need irrigation until they establish themselves, particularly if you are restoring buffer vegetation. This usually means providing water to the site at least through the first summer after the plants are installed, especially if the plants are installed during the late spring or if the summer following planting is unusually dry. Any plantings will require maintenance until well established to minimize competition from competing vegetation.

Storage area requirements for plants that need to be held for a time before planting include a water supply and irrigation system, and shade for species that do not tolerate full sun. Species that require saturated soil can be held in a temporary wet bed made by draping plastic sheeting over a frame of railroad ties or other timbers. A child's plastic wading pool can also be used. Keep the roots of bare root plants covered and moist until needed by heeling them into sawdust or soil.

The following checklist provides a list of tools and supplies that may be needed to complete your work:

For planting:

- ☐ Shovel
- ☐ Machete
- ☐ Rake
- ☐ Weed eater
- ☐ Hand trowel
- ☐ Leather gloves
- ☐ Hose and nozzle
- ☐ Wheelbarrow
- ☐ Pruners
- ☐ Loppers
- ☐ Pruning saw

For fencing:

- ☐ Post hole digger
- ☐ Come-along
- ☐ Fence posts and fencing material
- ☐ Hammer and fence staples, nails, or other fasteners
- ☐ Machete or weed eater
- ☐ Leather gloves

For installing nest boxes:

- ☐ Galvanized self-driving #2 screws in assorted lengths
- ☐ #2 Phillips-head screwdriver
- ☐ Cordless drill with #2 Phillips-head screwdriver bit
- ☐ Ladder

Providing for Human Access

Repeatedly traveling the same route along streambanks and through wetlands can do considerable damage to plants and soil. Trails destroy vegetation, compact soil, alter water flows, and once established may invite other people to use the area. Plan your project in a way that avoids nesting or den areas, and minimizes the number of trips into areas of saturated or erodible soils. Damage to vegetation and soil may be minimized by creating a temporary walkway by laying boards across a wetland surface. Permanent boardwalks for public access should be professionally designed and installed.

Planting

Methods for planting native species in the landscape are similar to those used in planting residential landscapes. Basic principles include ensuring plants are planted at the proper depths, watering in the backfilled soil to eliminate air pockets, staking large trees until they are established, and controlling competing vegetation (Figures 5 through 8). If you attempt to establish native trees and shrubs in an area of dense grass, strip and maintain a grass-free area around each plant until it is well established.

Mulches of weed-free organic materials such as compost, sterile straw, or burlap sacks (available from coffee roasting houses) help retain soil moisture, protect against erosion, keep weeds down, and add organic matter to the soil as they break down. However, mulches should not be used in areas where they could wash into streams or wetlands and contribute excess nutrients.

Soils compacted by human or livestock use may require loosening to encourage plant growth. Tilling or spading the compacted layer and incorporating compost will increase the soil's water-

holding capacity, improve tilth, and provide nutrients Artificial fertilizers are not recommended for plantings along streams, or in wetlands or buffers. Instead, planting red alder, a plant that converts atmospheric nitrogen into a form it can use for growth, is a good tactic in areas with nitrogen-deficient soils.

