Guide for Wetland Mitigation Project Monitoring

Monitoring Guide – Operational Draft

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16. ABSTRACT

This document was prepared to guide the monitoring of wetland mitigation projects developed by the Washington State Department of Transportation. Monitoring is necessary to assess the development of wetland characteristics and functions and to determine whether the objectives of the mitigation project are met or, if not, how they might be met with remedial action.

The guide is organized in two parts. Part 1 identifies two types of monitoring that might be pursued: (1) Assessing the Achievement of Functional Objectives, and (2) Diagnostic Procedures. The first type is intended to evaluate a project's success, while the second type represents activities that might be carried out in planning a project or analyzing problems that occur in a completed project. Part 1 directs the user of the guide to a set of tasks in Part 2 tailored to the specific functional objectives being evaluated or problems being diagnosed.

These monitoring tasks are arranged in five groups: (1) Mapping and Hydrologic Tasks, (2) Water Quality Tasks, (3) Soil and Sediment Tasks, (4) Primary Producer Monitoring Tasks, and (5) Consumer Monitoring Tasks. Each task description provides background material and lists all equipment, supplies, and procedural steps needed to obtain and interpret data.

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GUIDE FOR WETLAND MITIGATION PROJECT MONITORING

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This Monitoring Guide has been printed as an operational draft for review and field testing. If you have any comments or recommendations, please send them to Jim Schafer at the following address:

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DISCLAIMER

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Washington State Transportation Commission, Department of Transportation, or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

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PART I

ORGANIZATION AND USE OF THE GUIDE

GENERAL ORGANIZATION

This document was prepared to guide the monitoring of wetland mitigation projects developed by the Washington State Department of Transportation (WSDOT).

It was predicated on several general assumptions:

1. Mitigation projects subject to monitoring are developed to achieve specific objectives established as a part of the project planning process.
2. Project designs are based on the designated objectives and on generally accepted principles and methods of wetland creation or rehabilitation.
3. The achievement of the designated objectives is measurable by appropriate methods.

The document is intended specifically to guide the development of monitoring programs for evaluating mitigation project success. It also offers some advice relative to monitoring for diagnostic purposes, either in planning projects or analyzing the causes of problems in mitigation site development. However, it is only one of several tools necessary for project planning and design and problem diagnosis.

The guide in its present form heavily emphasizes monitoring procedures that are most suitable for freshwater wetlands. This emphasis reflects the concentration of WSDOT mitigation work, the majority of which involves freshwater palustrine wetland creation.

The guide is organized in two parts. Part 1 provides general guidance on using the manual as appropriate for the wetland mitigation project circumstances. Depending on these circumstances, Part 1 directs the user to specific monitoring tasks in Part 2.

DEFINITIONS

The following definitions of terms apply in this guide:

Wetland monitoring	The periodic evaluation of a wetland mitigation site to assess the progress toward achieving established objectives relative to the development of wetland characteristics and functions. These objectives may include the successful development of hydrologic characteristics of a wetland, hydric soils, and wetland vegetation and such functions as the provision of food chain, support ecosystem diversity, and wildlife habitat. Normally, five years are necessary to ascertain whether progress is being made toward achieving the objective, or whether remedial action is required.
Mitigation	Wetland avoidance or improvement actions taken expressly for the purpose of compensating for unavoidable losses resulting from a highway project.

Other pertinent definitions appear in the "Instructional Letter, Wetlands" (Washington State Department of Transportation, 1989), which currently serves WSDOT as a wetland mitigation project planning and design guide. It is included as Appendix A of this guide. Another document that may be consulted for additional background on monitoring created wetlands is the report on guidelines for this activity by Brooks and Hughes (1988).

ORGANIZATION OF PART 1

Part 1 of the guide identifies two types of monitoring that may be pursued in analyzing the development of a wetland mitigation project: (1) Assessing the Achievement of Mitigation Objectives, and (2) Diagnostic Procedures. The first category recognizes that mitigation sites are intended to provide wetland characteristics and designated wetland functions, and that documenting the development of these characteristics and functions is the best way to assess a project's success. Diagnostic objectives represent monitoring activities that might be carried out in planning a mitigation project or analyzing problems that develop in a completed project. Therefore, diagnostic monitoring is an internal tool to assist project designers, and monitoring of mitigation functional objectives is a vehicle to satisfy external requirements to demonstrate project effectiveness. Both types of monitoring are discussed further in Part 1.

ORGANIZATION OF PART 2

The monitoring tasks in Part 2 of the guide are grouped under the following categories: (1) Mapping and Hydrologic Tasks, (2) Water Quality Tasks, (3) Soil and Sediment Tasks, (4) Primary Producer Monitoring Tasks, and (5) Consumer Monitoring Tasks. This portion of the guide is arranged so that new tasks can be conveniently added in future editions, and so that modifications can be made to existing task descriptions without disrupting the overall organization.

Each procedure in Part 2 provides all the information needed by a qualified wetland scientist to carry out the monitoring task and evaluate the results. The coverage includes, as appropriate, the background and purpose of the task, equipment and supplies needed to carry out the task, the design of a sampling or observational program, the process of sampling or observing, analysis of samples, calculations, and interpretation of data to make an evaluation. The task segments are arranged in a stepwise fashion for convenient use by the analyst.

USE OF THE GUIDE

To use the guide the analyst should refer to the appropriate section of Part 1, either Assessing the Achievement of Mitigation Objectives or Diagnostic Procedures. With the assistance of one of these sections, the user should identify the objectives or problems that will be evaluated and the associated monitoring tasks. The user can then proceed to Part 2 to perform these tasks.

Reporting of results is covered by the "Instructional Letter, Wetlands" (see Appendix A). While a standard form for computerized databases would be desirable, development of such a form is beyond the scope of the present work. Interagency efforts to standardize created wetland data filing and reporting have not advanced sufficiently to provide a form. When a standard form becomes available, this guide will be adapted to incorporate it.

ASSESSING THE ACHIEVEMENT OF MITIGATION OBJECTIVES

WSDOT wetland mitigation projects are customarily designed to provide wetland characteristics and one or more of the recognized wetland functions (Adamus et al. 1987). During project planning, levels at which characteristics and designated functions are to be achieved and time periods for achieving them may be specified. These decisions then provide objectives to be pursued in designing, constructing, and maintaining the mitigation project. For illustration, Appendix B contains a typical WSDOT mitigation plan.

The purpose of this section is to provide guidance on the design of monitoring programs to meet regulatory requirements for assessing wetland mitigation project success in achieving established objectives. The section first discusses the objectives that are typical of WSDOT mitigation projects. It then proceeds to outline basic and detailed programs encompassing typical combinations of objectives and associated monitoring tasks. The next topic is a discussion of criteria to determine, after monitoring data are available, whether mitigation objectives are met. Finally, the section provides a suggested schedule of activities to accomplish monitoring at a number of mitigation sites in an efficient manner.

WSDOT MITIGATION PROJECT OBJECTIVES

The principal emphasis in WSDOT wetland mitigation project design and implementation is to develop a site that operates as a wetland from the standpoint of hydrologic, soils, and plant community considerations and provides corresponding habitat values. Therefore, developing recognized wetland characteristics is always an objective of WSDOT projects. In this guide the characteristics of hydrophytic vegetation, hydric soils, and wetland hydrology are those defined by the "Federal Manual for Identifying and Delineating Jurisdictional Wetlands" (Federal Interagency Committee for Wetland Delineation, 1989). From the standpoint of wetland functions, the primary objectives for most WSDOT projects are as follows:

- to provide food chain support;
- to provide ecosystem diversity; and
- to provide wildlife habitat (for purposes of breeding, rearing, feeding or foraging, refuge, and/or migration).

For a given project, these functional objectives are often stated in more specific terms (e.g., to provide food chain support for breeding and rearing waterfowl). These functions are expected to develop over the period of time specified in the project mitigation plan.

Wetlands can offer a number of other ecosystem and social functions. Developing these functions by design has not been common in WSDOT mitigation projects. Certain of these functions may become the objectives of future programs, depending on site characteristics, and provisions for monitoring their development are included in the guide. The functional objectives in this category are as follows:

- to provide fish habitat (for spawning, rearing, feeding, refuge, and/or migration);
- to provide flood storage and desynchronization;
- to provide water pollutant removal and retention; and
- to provide shoreline anchoring.

Groundwater recharge and discharge are additional functions that can be performed by wetlands. WSDOT mitigation projects have not been designed specifically to provide these functions. The guide includes no specific procedures for monitoring these functions. However, water level gaging, temperature and specific conductivity measurements, soil texture analysis, and observation of inflows and outflows can provide some basis on which to make subjective determinations of exchanges between surface and groundwater (see Data Interpretation sections of Tasks, A4, B1, B3, and C2). Local hydrologists should also be consulted. Although not yet verified for Washington state, the Wetland Evaluation Technique (WET) by Adamus et al. (1987) offers additional general guidance to define these functions.

Social functions of wetlands include providing recreation, education, heritage, and aesthetic values. The chance of a WSDOT construction project occurring in an existing recreational area is small because of considerations under the National and State Environmental Policy Acts. Therefore, no need is foreseen to mitigate for this impact. Most mitigation sites are within highway rights-of-way, where educational activities are not possible. Heritage values are inconsistent with a created wetland. Accordingly, the guide does not contain any provisions addressing these functions. Roadside aesthetics can be enhanced by the presence of a wetland. Achievement of the usual objectives listed above are assumed to also yield aesthetic values, and no techniques are included to measure these values directly.

MONITORING PROGRAM DESIGNS

A monitoring program design encompasses a set of tasks to perform in order to develop a data base for assessing the achievement of particular mitigation objectives. Table 1.1 specifies task selection for the various objectives that may be pursued in WSDOT mitigation projects. The set of objectives will normally consist of Developing Wetland Characteristics plus one or more functional objectives. Therefore, results of the tasks specified for the Wetland Characteristics objective will be available to help assess the achievement of functional objectives as well; those tasks are not repeated in the functional objective columns of the matrix. A user of the guide should select tasks appropriate for the identified mitigation project objectives from the matrix, and then refer to Part 2 for guidance in performing the tasks.

Several tasks in the matrix have been labeled "Detailed Analysis." These tasks are in general more complex, time-consuming, and expensive than the others. They represent options that can be exercised when an increased amount of information is necessary to assess a given function. Some of these tasks are also potential diagnostic tools (see the section on Diagnostic Procedures).

Table 1.1 Matrix of Task Selections for Identified Mitigation Project Objectives

Objectives / Tasks	Develop Wetland Characteristics	Functional Objectives: Food Chain Support and/or Ecosystem Diversity	Wildlife Habitat	Fish Habitat	Flood Storage	Pollutant Capture	Shoreline Anchoring
Mapping and Hydraulic							
A1. Mapping	X						
A2. Transects	X						
A3. Photographic	X						
A4. Water Level	X						
A5. Crest Stage (Detailed Analysis)	(X)						
Water Quality [a]							
B1. Temperature/pH		X	X	X		X	
B2. Dissolved Oxygen		X	X	X		X	
B3. Conductivity		X	X	X		X	
B4. Pollutant Removal (Detailed Analysis)						(X)	

(cont.)

a. To be performed when the wetland has surface water during any part of the year.

Table 1.1 (cont.)

Objectives / Tasks	Develop Wetland Characteristics	Functional Objectives: Food Chain Support and/or Ecosystem Diversity	Wildlife Habitat	Fish Habitat	Flood Storage	Pollutant Capture	Shoreline Anchoring
Soil and Sediment							
C1. Organic Content	X						
C2. Texture		X		X		X	
C3. Sediment Accumulation		X		X	X	X	
C4. Shoreline Stability							X
C5. Hydric Conditions (Detailed Analysis)	(X)						
Primary Producer							
D1. Plant Community	X						
D2. Phytoplankton [b] (Detailed Analysis)		(X)					
Consumer							
E1. Invertebrates		X	X	X			
E2. Fish				X			
E3. Wildlife			X				

b. To be performed when phytoplankton are an important component of food chain support, or when the trophic status of the open water portion of the wetland is a concern.

CRITERIA FOR ASSESSMENT OF MITIGATION OBJECTIVES

Assessment of mitigation objectives requires criteria as a basis to determine whether the selected objectives are achieved. Three types of criteria can theoretically provide this needed basis: (1) comparisons of monitoring results with values reported in the literature, (2) comparisons of monitoring results from mitigation and reference sites, and (3) comparisons of monitoring results from the mitigation site and the wetland that it is intended to replace. Each of these types of criteria is potentially useful, but each also has drawbacks, as discussed in the following subsections.

An additional consideration in the assessment process is the time span over which objectives are expected to be achieved. Individual WSDOT mitigation project plans specify the time dimension on the basis of the objectives being pursued and site conditions. Normally, the period is five years from the completion of construction. However, longer periods may pertain in certain circumstances (e.g., for objectives such as full hydric soil development from initial upland soils, or development of a forested wetland zone).

Literature-Based Criteria

Literature-based criteria offer a standard for judgment that has been scientifically verified. However, the literature is incomplete in many respects, especially for the Pacific Northwest. To a large extent, this incompleteness stems from the great variety of wetlands and their characteristics, and the lack of a comprehensive effort to define environmental variation among wetland types. Systematic wetland research has increased substantially, though, in the last several years, and some of the existing gaps will be filled. Future editions of this guide will incorporate these findings. The available literature-based criteria are cited in the Data Interpretation sections of the respective tasks in Part 2 of the guide.

Reference Wetlands

A reference wetland is defined as a natural wetland that is sufficiently similar to the mitigation site in certain specific ways to serve as a basis for judging the degree and rate of

achieving functional objectives. Furthermore, a reference wetland is one expected to exhibit changes in structure and function, during its period of use as a reference, only in response to changes in natural environmental conditions, rather than in response to human-generated factors that do not affect the mitigation site in the same way. Such a site is referred to as a "reference" rather than a "control" because it is usually impossible to obtain the degree of similarity in natural systems implied by the scientific term control.

The potential usefulness of reference sites as a basis for assessment criteria depends on the closeness of their match to the mitigation site. In considering whether productive use of a reference site will be possible, the analyst should exclude the degree of similarity or difference between the mitigation and the potential reference wetlands in a number of areas, including the following:

1. functional similarity;
2. climatological and hydrologic similarity;
3. similarity in influences by human access, habitation, and economic activities, and in the quantity and quality of water runoff from those activities to the wetland;
4. similarity in the history of and potential for such activities as grazing, mowing, and burning;
5. similarity in size, morphology, water depth, wetland zones and their proportions, and general vegetation types;
6. similarity in soils and nonsoil substrates; and
7. similarity in access by fish and wildlife.

Avoiding significant differences in these many areas is very difficult. The most suitable reference site is usually close to the mitigation site. Reference locations can sometimes be found within the same wetland complex as the mitigation project. Such sites should always be seriously considered in preference to more distant alternatives, unless they differ excessively in important aspects.

Comparisons with the Replaced Wetland

Comparisons can be made between the mitigation site and the wetland that it is intended to replace when in-kind replacement occurs. However, many WSDOT projects do not involve in-kind replacement. Frequently, the replaced site is a degraded system, and the mitigation site is designed to provide more functions, enhanced functions, or both. In those situations where in-kind replacement will be practiced, baseline monitoring of the replaced site is necessary before it is lost in order to use it as a basis for comparison.

Recommendation

The general recommendation is to use the literature-based criteria and to update these criteria as more research results become available. Furthermore, the status of the wetland to be replaced should be documented whenever possible. When in-kind replacement will occur, this documentation should be used as a basis for assessing the achievement of functional objectives. The possibility of finding a suitable reference wetland should be explored for each mitigation site. Using such a site as the principal basis for criteria should be restricted to cases in which a good match between mitigation and reference wetlands occurs in most important respects. Reference wetlands may have additional uses for diagnostic purposes, as covered under Diagnostic Procedures.

SCHEDULE OF ACTIVITIES

Monitoring can be performed according to two strategies: (1) perform all tasks during a single site visit, or (2) perform one task or a set of similar tasks at several sites in a single day. The latter strategy is generally better, most importantly because seasonal considerations enter into the selection of a day to perform certain tasks. Also, repeating tasks at several sites in a day usually is more efficient, if the monitoring and travel times fit well into a day's work. The following schedule is intended to assist the application of that strategy:

Initial visit	Task A1. Wetland Mapping Task A2. Transect Establishment
Initial visit, after one year, and then at three-year intervals (Intervals reflect anticipated relatively slow changes in soil characteristics.)	Task C1. Soil Organic Content Measurement Task C2. Soil Texture Analysis
After winter storms and runoff (following the period of maximum potential erosion and sedimentation)	Task C3. Sediment Accumulation Gaging (Some specific objectives may require additional monitoring; see task description.) Task C4. Shoreline Stability Monitoring (if performed)
Late spring-summer (anticipated periods of maximum biological activity for the communities of interest)	Task B1. Water Temperature and pH Measurement (Repeat during all site visits, if possible.) Task B2. Dissolved Oxygen Measurement (Repeat during all site visits, if possible.) Task B3. Specific Conductivity Measurement (Repeat during all site visits, if possible.) Task D1. Plant Community Assessment (Exact timing should depend on community composition.) Task D2. Phytoplankton Biomass Measurement (If performed; repeat during all summer visits, if possible.) Task E1. Aquatic Invertebrate Community Assessment (Repeat during each summer visit, if possible.)

Notes

1. Task A3 (Photographic Record) should be performed during each site visit through the year, but not more often than once a month.
2. Tasks A4 (Water Level Gaging) and A5 (Crest Stage Gaging, if performed) should be performed during each site visit through the year, with more frequent readings by highway maintenance personnel or a volunteer, if possible.
3. Scheduling of Task E3 (Wildlife Community Assessment) is highly dependent on the specific habitat functions being monitored. See the task description for guidance.

DIAGNOSTIC PROCEDURES

A wetland mitigation project designer could be assisted by diagnostic procedures in two different stages of project development: (1) during initial planning; and (2) after project completion, to analyze the causes of any problems that arise. This section outlines the tasks necessary to perform diagnostic analysis in different situations during these two stages. As with assessment of functional objectives, the monitoring procedures referenced in the section are contained in Part 2 of the guide.

DIAGNOSTIC PROCEDURES FOR INITIAL PLANNING

Successful wetland mitigation project planning requires certain information that can be collected through monitoring. Following are situations that may occur in the planning stage, along with the site monitoring tasks that should be performed in each situation.

Beyond site monitoring, other analytical tasks should also be performed during project planning. For example, the characteristics of the watershed contributing to the site should be fully understood and considered in site selection and design decisions.

Particularly if a candidate site is an existing wetland, its plant community should be generally assessed, especially with respect to the presence of any exotic species.

In-kind wetland replacement is to be undertaken, but the functions of the wetland to be replaced are poorly defined.

Use an accepted evaluation technique and/or consult with local experts to define the functions of the affected wetland. Although not yet verified for Washington state, WET (Adamus et al. 1987) can be used, in the absence of a more accepted alternative, for an initial definition. The U.S. Fish and Wildlife Services (1980) Habitat Evaluation Procedures is another possibility, but it is best suited for large sites.

In-kind wetland replacement is to be undertaken; the functions of the wetland to be replaced are defined, but the extent to which these functions are provided is unknown.

Refer to the preceding section on Assessing the Achievement of Mitigation Objectives. Design and carry out a monitoring program at the wetland to be replaced according to the directions in that section. Incorporate elements from the Basic Wetland Operation and Detailed Analysis programs as appropriate for the functions of the wetland in question.

A mitigation site is to be selected from among alternative potential sites (either upland sites to be used in wetland creation or existing degraded wetland sites to be rehabilitated).

Perform one-time monitoring at the candidate sites for screening purposes. Include the following tasks:

Task B1.	Water Temperature and pH Measurement **(if surface water is present prior to excavation)**
Task B3.	Specific Conductivity Measurement **(if surface water is present prior to excavation)**
Task C1.	Soil Organic Content Measurement
Task C2.	Soil Texture Analysis
Task C5.	Assessment of Hydric Soil Conditions

A selected mitigation site is to be characterized in more detail to assist project design.		
Perform the following tasks at some point during each season over a full year, if possible:	Task B1.	Water Temperature and pH Measurement **(if surface water is present prior to excavation)**
	Task B3.	Specific Conductivity Measurement **(if surface water is present prior to excavation)**
	Task C5.	Assessment of Hydric Soil Conditions
Perform the following tasks once:	Task C1.	Soil Organic Content Measurement
	Task C2.	Soil Texture Analysis

Note: To use the information derived from performing these tasks to benefit the site selection or planning function, refer to the Data Interpretation sections of the respective tasks for criteria that will help in judging the site's suitability or designing the created wetland appropriately for the site's characteristics.

DIAGNOSTIC PROCEDURES FOR PROBLEM ANALYSIS

The Basic Wetland Operation monitoring program outlined in the previous section of the guide should provide some or even all of the information needed to diagnose problems in mitigation project development. If this information is insufficient, more extensive monitoring according to the same tasks may be necessary. This more extensive monitoring could involve more frequent sample collection, more spatial coverage, more analyses of the samples, or a combination of these measures. Monitoring at a reference site may also be an aid to diagnosing the causes of problems. A reference site should be considered if monitoring at the mitigation wetland fails to reveal the cause. In that event, consult the

discussion of reference wetlands in the preceding section of the guide as an aid in selecting an appropriate site.

Following are potential problems that may develop and recommended diagnostic procedures to analyze their causes. It is important to note that many problems may originate in the contributing watershed, rather than in the wetland itself. If the source is not isolated in the wetlands, it must be traced in the watershed through wider investigations. Project mitigation plans specify possible contingency actions that can be prescribed once the problem is identified.

The following guidelines frequently note that evaluations beyond those covered by this guide may be necessary to diagnose problems. If that should be the case, the recommended course is to consult experts in the area(s) of concern to develop further diagnostic procedures tailored to the situation at each.

Plant community composition and/or cover development do not meet objectives.

A likely cause is unfavorable hydrology (i.e., excessive or insufficient depths, frequencies, and/or durations of inundation). Perform additional water level gaging, including crest stage gaging, according to Tasks A4 (Water Level Gaging) and A5 (Crest Stage Gaging).

Another potential cause is unfavorable soils. Perform additional soils evaluations according to Task C2 (Soil Texture Analysis). Additional possible causes are the presence of aggressive, weedy plants that crowd out the planted stock, or improperly selected or planted stock initially. Review the data from Tasks A3 (Photographic Record)

or D1 (Plant Community Assessment) to evaluate these possibilities.

Desirable hydrologic characteristics (e.g., adequate but not excessive depths, frequencies, and/or durations of inundation) do not develop.

An adequate water supply may not develop because of insufficient surface water discharge, groundwater discharge, or both. An excessive water supply is associated with surface water discharge. Arrange for hydrologic evaluations beyond those covered by the guide. Depending on circumstances, these evaluations may consist of frequent or continuous surface inflow gaging, groundwater assessment through piezometers or wells, and/or tracing of sources of hydrologic effects in the watershed.

Desirable soil characteristics (e.g., a hydric soil, medium texture, relatively high organic content) do not develop.

Lack of progress toward developing a hydric soil may be due to unfavorable hydrology (i.e., insufficient frequency or duration of inundation), or simply to lack of passage of adequate time for slow soil development processes to occur. Perform additional water level gaging, including crest stage gaging, according to Tasks A4 (Water Level Gaging) and A5 (Crest Stage Gaging).

Soil texture and organic content may not develop as desired because of inadequate or excessive deposition of sediments, or deposition of the wrong type of sediments.

Perform additional sediment accretion monitoring according to Task C3 (Sediment Accumulation Gaging).

Monitoring suggests that the aquatic invertebrate community is depauperate (lacking numbers, diversity, or both).

This tentative conclusion should be checked by additional invertebrate community assessment (Task C1). Possible causes are lack of development of food chain support, unfavorable hydrology (extended dry periods), unfavorable substrate, lack of detrital food, and poor water quality. Perform additional water level gaging (Task A4), soils (Tasks C1, C2, and C3), and water quality (Tasks B1, B2, and B3) monitoring. If other causes are ruled out, arrange for water quality evaluations beyond those covered by the guide. These additional water quality evaluations could include analyses of potential toxicants and/or bioassay procedures.

Monitoring suggests that wildlife habitat objectives are not met.

This tentative conclusion should be checked by additional wildlife community assessment. Possible causes are lack of development of appropriate vegetation, food chain support, and hydrologic regime, as well as poor water quality. Start by performing Task D3 (Habitat Suitability

Evaluation). Using the results and considering the specific functions at issue, select appropriate monitoring tasks from Part 2.

Inadequate response of wildlife populations could result from the lack of habitat for wetland-dependent species (i.e., aquatic habitat). Assess aquatic habitat development by performing additional data analysis (and, possibly, monitoring) according to Tasks A1 (Wetland Mapping), A4 (Water Level Gaging), and D1 (Plant Community Assessment). The broad question to consider in these assessments is whether there is a proper mix of vegetated and open water areas, as per the mitigation plan.

Other factors that could affect wildlife response are lack of connectivity with other necessary habitat, inadequate vegetative screening around the wetland to protect it from disturbance, and a concentration of predators if regional habitat is limited.

If other causes are ruled out, arrange for water quality evaluations beyond those covered by the guide according to the advice

given for the analysis of the aquatic invertebrate community above.

Fish habitat objectives are not met.

Possible causes are lack of access or cover, lack of development of vegetation and food chain support, insufficient water depth, and poor substrate or water quality. Employ the same procedure as outlined above for wildlife habitat objectives.

Excessive sediment deposition and/or poor water quality occur.

These conditions likely result from transport of sediments and/or other pollutants into the wetland via surface inflow. Dissolved pollutants can also enter with contaminated groundwater discharge. The task is to determine the origin of these pollutants and whether the source can be adequately controlled, or whether the polluting inflow can be redirected from the wetland. Arrange for water quality evaluations beyond those covered by the manual. These evaluations should be aimed at pollutant source tracing and assessment of remedial options.

Phytoplankton biomass provides inadequate food chain support; conversely, phytoplankton blooms are at nuisance proportions.

The probable cause is low (or, conversely, high) limiting nutrient concentration. Arrange for water quality evaluations beyond those covered by the guide. Monitoring should be sufficient to identify the limiting nutrient (phosphorus or nitrogen) during the spring period and the mean concentration of that nutrient during this period.

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PART II
MONITORING TASKS

A. MAPPING AND HYDROLOGIC TASKS

TASK A1

WETLAND MAPPING

OBJECTIVE

The objective of this task is to produce a map that can be used to locate transects and sampling points and to assist with evaluation of the fulfillment of the mitigation plan.

BACKGROUND

This procedure quantifies the areal extent of the created wetland and the coverage of the different wetland classes (e.g., open water, emergent, scrub-shrub, etc.) for comparison to the objectives of the mitigation plan. For example, the mitigation plan will define the desired composition of the wetland and associated upland buffers and give a time schedule for development. A plan might call for the created wetland to contain 50 percent open water, 30 percent persistent emergent (PEM1 in the system designed by Cowardin et al. 1979), 20 percent broad-leaved deciduous scrub-shrub (PSS1), and an upland shrub community around the wetland at five years after construction.

The initial mapping of the wetland will be based on the wetland boundary, delineated with the help of the Federal Manual for Identifying and Delineating Jurisdictional Wetlands (Federal Interagency Committee for Wetland Delineation, 1989). The mitigation plan will contain a detailed map of the created wetland and adjacent uplands for use as a base map in the monitoring program.

EQUIPMENT AND SUPPLIES

1. The base map of the wetland clearly showing the wetland boundary and surrounding geographic landmarks from the mitigation plan. For a created wetland, the base map should be a topographic map of the proposed wetland, modified as necessary to the as-built condition.
2. Current aerial photographs of the wetland taken after the main growing period in the sample year (e.g., June or July for most areas in Washington).

Photographs should be taken at a scale sufficient to distinguish the different wetland classes (1 inch = 20 feet if possible, but not smaller than 1 inch = 100 feet). Color aerial photographs are preferred. Aerial photos should provide stereographic coverage of the wetlands.

3. Stereoscope for interpreting aerial photographs, and a zoom-transfer scope to transfer the photographic information onto the wetland base map.
4. Measuring tapes, 30 and 60 m.
5. Drafting board and equipment.

Note: If an aerial photograph of the wetland is not available, use the transects and sampling points established in Tasks A2 and D1, along with Detailed Analysis steps 1-3, below, to determine the location of the wetland class boundaries; plot them on the base maps.

SAMPLING PROGRAM DESIGN

Assessment of Basic Wetland Operation

1. Delineate the wetland classes present in the wetland as definable on the aerial photographs using a stereoscope.
2. Transfer the wetland mapping in Step 1 above onto the wetland base map using the zoom transfer scope, or a grid method if a transfer scope is not available.
3. Plot the photo points, vegetation transects, and sampling point locations established in the wetland under the various measurement tasks onto the base map.

Detailed Analysis

1. Using the vegetation plot data gathered in Task D1, and supplementary field reconnaissance as needed, classify the vegetation in each plot into wetland classes on the basis of the USFWS wetland classification system described

by Cowardin et al. (1979). Use the results of the vegetation sampling to define the wetland classes identified in the aerial photographic interpretation (e.g., POW, PEM1, PSS1, etc.).

2. On the basis of the vegetation plot data, along the transects and the wetland reconnaissance, correct the aerial photo mapping of the wetland class boundaries.

3. On the basis of the above step, draw a final map of the wetland and the wetland classes within the wetland.

CALCULATIONS

Using either a planimeter or a dot-grid, calculate the area of each of the wetland classes mapped. Sum the areas of the individual wetland classes to get a total area of the wetland.

DATA INTERPRETATION

The mitigation requirements will be considered to be met if, within the period designated by the mitigation plan,

1. the total area of the wetland equals the mitigation requirement; and
2. the areas of the different wetland classes identified equal the coverages as specified in the mitigation plan for the sampling period.

If the mitigation requirements are not met after the designated time, or doubt exists that they will be met as the time approaches, refer to the Diagnostic Procedures for guidance.

REFERENCE

Federal Interagency Committee for Wetland Delineation, "Federal Manual for Identifying and Delineating Jurisdictional Wetlands," U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, and U.S.D.A. Soil Conservation Service, Washington, D.C., Cooperative technical publication, 1989.

TASK A2

TRANSECT ESTABLISHMENT

OBJECTIVE

The objective of this task is to determine the locations of and install transects that will be used in several subsequent monitoring tasks.

BACKGROUND

Transects are used to locate sampling points for several measurements in the wetland. The same transect lines will be used in Tasks C1, C2, D1, E1, and E2. The following procedure is designed to locate transects randomly, in order to remove observer bias from the data collection procedures.

EQUIPMENT AND SUPPLIES

1. Wetland map
2. Random number table or calculator random number generator
3. Tape measures, 30 and 60 meter
4. Steel fence posts
5. Post driver
6. Compass
7. Marking paint

PREPARATORY PROCEDURE

1. From the wetland map (Task A1), determine the approximate dimensions and area of the wetland.
2. Select one side of the wetland as a baseline. The baseline should be parallel to the water course in the case of streams; perpendicular to a topographic gradient; or

along the longest side of the basin. A straight baseline is preferred but is not essential (see Figure A2.1).

3. Interpretation of guidelines presented by the Federal Interagency Committee for Wetlands Delineation (1989) lead to the recommendation that, for most small wetlands (less than 2 hectares (5 acres) in area), six transects will give good coverage of the site and an adequate number of sampling plots. Randomly select the starting points for each transect by the following method: (a) divide the length of the baseline by the number of transects, usually six; the resulting value is the segment length; (b) use a two-digit random number as a fractional multiplier to get the location of each transect starting point.

Formulas

a. $$\text{segment length} = \frac{\text{baseline length}}{\text{number of transects}}$$

b. $$\text{transect starting point (measured from baseline origin)} = \left[\text{segment length} \times \frac{\text{random number}}{100}\right] + \text{segment starting point}$$

Example

baseline length = 156 m

number of transects = 6

random numbers: 31, 78, 18, 11, 54, 44

a. $$\text{segment length} = \frac{156\text{ m}}{6} = 26\text{ m}$$

b. starting point of transect 1 = (26 m x .31) = 8 m (from baseline origin)

starting point of transect 2 = (26 m x .78) + 26 m = 46 m

starting point of transect 3 = (26 m x .18) + 52 m = 57 m

starting point of transect 4 = (26 m x .11) + 78 m = 81 m

starting point of transect 5 = (26 m x .54) + 104 m = 128 m

starting point of transect 6 = (26 m x .44) + 130 m = 141 m

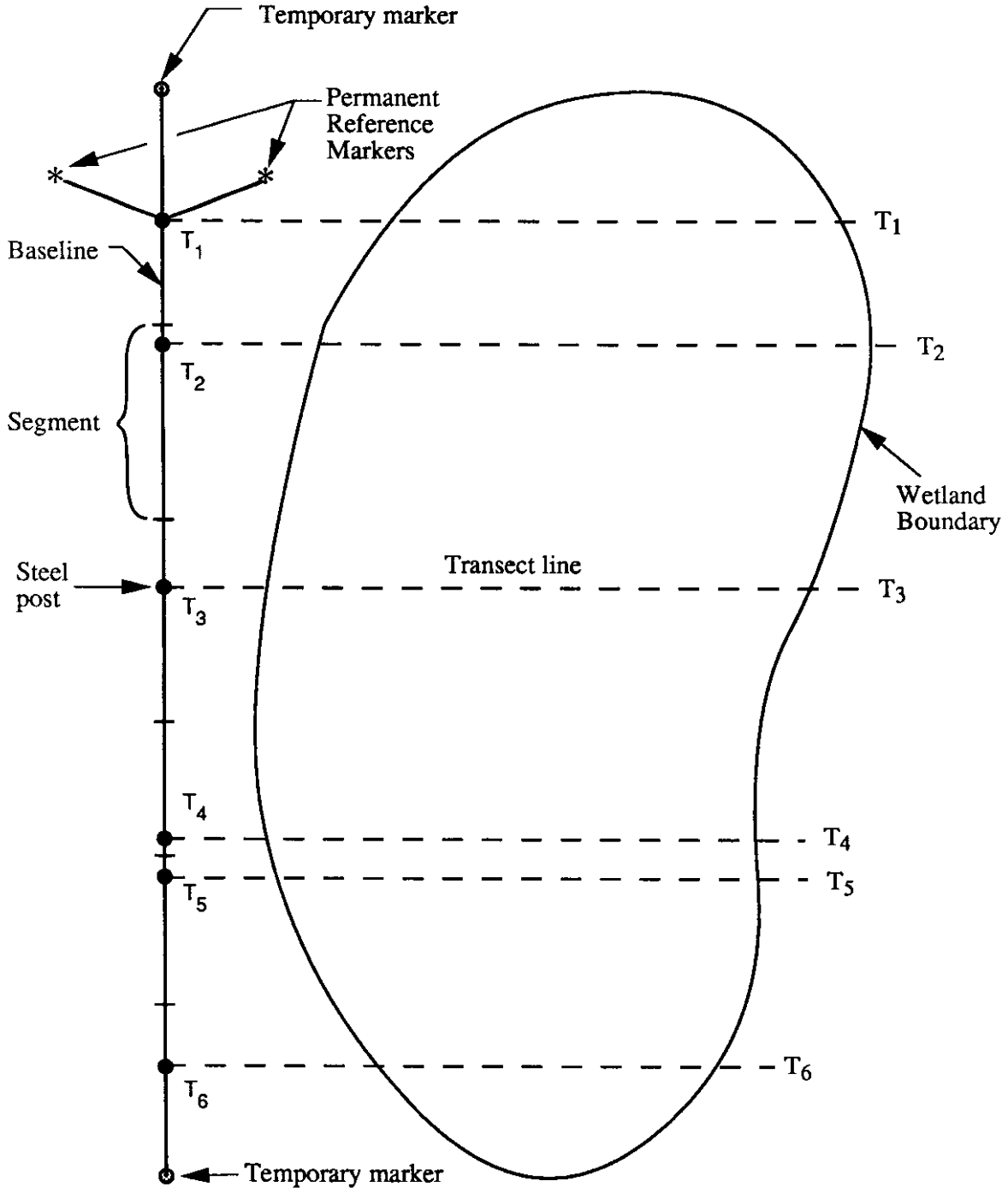

Figure A 2.1. Typical Plan of Baseline and Transects

FIELD PROCEDURE

1. When laying out the transects, be careful to stay on the side of the baseline away from the wetland.
2. Drive temporary markers at the ends of the baseline.
3. Measure the distance to the first transect, as determined using the formulas above. Drive a steel fence post at the starting point for the first transect.
4. Record the angle and distance to two permanent markers or reference points, so that the transect marker can be relocated if it is disturbed.
5. Lay out the first transect perpendicular (at 90 degrees) to the baseline and drive a steel post at the end point. Be careful to stay on the left side of the transect to avoid disturbing vegetation on the right side, where sampling plots will be placed. Label the end posts with identifying numbers using marking paint. If the transect is longer than 60 m, drive additional steel posts at 60 m intervals along the transect.
6. Lay out the remaining transects parallel to the first, marking each as above.
7. Transects across deep water should be interrupted when the depth is too great to work on foot (approximately 0.75 in). Resume the transect on the opposite side of the deep water area and continue to the wetland boundary.

TASK A3

PHOTOGRAPHIC RECORD

OBJECTIVE

The objective of this task is to produce a visual record of the created wetland development over time.

BACKGROUND

Photographs from set positions over a long period of time are an excellent means of qualitatively documenting plant community development in a created wetland. Such photographs can reveal the extent and rate of plant cover development and increase in height. The technique is an adjunct to quantitative vegetation characterization (see Task D1) and allows the record to be filled in with more frequent observations.

EQUIPMENT AND SUPPLIES

1. 35 mm camera with 50 mm lens
2. Color slide film, 64 ASA
3. Metal fence posts
4. Marking paint
5. Compass
6. Photo pole, 1 m
7. Tripod (if low light conditions)

PHOTOGRAPHIC PROGRAM DESIGN

1. Select sufficient points to allow photographing of every plant community type and vegetation layer in the wetland. Transect starting or ending points are usually good choices for photo points (see Task A2). Assign permanent designations to the points (e.g., P1, P2, etc.).

2. Mark the photo points permanently with painted metal fence posts and record their positions on the wetland map. Also record the compass bearing along which the camera should be aligned. A paint color should be selected that blends with the background at a distance but appears unnatural at close proximity. A flag on a nearby tree or bush can identify the approximate location of the point.

3. Photograph from each photo point along the compass bearing indicated during each visit to the wetland, unless visits are more frequent than monthly. Take photographs on approximately the same dates each year. The most important period to photograph is during peak vegetation growth. Place a 1 m photo pole in the field of view to serve as a reference for vegetation height.

4. Take two photographs (to reduce the chance of losing information) at each photo point on each occasion. Make a careful record of the photo point designation, compass bearing, frame number, date, and time.

DATA INTERPRETATION

The mitigation requirements will be considered to be met if, within the period designated by the mitigation plan, the photographs in conjunction with quantitative information demonstrate that

1. coverage and height of the overall vegetation canopy equals the mitigation requirements; and
2. coverage and height of key individuals or groups of plants (trees, saplings/shrubs, woody vines, and herbs) equal the specifications of the mitigation plan.

If the mitigation requirements are not met after the designated time, or doubt exists that they will be met as the time approaches, refer to the Diagnostic Procedures for guidance.

REFERENCE

Federal Interagency Committee for Wetland Delineation, "Federal Manual for Identifying and Delineating Jurisdictional Wetlands," U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, and U.S.D.A. Soil Conservation Service, Washington, D.C., Cooperative technical publication, 1989.

TASK A4

WATER LEVEL GAGING

OBJECTIVE

The objective of this task is to yield a basic definition of hydrologic fluctuations in the wetland over time.

BACKGROUND

Since the hydrologic regime distinguishes emergent wetlands from terrestrial and open-water aquatic environments, it is the primary determinant of all wetland systems (Gosselink and Turner, 1978). Therefore, a record of water level fluctuations is very important. Despite this importance, hydrologic measurements have frequently been omitted from wetland investigations. It is relatively simple and inexpensive to obtain a sufficient record to determine whether a created wetland maintains the depth, frequency, duration, and pattern of inundation conducive to achieving designated functional objectives.

The recommended method utilizes a conventional staff gage, illustrated by Figure A4.1. For Detailed Analysis, a crest stage gage should be used in addition (see Task A5). The staff gage provides a visual determination of instantaneous water level relative to a reference. No special skill is needed to read it, and maintenance personnel or a volunteer can be engaged to take the readings. The staff gage should be placed where it will register the lowest annual water level, so long as it can be read by eye or with the aid of binoculars.

If the wetland does not maintain surface water at all times, a provision should be made to observe the groundwater level elevation. This observation can be made either by digging a pit (on each visit, or installing a liner to keep the pit open), or by installing a perforated tube that can be read by inserting a marked tape. The latter method is recommended for its convenience.

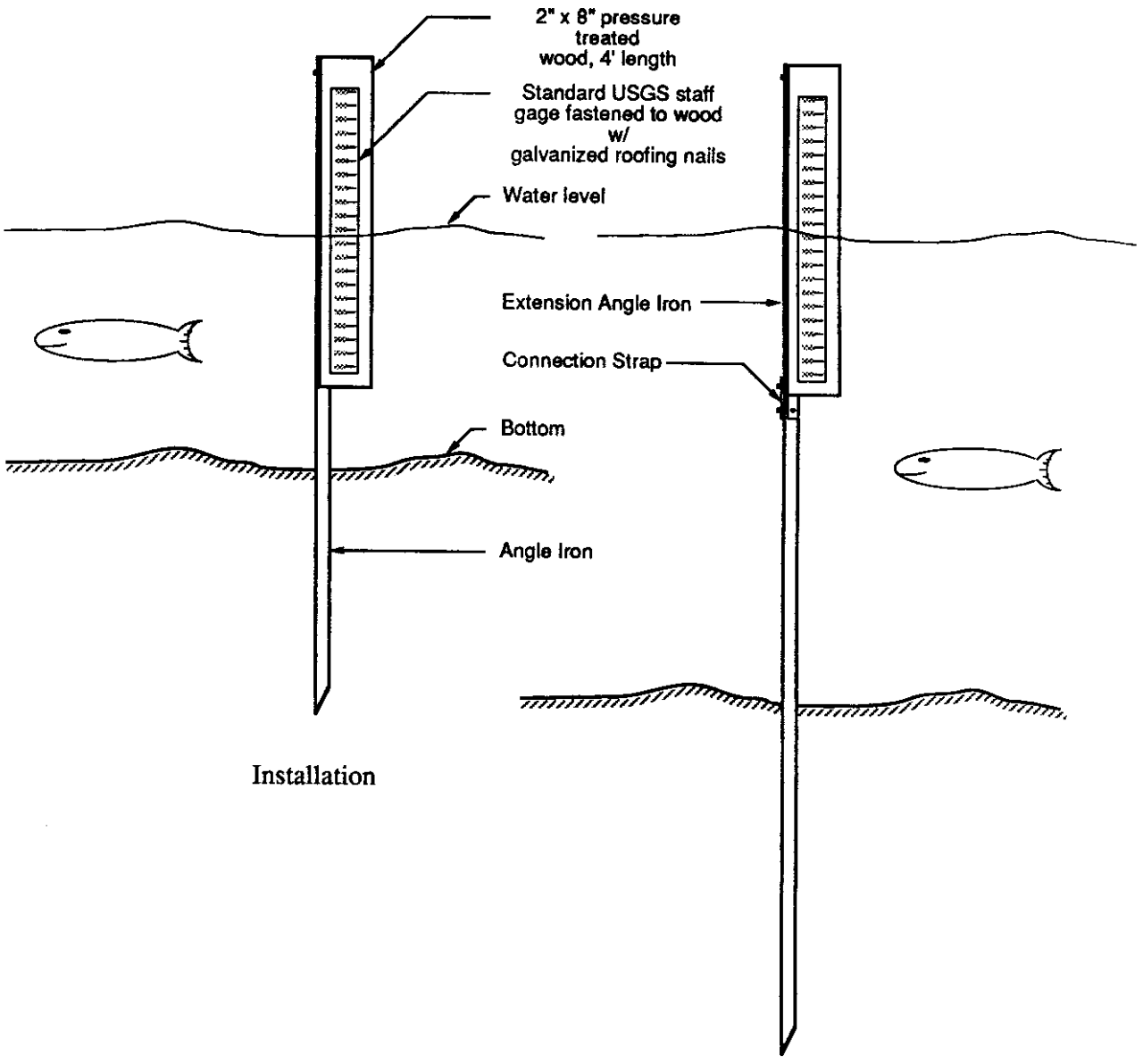

Figure A 4.1. Staff Gage

Superior to these devices is a continuous instrumental recording of water level. However, this technique requires an expensive instrument and weekly changing of the chart and other maintenance by a trained person. Wetlands are generally quite hydrologically resilient, so that water level change is usually relatively slow. Therefore, the staff and crest stage gages should be adequate to serve most objectives.

EQUIPMENT AND SUPPLIES

1. Staff gage assembly (see Figure A4.1)

   The staff gage plate may be obtained from the U.S. Geological Survey; 1200 Pacific Avenue; Tacoma, Washington 98402; telephone (206) 593-6510. The angle is available from Miller Fabrication, Inc.; 1435 R Street N.W.; Auburn, Washington 98001; telephone (206) 395-3117.

2. Measuring tape
3. Binoculars (some sites)
4. Post driver
5. Perforated plastic pipe, capped at one end (drill a number of holes along length)
6. Soil auger
7. Removable cap
8. Carpenter's chalk

EQUIPMENT INSTALLATION

1. Attach the staff gage plate to the board.
2. Using a weighted driver, drive the pointed angles for the gage until the lower bolt holes are just above the water level. If they are not anchored securely, attach an extension and drive further. Place it where it will register the lowest annual water level, so long as it can be read, at least with binoculars. Mark gage locations on a wetland map (see Task A1).
3. Attach the boards to a pointed angle.

4. Select or install a permanent benchmark to use as a reference for the gage position. There should be assurance that the benchmark will not move for any reason (including tampering). A good benchmark is an unobtrusive nail driven in a sturdy tree. In the absence of trees, a permanent natural feature (e.g., a rock) may be selected. Carefully record the benchmark location and place it on the wetland map.
5. Use surveying equipment to establish the level of each gage relative to the benchmark. Carefully record the levels.
6. If a gage should ever move, reinstall it with reference to the level data, either placing it in the same position or correcting readings to a constant base.
7. If the wetland does not maintain surface water at all times, auger a hole for a perforated plastic pipe deep enough to intercept groundwater in all seams. Install the pipe and cover the open end with a removable cap.