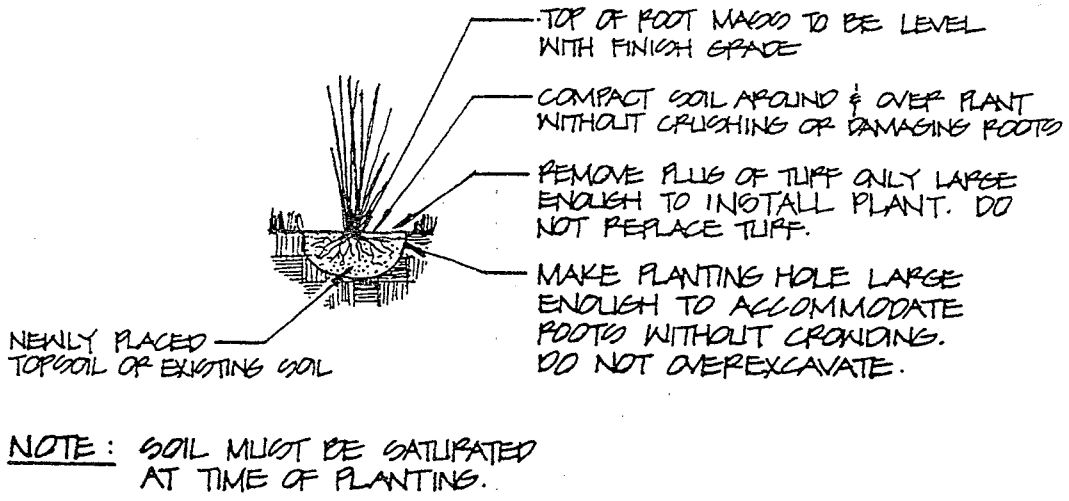


Figure 5: Herbaceous Planting Detail

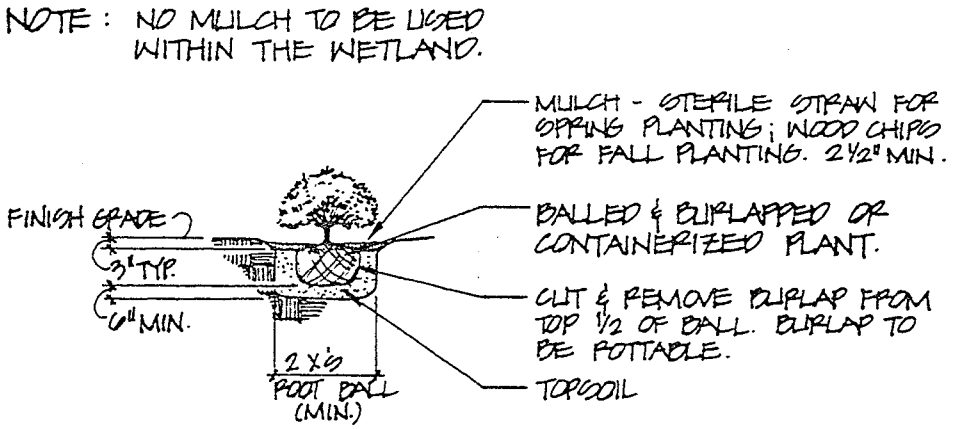


Figure 6: Shrub Planting Detail

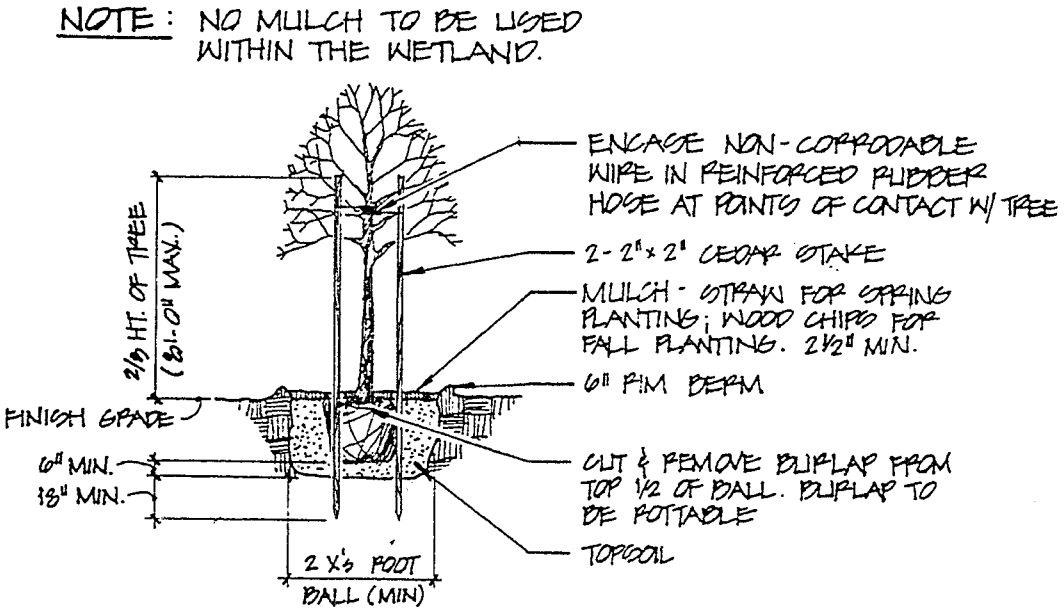


Figure 7: Deciduous Tree Planting Detail

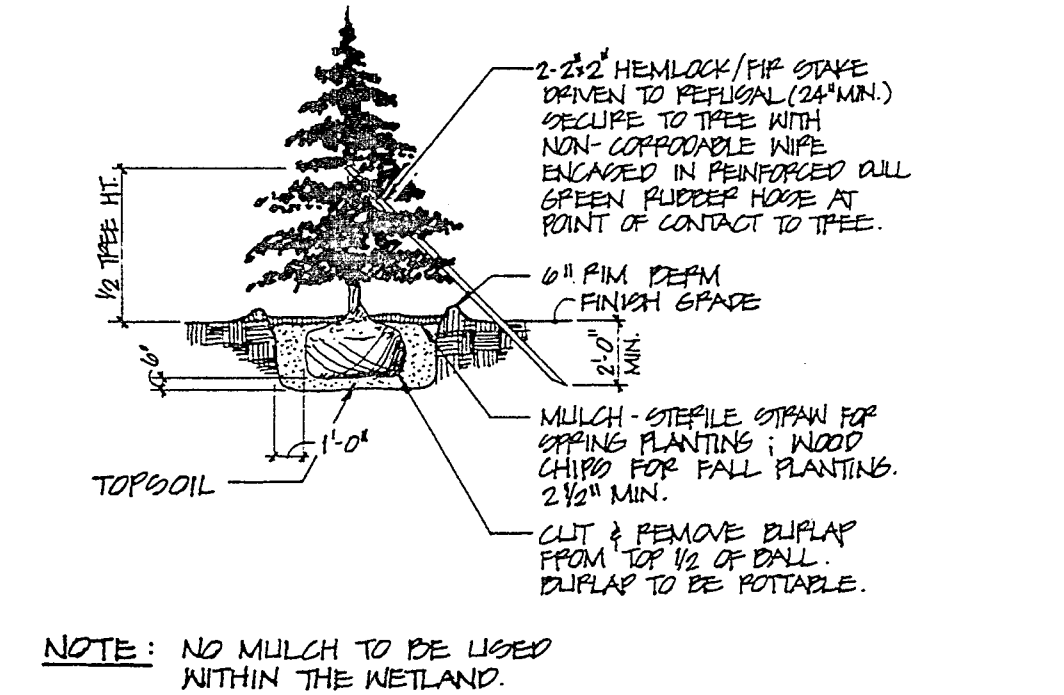


Figure 8: Coniferous Tree Planting Detail

Tool Suppliers:

Most of the tools and supplies commonly used in restoration projects are available from local discount hardware suppliers. Specialized tools or supplies may be available from:

Forestry Suppliers, Inc.
P. O. Box 8397
Jackson, MS 39284-8397

(800) 647-5368

Ben Meadows Company
3589 Broad Street
Atlanta. Georgia 30341

(800) 241-6401

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Appendix A:
Native Plant Growth Requirements and Landscape Specifications

LEGEND

Species	Scientific name according to Hitchcock and Cronquist (1976)
Common Name	According to Hitchcock and Cronquist (1976).
USFWS Rating	From the National List of Plant Species that occur in the National Summary (Reed, 1988)
OBL	Obligate wetland plants that almost always occur in wetlands (estimated probability 99%) under natural conditions.
FACW	Facultative wetland plants that usually occur in wetland (estimated probability 67-99%) but are occasionally found non-wetland areas.
FAC	Facultative plants area that are equally likely to occur in wetlands (estimated probability 34-66%) or non-wetland areas.
FACU	Facultative upland plants that usually occur in non-wetland areas but occasionally occur in wetlands (estimated probability 1-33%).
NR	Not Rated - No indicator status assigned.
Community	The biological community where the species is likely to occur.

Soil — The soil type that species is usually found in. Mineral (m) or Organic (o).