SAMPLING PROGRAM DESIGN

1. Arrange to have the staff gage read as often as convenient. Highway maintenance personnel who frequent the area of the wetland are recommended to take the readings. In other locations, volunteers may be recruited from among other government agency personnel who work in the area or private citizens who live nearby. For the first year of the program, readings should be taken no less frequently than biweekly.
2. If experience shows that water levels are very stable over long periods, the frequency of reading can be reduced with little loss of information. The needed frequency may differ seasonally and should be dictated by the first year's experience.
3. If the perforated pipe is being used, read it by chalking the measuring tape and reading the level at which chalk is dissolved away when the tape is inserted into the pipe.

4. Record all data on a form such as the Water Level Data sheet included in this task description.

DATA INTERPRETATION

The mitigation requirements will be considered to be met if, within the period designated by the mitigation plan,

1. the depths, frequencies, durations, and patterns of inundation in the created wetland are adequate (neither too little nor too much water) relative to such factors (depending on objectives) as
   a. support of wetland plant species, specifically those planted or intended to be encouraged (see Table A4.1);
   b. wildlife habitat for the species of interest (water must be present at the times and in the amounts necessary to support the specific functional objectives);
   c. fish habitat for the species of interest (water must allow access at the times and be present in the amounts necessary to support specific functional objectives);
   d. flood storage;
   e. provision of sufficient water residence time for pollutant removal, if that is a functional objective; or
2. if the results are being compared between the created wetland and a reference or replaced wetland, they indicate that the wetlands being compared have equivalent hydrologic conditions to support aquatic life.

Table A4.1. Water Level Requirements of Common Pacific Northwest Wetland Plants

Scientific Name	Common Name	Optimum Water Depth (meters)[a]	Reference[b]
Acorus calamus	Sweetflag	0-0.3	1
Alisma plantago-aquatica	American water plantain	0.05-0.15	3
Carex spp.	Sedges	-0.05-0.95	2
Carex lyngbyei	Lyngby's sedge	MT-MHHW	1
Carex obnupta	Pacific sedge	≥ MHW	1
Distichlis spicata	Saltgrass	≥ MHW	1
Iris pseudacorus	Yellow iris	0.4-0.7	3
Juncus spp.[c]	Rushes	wide range	2
Nuphar polysepalum	Spatterdock	1-2.5	3
Nymphaea odorata	White water lily	0.3-2	3
Phalaris arundinacea[c]	Reed canarygrass	wide range	2
Phragmites communis[c]	Common reed	-0.3-1.5	2
Polygonum spp.	Smartweeds	0-0.6	1
Potamogeton pectinatus	Sago pond weed	0.6-1.8	1
Sagittaria spp.	Arrowhead	0-0.6	1
Scirpus spp.	Bulrushes	-0.7-2	2
Scirpus americanus	Common three-square	0-0.3	1
Scirpus robustus	Saltmeadow bulrush	≥MHW	1
Spartina spp.	Cordgrasses	0-0.5	2
Spartina alterniflora[c]	Smooth cordgrass	MLW-MHW (range < 0.6) MT-MHW (range > 1)	1
Typha spp.[c]	Cattails	0.15-1	2
Typha latifolia	Cattail	0-0.15	1
Zostera japonica	Dwarf eelgrass	1-2.4 above MLLW	3
Zostera marina	Eelgrass	6.6 below MLLW - 1.8 above MLLW	3

[a] Abbreviations: MHHW–mean higher high water; MHW–mean high water; MLLW–mean lower low water; MLW–mean low water; MT–mean tide.

[b] 1–Garbisch, 1986; 2–Stephenson, et al., 1980; 3–Weinmann, et al., 1984.

[c] This plan is not necessarily a desirable member of the vegetation community.

Hydrologic data and observations can also be evaluated to determine whether the wetland is serving a groundwater recharge or discharge function. There is a relatively high probability that the wetland can serve a net recharge function under the following conditions (Adamus et al. 1987, p. 90):

1. the wetland is in a precipitation deficit region (e.g., eastern Washington), is not permanently flooded, has an inlet but no outlet or obviously less outflow than inflow, and has favorable topography and soils (see Task C2); or
2. the wetland is not in a precipitation deficit region (e.g., western Washington), has an inlet but no outlet or obviously less outflow than inflow, and has favorable topography and soils (see Task C2).

There is a relatively high probability that the wetland can serve a net discharge function under the following conditions (Adamus, et al., 1987, p. 93):

1. the wetland is permanently flooded or saturated; and
2. the wetland is in a precipitation deficit region, has a steeper gradient downstream of the outlet than upstream of the inlet, lacks an inlet but has an outlet, has a fairly stable water level seasonally, or exhibits signs of springs (e.g., temperature or specific conductivity measurements suggesting groundwater discharge (see Tasks B1 and B3, respectively)).

This task should be performed each year of the monitoring program to document basic wetland operation. If the mitigation requirements are not met after the designated time, or doubt exists that they will be met as the time approaches, refer to the Diagnostic Procedures for guidance.

REFERENCES

Adamus, P.R., E.J. Clairain, Jr., R.D. Smith, and R.E. Young, "Wetland Evaluation Technique (WET), Volume II: Methodology," Waterways Experiment Station, Corps of Engineers, Vicksburg, MS, 1987.

Garbisch, E.W., "Highways and Wetlands: Compensating Wetland Losses," FHWA-IP-86-22, Federal Highway Administration, McLean, VA, 1986.

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Weinmann, F., M. Boulé, K. Brunner, J. Malek, and V. Yoshino, "Wetland Plants of the Pacific Northwest," U.S. Army Corps of Engineers, Seattle District, Seattle, WA, 1984.

WATER LEVEL DATA

Wetland Site _____

Date	Time	Read By	Gage[a]	Level[b]	Remarks[c]

[a] S — staff gage; CS — crest-stage gage; T — groundwater tube

[b] Stage elevation for staff gage elevation + bolt elevation for crest-stage gage (also record subpeak elevations if clearly delineated; or groundwater position relative to surface for tube).

[c] Record observations of current and preceding weather conditions; quality of crest-stage gage mark (good, fair, or uneven), etc.

TASK A5

CREST STAGE GAGING
(Detailed Analysis)

OBJECTIVE

The objective of this task is to yield a definition of hydrologic fluctuations in the wetland over time that is more complete than that offered by Task A4.

BACKGROUND

The crest stage gage allows determination of the highest water level since the previous reading. It operates by registering the highest rise of cork dust above a base point. With this gage, one is not limited to the information only obtainable when a reader can be present. Maintenance personnel or a volunteer should read the crest stage gage at the same time the staff gage is read. Figures A5.1 and A5.2 illustrate and give specifications for a crest stage gage.

EQUIPMENT AND SUPPLIES

1. Crest stage gage assembly (see Figures A5.1 and A5.2)

   The assembly can be fabricated by Miller Fabrication, Inc. (see Task A4) for approximately $70 per unit (1988 cost).
2. Cork dust (available from U.S. Geological Survey; see Task A4)
3. Measuring tape
4. Post driver

EQUIPMENT INSTALLATION

1. Place it in a location accessible without difficulty by a reader in rubber boots.
2. Install it as described for the staff gage (see Task A4).
3. Establish the level of the gage as described for the staff gage (see Task A4).
4. Pour one tablespoon of cork dust into the pipe and drop it in the PVC measuring tube.

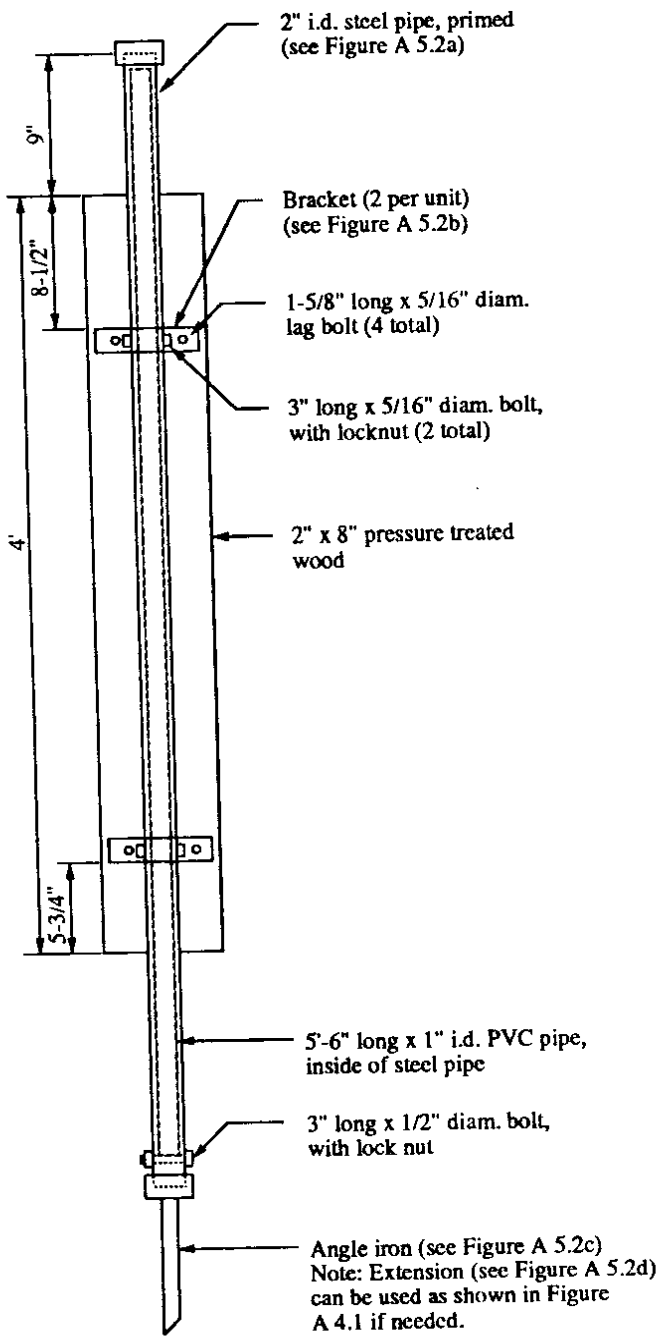
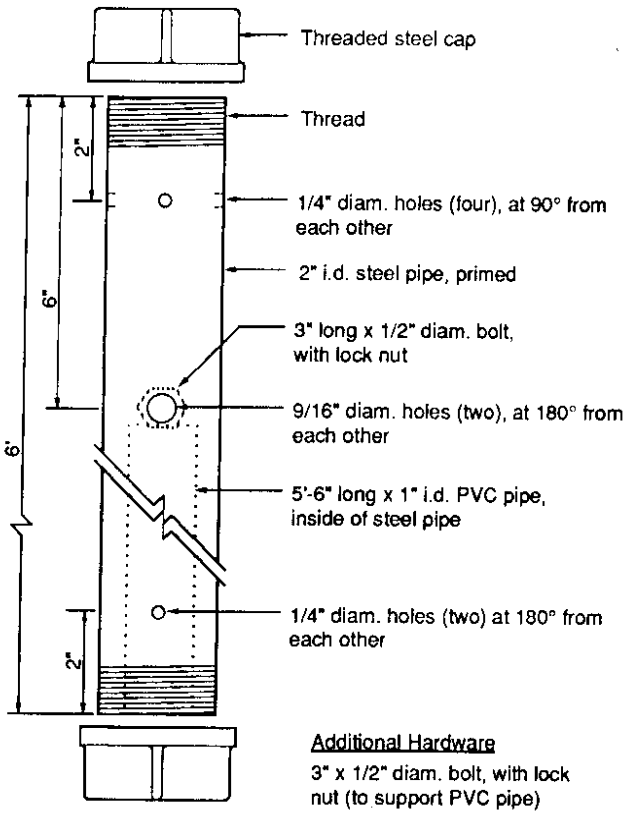
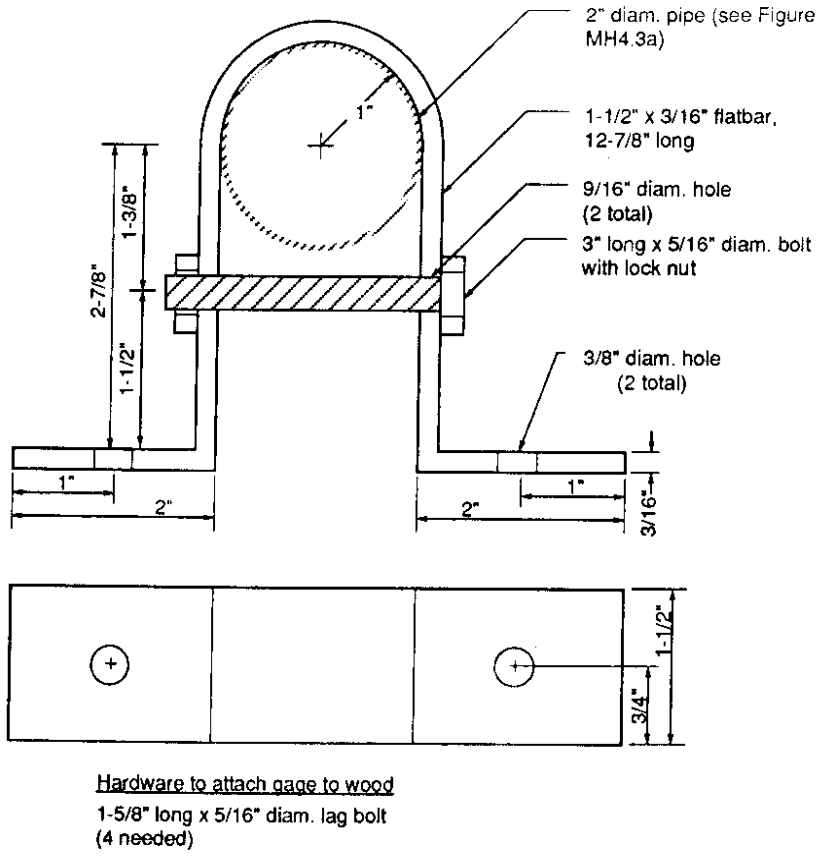


Figure A 5.1. Crest Stage Gage

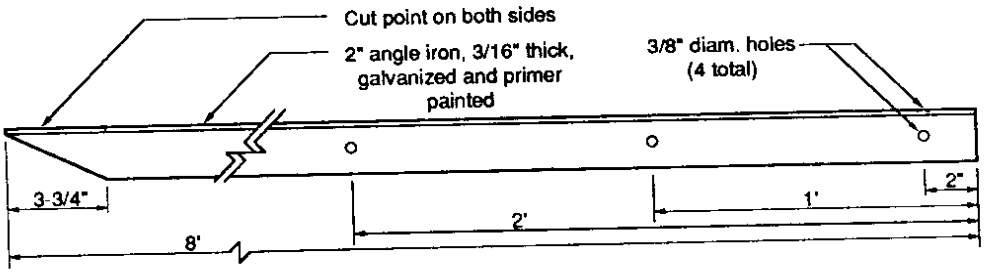


a) Steel Pipe



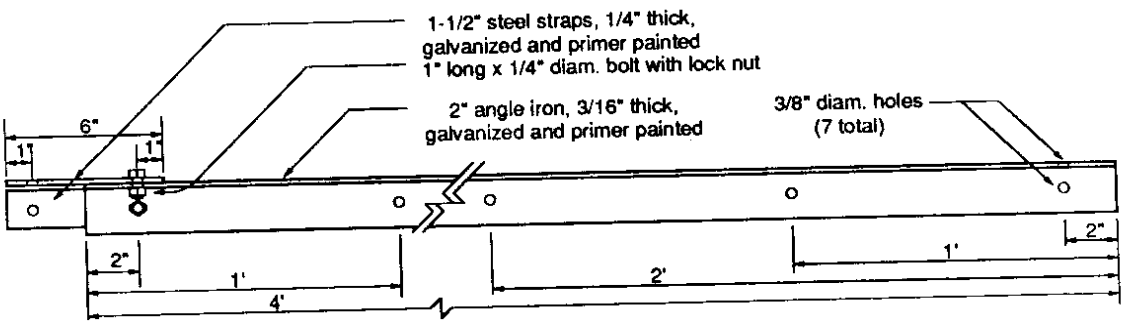
b) Bracket (two per unit)

Figure A 5.2. Details of Crest Stage Gage Parts



Hardware to attach wood to angle iron
1-5/8" long x 5/16" diam. lag bolt (3 needed)

c) Angle Iron



Hardware
1" long x 1/4" diam. bolt with lock nut (4 needed)

d) Angle Iron Extension (if required)

Figure A 5.2. (cont.)

SAMPLING PROGRAM DESIGN

1. Arrange to have the staff gage read as often as convenient.
2. To read the gage, remove the PVC tube and measure the peak stage elevation, and any other obvious cork concentrations, using a measuring tape.
3. Record the data on the Water Level Data Sheet (see Task A4).

DATA INTERPRETATION

1. See Task A4.

B. WATER QUALITY TASKS

TASK B1

WATER TEMPERATURE AND PH MEASUREMENT

OBJECTIVE

The objective of this task is to determine two fundamental water quality characteristics to provide one basis for judging the water quality for wetland organisms, to aid in interpreting other test data, and to provide a basis for inferences concerning groundwater supply to the wetland.

BACKGROUND

Temperature is a basic water quality property that regulates the rates of chemical and metabolic processes in the aquatic medium. Organisms have evolved to favor certain temperature ranges, and changes in temperature can create competitive advantages for some organisms over others.

In wetlands, the water temperature is dependent on the temperature of surface water sources, the relative contribution of groundwater to the total water balance, the degree of shading, water depth, and water residence time in the wetland. Differences in temperature between neighboring wetlands can signify differing groundwater contributions, and gradients within wetlands can help to locate springs.

Temperature considerations are most important when salmonid fish inhabit a wetland. The optimum temperature for the growth of these species is approximately 15°C, while hatching and survival of the young is most favorable at 1-2°C lower. Warmwater fishes (e.g., bass, perch) have varying temperature preferences, with optimums for most game species being in the range 20-25°C (Welch 1980). Temperature also has a strong effect on the community composition of aquatic invertebrates and phytoplankton, although it is of less importance in defining the macrophytes. In general, lower temperatures (< 20°C) favor diverse invertebrate life and unicellular diatoms among the phytoplankton. Green algae tend to predominate as temperature rises, and very high temperatures (> 30°C)

offer a competitive advantage to blue-green algae, which have nuisance tendencies and are relatively poor food sources. Invertebrate diversity is much reduced at this level, with only tolerant forms present (Welch 1980).

Therefore, knowledge of water temperature is often necessary to interpret other test data and to explain fully the water quality for aquatic life. It is easily measured by suspending a mercury thermometer in the water column for a sufficient time for it to come to equilibrium (a few minutes). Many pH meters also measure temperature; however, this measurement is best done in a beaker of sample and is subject to inaccuracy caused by warming of the sample.

The pH expresses the hydrogen ion activity in a solution. By definition, pH is the negative base-10 logarithm of the hydrogen ion concentration in moles/liter. A pH of 7 represents equality of hydrogen and hydroxyl ions, and therefore neutrality; while pH < 7 signifies acidity (predominance of hydrogen) and pH > 7 (maximum 14) signifies a basic condition (predominance of hydroxyl). On the logarithmic scale, a change of one pH unit represents a tenfold change in hydrogen ion concentration.

General aquatic production and species richness is favored by circumneutral and slightly alkaline pH, approximately 5.6-8.6 (Darnell et al. 1976, Fryer 1980, Friday 1987). That range is usually maintained by carbonate and bicarbonate buffering of naturally acidic precipitation. Because of carbon dioxide solubility, rain affected by no other dissolved gases or ions has a pH of 5.65. Of course, acidic or alkaline species can lower or raise that pH, respectively. Eastern Washington surface water pH tends toward the slightly alkaline range, because of relatively soluble geological materials, while western Washington waters are frequently slightly acidic. Bogs are typically quite acidic (pH < 5.0) as a result of high organic acid release from bog vegetation and lack of buffering surface water inflow (Mitsch and Gosselink 1986). On the other hand, eutrophic pools can exhibit pH > 9 during the day, when high photosynthetic rates by phytoplankton and macrophytes extract carbon dioxide (CO_2) from the water. The pH tends to fluctuate diurnally in these systems in

response to net CO_2 uptake during photosynthesis and release during the night, when only decomposition occurs.

Water chemistry is largely the study of chemical processes in the aquatic medium as affected by pH. The chemical speciation of such important water quality constituents as nutrients and metals is determined chiefly by pH. Metals tend to be more soluble, and therefore more available to organisms, at acidic rather than at higher pH. Hence, toxicity can be increased by acidification.

For these biological and chemical reasons, pH is a fundamental water quality characteristic. Like temperature, it is easily and rapidly measured: the measuring instrument is an electronic pH meter. This measurement should be performed in the field, immediately after sampling, because of rapid changes due to gas diffusion, biological activity, and chemical reactions. However, the accuracy of laboratory measurement should be adequate for the purposes of created wetland monitoring if the sample is transported from the field on ice, in a tightly sealed container with no air space, and is analyzed as soon as possible, but always within 24 hours, after collection.

EQUIPMENT AND SUPPLIES

1. Mercury thermometer
2. pH meter and electrode
3. Screw-top poly bottle(s) for sampling
4. Buffer solutions of known pH
5. Beakers for pH measurement
6. Distilled water in a squeeze bottle to clean the electrode

SAMPLING PROGRAM DESIGN

1. Perform temperature and pH measurements during each site visit to the wetland(s) of interest (including reference, if selected). Timing of visits should be a function

of the monitoring program objectives. Most important is measurement during the warmest period, especially if the provision of fish habitat is an objective.

2. If a site visit is lengthy, it is advisable to measure temperature and pH early in the day and then at highest solar altitude, when maximums of both are probable (pH due to photosynthetic activity).

3. Determine the spatial coverage of the sampling on the basis of the project's objectives and the wetland configuration. Some common situations that might occur include the following:

   a. there is a major surface inflow (tidal or fresh) — sample the influent water, as well as water within the wetland;

   b. there is a complex pattern of pools and/or channels with differing vegetation communities — sample the water column in representative locations;

   c. there is a relatively homogeneous open water pool — take a single water column sample; and

   d. there is interest in gaining some qualitative understanding of groundwater contribution — measure temperature in a series of locations around and across the wetland.

   Assign site designations to each sampling location and mark them on a wetland map (see Task A1).

4. To measure temperature, suspend a mercury thermometer from a cord into the water column and wait a few minutes for equilibrium to be established.

5. To sample for pH measurement, dip a container by hand in an area that is undisturbed by your presence. In shallow water, take the sample at about one-third of the full depth above the bottom. In deeper water, sample about 50 cm below the surface. (Except for some estuarine sites, all wetland project sites are assumed to be sufficiently shallow to be completely mixed top to bottom. Therefore, a sample taken at a point in the water column should be representative.)

6. Analyze the samples immediately according to the instructions below, if possible. If laboratory measurement is necessary, transport the sample on ice, in a tightly sealed container with no air space. Analyze the sample as soon as possible, but always within 24 hours after collection.

ANALYTICAL PROCEDURE

1. Follow the instructions provided with the pH meter. These instructions generally require calibrating the meter at one or two pH values (at least one near the expected pH) using the buffer solutions, then measuring the the sample. Setting a temperature compensation may be required in both steps. Always rinse the electrode thoroughly with distilled water before inserting it in a buffer or sample.
2. Although pH is very simple and fast to measure, several precautions can increase accuracy, as follows:
   a. Swirl the electrode gently and wait until the meter becomes steady before recording the reading.
   b. Attempt to keep the temperatures of the buffers and the sample as close as possible. This can be accomplished by immersing the buffer bottles in the water column for a short time before use.
   c. Keep the electrode clean, and check the electrolyte level regularly (refill as needed). Put some water in the protective cap before replacing it on the electrode for storage.
   d. Only remove the electrode from water when the meter is switched to "standby" or "off."

DATA INTERPRETATION

The mitigation requirements will be considered to be met if, within the period designated by the mitigation plan,

1. the created wetland demonstrates the existence of the appropriate conditions in Table B1.1; or

2. if the results are being compared between the created wetland and a reference or replaced wetland, they indicate that the wetlands being compared have equivalent water quality conditions to support aquatic life.

Temperature data can also be evaluated to determine whether the wetland is serving a groundwater discharge function. Evidence that could be attributed to groundwater discharge includes (1) locally cooler or less variable temperatures in summer, or (2) less variable temperature in winter not associated with other factors such as snowmelt, water depth or velocity, differential solar absorption, shading, or wind (Adamus et al. 1987, p. 88).

This task should be performed throughout the monitoring program. If the mitigation requirements are not met after the designated time, or doubt exists that they will be met as the time approaches, refer to the Diagnostic Procedures for guidance.

TABLE B1.1. TEMPERATURE AND pH CRITERIA

Variable	Functional Objective	Criterion	Reference[a]
Temperature	Salmonid fish feeding	≈15°C	4
	Salmonid fish rearing	≈13-14°C	4
	Warmwater fish production	20-25°C	4
	Invertebrate production	< 20°C	4
pH	General aquatic production and richness	5.6 - 8.6[b]	1, 2, 3

[a]1–Darnell et al. 1976; 2–Fryer 1980; 3–Friday 1987.

[b]Except in bog systems, which typically have lower pH.

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TASK B2

DISSOLVED OXYGEN MEASUREMENT

OBJECTIVE

The objective of this task is to determine a characteristic fundamental for both judging the water quality for wetland organisms and understanding wetland chemical and biochemical processes.

BACKGROUND

No quantity is more basic to the character of biological organisms living in a water body than the amount of oxygen dissolved in it. Oxygen status has a special significance in wetlands, which are defined on the basis of their hydric soils, or soils that are saturated for a sufficient period during the growing season to develop anaerobic conditions (Federal Interagency Committee for Wetland Delineation 1989).

Oxygen is depleted from aquatic media by decomposers (bacteria and fungi) during biodegradation of organic matter, and by chemical processes in which oxygen reacts with organic and inorganic substances. The high production of organic matter in wetlands and generally slow rate of water exchange lead to anaerobiosis in the soils and interstitial waters and, sometimes, the water column. Biodegradable organic pollutants transported from the watershed add to the oxygen demand. Density stratification (e.g., as a result of salinity differences in an estuarine wetland) can produce strata differing in oxygen content.

Oxygen can be returned to water through interactions between the water and the atmosphere and by photosynthesis. The ability of all gases, including oxygen, to dissolve in water is a function of its temperature. Cooler water is able to dissolve more gaseous components. Thus, dissolved oxygen (DO) results must be interpreted in terms of water temperature. The relationship is expressed as percentage of saturation, a comparison of how much DO the water contains with how much it could hold at the temperature when it

was sampled. Because the liberation of dissolved gases lags temperature changes, water can actually hold more oxygen than theoretically possible at any given temperature. This condition (> 100 percent saturation) is known as supersaturation. Supersaturation tends to occur after several daylight hours during which plants have been producing oxygen in their photosynthetic activities. Early-morning readings are often lower because of the lack of photosynthetic production overnight.

The hydrophytic vegetation forms characteristic of wetlands develop in direct response to the saturated soils and oxygen-poor conditions. These species exhibit various adaptations to this environment, such as tissue development to improve oxygen transport to the root zone and to retain oxygen around the roots.

Salmonid fish and their preferred invertebrate foods require consistently high DO levels. Deteriorated swimming performance has been witnessed in salmonids when DO has dropped below saturation. Concentrations above 7 mg/L are favorable to spawning and rearing, above 6 mg/L are favorable to growth, and above 5 mg/L are necessary for survival (Welch 1980). The most productive freshwater and saltwater fisheries, especially of coldwater fishes such as salmonids, maintain DO levels consistently above 5 mg/L and 80 percent saturation (Bell 1973). Warmwater fishes (e.g., bass, perch) have less restrictive requirements, but maintenance of at least 4 mg/L is generally necessary for the game species in this group. Levels below this concentration and 60 percent saturation have been found to limit the species richness of invertebrate (Ziser 1978) and fish (Tonn and Magnuson 1982) communities in wetlands. As oxygen declines to very low levels, tolerant, less functionally desirable organisms tend to predominate. These considerations may become important if a wetland is to function as a fish habitat and/or to support insectivorous birds.

Dissolved oxygen may be measured by chemical titration (the azide-modified Winkler method) or electronic meter. The former is recommended because of its ease of use and low cost, and because of the difficulty in maintaining meter calibration and the

frequent need to change membranes in the meter probe. A meter must be calibrated against a chemical measurement each time it is moved and intermediately during use, if the period of operation is extended. Therefore, the meter is only convenient if a series of measurements are to be made in one location. Sampling for a chemical determination of DO requires particular care, since any contact between the sample and the air will modify the results. If a percentage of saturation is to be determined, the water temperature must be measured at the same time and location. Reagents should be made up in volume by a qualified laboratory according to the instructions below.

The following methods were derived from and are consistent with American Public Health Association (1985) Methods 421B for the chemical titration and 421F for the electronic meter measurement.

EQUIPMENT AND SUPPLIES

1. 300-mL, glass-stoppered BOD bottle
2. Apparatus to draw the sample
3. Buret, graduated at 0.1 mL
4. 100-mL graduated cylinder
5. Reagent bottles and pipet dispensers
6. Distilled water in a squeeze bottle to clean pipets
7. Mercury thermometer
8. Manganous sulfate solution: Dissolve 480 g $MnSO_4 \cdot 4H_2O$, 400 g $MnSO_4 \cdot 2H_2O$, or 364 g $MnSO_4 \cdot H_2O$ in distilled water, filter, and dilute to 1 L.
9. Alkali-iodide-azide reagent: Dissolve 500 g NaOH (or 700 g KOH) and 135 g NaI (or 150 g KI) in distilled water and dilute to 1 L. Add 10 g NaN, dissolved in 40 mL distilled water. This reagent is very caustic and poisonous; do not pipet by mouth.
10. Sulfuric acid, H_2SO_4, concentrated

11. Starch: Dissolve 2 g laboratory-grade soluble starch and 0.2 g salicyclic acid, as a preservative, in 100 mL hot distilled water.

12. Standard sodium thiosulfate titrant: Dissolve 6.205 g Na2S2O3 . 5H2O in distilled water. Add 1.5 mL 6N NaOH or 0.4 g solid NaOH and dilute to 1000 mL. Standardize with bi-iodate solution

13. Standard potassium bi-iodate solution, 0.0021*M*: Dissolve 812.4 mg $KH(IO_3)_2$ in distilled water and dilute to 1000 mL

    Standardization. Dissolve approximately 2 g KI, free from iodate, in an Erlenmeyer flask with 100 to 150 mL distilled water. Add 1 mL 6*N* H_2SO_4 or a few drops of concentrated H_2SO_4 and 20.00 mL standard bi-iodate solution. Dilute the solution to 200 mL and titrate the liberated iodine with thiosulfate titrant, adding starch toward the end of titration, when a pale straw color is reached. When the solutions are of equal strength, 20.00 mL 0.0021*M* Na2S2O3 should be required. If not, adjust the Na2S2O3 solution to 0.0021*M*.

14. Electronic dissolved oxygen meter (optional).

SAMPLING PROGRAM DESIGN

1. Measure dissolved oxygen during each site visit to the wetland(s) of interest (including reference, if selected). Timing of visits should be a function of the monitoring program objectives. The most important time for the measurement is during the warmest period, when anoxia in and near the soils is most likely and when the potential for organisms to be stressed by low oxygen is highest.

2. If a site visit is lengthy, it is advisable to measure DO early in the day, when the minimum value is expected, and then at highest solar altitude, when photosynthetic activity should maximize DO.

3. Determine the spatial coverage of the sampling on the basis of the project's objectives and the wetland configuration. Some common situations that might occur include the following:

   a. there is a major surface inflow (tidal or fresh) — sample the influent water, as well as water within the wetland;

   b. there is a complex pattern of pools and/or channels with differing vegetation communities — sample the water column in representative locations; and

   c. there is a relatively homogeneous open water pool — take a single water column sample.

   Assign site designations to each sampling location, and mark them on a wetland map (see Task A1).

4. In shallow water, take a sample (or a meter measurement) at about one-third of the full depth above the bottom. In deeper water, sample about 50 cm below the surface. (Except for some estuarine sites, all wetland project sites are assumed to be sufficiently shallow to be completely mixed top to bottom. Therefore, a sample taken at a point in the water column should be representative, except possibly for a thin layer near the sediment surface where DO may be relatively more depleted.) Measure the water temperature at the same time and place.

5. The recommended sampling procedure is to draw water into the BOD bottle using the apparatus illustrated in Figure B2.1. Pump until the water has overflowed the BOD bottle about three times. Then disconnect the pump at the tubing connection and raise the tubing quickly, to prevent air bubbles from entering. Remove the rubber stopper from the jar and immediately stopper the BOD bottle without trapping any air. This procedure makes sampling near the soil surface possible, although it still may not be possible to draw from within a very thin oxygen-depleted zone. A less highly recommended, but simpler and still acceptable,

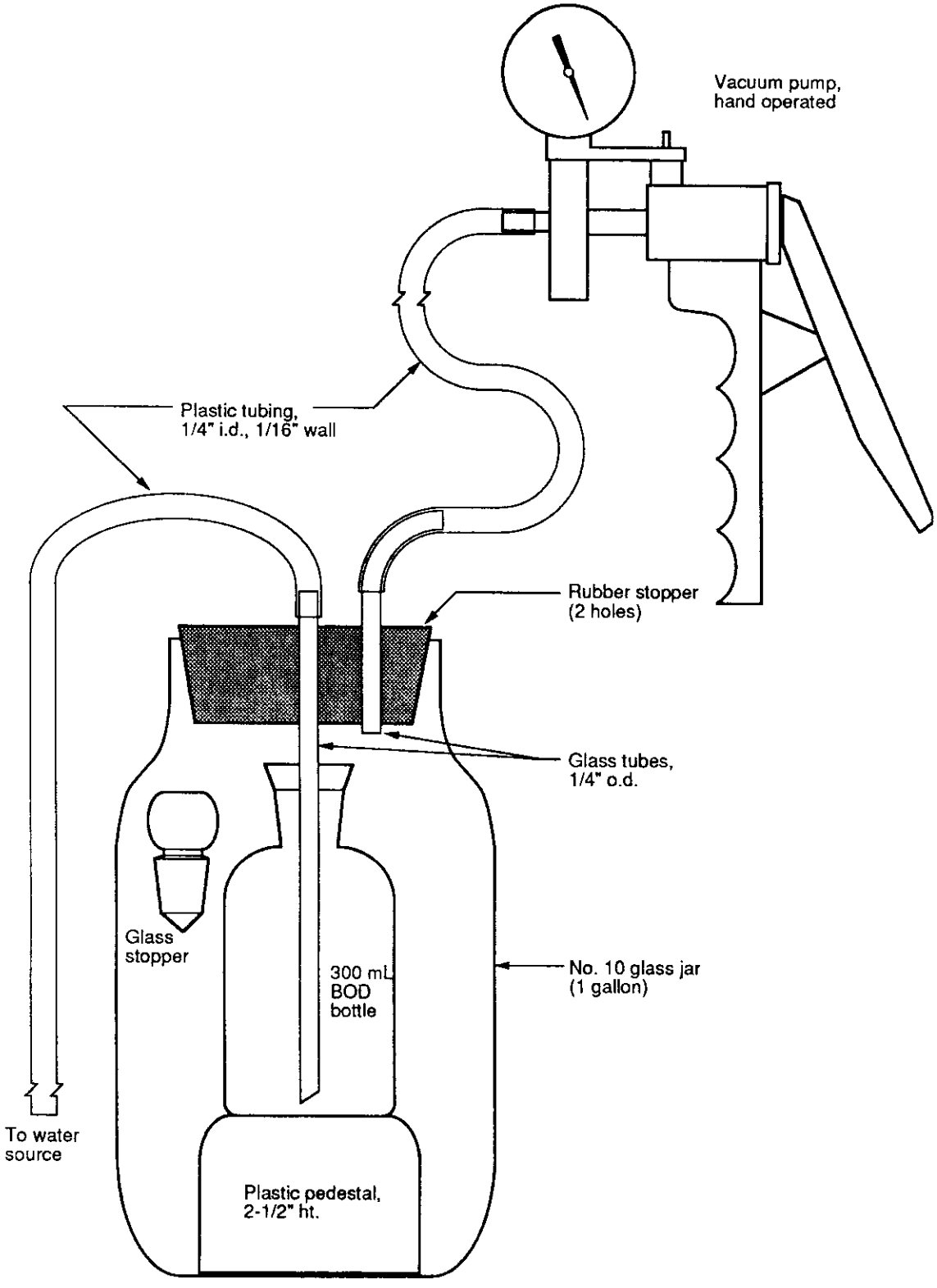

Figure B2.1. Dissolved Oxygen Sampling Apparatus

procedure is to submerge the BOD bottle at the sampling depth and stopper it under water, taking care to avoid capturing any air bubbles.

6. Analyze the sample immediately in the field according to the instructions below.

ANALYTICAL PROCEDURE

Chemical Measurement

1. By holding the tips of the pipets just below the water surface in the BOD bottle, add 1 mL of manganous sulfate solution, followed by 1 mL of alkali-iodide-azide reagent. Rinse the pipets with distilled water before returning them to the reagent bottles.
2. Stopper the bottles carefully to exclude air bubbles, and mix the solution by inverting the bottle a few times.
3. When the precipitate has settled about halfway to leave clear supernate above the floc, add 1 mL of concentrated sulfuric acid by allowing the acid to flow down the neck of the bottle.
4. Restopper the bottle and mix the solution by inverting the bottle several times until dissolution is complete.

   Note: The remaining steps should be completed immediately. However, the preceding steps have chemically fixed the DO, and researchers have found that the results will not change if the titration is performed later the same day at a more convenient location. To transport the sample, pour some distilled water around the glass stopper and cover it with aluminum foil held in place with a rubber band.
5. Pour out 99 mL from the BOD bottle and discard them.
6. Stirring continuously, titrate the remainder with the standardized sodium thiosulfate solution from the buret until a pale straw color develops.
7. Keep stirring without stopping and add 1 mL of starch solution (a blue color will appear).

8. Continue titration slowly and carefully (drop by drop near the end) until the blue color just disappears. Record the total mL (to 0.1 mL) of sodium thiosulfate used, which numerically equals the mg/L of DO. Disregard any return of the blue color.

Electronic Meter Measurement

1. Follow the manufacturer's recommendations concerning changing the probe membrane (a membrane in need of replacement is a frequent cause of poor meter performance).
2. Calibrate the meter according to the manufacturer's instructions against a sample analyzed by the chemical method above. Calibrate the meter after it has been moved to the site and intermediately if a long series of measurements is taken.
3. Read the DO according to the manufacturer's instructions.

CALCULATION

1. Express the results in percentage of saturation as follows:

$$\text{Percent saturation} = \frac{\text{Measured DO}}{\text{DO Solubility}} \times 100$$

where DO solubility is taken from Table B2.1 for the measured water temperature and estimated chloride concentration (see Task B3 for the method of estimating chloride in seawater).

DATA INTERPRETATION

The mitigation requirements will be considered to be met if, within the period designated by the mitigation plan,

1. the created wetland demonstrates the existence of the appropriate conditions in Table B2.2; or
2. if the results are being compared between the created wetland and a reference or replaced wetland, they indicate that the wetlands being compared have equivalent water quality conditions to support aquatic life.

This task should be performed throughout the monitoring program. If the mitigation requirements are not met after the designated time, or doubt exists that they will be met as the time approaches, refer to the Diagnostic Procedures for guidance.

TABLE B2.1. SOLUBILITY OF OXYGEN AT VARIOUS TEMPERATURES AND SEAWATER CONCENTRATIONS AT MEAN SEALEVEL PRESSURE

	Dissolved Oxygen (mg/l) for Stated Concentrations of Chloride, mg/l					
Temper-ature (°C)	0	5.000	10.000	15.000	20.000	Difference per 100 mg/l Chloride
0	14.62	13.79	12.97	12.14	11.32	0.0165
1	14.23	13.41	12.61	11.82	11.03	.0160
2	13.84	13.05	12.28	11.52	10.76	.0154
3	13.48	12.72	11.98	11.24	10.50	.0149
4	13.13	12.41	11.69	10.97	10.25	.0144
5	12.80	12.09	11.39	10.70	10.01	.0140
6	12.48	11.79	11.12	10.45	9.78	.0135
7	12.17	11.51	10.85	10.21	9.57	.0130
8	11.87	11.24	10.61	9.98	9.36	.0125
9	11.59	10.97	10.36	9.76	9.17	.0121
10	11.33	10.73	10.13	9.55	8.98	.0118
11	11.08	10.49	9.92	9.35	8.80	.0114
12	10.83	10.28	9.72	9.17	8.62	.0110
13	10.60	10.05	9.52	8.98	8.46	.0107
14	10.37	9.85	9.32	8.80	8.30	.0104
15	10.15	9.65	9.14	8.63	8.14	.0100
16	9.95	9.46	8.96	8.47	7.99	.0098
17	9.74	9.26	8.78	8.30	7.84	.0095
18	9.54	9.07	8.62	8.15	7.70	.0092
19	9.35	8.89	8.45	8.00	7.56	.0089
20	9.17	8.73	8.30	7.86	7.42	.0088
21	8.99	8.57	8.14	7.71	7.28	.0086
22	8.83	8.42	7.99	7.57	7.14	.0084
23	8.68	8.27	7.85	7.43	7.00	.0083
24	8.53	8.12	7.71	7.30	6.87	.0083
25	8.38	7.96	7.56	7.15	6.74	.0082
26	8.22	7.81	7.42	7.02	6.61	.0080
27	8.07	7.67	7.28	6.88	6.49	.0079
28	7.92	7.53	7.14	6.75	6.37	.0078
29	7.77	7.39	7.00	6.62	6.25	.0076
30	7.63	7.25	6.86	6.49	6.13	.0075

TABLE B2.2. DISSOLVED OXYGEN CRITERIA

Functional Objective	Criterion	Reference[a]
Coldwater fish spawning and rearing	> 7 mg/L	3
Coldwater fish feeding	> 6 mg/L	3
Coldwater fish refuge and migration	> 5 mg/L	1, 3
Warmwater fish and aquatic invertebrate production	≥ 4 mg/L	2, 3, 4

[a]1–Bell 1973; 2–Ziser 1978; 3–Welch 1980; 4–Tonn and Magnuson 1982.

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TASK B3

SPECIFIC CONDUCTIVITY MEASUREMENT

OBJECTIVE

The objective of this task is to obtain a general indication of the quantity of dissolved solids in the surface water, which is useful in both judging the water quality for wetland organisms and making inferences concerning the groundwater supply to the wetland.

BACKGROUND

Conductivity is a measure of the ability of water to conduct an electric current. This ability is temperature-dependent, and specific conductivity is a measure based on a specific reference temperature.

An electrical current represents the movement of positive and negative electrical charges. In solution, solids are present as positively or negatively charged ions. The relationship of conductivity to ionized matter concentration varies, in general, with both the types and relative amounts of ions present. However, at relatively low concentrations the ions move and behave independently, and the conductivity-concentration relationship is nearly linear. Temperature comes into play by affecting the velocity of ion movements.

Although only a general indicator of all dissolved quantities rather than a measure of any particular substance, specific conductivity is easy to measure and has several important uses in water quality analyses. First, it indicates the salinity of a sample and may be used to establish the proportion of seawater present. Conductivity is related to fertility and the alteration of water quality by many soluble pollutants. Thus, it can be an indicator of the existence of a contamination problem, while not, however, identifying the specific nature of the problem. Finally, conductivity variation in a water-body can signal the entrance of groundwater with a dissolved solids concentration that differs from surface contributions.

Conductivity is measured with a meter that emits a tiny electrical signal in the sample and measures the conductivity of the medium between two electrodes. Since conductance is the inverse of resistance, its unit, mho, is a transposition of the unit for resistance, ohm. Recently, this unit was termed the sieman (S) in the SI system of units. The usual magnitudes in natural waters make the measurement numerically most convenient by expressing its results in micromhos (μmhos) or microsieman (μS). Because the measurement is usually performed with two electrodes 1 cm apart, conductivity is usually reported as μmhos/cm or μS/cm.. The most common base temperature for the expression of specific conductivity is 25°C. The temperature of the sample during analysis must be taken. Some meters allow temperature compensation. If not, a factor must be applied to correct from the sample temperature to the base temperature (see below). The use of a common base allows comparison among samples that may have been analyzed at different temperatures. The following method was derived from and is consistent with American Public Health Association (1985) Method 205.

Because of the natural variability in specific conductivity associated with differing solubilities of parent geological materials, no particular index values can be selected to use as a gauge for pollution. Instead, relative specific conductivities between sites and over time must be judged. Data collected by one of the authors during the current and other recent projects in western Washington have shown that natural wetlands and other freshwaters usually exhibit values under 200 μmhos/cm because of their relatively insoluble igneous parent materials. However, in eastern Washington much higher readings (500-10,000 μmhos/cm) are common.

EQUIPMENT AND SUPPLIES

1. Conductivity meter and electrode or cell
2. Mercury thermometer
3. Screw-top poly bottle(s) for sampling

4. 250-mL beaker

5. Distilled water in a squeeze bottle to clean the electrode

6. 0.00702 N potassium chloride solution to check the cell constant periodically (see below)

SAMPLING PROGRAM DESIGN

1. Perform the specific conductivity measurement during each site visit to the wetland(s) of interest (including reference, if selected). Timing of visits should be a function of the monitoring program objectives. Generally, the timing can be equivalent to that established for pH and dissolved oxygen measurements. If there is a chance that unusual quantities of dissolved solids could enter the wetland at times when these other measurements would not ordinarily be planned (e.g., during runoff of deicing salt from a highway), the schedule should be modified to accommodate coverage of such an event. During the first year, samples should be obtained from other surface waters near the wetland (as well as groundwaters, if there is an interest in groundwater exchange). Data on conductivities in nearby wetlands, streams, and lakes can define prevailing local conditions and aid in interpretation of the results from the wetland of interest.

2. Determine the spatial coverage of sampling on the basis of the project's objectives and the wetland configuration. Some common situations that might occur include the following:

   a. there is a major surface inflow (tidal or fresh) — sample the influent water, as well as water within the wetland;

   b. there is a complex pattern of pools and/or channels with differing vegetation communities — sample the water column in representative locations;

   c. there is a relatively homogeneous open water pool — take a single water column sample; and

d. there is interest in gaining some qualitative understanding of groundwater contribution — sample for specific conductivity measurements in a series of locations around and across the wetland.

Assign site designations to each sampling location, and mark them on a wetland map (see Task A1).