Water — The typical water regime requirements of the species:

PF	permanently flooded
SF	seasonally flooded
PS	permanently saturated
SS	seasonally saturated
SM	seasonally moist

Light — The typical light requirements of the species

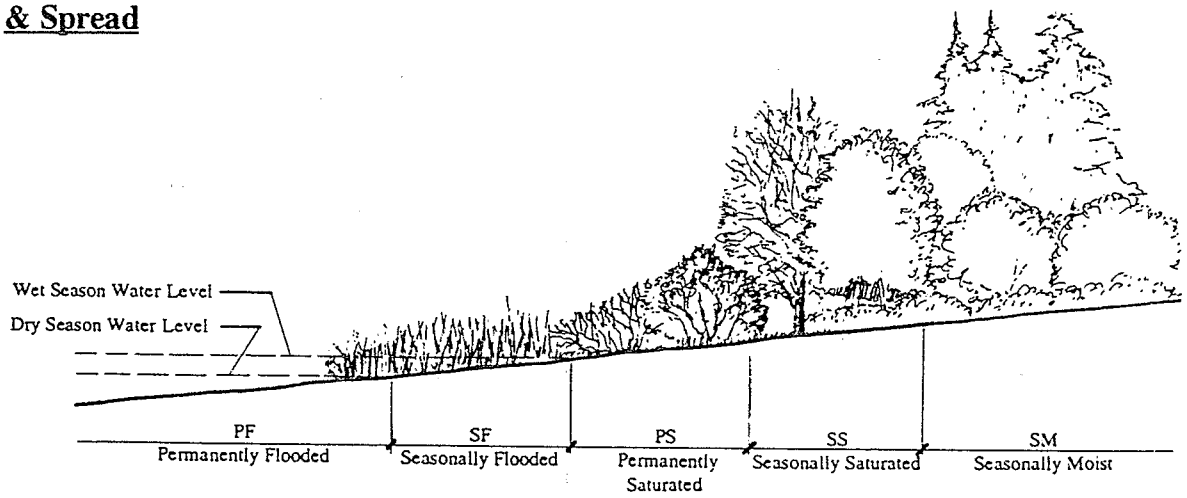
fs	full sun
s/s	partial sun/shade
s	full shade

Condition

Available Size — The typical size available from nurseries.

Spacing — Recommended spacing for installation.

Mature Ht. & Spread — Typical height and canopy diameter of the mature plant.



Appendix A: Native Plant Growth Requirements and La

SPECIES	COMMON NAME	USFWS RATING	COMMUNITY
TREES			
Abies grandis	grand fir	NR	forested buffer
Acer macrophyllum	bigleaf maple	FACU	forested buffer
Alnus rubra	red alder	FAC	forested wetland, streambank, forested buffer
Arbutus menziesii	madrona	NR	forested buffer
Crataegus douglasii	black hawthorn	FAC	shrub wetland, streambank
Fraxinus latifolia	Oregon ash	FACW	forested wetland, streambank, forested buffer
Pinus monticola	western white pine	FACU	forested buffer
Populus tremuloides	quaking aspen	FAC	forested wetland
Populus trichocarpa	black cottonwood	FAC	forested wetland, streambank, forested buffer
Prunus emarginata	bitter cherry	NR	forested buffer
Pseudotsuga menziesii	Douglas fir	NR	forested buffer
Pyrus fusca	western crabapple	FAC	shrub wetland, streambank
Rhamnus purshiana	cascara	FAC ?	forested buffer shrub buffer

pe Specifications.

WATER	LIGHT	CONDITION	AVAILABLE SIZE	SPACING	MATURE HT. & SPREAD
SM	fs,s/s, s	bare root, b & b	1-6'	12'+	125' ht. x 30' dia.
SM	fs, s/s	container	1-6'	12'+	80' ht. x 40' dia.
SF, PS SS, SM	fs, s/s	bare root, container	2-8'	6'+	40'-60' ht. x 25' dia.
SM	fs, s/s			12'+	80' ht. x 25' dia.
PS, SS	fs, s/s	container	1-4'	12'+	20' ht. x 15' dia.
SF, PS, SS	fs, s/s	bare root, container	3-8'	6'+	80' ht. x 40' dia.
SM	fs, s/s	bare root, b & b	1-10'	12'+	165' ht. x 40' dia.
SF, PS, SS	fs, s/s	container, b & b	1-10'	6'+	50' ht. x 30' dia.
SF, SS, SM	fs	bare root, container	3-8'	6'+	60'-80' ht. x 30' dia.
SM	fs, s/s	container	1-6'	12'+	50' ht. x 30' dia.
SM	fs	container, b & b	1-8"	6'_	80'-100' ht. x 30' dia.
PS,SS	fs,s/s	bare root, container	1-4'	12'+	30' ht. x 20' dia.
SM	fs	container, bare root	1-6'	12'+	30' ht. x 20' dia.

PF	permanently flooded	fs	full sun
SF	seasonally flooded	s/s	partial sun/shade
PS	seasonally saturated	s	full shade
SM	seasonally moist		

Appendix A: Native Plant Growth Requirements and La

SPECIES	COMMON NAME	USFWS RATING	COMMUNITY
TREES			
Salix lasiandra	Pacific willow	FACW	forested wetland, shrub wetland, streambank
Salix scouleriana	Scouler willow	FAC	forested buffer
Salix sitchensis	Sitka willow	FAC	forested wetland, shrub wetland, streambank
Thuja plicata	western red cedar	FAC	forested wetland, streambank, forested buffer
Tsuga heterophylla	western hemlock	FACU	forested buffer, streambank
SHRUBS			
Acer circinatum	vine maple	FACU	forested buffer, streambank
Cornus stolonifera	red-osier dogwood	FACW	forested wetland, shrub wetland, streambank
Gaultheria shallon	salal	NR	forested buffer
Holodiscus discolor	ocean spray	NR	shrub buffer
Lonicera involucrata	black twinberry	FAC	shrub wetland, streambank
Oemleria cerasiformis	Indian plum	NR	forested buffer, shrub buffer
Physocarpus capitatus	Pacific ninebark	FAC	shrub wetland, streambank

pe Specifications

WATER	LIGHT	CONDITION	AVAILABLE SIZE	SPACING	MATURE HT. & SPREAD
SF, PS, SS	fs	bare root, rooted or unrooted cuttings,	1-6'	2'+ for cuttings, 6'+ for container	60' ht. x 30' dia.
SM	fs	container	1-6'	12'+	40' ht. x 20' dia.
SF, PS, SS	fs	bare root, rooted or unrooted cuttings, container	1-8'	2'+ for cuttings, 6'+ for container	30' ht. x 30' dia.
SF, PS, SS, SM	s/s, s	bare root, container, b&b	1-8'	6'+	60'-130' ht. x 40' dia.
SS, SM	fs, s/s, s	bare root, container, b&b	1-8"	6'+	40'-100' ht. x 40' dia.
SM	s/s, s	container, b&b	1-6'	6+	20' ht. x 20' dia.
SF, PS, SS, SM	fs, s/s	bare root, unrooted cuttings, container	1-6'	2'+ for cuttings, 4'+ for container	10' ht. x 10' dia.
SM	s/s, s	container	4-12"	18"	2' ht. x 3' dia.
SM	fs, s/s	container	1-4'	6'+	15' ht. x 40' dia.
PS, SS	fs, s/s	container	1-4'	12'+	8' ht. x 8' dia.
SM	fs, s/s, s	container	1-3'	6'+	10' ht. x 10' dia.
PS, SS	fs, s/s	bare root, container	1-3'	3'+	6'-12' ht. x 6' dia.

PF	permanently flooded	fs	full sun
SF	seasonally flooded	s/s	partial sun/shade
PS	seasonally saturated	s	full shade
SM	seasonally moist		

Appendix A: Native Plant Growth Requirements and La

SPECIES	COMMON NAME	USFWS RATING	COMMUNITY
SHRUBS			
Rhododendron macrophyllum	Pacific rhododendron	NR	forested buffer
Ribes bracteosum	stink currant	FAC	streambank
Ribes sanguineum	red-flowering currant	NR	shrub buffer
Rosa nutkana	Nootka rose	NR	shrub buffer
Rubus parviflorus	thimbleberry	FACU	shrub buffer
Rubus spectabilis	salmonberry	FAC	forested wetland, shrub wetland, forested buffer shrub buffer
Sambucus racemosa	red elderberry	FACU	forest buffer, shrub buffer
Symphoricarpos albus	snowberry	FACU	shrub buffer, forested buffer
Vaccinium ovatum	evergreen huckleberry	NR	forested buffer
HERBS			
Athyrium filix-femina	lady fern	FAC	forested wetland, streambank,
Carex obnupta	slough sedge	OBL	forested, shrub, emergent wetland
Carex stipata	sawbeak sedge	FACW	emergent wetland
Dicentra formosa	bleeding heart	NR	forested buffer
Elocharis palustris	common spikerush	OBL	emergent wetland