3. To sample, dip a container by hand in an area that is undisturbed by your presence. In shallow water, take the sample at about one-third the full depth above the bottom. In deeper water, sample about 50 cm below the surface. (Except for some estuarine sites, all wetland project sites are assumed to be sufficiently shallow to be completely mixed top to bottom. Therefore, a sample taken at a point in the water column should be representative.)

4. Analyze the sample as soon as possible after collection according to the instructions below. Until analysis, store the sample on ice or in a refrigerator at 4°C.

ANALYTICAL PROCEDURE

1. If the conductivity meter cell constant is unknown or in doubt, check it as follows. Prepare a 0.00702 N potassium chloride standard solution by dissolving 0.0373 g KCl, oven dried at 180°C for 1 hour, in 1 L of distilled water. This electrolyte has a specific conductivity of 74 µmho/cm at 25°C. Determine the cell constant by dividing this value by the measured conductivity at 25°C (the constant should be 1.0, or very close to it). The cell constant should be checked several times a year.

2. Follow the instructions with the conductivity meter.

3. Measure the sample temperature during the analysis and either compensate with the meter adjustment or correct it as described below.

4. Rinse the electrode or cell with distilled water after use.

CALCULATIONS

1. Correct for cell constant and temperature, if necessary, as follows:

   Specific conductivity = measured conductivity x cell constant x temperature correction factor where the temperature correction factor is that from Table B3.1.

2. If the saturation level of the dissolved oxygen is to be determined in saline water, estimate the chloride concentration in mg/L by dividing specific conductivity in µmho/cm by 2.14 (convert it from millimho/cm if it was originally in one of those units). Use the result in Task B2.

DATA INTERPRETATION

The mitigation requirements will be considered to be met if, within the period designated by the mitigation plan,

1. the created wetland exhibits water quality conditions consistent with the needs of aquatic life native to the region; or
2. if the results are being compared between the created wetland and a reference or replaced wetland, they indicate that the wetlands being compared have equivalent water quality conditions to support aquatic life.

TABLE B3.1. CORRECTION FACTORS FOR SPECIFIC CONDUCTIVITY DETERMINATION

Temperature ℃	Correction Factor	Temperature ℃	Correction Factor
2	1.70	14	1.25
3	1.65	15	1.22
4	1.61	16	1.19
5	1.57	17	1.16
6	1.53	18	1.14
7	1.49	19	1.12
8	1.45	20	1.10
9	1.41	21	1.08
10	1.37	22	1.06
11	1.34	23	1.04
12	1.31	24	1.02
13	1.28	25	1.00

Establish the conditions consistent with the needs of native aquatic life by surveying other surface waters in the vicinity of the created wetland (see Sampling Program Design), if possible. In western Washington, specific conductivities of natural freshwaters are usually less than 200 µmhos/cm. Higher readings may be, but are not necessarily, a sign of contamination. A much larger range (500-10,000 µmhos/cm) prevails in eastern Washington. Therefore, local data are more essential for interpretation.

Specific conductivity data can also be evaluated to determine whether the wetland is serving a groundwater discharge function. Because of contact with geological materials, groundwater inflows usually have higher conductivities than surface waters. However, if surface contamination is present, unaffected groundwater may have lower conductivity. In either event, local anomalies within the wetland may be attributable to groundwater discharge (Adamus et al. 1987, p. 87).

This task should be performed throughout the monitoring program. If the mitigation requirements are not met after the designated time, or doubt exists that they will be met as the time approaches, refer to the Diagnostic Procedures for guidance.

REFERENCES

American Public Health Association, *Standard Methods for the Examination of Water and Wastewater*, 16th Ed., American Public Health Association, Washington, D.C., 1985.

Adamus, P.R., E.J. Clairain, Jr., D.R. Smith, and R.E. Young, "Wetland Evaluation Technique (WET), Volume II: Methodology," Waterways Experiment Station, Corps of Engineers, Vicksburg, MS, 1987.

TASK B4

DETERMINATION OF POLLUTANT REMOVAL AND RETENTION (Detailed Analysis)

OBJECTIVE

The objective of this task is to employ observations and the results of other tasks to draw inferences concerning the performance of the pollutant trapping function of wetlands.

BACKGROUND

Pollutant trapping is a recognized wetland function that reduces contaminant transport further downstream and may prevent potential impacts in those locations. Most attention in the past has been directed at the special case of sediment trapping, which is covered separately by Task C3. This special attention is appropriate for several reasons: the fact that many chemical contaminants are combined with and transported by the sediments; the wetland soil-building mechanism represented by sediment deposition; and the relatively long recognition and study of sedimentology functions of wetlands. Nevertheless, at times more specific evaluation of the created wetland's capture of certain pollutants may be appropriate. Such situations may occur when the wetland that has been replaced was well recognized for protecting a sensitive receiving water by interrupting pollutant transport, and the new wetland has been created to serve the same purpose.

Water pollutants in a number of categories can potentially be removed from an inlet stream and retained in a wetland. In addition to solids, these categories include nutrients, oxygen-demanding materials, metals, xenobiotic organics, pathogenic microorganisms, and salts (especially chlorides). Many specific chemical elements, ions, and compounds are represented by these categories. Thus, generalizations about their nature are difficult to make. However, frequently the solids in land runoff transport the majority of the total mass of the various substances, except for certain nutrients and the chlorides. Metals differ in solubility, and thus in their degree of association with the solids, but solid-phase

transport is dominant overall. Therefore, in general, interrupting pollutant transport is largely a matter of stopping sediment travel. Also, monitoring the pollutant removal function of a wetland depends most on understanding solids capture.

Comprehensive, direct monitoring of pollutant removal and retention is a large undertaking. Ideally, it involves extensive measurements to construct an inflow/outflow mass balance for the pollutant(s) of interest. However, wetlands have features that are much easier to measure or observe than water pollutant mass balances and that are associated with the pollutant trapping function. Some of these features can be provided through the design and construction of the wetland replacement area, and many can be characterized by methods outlined in other tasks. This task emphasizes the measurements and observations needed to evaluate the function through this more indirect but more feasible technique.

The essential monitoring for developing a mass balance is wet and dry weather flow measurement and water sampling at the inlet(s) and outlet(s), followed by analysis of pollutant concentrations. Mass flow rates are then the products of water flow rates and concentrations. Year-round coverage is necessary to determine the permanence of pollutant capture. Sophisticated flow measurement, sampling, and analytical techniques are required. Auxiliary monitoring may also be considered in some instances, particularly hydrologic and water quality measurements on precipitation and groundwater. In view of the complexity of comprehensive monitoring of this type, and the specialized knowledge needed to perform it, transportation agencies should contract for the expertise if functional objectives require such monitoring. Techniques for sample collection and flow estimation applicable to this task were developed during the Washington State Highway Runoff Water Quality Research Program (Clark and Mar 1980).

OBSERVATIONAL AND MEASUREMENT PROGRAM

The following observations and measurements contribute toward a qualitative judgment concerning the development of a created wetland to serve the pollutant removal and retention function. The equivalence between a created and the original or a reference wetland in these features is an indication of equivalent water quality functioning. The generalized guidelines presented originate from the research findings on land treatment of contaminated waters, as reported by a number of sources, including Wang et al. (1982), Overcash and Pal (1979), Canning (1985), Schueler (1987), and Horner (1986, 1988b). For a review of these concepts, see Horner (1985, 1988a).

Hydrologic and Hydraulic Features

1. The existence of a pool of water, shallow sheet flow, or multiple flow channels is more favorable to pollutant capture than a highly channelized configuration.
2. Maximizing water residence time and preventing short circuiting of the flow between inlet and outlet favors pollutant removal. For pollutant removal, the residence time should be the longest possible period, but in all cases at least 36 hours. Residence time can be established by a survey with a nontoxic, biodegradable dye, such as sodium fluorescein.
3. Low entrance velocity prevents resuspension of settled solids, and low velocity of flow through the wetland favors pollutant reduction. Entrance velocity should be 10 cm/s or less, and average velocity of flow through the wetland should be no more than 5 cm/s. Velocity can be measured with a current meter or approximated by timed measurement of dye or float travel.
4. Maintenance of relatively shallow depth ($\leq$ 1 meter) improves pollutant capture and retention by allowing better mixing and aeriation, thus stimulating biological and chemical oxidation of contaminants. Restricting depth also maximizes light penetration through the water volume, supporting photosynthetic processes that are

associated with pollutant uptake. **Tasks A4 and A5** cover water depth monitoring.

Chemical Features

1. Pollutant removal and retention generally decline as pH decreases below approximately 5.5 to 6.0, depending on the contaminant. Near-neutral and alkaline pH is generally favorable to the pollutant trapping function. **Task B1** concerns pH measurement.
2. The pollutant capture function is favored by oxygenated waters and soils. Anaerobic conditions restrict biodegradation, prevent chemical oxidation, and cause the release of some substances, such as phosphorous, which are bound to aerobic sediments. **Task B2** covers dissolved oxygen measurement.
3. Specific conductivity is a general measure of dissolved quantities in water. Conductivity surveys at the inlet(s) and outlet(s) of wetlands may provide some indication of the degree of soluble contaminant retention within the system. **Task B3** describes specific conductivity measurement.

Soil Features

1. Organic soils favor pollutant capture by supporting biological and chemical removal processes. **Task C1** concerns organic content measurement.
2. Moderate soil texture (tending neither toward extreme clay or extreme sand) is favorable to the pollutant trapping function by also supporting helpful biological and chemical processes. In addition, medium textures allow soil infiltration by water without permitting very rapid travel to groundwater that could degrade its quality. **Task C2** covers soil texture measurement.
3. As discussed above, sediment accumulation is a sign of the capture of numerous pollutants besides solids. **Task C3** concerns this function.

Vegetation Features

1. Fine herbaceous vegetation assists filtration and gravity settling of solids and uptake of dissolved substances, and thus is generally more favorable to pollutant trapping than woody plants. **Task D1** concerns characterization of the plant community.

2. Dense vegetation coverage likewise assists these pollutant removal processes. **Task D1** applies to coverage observation and measurement.

3. Phytoplankton cells in water pools assimilate dissolved nutrients and other substances and deliver them to the sediments when the cells die and sink. **Task D2** covers phytoplankton biomass measurement.

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C. SOIL AND SEDIMENT TASKS

TASK C1

SOIL ORGANIC CONTENT MEASUREMENT

OBJECTIVE

The objective of this task is to determine soil organic content as an aid in evaluating both soil development substrate conditions for wetland organisms and the wetland's ability to perform certain functions.

BACKGROUND

Organic content is a fundamental soil property and an important determinant of physical, chemical, and biological processes in the substrate of a wetland. Changes in organic content over time also reflect soil development after a system has been created or disturbed. Organics increase the water-holding capacity of a mineral soil, as well as its ability to absorb ions from solution. Organic molecules also incorporate nutrients, such as nitrogen and phosphorous. Therefore, organics aid the retention of nutrients in the root zone for potential uptake by plants. Organic soils also have a greater capacity to assimilate pollutants, such as heavy metals, than soils low in organic content. Decomposition of organic material by bacteria and fungi consumes oxygen and imparts the characteristic reducing quality of hydric soils. Organic humic and fulvic acids, associated with typical bog vegetation, are responsible for the acidic nature of those systems.

Organic soils are built by accumulation of the detritus of primary producers and consumers inhabiting an ecosystem, as well as through import from the surroundings. Principal sources in wetlands are resident macrophytic plants and planktonic (water column) and periphytic (attached) algae. Therefore, the organic soil development follows primary producer community development and is, in a sense, an index of it. Wetland soils are classified as "mineral" if they are composed largely of sand, silt, and/or clay, with organic content being less than 20-35 percent, and as "organic" if it is greater than 20-35 percent (Mitsch and Gosselink 1986). Some mineral soils may have thick organic surface

layers, yet they are still composed largely of mineral matter. Organic soils can be peat (having undecomposed organic material) or muck (in which organic material is largely decomposed). Well developed wetland soils can have very high organic contents, frequently exceeding 50 percent by weight. All organic soils (as defined above), with the exception of folists (briefly saturated tropical or boreal mountain soils), are hydric soils. Appendix C lists the hydric soils of Washington state.

To analyze soil organic content, the loss on ignition method is recommended for routine wetland mitigation project monitoring. In this technique a weighed soil sample is volatilized in a 600°C furnace and reweighed to determine ash content. The difference, expressed as a percentage of the original mass, is an indicator of the sample's organic content. This method is an accurate indicator except in calcareous soils. Calcium carbonate can be volatilized or decomposed and falsely augment the apparent organic content. No western Washington soils are in this category, but some eastern Washington soils are calcareous. If a soil of this type is involved, the possible range of error can be estimated by determining the calcium carbonate content and assuming that the actual organic content is lower than the percentage loss on ignition by an amount up to the calcium carbonate percentage. The calcium carbonate determination is straightforward, but a soil chemist should be consulted to make the measurement.

EQUIPMENT AND SUPPLIES

1. Soil corer for sampling to at least 7.5 cm depth
2. Plastic sample bags, minimum 125 g capacity
3. Labels, Rite-in-the-Rain
4. Evaporating dish
5. 103°C drying oven
6. 600°C furnace
7. Analytical balance to weigh to ± 0.0001 g
8. Dessicator

SAMPLING PROGRAM DESIGN

1. Sample for soil organic content measurement during an initial visit to each wetland of interest (including reference, if selected). Repeat after one year and then at three-year intervals as long as the study proceeds.
2. Use the same samples for both soil organic content and texture analysis (see Task C2). Sample along the transects selected in Task A2. The total number of samples taken should be determined by the size and configuration of the wetland and the apparent variability in soil types present. In most wetlands of the size and characteristics encountered in wetland mitigation project analysis, five to ten samples will usually be adequate.
3. Randomly select two points along each transect as sampling locations. Be careful to avoid trampling vegetation that will be characterized in Task D1. Assign a site designation to each sampling location and mark it on the map (see Task A1).
4. Take a 7.5 cm deep soil core at each sampling location (unless deeper topsoil has been placed in the created wetland). If 100 g of material will probably not be available for allocation to the organic content analysis (plus additional mass for soil texture analysis; see Task C2), collect another core within 10 cm. Put the sample in a labeled plastic bag. Note whether any substantial amount of rock was encountered while coring.
5. Pool the samples for analysis when the same substrate is encountered. Analyze them separately when substrates differ.

ANALYTICAL PROCEDURE

1. Place the empty evaporating dish to be used in the analysis in a 600°C furnace for one hour, cool it in a dessicator, weigh it to the nearest 0.0001 g (record as W_1) on an analytical balance, and keep it in the dessicator until use.
2. Put 100 g of sample in the prepared evaporating dish. Place the dish and sample in a 103°C oven overnight, cool them in a dessicator and weigh them as before (W_2).

3. Place the dish and sample in a 600°C furnace for one hour, cool them in a dessicator and weigh them as before (W_3).

CALCULATIONS

1. Calculate the percentage loss on ignition to = $\frac{W_2 - W_3}{W_2 - W_1} \times 100$.

DATA INTERPRETATION

The mitigation requirements will be considered to be met if, within the period designated by the mitigation plan,

1. the created wetland exhibits consistently increasing organic content, indicative of the development of a soil conducive to plant growth and the performance of various wetland functions; or
2. if the results are being compared between the created wetland and a reference or replaced wetland, they indicate that the wetlands being compared have equivalent soils and nonsoil substrates.

If the mitigation requirements are not met the designated time, or doubt exists that they will be met as the time approaches, refer to the Diagnostic Procedures for guidance.

REFERENCES

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TASK C2

SOIL TEXTURE ANALYSIS

OBJECTIVE

The objective of this task is to define the soil's physical structure as an aid in evaluating both substrate conditions for wetland organisms and the wetland's ability to perform certain functions.

BACKGROUND

Soils are porous systems composed of individual particles of various sizes. Individual particles are aggregated together, forming peds or aggregates. A fundamental soil property is the particle size distribution, which expresses the proportions of individual particles in each size range, such as sand, silt, and clay. Soil texture refers to the overall mix of these ranges.

Texture is related to other physical properties, such as

- **structure** — size, shape, and strength of the layer units into which the individual particles are aggregated;
- **porosity** — the proportion of the total volume that is void of particles and can contain air or water;
- **pore size distribution** — the proportion of pores in each size range; and
- **bulk density** — the weight of dry material per unit total volume of soil sample.

Soil texture is a fundamental characteristic of wetland environments. Texture and the related physical properties determine a soil's capacity to receive and retain air and water and its response to tillage and compaction. In turn, these factors have many potential biological effects, such as the relative success of seed germination and plant rooting, support for microorganisms, ability of fish to spawn, and accommodation of burrowing animals.

Soils usually have a continuous range of particle sizes, but in practice three groupings are conventionally defined, namely sand (0.06 to 2.0 mm), silt (0.002 to 0.06 mm), and clay (< 0.002 mm). Loams are soils of medium texture composed of a mix of sand, silt, and clay. Nonsoil components, such as gravel, rocks, and boulders, can also be taken into account. The complex is sometimes referred to as "soils and nonsoil substrates."

Soils of medium texture (e.g., loams and silt loams) are more conducive to the performance of most wetland functions than soils at either the coarse (sand) or fine (clay) extremes. The finer particles best retain nutrients to stimulate plant growth (Adamus et al. 1987, p. 109), although extremely fine textures do not allow good water or root penetration. Groundwater recharge is associated with soils of somewhat restricted infiltration, although without underlying impervious strata (discharge tends to occur with very coarse material) (Adamus et al. 1987, p. 90). Aquatic organism diversity and abundance is favored by substrates finer than sands (Whitlatch 1980, Beckett et al. 1983, Anderson and Day 1986, Adamus et al. 1987, p. 118). Salmonid fish depend on unsilted gravels for spawning and rearing habitat (Platts et al. 1979, Shirazi and Seim 1979, Hale et al. 1985, Raleigh and Nelson 1985).

Numerous methods are available for particle size analysis. Generally, all methods depend on sieving to separate coarser fractions and measuring the rate of sedimentation from a suspension to separate finer material. A prerequisite to the successful use of any method is disaggregation and dispersion of the sample. Surface tension, carbonates, colloidal iron and aluminum oxides, organic matter, electrolytes, and certain cations all tend to aggregate soils. Therefore, analysis is most accurate when these agents are insignificant or are removed.

The best analytical method (ASTM D422-63 [1972]) incorporates appropriate preparatory steps, sieving of the coarsest material, and a series of hydrometer readings to quantify the fines. This method is very time consuming and, therefore, expensive to process each sample. Frequent soil variability among the different wetland zones suggests

that effort can be better placed in characterizing the various microhabitats than in obtaining the fullest analysis of a single sample. A short procedure by Ugolini (1987) is available to obtain the essential particle size breakdown through one sieving operation, if necessary, and two hydrometer readings over two hours. This method has been tested on a variety of soil samples alongside ASTM D 422-63 [1972] and has been found to generally agree with that method within 5 percent (clay fraction), except in two of 12 soils tested, where the deviation was up to 25 percent. The short method is least satisfactory in soils with very high organic contents (> 50 percent). An even simpler method is to use a commercial soil texture kit, which is usually accurate enough to obtain the data needed to read a soil texture chart.

EQUIPMENT AND SUPPLIES

1. Soil corer for sampling to at least 7.5 cm depth
2. Plastic sample bags, minimum 125 g capacity
3. Labels, Rite-in-the-Rain
4. No. 10 U.S. Standard sieve (2 mm)
5. One-liter graduated cylinder and plunger (plastic or glass rod)
6. Hydrometer graduated in g/L and calibrated at 68°F (20°C)
7. Mercury thermometer
8. Balance to weigh $\pm$ 0.1 g
9. 103°C drying oven
10. Stop watch
11. Five percent Calgon solution
12. Distilled water
13. Soil texture kit (optional)

SAMPLING PROGRAM DESIGN

1. Sample for soil texture analysis during an initial visit to each wetland of interest (including reference, if selected). Repeat the sampling after one year and then at three-year intervals as long as the study proceeds.
2. Use the same samples for both soil texture and organic content analyses (see Task C1). Sample along the transects selected in Task A2. The total number of samples taken should be determined by the size and configuration of the wetland and the apparent variability in soil types present. In most wetlands of the size and characteristics encountered in wetland mitigation project analysis, five to ten samples are usually adequate.
3. Randomly select two points along each transect as sampling locations. Be careful to avoid trampling vegetation that will be characterized in Task D1. Assign a site designation to each sampling location, and mark it on the map (see Task A1).
4. Take a 7.5 cm deep soil core at each sampling location (unless deeper topsoil has been placed in the created wetland). If at least 80 g of soil, exclusive of gravel and rocks, will not be available for allocation to the soil texture analysis (plus additional mass for organic content measurement; see Task C1), collect another core very nearby. Put the sample in a labeled plastic bag. Note whether any substantial amount of rock was encountered while coring.
5. Pool the samples for analysis when the same substrate is encountered. Analyze them separately when the substrates differ.

ANALYTICAL PROCEDURE

1. Numerous samples can be run simultaneously by using a number of graduated cylinders, so long as careful track is kept of the sedimentation times.
2. Calibrate the hydrometer as follows: add 100 mL of Calgon solution to a graduated cylinder, and bring up the level to the 1 L mark with distilled water. Mix with the plunger, and record the temperature. Lower the hydrometer into the solution

carefully. Read the scale at the upper edge of the meniscus surrounding the hydrometer stem (record this reading as the correction for hydrometer volume, R_L).

3. Air dry the sample and mix it well.

4. Weigh out 40 g of soil, dry it for two hours at 105°C and reweigh it and record (W_D).

5. If any gravel or rocks are or might be present, weigh out a 40 g subsample of air-dry soil and sieve it through the No. 10 sieve. Weigh the material caught on the sieve (W_G). If 40 g is too little to produce a representative sample, repeat steps 4 and 5 with a larger mass.

6. Place another 40 g subsample of air-dry soil in a 1 L graduated cylinder, add 100 mL of Calgon solution, and fill the cylinder to the 1 L mark with distilled water.

7. Insert the plunger and move it up and down to mix the contents thoroughly (caution: hold the cylinder firmly with the free hand and move the plunger cautiously to avoid spillage). Use strong upward strokes near the bottom to lift any settled particles into suspension (incline the cylinder slightly and rotate it if necessary). Finish with two or three smooth strokes and remove the plunger, tipping it slightly to remove adhering drops. Start the stop watch immediately.

8. Lower the hydrometer carefully into the suspension. After 40 seconds, read the scale at the top of the meniscus and record (R_{40s}). Remove the hydrometer.

9. At 10 seconds before the two-hour point, lower the hydrometer carefully again and read the scale at the top of the meniscus and record (R_{2h}).

CALCULATIONS

1. Correct all hydrometer readings for temperature, if necessary. For each 1°F above 68°F, add 0.2 g/L. For each 1°F below 68°F, subtract 0.2 g/L.

2. Calculate % (silt + clay) $= \dfrac{(R_{40s} - R_L) \times 100}{W_D}$

where R_{40s} and R_L are corrected according to Step 1.

3. Calculate % clay = $\frac{(R_{2h} - R_L) \times 100}{W_D}$

where R_{2h} and R_L are corrected according to Step 1.

4. Calculate % silt = % (silt + clay) - % clay.

5. Calculate % (sand + gravel) = 100% - % (silt + clay)

6. Calculate % gravel = $\frac{W_G}{W_D} \times 100$

7. Calculate % sand = % (sand + gravel) - % gravel.

8. Use the USDA soil texture triangle (Figure C2.1) to characterize the texture of the sample. If any gravel is present, append the term "gravelly" to the beginning of the classification (e.g., gravelly sandy loam).

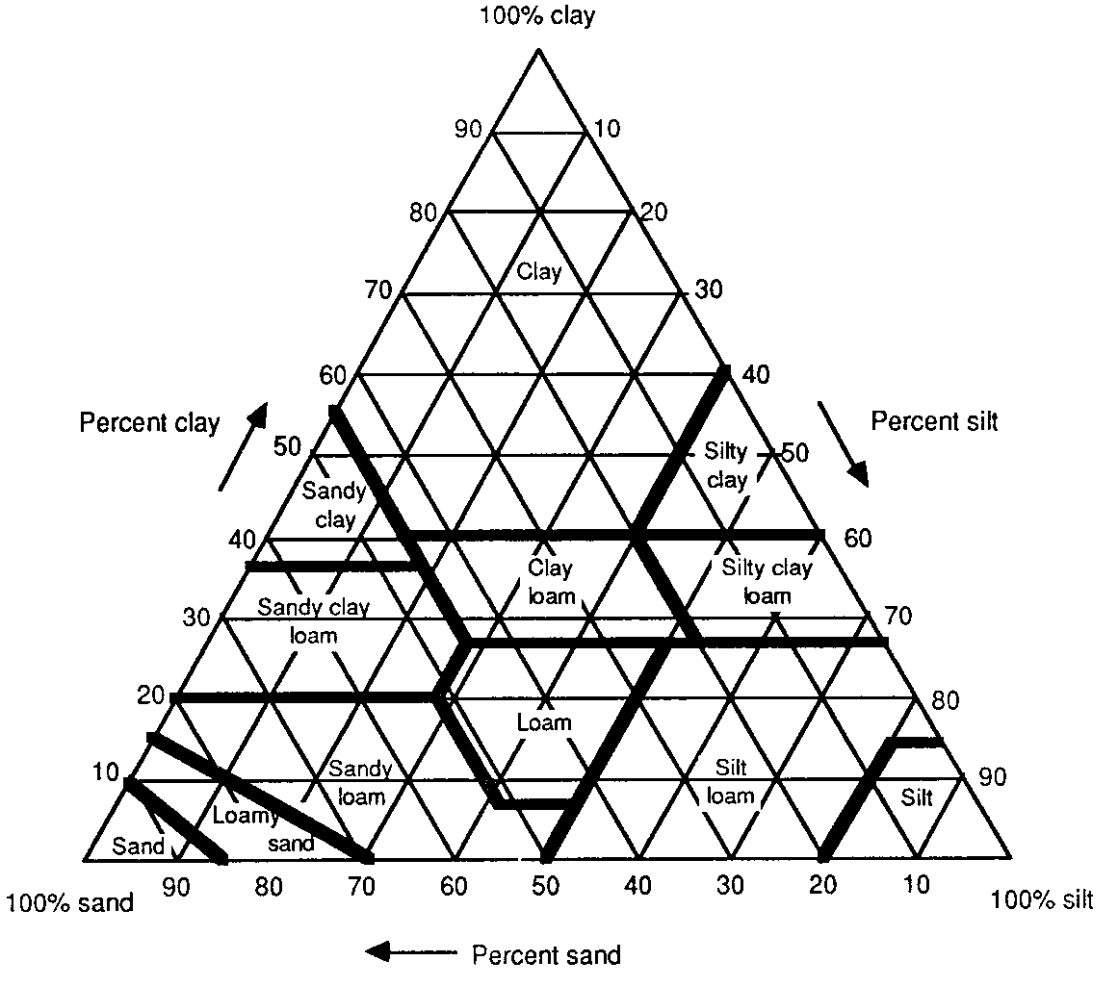

Figure C2.1. Textural Triangle U.S.D.A.

DATA INTERPRETATION

The mitigation requirements will be considered to be met if, within the period designated by the mitigation plan,

1. the created wetland exhibits such conditions as the following:
   a. textures generally in the medium ranges and without substantial stoniness, which generally promotes good plant growth (Adamus et al. 1987, p. 109);
   b. textures finer than sand, to promote aquatic organism diversity and abundance (Whitlatch 1980, Beckett et al. 1983, Anderson and Day 1986, Adamus et al. 1987, p. 118);
   c. gravels, which are favorable to spawning and rearing (if fish propagation is an objective) (Platts et al. 1979, Shirazi and Seim 1979, Hale et al. 1985, Raleigh and Nelson 1985);
   d. relative fine texture, if water storage or groundwater recharge is an objective; or
2. if the results are being compared between the created wetland and a reference or replaced wetland, they indicate that the wetlands being compared have equivalent soils and nonsoil substrates.

If the mitigation requirements are not met after the designated time, or doubt exists that they will be met as the time approaches, refer to the Diagnostic Procedures for guidance.

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TASK C3

SEDIMENT ACCUMULATION GAGING

OBJECTIVE

The objective of this task is to obtain measurements of sediment accumulation as an aid in evaluating soil development, substrate conditions for wetland organisms, and the performance of sediment trapping and water storage.

BACKGROUND

Sediment trapping is a recognized wetland function that reduces sediment transport further downstream and may prevent potential impacts in those locations. Sediment deposition is also a soil-building mechanism that can facilitate development of a soil profile in a newly created wetland. On the other hand, an excessive rate of sediment accumulation may be detrimental to the wetland. Therefore, the sediment accumulation rate is of interest to judge the performance of the sediment trapping function and to evaluate the degree and rate of change in water storage capacity and general benthic habitat characteristics. Vertical sediment accretion rates have been reported in a number of wetland environments, as given in Table C3.1 in the Data Interpretation section.

Quality of sediment is also an issue, in terms of both texture and pollutants that may be transported with the entering solids. Task C2, supplemented by C1, assesses texture and organic content. Task B4 can be used to obtain information on influent contaminants, if the procedure is warranted by project objectives.

A number of techniques of measuring sediment accretion have been reported in the literature (Baker and Wolff 1987). The most common have been sediment traps, which are open-top containers in a variety of shapes and sizes. Another method potentially useful in wetlands is measuring accretion as the difference between the soil surface and the top of a rod (e.g., a bamboo cane) pushed into the substrate (Ranwell 1964). Since this method is

somewhat inconvenient in water too deep for working on foot or where visibility is limited, the use of some form of sediment trap is recommended for created wetland investigations.

In an assessment of sediment trap collection efficiency, Hargrave and Burns (1979) found that, in turbulent water, efficiency increased as aspect ratio (height : mouth opening) increased up to an approximate value of five. However, efficiency was independent of this ratio in calm water. As a consequence, tray designs did not perform well in turbulent conditions but were efficient in calm waters. Since wetland environments are relatively quiescent, trays are expected to be adequate in these applications. A design of this type is recommended for created wetland sediment accretion gaging. In the event that a site will experience some turbulence, a cylindrical design with an aspect ratio of at least five is recommended.

Placement of sediment traps depends on the pattern of deposition expected or for which one wishes to monitor. Where the objective is to compare the performance of the sediment trapping function to a replaced or reference wetland, measuring at several spots in the major deposition zone(s), near the inlet(s), is probably adequate. If the objective is to gage the loss of water storage capacity, a more widespread determination may be necessary.

EQUIPMENT AND SUPPLIES

1. Sediment trap assembly (see Figure C3.1)
2. Compass
3. Tape measure
4. Ruler
5. Soil corer

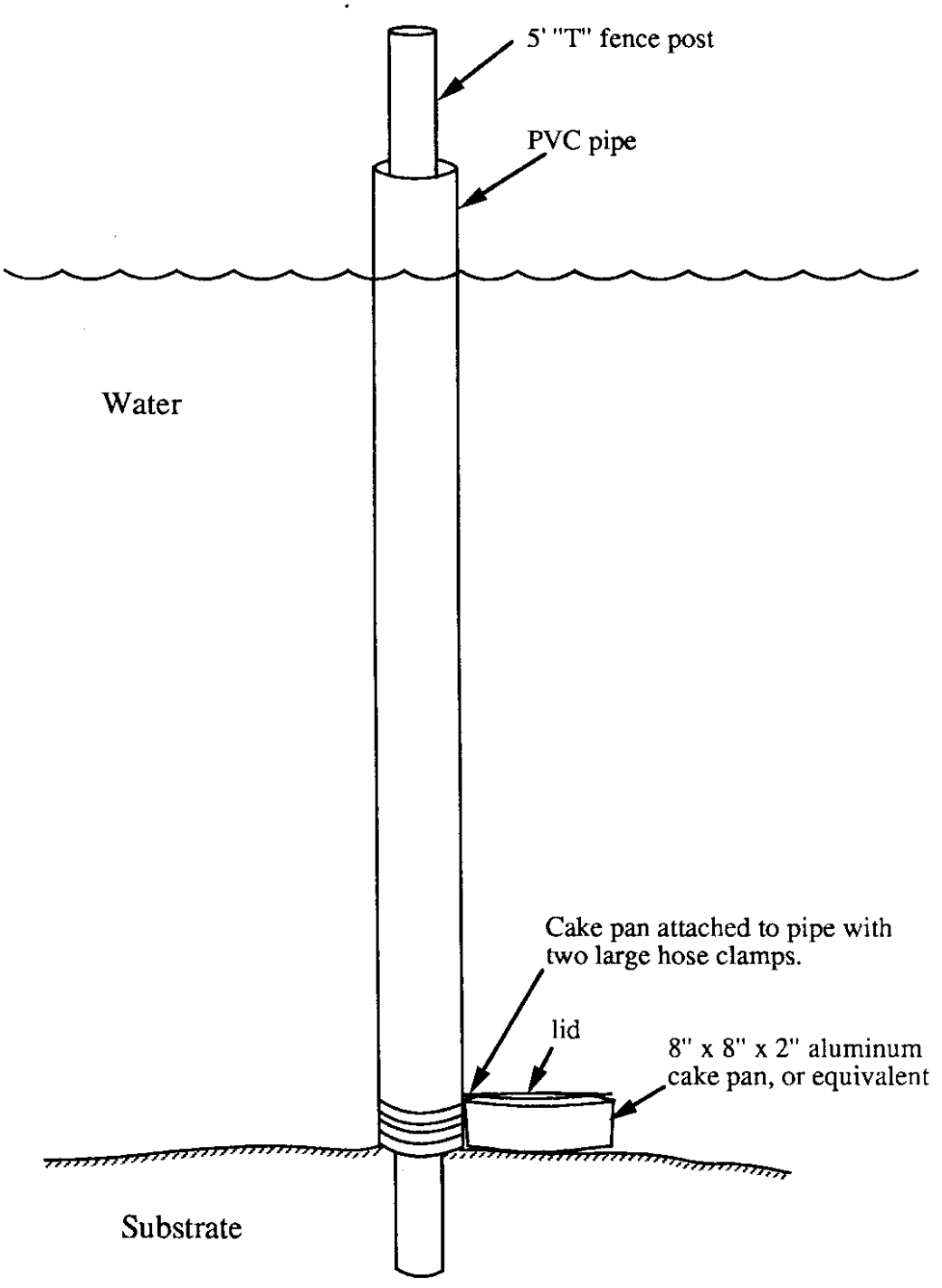

Figure C3.1. Sediment Trap Assembly

SAMPLING PROGRAM DESIGN

1. Determine the number and location of sediment traps on the basis of the project's objectives and the wetland configuration. Some common situations that may occur include the following:

   a. the objective is to compare sediment trapping in the mitigation and another wetland — place at least one trap in the expected deposition zone(s) near each major inlet; and

   b. the objective is to estimate the overall sediment accretion rate or to compare the maintenance of water storage capacities in the mitigation and another wetland — place at least one trap in the expected deposition zone(s) near each major inlet and at least three additional traps at other locations in the wetland where deposition may be significant. Estimate the surface area represented by each plate.

2. Drive the T fence post securely into the substrate and slide the pipe, with the pan attached, over the post. A wooden wedge may be driven lightly between the top of the post and the pipe to prevent the apparatus from pivoting on the post.

3. Very carefully determine and record the position of each trap when it is installed. Use a permanent object (large tree, structure, etc.) as a reference and locate the trap using a compass bearing and tape measurement relative to the reference. Record the bearing and distance from the reference and mark on the wetland map (see Task A1). Assign permanent designations to the trap plates (e.g., Tr1,Tr2, etc.).

4. Determine the monitoring schedule on the basis of the project's objectives. Some common situations that might occur include the following:

   a. the objective is to compare sediment trapping in the mitigation and another wetland, and the sediment accumulation rate appears on the basis of

qualitative observations to be fairly uniform through the year — monitor annually, after the winter runoff period if possible;

b. the objective is the same as (a), but sediment appears to accumulate irregularly — monitor before winter runoff begins (September), at least once during the period of high winter runoff (January to March), and after its completion; and

c. the objective is to estimate the overall sediment accretion rate or to compare the maintenance of water storage capacities in the mitigation and another wetland — monitor annually, after the winter runoff period if possible.

5. To obtain a measurement, cover the pan, remove the wedge, and carefully raise the pipe with the pan attached. Measure it with a ruler and record the depth of the sediment in the pan. If the pan is more than one-quarter full, empty it before returning it to its original location. If the pan has been covered with sediment, use a soil corer to determine the depth of the sediment. Because a corer may not be capable of sampling relatively short soil columns, attempt to avoid this situation by installing a deeper pan or by monitoring it more often.

6. If visibility is sufficient, estimate the extent of any notable sediment deposits, and note how representative of the overall deposition the measurements are.

CALCULATIONS

1. If the objective is to estimate the overall sediment accretion rate or to compare sediment trapping in the mitigation and another wetland, average the results of the measurements from each sediment trap.

2. If the objective is to compare the maintenance of water storage capacities in the mitigation and another wetland, multiply the depth measured at each location (use an average if multiple measurements are made in an area) by the surface area

represented by the depth measurement. The product is an estimate of the reduction in water storage capacity due to sediment accumulation.

DATA INTERPRETATION

The mitigation requirements will be considered to be met if, within the period designated by the mitigation plan,

1. the created wetland exhibits an accretion rate in the range reported for a natural wetland of its type (see Table C3.1); or
2. if the results are being compared between the created wetland and a reference or replaced wetland, they
   a. indicate that the wetlands being compared are accumulating sediments at the same rate; and/or
   b. indicate that the wetlands being compared are maintaining similar water storage capacities.

This task should be performed each year of the monitoring program. If the mitigation requirements are not met after the designated time, or doubt exists that they will be met as the time approaches, refer to the Diagnostic Procedures for guidance.

TABLE C3.1. VERTICAL SEDIMENT ACCRETION RATES REPORTED IN THE LITERATURE FOR VARIOUS NATURAL WETLAND TYPES

Wetland Type	Typical Accretion Rate (inches/year)	Reference[a]
Marine shoreline	0.02	2
Estuarine shoreline	0.008-0.16	1
Riverine, palustrine	0.3-1.1	4, 5, 6
Bog	0.04	3

[a]1—Shepard and Moore 1960; 2—Rusnak 1967; 3—Walker 1970; 4—Eckblad et al. 1977; 5—Nanson 1980; 6—Cooper et al. 1986.

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TASK C4

SHORELINE STABILITY MONITORING

OBJECTIVE

The objective of this task is to obtain objective measurements for assessing the performance of the shoreline anchoring wetland function.

BACKGROUND

Shoreline anchoring is a recognized wetland function provided chiefly by the rooted vegetation. This function is most obvious in coastal settings, but it potentially applies in all wetland types; e.g., a riverine wetland can protect a river bank from erosion. While the relative merits of different plantings in offering erosion control have appeared in the literature, a review has revealed no particular indices that could serve as criteria for judging success in establishing this function. Therefore, success can best be established by comparing erosion of the created wetland shoreline with a nearby natural shoreline.

No standard techniques have been formulated to quantify shoreline anchoring. The technique presented here simply involves installing one or more benchmarks to use as references for judging whether erosion is occurring and, if so, at what rate. This technique can provide an index of shoreline stability for use when such suitability is one of the project's objectives.

EQUIPMENT AND SUPPLIES

1. A post for each benchmark reference
2. Post driver
3. Tape measure

SAMPLING PROGRAM DESIGN

1. Place vertical benchmark posts at the most probable spots of shoreline erosion and, at other locations, approximately every 30 m (100 feet) (use a longer interval if this

spacing would result in more than ten total reference points). Assign permanent designations to the posts (e.g., Po1, Po2, etc.). Mark the locations on a wetland map (see Task A1). The pointed angle specified for hydrologic gages in Task A2 may be used as the benchmark post. Drive the posts well below the depth of any expected erosion.

2. On each post, mark a permanent reference point at the shoreline soil surface when the post is installed.

3. Monitoring can be performed rapidly and easily during each site visit. Most important is measurement after the winter storm season.

4. Measure from the reference point to shoreline soil surface. Depending on the erosion pattern, this measurement may be taken vertically along the post or perpendicular to the post from the reference point to a sloping bank. However, the measuring technique must be consistent in the pair of wetlands being compared.

CALCULATIONS

1. Obtain an index of shoreline stability by averaging the measured erosion and dividing it by the total shoreline length.

2. Express the result of Step 1 as a rate by dividing the index by the time elapsed since post installation.

DATA INTERPRETATION

The mitigation requirements will be considered to be met if, within the period designated by the mitigation plan, the results indicate that the created wetland shoreline is experiencing no greater measurable erosion than a nearby natural shoreline selected as a reference. This task should be performed each year of the monitoring program. If the mitigation requirements are not met after the designated time, or doubt exists that they will be met as the time approaches, refer to the Diagnostic Procedures for guidance.

TASK C5

ASSESSMENT OF HYDRIC SOIL CONDITIONS (Diagnostic Procedure, Detailed Analysis)

OBJECTIVE

The objective of this task is to investigate either the presence of hydric soils for initial created wetland site selection or the development of hydric soils following creation.

BACKGROUND

Because of saturation during the growing season, hydric soils usually develop certain morphological properties that can be readily observed in the field. Prolonged anaerobic soil conditions chemically reduce some soil components, especially iron and manganese oxides, and produce characteristic soil colors and other physical characteristics that are indicative of hydric soils (Federal Interagency Committee for Wetland Delineation 1989).

Hydric soils can be either organic or mineral. Most organic soils are hydric (see Task C1) and are readily identifiable. Mineral hydric soils are identifiable by the appearance of gleying and mottling that accompany reduced conditions.

Gleyed soils are usually neutral gray but sometimes greenish or bluish gray as a result of the removal of soluble ferrous iron. A mineral soil is hydric if it is gleyed to the surface, except for evidence of oxidizing conditions along root channels. Nonhydric soils can also be gleyed, but they have interlayed brighter (e.g., reddish or brown) layers.

Mineral soils that are alternately saturated and oxidized usually exhibit mottling in the seasonally wet portion. Mottles are spots of different colors interspersed with the dominant color. The abundance, size, and color of mottles reflect the duration of saturation and indicate whether the soil is hydric. Hydric mineral soils tend to be predominantly grayish with brown or yellow mottles.

To evaluate soil coloration objectively, a sample is compared with a Munsell soil color chart. The standardized Munsell soil colors are classified according to three

components: hue, value, and chroma. Hue represents one of the main spectral colors, or a mixture of them. Value refers to the degree of lightness, and chroma signifies color strength or purity. Chromas of 2 or less are often diagnostic of hydric soils.

The procedures presented here were derived from the federal wetland delineation manual (Federal Interagency Committee for Wetland Delineation 1989). They are useful for initially characterizing the soils of a site that is being considered or has been chosen for a created wetland, as well as for investigating hydric soil development over time.

EQUIPMENT AND SUPPLIES

1. Spade (tile spade preferred)
2. Munsell Color Book (Kollmorgen Corporation)

SAMPLING PROGRAM DESIGN

1. Select one or more areas, where the water table is not at the surface, at which to dig a soil pit. If the site is small and appears to be relatively homogeneous, a single, central site will suffice. Additional pits should be considered when the area is relatively large and/or may not be fairly homogeneous.
2. Digging and observing one pit is adequate for site screening, but the procedure should be performed during each season, if possible, for detailed site characterization.
3. Dig a one-foot diameter pit to the water table or the two-foot depth, whichever occurs first.
4. Observe and record the water table depth and soil horizon characteristics (thickness, texture, and color, including mottling).
5. Collect samples of soil from each identifiable horizon, or from several equally spaced points, down to 18 inches' depth. Examine these samples to judge whether the soil is organic. Organic soils are either peat (in which original plants exhibit little decomposition), muck (in which plant remains are decomposed beyond

recognition), or a mix of the types. When rubbed, mucks feel greasy and leave hands dirty, while mineral soils are relatively pliable and leave the hands cleaner. If the soil column is peat, muck, or a mix to 18 inches' depth, the soil is classified as an organic soil and is most likely hydric.

6. If the soil is not organic, investigate whether the mineral soil is hydric by characterizing its color using the Munsell notations. Also, observe and record the soil structure (grade, size, and form), consistence (dry, moist, or wet), roots, and pores in each horizon. These observations should be made by a person with the appropriate soil science training.

DATA INTERPRETATION

When used diagnostically, the purpose of this task is to provide information concerning whether a potential mitigation site has hydrologic and soil resources appropriate for the functional objectives to be pursued. Therefore, the use of the data depends on these objectives. They should be used to determine overall site suitability, need for soil amendment and/or excavation, planting specifications, etc.

When used to investigate the development of wetland characteristics, the analysis should be performed during an initial visit to each wetland of interest (including reference, if selected). Repeat the procedure after one year and then at three-year intervals as long as the study proceeds. The results should be used to assess the extent and rate of hydric soil development and compared to any mitigation requirements established in this regard. If mitigation requirements are not met after the designated time, or if doubt exists that they will be met as the time approaches, refer to the diagnostic procedures for guidance.

REFERENCE

Federal Interagency Committee for Wetland Delineation, "Federal Manual for Identifying and Delineating Jurisdictional Wetlands," U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, and U.S.D.A. Soil Conservation Service, Washington, D.C., Cooperative technical publication, 1989.

D. PRIMARY PRODUCER MONITORING TASKS

TASK D1

PLANT COMMUNITY ASSESSMENT

OBJECTIVE

The objective of this task is to document the development of the wetland plant community to provide an important part of the basis for evaluating the achievement of wetland characteristics and most of the wetland functions of interest.

BACKGROUND

The extent and the rate of wetland plant establishment is an important indicator of the success of a created wetland. Wetland plants, or hydrophytic vegetation, are those plants growing in water, or soil that is at least periodically deficient in oxygen as a result of excessive water content. The U.S. Fish and Wildlife Service (FWS) has published the "National List of Plant Species that Occur in Wetlands," which groups plants according to their wetland indicator status, or probability of occurring in wetlands. The FWS identifies wetland plants as obligate (OBL), facultative wet (FACW), facultative (FAC), and facultative upland (FACU), with all other plants being upland (UPL). The FWS list of wetland plants for the Northwest Region is attached as Appendix D.

Data collected according to this task are used to describe plant communities and to quantify the relative dominance of individual plant species in a wetland. The sampling procedures are designed to collect data both rapidly and consistently, so that data can be compared among years to infer change through time.