ɔe Specifications

WATER	LIGHT	CONDITION	AVAILABLE SIZE	SPACING	MATURE HT. & SPREAD
SM	s/s, s	container, b&b	1-4'	12'+	12' ht. x 12' dia.
SS	fs, s/s	container	1-4'	6'+	
SM	fs, s/s	bare root, container	1-3'	3'+	5' ht. x 4' dia.
SM	fs	bare root, container	1-3'	3'+	5'-10' ht. x 5'-8' dia.
SM	fs, s/s	bare root, container	1-3'	3'+	4' ht. x 4' dia.
PS, SS, SM	fs, s/s, s	bare root, container	1-3'	4'+	6'-8' ht. x 6' dia.
SM	fs, s/s	bare root, container	1-4'	4'+	10'-20' ht. x 10'-15' dia.
SM	fs, s/s	container	1-3'	4'+	4' ht. x 4' dia.
SM	s/s	container	1-3'	3'+	4'-6' ht. x 4' dia.
SF, PS, SS	s/s, s	container		12-18"	2'
SF, PS	s/s, s	sprigs container		12-18"	2'
SF, PS	fs, s/s	sprigs		12-18"	2'
SM	s/s, s			12-18"	1'
PF, SF, PS	fs, s/s	sprigs		12-18"	1'

PF	permanently flooded	fs	full sun
SF	seasonally flooded	s/s	partial sun/shade
PS	seasonally saturated	s	full shade
SM	seasonally moist		

Appendix A: Native Plant Growth Requirements and La

SPECIES	COMMON NAME	USFWS RATING	COMMUNITY	
HERBS				
Lysichitum americanum	skunk cabbage	OBL	forested wetland	
Nuphar polysepalum	yellow pond lily	OBL	aquatic bed wetland	
Oenanthe sarmentosa	water parsley	OBL	forested, shrub, emergent wetland	
Polystichum munitum	western sword fern	NR	forested buffer	
Potamogeton species	pondweed	OBL	aquatic bed wetland	
Sagittaria latifolia	wapato, arrowhead	OBL	emergent wetland	
Scirpus acutus	hardstem bulrush	OBL	emergent wetland	
Scirpus microcarpus	small-fruited bulrush	OBL	emergent wetland	
Sparganium emersum	simple-stem burreed	OBL	emergent wetland	
Tiarella trifoliata	foamflower	NR	forested buffer	m
Tolmia menziesii	piggyback plant	FAC	forested wetland, forested buffer	

pe Specifications

WATER	LIGHT	CONDITION	AVAILABLE SIZE	SPACING	MATURE HT.
PF,PS	s/s, s	container, bare root		24"+	3'
PF	fs	bare root		48"	floating leaves
PF, SF, PS	s/s, s	bare root, container		12-18"	1'
SM	s/s, s	bare root, container		36-48"	3'
PF	fs	bare root		48"	floating leaves
PF	s/s, s	tuber		12-24"	3'
PF, SF	fs, s/s	bare root		18-36"	6'
SF, PS	fs, s/s	sprigs, container		12-18"	2'
PF	fs, s/s	rhizome, container		12-18"	2'
SM	s	container		18"	1'
SS, SM	s/s, s	container		18"	6"

PF	permanently flooded	fs	full sun
SF	seasonally flooded	s/s	partial sun/shade
PS	seasonally saturated	s	full shade
SM	seasonally moist		

Appendix B:
Typical Puget Lowland Plant Communities

The native species listed below were chosen because they are generally available in nurseries and, except as noted for individual species, grow throughout the Puget Lowland. Under each plant community, species that typically provide the greatest amount of cover and therefore dominate a community's appearance are listed under the heading "Dominant Species". Additional species that generally grow as scattered individuals within the community are listed under the heading "Associated Species". Since these lists are incomplete and only general guides covering the entire Puget Lowland, visits to local streams and wetlands will help you fine-tune your plant list to reflect local plant communities.

STREAMSIDE COMMUNITIES

Streamside Shrub Thicket

Dominant Species: salmonberry, red osier dogwood, Sitka willow, Pacific willow

Associated Species: red elderberry, Pacific ninebark, stink currant, western crabapple, black twinberry

Streamside Forest

Dominant Species: western red cedar, western hemlock, red alder, Oregon ash (distribution limited to southern portion of Puget Lowland only), black cottonwood, salmonberry, red osier dogwood, vine maple, piggyback plant, false lily of the valley

Associated Species: Pacific willow, red elderberry, stink currant, Indian plum, lady fern, sword fern

WETLAND COMMUNITIES

Aquatic Bed (permanently flooded shallow water zones of ponds and lakes)

Dominant Species: yellow pond lily, pondweed

Associated Species: none

Emergent Wetland (seasonally or permanently saturated or flooded herb-dominated communities)

Dominant Species: hardstem bulrush, small-fruited bulrush, spikerush

Associated Species: sawbeak sedge, simplestem burreed

Shrub Wetland

Dominant Species: Sitka willow, Pacific willow, red osier dogwood, salmonberry

Associated Species: black twinberry, western crabapple

Forested Wetland

Dominant Species: western red cedar, western hemlock, red alder, Oregon ash, salmonberry, red osier dogwood, slough sedge, water parsley, piggyback plant, skunk cabbage

Associated Species: Sitka spruce, lady fern

BUFFER COMMUNITIES

Forest

Dominant Species: Douglas fir, western red cedar, western hemlock, red alder, bigleaf maple, bitter cherry, salmonberry, salal, sword fern

Associated Species: western white pine, grand fir, Scouler willow, madrona, cascara, ocean spray, snowberry, red elderberry, Indian plum, evergreen huckleberry, rhododendron, bleeding heart

Shrub

Dominant Species: Nootka rose, thimbleberry

Associated Species: Indian plum, cascara, red-flowering currant, red elderberry

Appendix C:
Restoration Checklist

The following checklist provides a guide to restoration planning and implementation, and is organized in the same manner as the text.

1. Wetland Functions

A. Identify the functions the wetland that will be restored or enhanced provides:

- ☐ education and research
- ☐ erosion control
- ☐ fish habitat
- ☐ flood attenuation
- ☐ historic, cultural, and archaeological resources
- ☐ open space and aesthetic values
- ☐ recreation
- ☐ sediment control and water quality enhancement
- ☐ threatened, rare, and endangered species habitat
- ☐ wildlife habitat

B. Describe how your restoration plan will affect each of the wetland's functions. If your plan does not result in a net increase in functional value, consider changing or abandoning the plan.

2. Restoration Site Analysis

A. Gather baseline information concerning:

- ☐ soils
- ☐ hydrology (surface water inlets and outlets, seasonal fluctuations, high and low water levels)
- ☐ water quality
- ☐ topography and aspect
- ☐ existing vegetation
- ☐ aesthetic quality
- ☐ utility right-of-ways and other easements
- ☐ property lines and ownerships
- ☐ view corridors
- ☐ public and private intentions for future use of site

B. Summarize the information in a way that provides an understanding of existing conditions, describes the potential for restoration, and identifies limiting factors or constraints to restoring or enhancing the wetland.

C. Contact local, State, and Federal government agencies to determine whether permits are required for your project.

3. Developing and Implementing a Planting Plan

A. Identify potential actions:

- ☐ protect wetland by enhancing or restoring buffer vegetation, or installing fencing
- ☐ restore or enhance native wetland or stream vegetation
- ☐ control invasive species

- ☐ enhance wildlife habitat

B. Determine whether natural colonization can occur at the restoration site.

- ☐ Is there an acceptable seed bank in the existing soil on site?

- ☐ Are plant sources available in nearby or adjacent wetlands that may be transported to the site by wind, waves, currents, or animals?