Data collection should occur when most species are at their maximum growth and when they are most readily identified. The best time for sampling wetland vegetation in Washington is from July 1 to mid-August. Some early flowering plants may be missed, and most composites peak later; however, a good representation of the plant community is possible by sampling once during this period. If highly detailed data are required, up to three sampling times should be considered: late spring, midsummer, and late summer. For

the best comparisons among years, collect data from a site on approximately the same date each year, or a date on which the plants are in the same phenological stage.

EQUIPMENT AND SUPPLIES

1. Wetland map (with transect locations)
2. Tape measure, 60 m
3. Plot frame, 0.25 m^2, marked as in Figure D1.1
4. Photo pole, 1 m, with 10 cm segments alternating black and white
5. Diameter at breast height (dbh) tape
6. Vegetation data forms
7. Plastic sample bags
8. Plant press

SAMPLING PROGRAM DESIGN

1. The plant sampling techniques rely on a set of permanent transects to locate sampling sites. Establish transects according to the procedure in Task A2 for use with these methods.
2. Three separate plant methods can be used to evaluate the occurrence and influence of the plants on the study site. The sampling methods used at a particular site will depend on the number of strata, or layers, of vegetation present. Up to three strata are used, and dominance is calculated for each using the appropriate sampling method. The canopy coverage method (Daubenmire 1959) is used for all herbaceous plants and for small shrubs and tree seedings that are $\leq$ 1 m tall. The line-intercept method (Canfield 1941) is used for all shrubs and for trees $\leq$ 2 m tall. A belt transect technique (Phillips 1959, Daubenmire 1968, Mueller-Dombois and Ellenberg 1974) is used in forested sites to evaluate trees > 2 m tall.

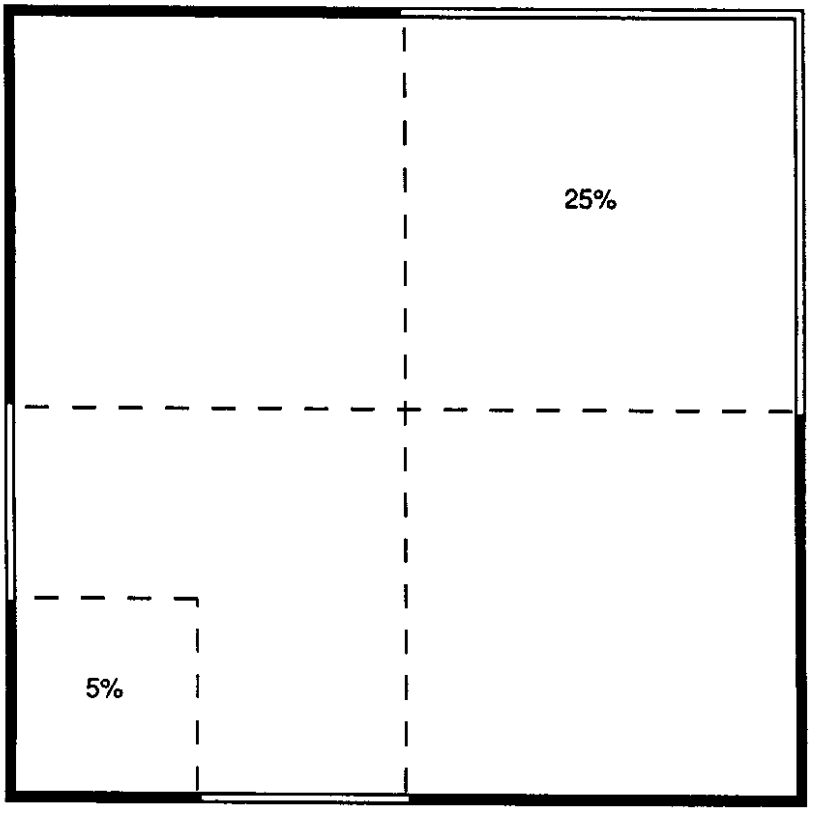

Figure D1.1. Plot Frame for Sampling Herbaceous Vegetation Using the Canopy Coverage Method

3. Use the canopy coverage method on all monitored sites. Use the line-intercept and belt transect if the appropriate shrub and tree strata are present. The relationship among the sampling techniques along the transect line is shown in Figure D1.2.

4. Unidentified plants: Each method requires identifying each taxon to the genus and in most cases to the species level. Plants that cannot be identified in the field must be collected for later identification. Assign the unidentified plant a pseudonym (e.g., Unknown A) and record the data. Collect at least two specimens of the plant from outside of the plot, place one in a sealed plastic bag with a label showing the pseudonym and date and place of collection, and preserve the others in a standard plant press. The sample in the bag should be identified as soon as possible in the lab. The pressed sample can be mounted and used as a reference specimen.

OBSERVATIONAL PROCEDURE

Canopy Coverage

This method, adapted from Daubenmire (1959), is used to evaluate plants ≤ 1 m tall. The procedure uses a series of 0.25 m^2 plots (0.5 m x 0.5 m) placed along the transects. Plot spacing is determined by the size of the wetland. For wetlands less than 0.3 hectares (0.75 acres) in area, plots are spaced at 3 m intervals along each transect. For wetlands greater than 0.3 hectares in area, plots are spaced at 6 m intervals. A minimum of 40 plots is recommended to characterize adequately the vegetation in the wetland. If the wetland is narrow, such as a stream corridor or a band of vegetation around a pond, space the plots at 3 m intervals and increase the number of transects, if necessary, to reach the minimum number of plots. The field procedures follow.

1. Lay out the 60 m measuring tape along the transect, making sure to stay on the left side of the transect to avoid disturbing the plots that will be sampled. Make sure the tape is taut, straight, and anchored firmly.

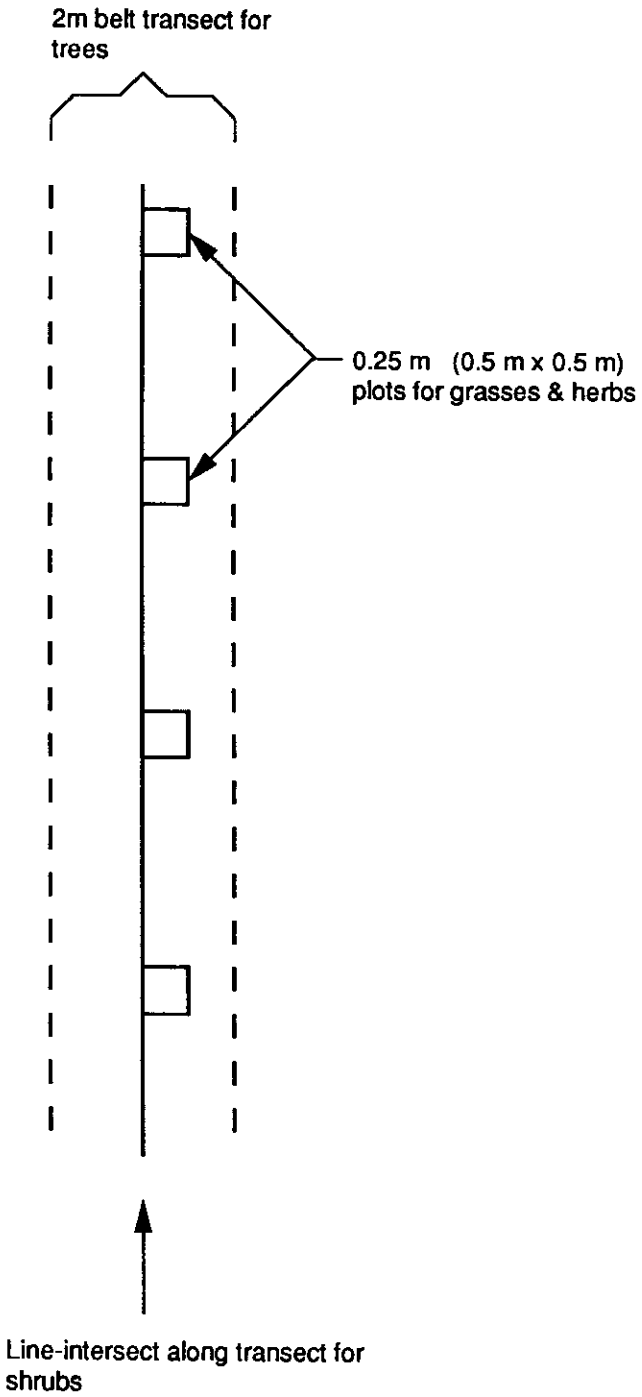

Figure D1.2. Relationship Among Sampling Techniques Shown Along Transect Lines

2. Starting at the 1 m point along the transect, place the plot frame on the right side of the 60 m, tape with the lower right corner at the meter marker and one side along the transect.

3. Record the depth of the water at the lower right corner of the plot, if water is present.

4. Consider all individuals of a species in the plot as a unit, ignoring for the moment all other kinds of plants. Imagine a line drawn about the leaf tips on the undisturbed canopies (ignoring inflorescences) and project these polygonal images on the ground. This projection is considered "canopy coverage." Note that the plant does not have to be rooted in the plot to have coverage over it, and accidents of foliage dispersal within the projected canopy outline are ignored. Decide which of the classes (Table D1.1) the canopy coverage of the species falls into, and record this value on the canopy coverage data form.

5. Then consider the remaining species in turn.

6. Similarly, estimate the coverage class for bare ground in the plot and record the class on the data form.

7. Advance to the next plot along the transect, either 3 m or 6 m from the first, and repeat the procedure.

8. Repeat the procedure for each transect.

Table D1.1. Canopy Coverage Classes for Plot Method

Coverage-Class	Range of Coverage	Midpoint of Range
1	0-5%	2.5%
2	5-25	15
3	25-50	37.5
4	50-75	62.5
5	75-95	85
6	95-100	97.5

Line-Intercept Method

The line-intercept method (Canfield 1941) is a rapid method used in this manual to quantify the influence of shrubs and small trees that are generally too large for the plot canopy coverage method. Small shrubs and trees ≤ 1 m tall are sampled in both the canopy coverage and line-intercept methods. The transect line is used as the sampling area for the line-intercept method. The field procedure follows.

1. Lay out the 60 m measuring tape along the transect, making sure to stay on the left side of the transect to avoid disturbing the plots sampled with the canopy coverage method. Make sure the tape is taut, straight, and anchored firmly.
2. Starting at the wetland boundary, record on the line-intercept data form the species and intercept length of each shrub and small tree along the transect. The intercept length is the portion of the transect length intercepted by a perpendicular projection of the plant's foliage.
3. Record the total length of the transect sampled.
4. Repeat the procedure for each transect.

Belt Transect Method

This method is used in this manual to sample only trees that are > 2 m tall and, therefore, will rarely be used during the first years of monitoring newly created wetlands. It may be used for baseline studies on wetland forests to assess the impacts of construction projects, as part of habitat suitability determinations for forest-dependent wildlife, or in the latter years of monitoring a created wetland. A belt or strip 2 m wide (1 m each side) along the transect is used as the sampling area. Tree diameters are measured at breast height (1.4 m, or 4.5 feet) using the photo pole or a dbh tape. The field procedure follows.

1. Lay out the 60 m measuring tape along the transect, making sure to stay on the left side of the transect to avoid disturbing the plots sampled with the

canopy cover method. Make sure the tape is taut, straight, and anchored firmly.

2. Use the 1 m photo pole held perpendicular to the transect tape to determine the outside boundary of each side of the sampling belt.

3. At each tree encountered in the belt transect, record on the belt transect data form the species and tally its diameter using the classes in Table D1.2. Use the 10 cm divisions on the photo pole to determine the diameter class of the tree at breast height. Include all trees whose stem is more than half within the belt. For trees exactly on the boundary, count them as one half.

4. Repeat the procedure for all transects.

Data Analysis

The data collected by these sampling methods are used to determine the dominant plant species in each of the vegetation strata on a site. Dominance is calculated in accordance with the criteria established by the Federal Interagency Committee for Wetland Delineation (198).

Dominance can be determined by the species comprising the first 50 percent of the cover when the species are ranked from most to least abundant, or a frequency analysis showing the percentage of cover for each of the wetland indicator status groups. Both methods of determination require transforming the raw data collected by the sampling techniques into percentage of cover values for each species.

Table D1.2. Diameter Classes for Sampling Trees with the Belt Transect Method

Diameter Class	Range (cm)	Mean Basal Area (cm^2)
1	<10	19.6
2	10-20	177
3	20-30	491
4	30-40	962
5	40-60	1964
6	60-80	3849
7	80-100	6362

Transforming Data to Percentage of Cover

In general, percentage of cover is the average coverage for a species divided by the sum of the average coverages for all species, and may be applied to a plot, a transect, or the site as a whole. The procedures for transforming the raw data are described below for each sampling method.

Canopy Coverage to Percentage of Cover. Total canopy coverage is the sum of the average canopy coverages for each species in the wetland. This value is based on raw coverage values and may frequently exceed 100. Values greater than 100 can indicate multiple vegetation layers. The calculation procedure follows.

1. **Canopy coverage of a single species on the site:**

   a. Add the midpoint values of the coverage classes.

   b. Average coverage = $\frac{\text{sum of midpoint values}}{\text{number of plots examined}}$

   Example:

   If 50 plots have been examined and cattail was found in 5 of the plots, the coverage classes recorded in the field being 1, 6, 6, 3, and 4, then in the laboratory, do the following:

   Add together the midpoint values of the coverage classes, 2.5 + 97.5 + 97.5 + 37.5 + 62.5 = 297.5, and divide by the number of plots examined (50) to get the average coverage, 5.9, for the total area sampled (50 x 0.25 m^2 = 12.5 m^2). This may be considered an estimate of average coverage for the species on the site as a whole.

2. **Total coverage by all plants:**

   a. Sum the average coverage for all species to get the total coverage by all plants.

3. **Percentage of cover:**

a. Percentage of plant cover for the site, as used in this manual, is the result of subtracting the proportion of bare ground from 100 percent:

$$\text{Percentage of Plant Cover} = 100 - \text{bare ground cover}$$

b. $$\text{Percentage of cover for a species} = \frac{\text{coverage for species i}}{\text{sum of coverages for all species}}$$

Line-Intercept to Percentage of Cover. Percentage of cover for the line intercept method is the proportion of the transect intercepted by the canopy of each species. The calculation procedure follows.

Sum the intercept lengths for each species. Calculate the percentage of cover, the linear coverage index, for each species using the following formula:

$$\text{Percentage of cover} = \frac{l_i}{L}$$

where: l_i = the sum of the intercept lengths for species i, and

L = the total length of all transects sampled.

Belt Transect — Basal Area to Percentage of Cover. Percentage of cover for each species is the proportion of the total basal area covered by each tree species. The basal area for a species is determined by multiplying the number of individuals in each diameter class by the mean basal area for the class and then summing the products for all classes, as follows:

$$\text{Percentage of cover} = \frac{b_{ai}}{BA}$$

where: b = the sum of the basal areas of all individuals of species i, and

BA = the sum of the basal areas of all tree species in the belt transect.

Percentage of cover for each of the wetland indicator status groups can be obtained by summing the percentage of cover for the species in each group. Percentage covered by particular types of plants, i.e., wetland and upland species, can be determined by summing the percentage of cover for species of the appropriate indicator status (OBL, FACW, and FAC for wetland species; FACU and UPL for upland species).

Dominance and Wetland Determinations

Wetland determinations are based in part on the role of hydrophytic vegetation on a site. More than 50 percent of the dominant plant species on a site must have an indicator status of OBL, FACW, or FAC to meet the hydrophytic vegetation criterion used in the federal manual (Federal Interagency Committee for Wetland Delineation 1989).

Dominant Plant Species. The dominant plant species must be determined for each stratum. The dominant species are then considered together to determine whether more than 50 percent of the dominant species are wetland species. The procedure follows.

1. Identify the dominant species in each stratum by ranking the species from the most to least abundant on the basis of percentage of cover. The species composing the top 50 percent, plus any additional species composing 20 percent or more of the percentage of cover, are the dominants for the stratum.
2. Combine the lists of dominants for all strata. If more than 50 percent of the species on the combined list of dominants have a wetland indicator status of OBL, FACW, or FAC, the hydrophytic vegetation criterion is met.

Species Diversity

Species diversity is a measure of the variety in the plants on a site. The simplest and most easily understood measure of diversity is species richness (S), or the number of species on a site. The species lists from all three plant sampling techniques can be combined to get a value for community species richness.

Other diversity measures are calculated indices that consider the number of species and their relative abundances in the community. The data from several strata cannot be combined because of their separate considerations of percentage of cover.

Diversity indices should be considered with a measure of evenness to assess the distribution of abundances among the species, since the indices are sensitive to the number of species in the community. The most widely used diversity index (H') was introduced

by Shannon and Weaver (1963). Pielou's evenness measure, J', is recommended to compare the calculated diversity, H', to the theoretical maximum diversity, H'_{max}, where the abundance of each species is equal (Pielou 1966). The formulae for these indices are the following:

1. $$H' = \sum_{i=1}^{S} p_i \log p_i$$

where: S = total number of species (richness)

p_i = proportional representation of the ith species in the total population (ratio of the number of individuals in the ith species group to the total number of individuals in all species groups)

2. $$J' = \frac{H'}{H'_{max}} = \frac{H'}{\log s}$$

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CANOPY COVERAGE DATA FORM

Site: ____________ Date: ____________ Observer: ________________ Sheet ___ of ___

Transect : ____

Species	Indicator Status	PLOT NO.																																								Cover	% Cover
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40		

[a] Denote transect containing each plot.

[b] Include open water (estimate depth in cm) and bare ground, if present.

LINE-INTERCEPT METHOD DATA FORM

Site: _____ Date: _____ Observer: _____ Sheet ___ of ___

Transect (or interval) identification _____ Length of transect (or interval) _____

Plant Number	Species: Intercept length (l)	Species: Intercept length (l)	Species: Intercept length (l)	Species: Intercept length (l)	Species: Intercept length (l)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
Totals					

Belt Transect Method Data Form

Site: ________________ Date: ____________ Observer: ________ Sheet ___ of ___

Transect #:

Species	Indicator Status	<10	10-20	20-30	30-40	40-60	60-80	80-100	Total Basal Area

Transect #:

Species	Indicator Status	<10	10-20	20-30	30-40	40-60	60-80	80-100	Total Basal Area

Transect #:

Species	Indicator Status	<10	10-20	20-30	30-40	40-60	60-80	80-100	Total Basal Area

TASK D2

PHYTOPLANKTON BIOMASS MEASUREMENT
(Detailed Analysis)

OBJECTIVE

The objective of this task is to measure phytoplankton biomass as chlorophyll to provide a basis for judging the trophic status of the open water portion of the wetland and its potential contribution to food chain support.

BACKGROUND

Not all of the primary production in a wetland is accounted for by the various macrophytic plants. Algae attached to surfaces (periphytic algae) and suspended in the water column (phytoplankton) also photosynthesize and provide food chain support. The phytoplankton represent a potentially important food source to zooplankton, pleustonic and neustonic (water column and surface film, respectively) invertebrates, and planktivorous fish. Their biomass indicates the trophic state of the open water portion of the wetland. Relatively high biomass provides a potentially high level of food chain support, but it can consist of forms that offer a less desirable food supply (a eutrophic system). Less biomass may not offer as much potential food, but the quality is likely to be higher (an oligotrophic system). The trophic state tends to change from oligotrophic to mesotrophic to eutrophic as the limiting nutrient (usually either phosphorous or nitrogen) is supplied in larger amounts.

The phytoplankton can consist of many algal species in several phyla. Most common are diatoms, various green algae, and blue-green forms. Diatoms tend to predominate in oligotrophic systems, while succession to greens and then blue-greens tends to accompany eutrophication. The filamentous greens and, especially, blue-greens are relatively low quality foods and have nuisance characteristics, which are actually more annoying in lakes and streams than in most wetlands.

Although the numbers or volume of algal cells by individual species or in total can be determined and provides specific information about trophic state, the procedure is very laborious. Analysis of trophic status is commonly performed by measuring the chlorophyll pigments common to all forms. Research has determined typical chlorophyll concentrations that signify various trophic states (Welch 1980). This procedure is well suited to comparing wetlands (e.g., a mitigation site with a replaced wetland or reference wetland). While the analytical procedure requires some specialized equipment, it is not difficult to perform. The method presented here was derived from and is consistent with American Public Health Association (1985) Method 1002G. Transportation agencies have the option of contracting for the analysis with a qualified water quality laboratory.

EQUIPMENT AND SUPPLIES

1. Screw top poly bottle(s) for sampling
2. Graduated cylinder, 1 L; pipets; miscellaneous laboratory glassware
3. Filter funnel and flask
4. Vacuum source
5. Whatman GF/C Fiberglas filter
6. Tissue grinder
7. Centrifuge, 3000 to 4000 rpm, with 15 mL graduated tubes
8. Spectrophotometer
9. Spectrophotometer cells, 1 cm light-path length
10. Acetone, 90 percent
11. Magnesium carbonate suspension: Dissolve 1 g reagent grade magnesium carbonate powder in 100 mL distilled water. Shake vigorously before each use.
12. Hydrochloric acid, 4 m: add 330 mL concentrated HCl to 670 mL distilled water.

SAMPLING PROGRAM DESIGN

1. Perform chlorophyll measurement during each summer visit to the wetland(s) of interest (including reference, if selected). Because algal blooms cause substantial fluctuations, a single measurement is not sufficient to characterize the full summer period. Measurement at approximately two-week intervals from June through August is best but may not be feasible in every case.
2. Determine the spatial coverage of the sampling on the basis of the wetland configuration. Some common situations that might occur include the following:
   a. there is a relatively homogeneous open water pool — take a single water column sample; and
   b. there is a complex pattern of pools and/or channels with differing shading, water velocities, etc. — sample the water column in representative locations.

   Assign site designations to each sampling location, and mark them on a wetland map (see Task A1).
3. To sample, dip a 2-L container by hand in an area that is undisturbed by your presence.
4. On the day of collection, perform at least steps 1 and 2 of the analysis below. Until analysis, store the sample on ice or in a refrigerator at 4°C.

ANALYTICAL PROCEDURE

1. Place a Whatman GF/C Fiberglas filter in the filtration apparatus and cover it with magnesium carbonate suspension.
2. Measure 1 L of sample and suction filter. (Note: use a smaller volume if the absorbance at any wavelength in Step 8 is greater than 0.5).
3. Roll the filter with the plankton on the inside and, preferably, complete the analysis immediately. If it cannot be completed immediately, freeze the filter in a vacuum dessicator for at least three weeks.

4. Place the filter in the tissue grinder, pipet 3 mL of 90 percent acetone, and grind the filter 2 minutes at about 500 rpm. Add 3 mL of 90 percent acetone.

5. Transfer the ground sample to a 15 mL graduated centrifuge tube. Wash the pestle and homogenizing chamber into the tube with 3 mL of 90 percent acetone. Close the vial with a stopper and place it in a refrigerator for 24 hours.

6. Dilute the solution with more 90 percent acetone to 9 mL if needed. Centrifuge it for 10 minutes at 3000 rpm.

7. Carefully pour or pipet the supernatant into the spectrophotometer cell. Do not disturb the precipitate.

8. Measure the absorbance in 1 cm spectrophotometer cells at 750, 665, 645, and 630 nm wavelengths. Use 90 percent acetone in the reference cell.