C. Will planting be required to meet your restoration objectives? If so:

- ☐ Identify potential native plant sources and determine whether enough seeds, transplants, and other propagules of appropriate size will be available when needed.

- ☐ Will selected species be compatible with existing nativeplant communities at your site?

- ☐ Will selected species be compatible with planned landscape features, aesthetics, and other constraints?

- ☐ Will invasive non-native species compete with the desired plant species?

- ☐ Determine plant costs and assure adequate funds are available to purchase plants and materials

- ☐ Identify and prepare stockpile areas if plants will need to be stored before planting

D. Will the desired plant species adapt to site conditions and the selected location? Consider the following conditions:

- ☐ soil type and depth
- ☐ shade or sun exposure
- ☐ water depth
- ☐ flood frequency
- ☐ water level fluctuation

E. Will wind or wave action uproot plantings?

F. Prepare the work site:

- ☐ dentify limits of work
- ☐ identify areas or plants that are to remain
- ☐ identify locations for plantings

G. Install plants and habitat features.

H. Is a temporary irrigation system or other maintenance needed to ensure survival of planted vegetation through the dry season?

I. Are vegetated buffers or fences needed to protect the restoration site from human disturbance, sedimentation, pollution, or grazing disturbance? Contact Federal, State, and local conservation agencies to determine whether assistance is available for installing fencing.

Appendix D:
Scientific Names of Plants Mentioned in the Text

bigleaf maple (*Acer macrophyllum*)
bitter cherry (*Prunus emarginata*)
black cottonwood (*Populus trichocarpa*)
black hawthorn (*Crataegus douglasii*)
black twinberry (*Lonicera involucrata*)
bleeding heart (*Dicentra formosa*)
cascara (*Rhamnus purshiana*)
common cattail (*Typha latifolia*)
common reed (*Phragmites communis*)
creeping buttercup (*Ranunculus repens*)
Douglas fir (*Pseudotsuga menziesii*)
evergreen huckleberry (*Vaccinium ovatum*)
false lily of the valley (*Maianthemum dilatatum*)
grand fir (*Abies grandis*)
hardhack (*Spiraea douglasii*)
hardstem bulrush (*Scirpus acutus*)
Indian plum (*Oemleria cerasiformis*)
lady fern (*Athyrium felix-femina*)
madrona (*Arbutus menziesii*)
narrow-leaved cattail (*Typha angustifolia*)
Nootka rose (*Rosa nutkana*)
ocean spray (*Holodiscus discolor*)
Oregon ash (*Fraxinus latifolia*)
Pacific ninebark (*Physocarpus capitatus*)
Pacific willow (*Salix lasiandra*)
piggyback plant (*Tolmiea menziesii*)
pondweed (*Potamogeton* spp.)
purple loosestrife (*Lythrum salicaria*)
red alder (*Alnus rubra*)
red elderberry (*Sambucus racemosa*)

red osier dogwood (*Cornus stolonifera*)
red-flowering currant (*Ribes sanguineum*)
reed canary grass (*Phalaris arundinacea*)
rhododendron (*Rhododendron macrophyllum*)
salal (*Gaultheria shallon*)
salmonberry (*Rubus spectabilis*)
sawbeak sedge (*Carex stipata*)
Scouler willow (*Salix scouleriana*)
simplestem burreed (*Sparganium emersum*)
Sitka spruce (*Picea sitchensis*)
Sitka willow (*Salix sitchensis*)
skunk cabbage (*Lysichitum americanum*)
slough sedge (*Carex obnupta*)
small-fruited bulrush (*Scirpus microcarpus*)
snowberry (*Symphoricarpos albus*)
soft rush (*Juncus effusus*)
spikerush (*Eleocharis palustris*)
stink currant (*Ribes lacustre*)
sword fern (*Polystichum munitim*)
thimbleberry (*Rubus parviflorus*)
vine maple (*Acer circinatum*)
water parsley (*Oenanthe sarmentosa*)
western crabapple (*Pyrus fusca*)
western hemlock (*Tsuga heterophylla*)
western red cedar (*Thuja plicata*)
western white pine (*Pinus monticola*)
yellow iris (*Iris pseudacorus*)
yellow loosestrife (*Lysimachia terrestris*)
yellow pond lily (*Nuphar polysepalum*)