9. Add one drop of 4 M HCl to the cell and stir it with a glass rod.

10. Measure the absorbance again at 665 and 750 nm.

CALCULATIONS

1. Compute the concentration of chlorophyll a from

$$\text{Chl\_a } (\mu g/L) = \frac{v(11.6D_{665} - 0.14D_{630} - 1.31D_{645})}{V}$$

where D = absorbance at respective wavelength - absorbance at 750 mm

v = extract volume (9 mL)

V = filtered sample volume (1 L or another volume in liters)

2. Compute the concentration of phaeophytin, a degradation product of chlorophyll, and chlorophyll a corrected for phaeophytin from

$$\text{Phaeo } (\mu g/L) = \frac{26.73v\ (1.7\ D_{665a} - D_{665o})}{V}$$

$$\text{Chl a } (\mu g/L) = \frac{26.73v\ (1.7\ D_{665a} - D_{665o})}{V}$$

where D_{655a} = absorbance at 665 mm - absorbance at 750 nm, both after acidification

D_{655o} = absorbance at 665 nm - absorbance at 750 nm, both before acidification

The phaeophytin correction can be significant when a large phytoplankton bloom is in a declining state.

3. Average all available chlorophyll a concentrations for the June-August period (use a corrected value in any case where phaeophytin is present in a significant amount).

DATA INTERPRETATION

1. Classify the trophic status of the open water portion of the wetland according to (Welch 1980):

Mean Summer Chlorophyll a (µg/L)	Trophic Status
< 4	Oligotrophic
4 - 10	Mesotrophic
> 10	Eutrophic

2. The mitigation requirements will be considered to be met if, within the period designated by the mitigation plan,

   a. the mean summer chlorophyll a in the created wetland is in the range 0-5 µg/L (if high water clarity is important), or 5-20 µg/L (if consumer productivity is important) (these values are for freshwater impounded wetlands only); or

   b. if the results are being compared between the created wetland and a reference or replaced wetland, they indicate that the wetlands being compared have equivalent trophic status and that their phytoplankton offer equivalent food chain support.

If the mitigation requirements are not met after the designated time, or doubt exists that they will be met as the time approaches, refer to the Diagnostic Procedures for guidance.

REFERENCES

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TASK D3

HABITAT SUITABILITY EVALUATION
(Diagnostic Procedure)

OBJECTIVE

The objective of this task is to make an overall assessment of the suitability of wetland habitat for supporting animal life.

BACKGROUND

This task involves performing the habitat suitability evaluation contained in Section 5.0 of the Wetland Evaluation Technique (WET) (Adamus et al. 1987). However, it is most convenient to perform the analysis using the computerized version of WET.

REFERENCE

Adamus, P.R., E.J. Clairain, Jr., R.D. Smith, and R.E. Young, "Wetland Evaluation Technique (WET), Vol. II: Methodology," Waterways Experiment Station, Corps of Engineers, Vicksburg, MS, 1987.

E. CONSUMER MONITORING TASKS

TASK E1

AQUATIC INVERTEBRATE COMMUNITY ASSESSMENT

OBJECTIVE

The objective of this task is to characterize the aquatic invertebrate community as one means of both evaluating the performance of the wetland functions of food chain support and providing ecosystem diversity.

BACKGROUND

The aquatic invertebrates are major potential food sources for fish, insectivorous birds, and certain mammals and herpetofauna that permanently or intermittently inhabit wetlands. Freshwater fish production is generally, but not always, correlated with aquatic invertebrate production (Hynes 1970, Binns and Eiserman 1979). Productivities of fish and shellfish in marine environments are also dependent on high densities of invertebrates in estuarine and coastal wetlands (Tyler 1971, Peterson and Peterson 1979, Whitlatch 1982).

Collectively, these invertebrates inhabit the wetland bed (benthic invertebrates, or benthos), the water column (pleuston), and the surface film (neuston). Some have an entirely aquatic life cycle, while many emerge as adults to the terrestrial realm. The latter may be in evidence above the wetland's water surface. Larger forms are known as macroinvertebrates, while the term meiofauna is often applied to smaller taxa (approximately 60 to 500 μm in length). Smaller still are the microfauna. Among the meiofauna, those essentially suspended in the water column are termed the zooplankton.

With the potential diversity in the overall invertebrate community, no one sampling method can provide a complete sampling. Collection is further complicated in wetlands, relative to streams and lakes, by the often highly patchy character of the substrates and vegetation. Standardization of sampling techniques for wetlands has progressed little.

Generally, accepted stream techniques are not applicable, and only selective use can be made of lake techniques. A number of unique methods have been attempted or recommended for wetlands, but all have drawbacks. A method or methods must be selected with reference to the site characteristics and study objectives.

Five methods are recommended for consideration in wetland mitigation project monitoring, depending on circumstances:

1. water column/benthic sampling tube;
2. emergence trap;
3. dip net;
4. Ekman dredge; and
5. Surber sampler.

The recommended general strategy is to base freshwater wetland mitigation project monitoring principally on the tube sampler, supplemented by an annual dip net survey. One of the other techniques can be incorporated in special circumstances. In particular, the emergence trap is likely to provide a better quantitative comparison between replacement and reference wetlands, for the emerging forms, when one or both has developed dense vegetation and a patchy character. Plankton and neuston nets are necessary for proper assessment of some estuarine microhabitats. Following are descriptions of the four methods.

Water column/benthic sampling tube. This device is simply a PVC pipe section of sufficient length to enclose a full segment of the water column and 3 to 5 cm of soil at the bed. A design presented in Figure E1.1 was adapted from earlier designs by Legner et al. (1975), and Swanson (1978). Where wading is possible, it can capture a wide range of invertebrates from a specific water volume and bed surface area. The invertebrate collection is separated from the water by screening. Depending on screen mesh selection, specific size classes can be captured or eliminated. The method has several drawbacks: (1) the difficulty or impossibility of effectively sampling in very dense

vegetation; (2) the difficulty of obtaining an adequate sampling design in a very patchy environment, and the resulting large numbers of samples required for good characterization, even for comparative purposes; (3) the ability of water column animals to escape capture; and (4) the large amount of organic and inorganic sedimentary debris often mixed with the live invertebrate collection. Still, this method is appropriate in many newly created wetlands, before dense vegetation growth and a high degree of patchiness develop. Later in the evolution of the wetland, the tube can be supplemented by the emergence trap.

A clam gun is an alternative where only benthic animals are important in the invertebrate community. This alternative can be considered particularly in estuarine and coastal wetlands.

Emergence traps. Emergence traps are anchored, floating devices that offer an opportunity to capture all adults emerging from a defined area over a selected time period. McCauley (1976) introduced a trap of this type. Figure E1.2 presents a design that was produced by Wisseman (personal communication). The method has major advantages for sampling in patchy environments, where other techniques are difficult or unrepresentative. It also avoids inaccurate characterization of the community caused by poor timing of discrete sampling and saves considerably on field effort. This method does require an initial investment in traps (approximately $100 each) and does not sample nonemerging invertebrates. Therefore, used alone, it does not produce a full community definition, but it is very useful for relativistic comparisons between sites (e.g., between a created and reference wetland).

Dip net. The dip net is a qualitative means of quickly sampling a large area. Available in different configurations (a D-frame net is a good choice), the dip net captures macroinvertebrates when it stirs up their habitat and loosens them from surfaces and suspends them in the water. A good strategy is to operate the net in a representative selection of all the aquatic habitats. However, the survey cannot be made quantitative. The best that can be accomplished in this regard is to attempt to constrain sampling to equal unit

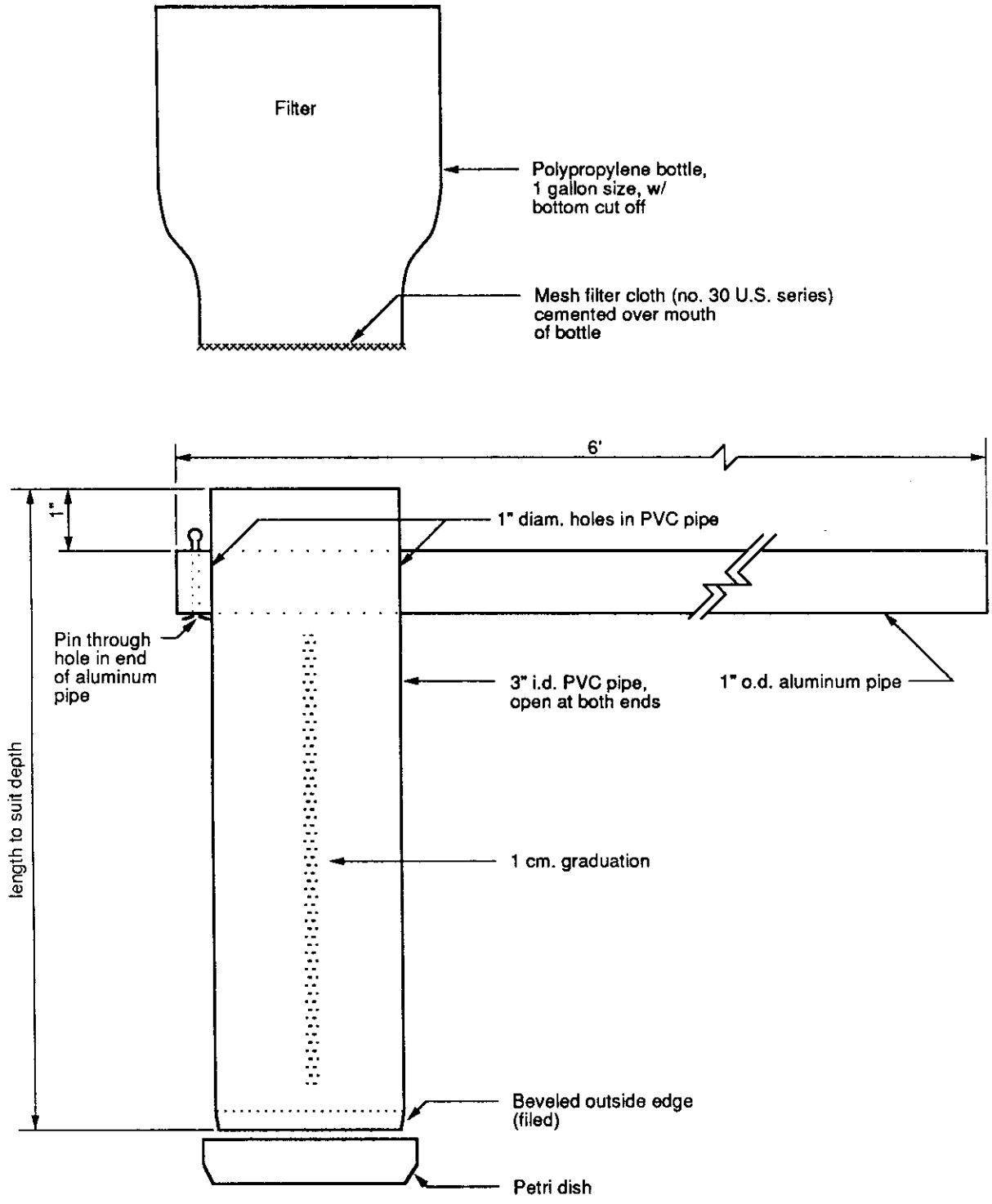

Figure E1.1. Water Column/Benthic Sampling Tube

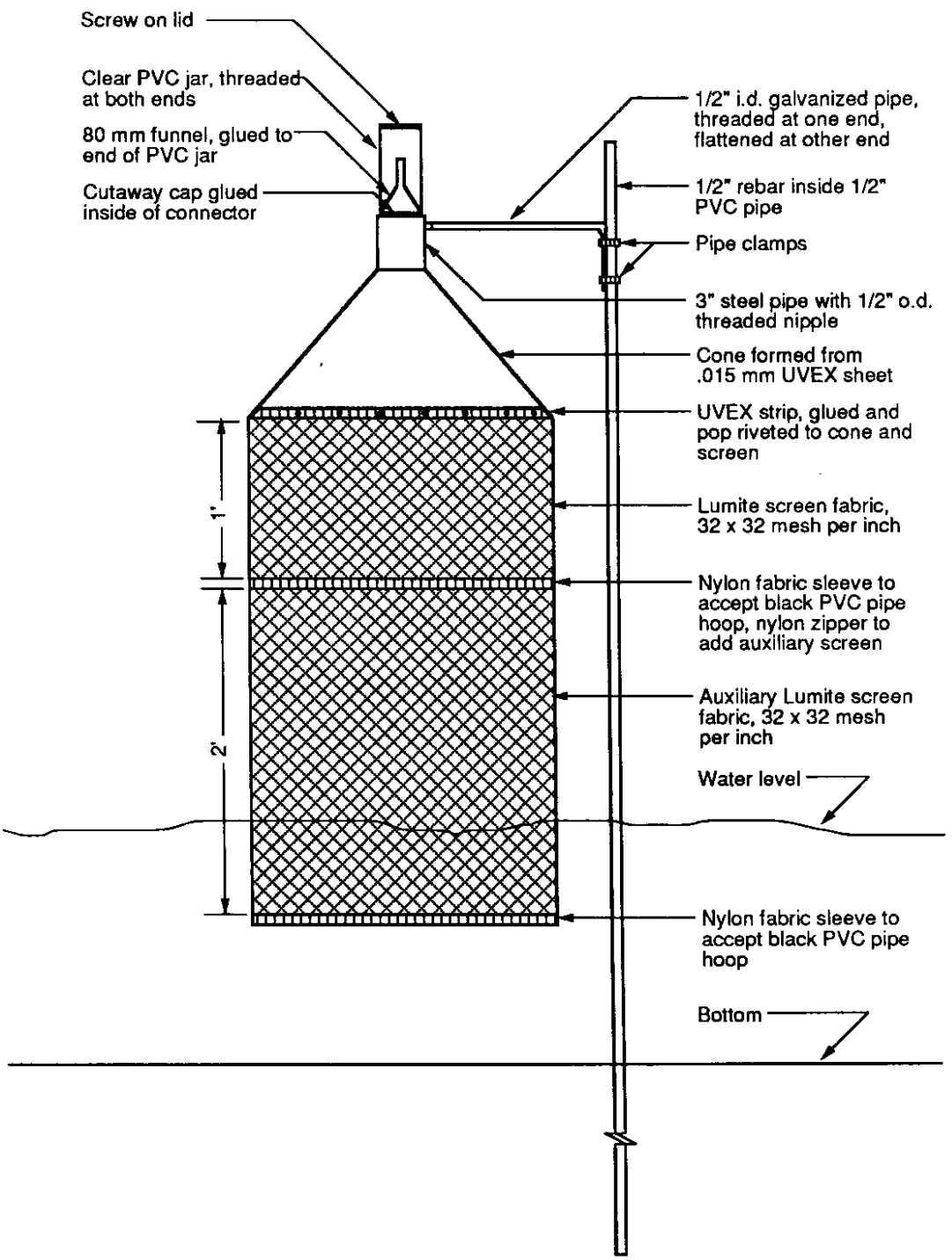

Figure E1.2. Emergence Trap

efforts in each wetland sampled. However, achieving equality of effort is difficult in practice, unless the two systems are quite similar in geometric, hydrologic, and vegetation characteristics. Again, netting can be used to supplement emergence trapping.

Ekman dredge. The Ekman dredge is commonly used in lakes. It does capture a defined area of sediment but misses all water column animals. It is best used in areas without rooted plants, logs, etc., and thus is often poorly suited to wetland sampling. Nevertheless, the Ekman dredge can supplement other techniques; for example, it can be used in relatively deep open water, where the tube sampler and dip net cannot be employed.

Surber sampler. The Surber sampler is the most common invertebrate sampling device in flowing water. It consists of a one-foot-square frame and a fine-mesh net The net trails in the current to catch animals dislodged by the distured sediments within the frame. This sampler can be used as the primary or a supplementary device in wetlands with flowing water.

Another issue in characterizing the invertebrate community concerns how the sampling results should be quantified. The first decision is to what taxonomic level to identify the specimens. Regardless of that level, their abundance can be expressed as a total number or numbers by taxa on a per unit area or volume basis (if a quantitative collection method was used). Likewise, their dry weights can be determined as a measure of biomass and expressed on the same basis. Popular means of expressing community composition are species richness (number of species represented) and diversity, usually according to some mathematical diversity index. These expressions require a detailed level of taxonomic identification that necessitates specialized abilities.

Created wetlands are expected to generate an abundance of a few taxa before diversity develops along with habitat formation. Also, the few literature-based criteria that exist to serve as a basis for judging created wetland development are abundance measures (see Data Interpretation section). For these reasons, and because of the difficulty of identification to the species or genus levels in many cases, an abundance measure is

recommended as the basis for invertebrate data quantification for wetland mitigation projects. Determination of richness or diversity following detailed taxonomic identification can be performed as a Detailed Analysis task if warranted, and the procedures for doing so are given.

EQUIPMENT AND SUPPLIES

1. Water column/benthic sampling tube (see Figure E1.1) or clam gun
2. Wide-mouth sample jars
3. Labels
4. D-frame aquatic net
5. U.S. Standard No. 70 sieve (Note: sieves with larger openings, e.g., Nos. 18 and 30, may be useful to remove large debris or when animals are relatively large, but No. 70 as the final sieve ensures capture of all macroinvertebrates (Greeson et al. 1977).)
6. 70% ethanol for preservation
7. Equipment for taxonomic identification (white enamel pans, forceps, eye droppers, microscope, taxonomic key)
8. For selected locations, emergence trap (see Figure E1.2), Ekman dredge, or Surber sampler (Note: Ethylene glycol is needed for the emergence trap.)
9. For estuarine locations, a balance that weighs to 0.01 g
10. For optional sorting procedures, granulated sugar or Rose Bengal biological stain

SAMPLING PROGRAM DESIGN

Recommended Procedure

1. Consider the transects installed in Task A2 in pairs. Randomly select one point within the open water zone for each pair of ransects. Check that the points selected represent each distinct aquatic habitat type with replication (three points in each habitat type are recommended) in each wetland of interest (including reference

wetland, if selected). Many created wetlands will have only one distinct habitat type, at least in the initial stages of development.

2. Sample in the late spring-summer period and, if possible, in other seasons. Select approximately the same sampling date each year of the study. A better basis, but a harder one to monitor, is to sample after the accumulation of a set number of degree-days past a selected base date (e.g., the spring equinox) each summer.
3. To sample, force the tube 3 to 5 cm into the sediment. Stopper the top. Lift the tube slightly and slide a Petri dish beneath it. Drain through the screen funnel.
4. Preserve the collections from each point separately and return them to the laboratory for identification and counting.
5. On approximately the same date each year, conduct a dip net survey in representative aquatic habitats of each wetland being compared. Attempt to maintain an equal unit effort in each wetland. Composite the invertebrates collected from all habitats.
6. Preserve the specimens in 70% ethanol and transport them to the laboratory for identification and counting.

Optional Procedures

1. For each sampling period of interest, install three emergence traps in each distinct aquatic habitat type in each wetland of interest (including reference wetland, if selected). Many created wetlands will have only one distinct habitat type, at least in the initial stages of development. The samplers placed in that habitat should be matched by three in a similar habitat in the reference wetland. Late spring-summer is the season of greatest adult invertebrate emergence. Select at least one two-week period during which samplers can collect in each wetland of interest. Repeat the process as many times as possible. Collections can also be made in other seasons. Select approximately the same calendar periods each year of the study. A better basis, but a harder one to monitor, is to place the traps for summer sampling after

the accumulation of a set number of degree-days past a selected base date (e.g., the spring equinox) each summer. Return the collections from each trap separately to the laboratory for identification and counting.

2. As appropriate, sample with the Ekman dredge or Surber sampler according to the same sampling program designed for the Recommended Procedure.

ANALYTICAL PROCEDURE

For Monitoring of Basic Wetland Operation

1. Sieve the specimens to separate debris. Use a U.S. Standard No. 18 sieve if relatively large debris is present. Pass the preservative solution containing the spedimens through a No. 70 sieve for the final separation, unless it is certain that all specimens are relatively large (a No. 30 sieve may be used in that case).

2. If fine debris requires an aid for further sorting, two alternatives are available: (1) 1.12 specific gravity sucrose solution, or (2) Rose Bengal biological stain.

   - **Sucrose solution**. Dissolve 360 g of granulated sugar in one liter of water. Flood the sieved specimen/debris mixture with sucrose solution in a pan and stir. Remove organisms from the surface with forceps. Resieve and repeat several times until it is certain that no organisms remain.
   - **Rose Bengal**. Obtain the stain from a scientific supplier. Add it to the preservative solution at a concentration of 200 mg/L. Examine it after 24 hours to recover the stained specimens.

3. Identify Insecta and Amphipoda to at least the level of order and count them.

4. Identify other organisms to at least the level of class, but if possible to a more detailed level, and count them.

5. For estuarine wetlands, determine wet weights of the total collections of each taxon, in order to apply the procedure presented under Data Interpretation.

For Detailed Analysis

1. Identify the specimens to the most detailed taxonomic level possible, preferably species.

CALCULATIONS

For Monitoring of Basic Wetland Operation

1. Estimate the productivities of emergents by dividing the numbers of each taxon in each trap by the trap area and the length of time over which they were collected. Compute the mean and standard deviation for each set of three traps.
2. Total the numbers of each taxon collected in dip net surveys.
3. Express the population densities of animals (also wet-weight biomass for estuarine and coastal wetlands) collected by tube sampler, Ekman dredge, or Surber sampler, by dividing the numbers of each taxon in each sample by the sampler volume (tube) or area (Ekman and Surber). Compute the mean and standard deviation for all sampling points.
4. If a created wetland is being compared to a reference or replaced wetland, determine by means of statistical tests whether the mean population densities of each taxon differ significantly in the wetlands being compared (for tube, emergence trap, Ekman dredge, and Surber sampling). The tests may be by distinct habitat type and/or for the wetland as a whole. Use the appropriate procedures in a biostatistics text, such as the one by Zar (1984). The appropriate procedure may be a Student's t-test, if the assumptions of the test are upheld. Otherwise, data may have to be logarithmically transformed, or a nonparametric test may have to be performed. Making the proper choice of a test procedure may require the advice of a statistician.

For Detailed Analysis

1. Compute diversity indices (H') on the basis of the emergence trap, tube, Ekman dredge and/or Surber sampler results. Diversity indices can be computed with dip

net results, but this procedure is not advised because of its less controlled and quantitative nature. The formula is the following (Shannon and Weaver 1963):

$$H' = -\sum_{i=1}^{S} p_i \log_2 p_i$$

where S = total number of species (richness)

p_i = proportional representation of the ith species in the total population (ratio of the number of individuals in the ith species group to the total number of individuals in all species groups)

$\log_2$ = logarithm to base 2

DATA INTERPRETATION

The mitigation requirements will be considered to be met if, within the period designated by the mitigation plan,

1. the created wetland exhibits invertebrate production as follows:
   a. freshwater wetlands — mean growing season density of aquatic invertebrates (excluding annelid worms) is at least 269 individuals/m^2 (25 individuals/ft^2) (Adamus et al. 1987)*; or
   b. estuarine wetlands — community development is in the "H" region of the appropriate graph in Figure E1.3; or
2. if the results are being compared between the created wetland and a reference or replaced wetland, statistical test results, diversity indices,

* Note: Adamus et al. (1987) cited no primary reference for this criterion, nor did they provide any breakdown by taxon. Population density and taxonomic composition would be expected to vary substantially geographically and by wetland type. Until the literature is more comprehensive, comparison with other local aquatic communities would be very beneficial for data interpretation. Lammers (1977) performed emergence trapping surveys in Minnesota wetlands and compared the results to a similar survey in an Ontario pond by Judd (1961). Table E1.1 summarizes the results.

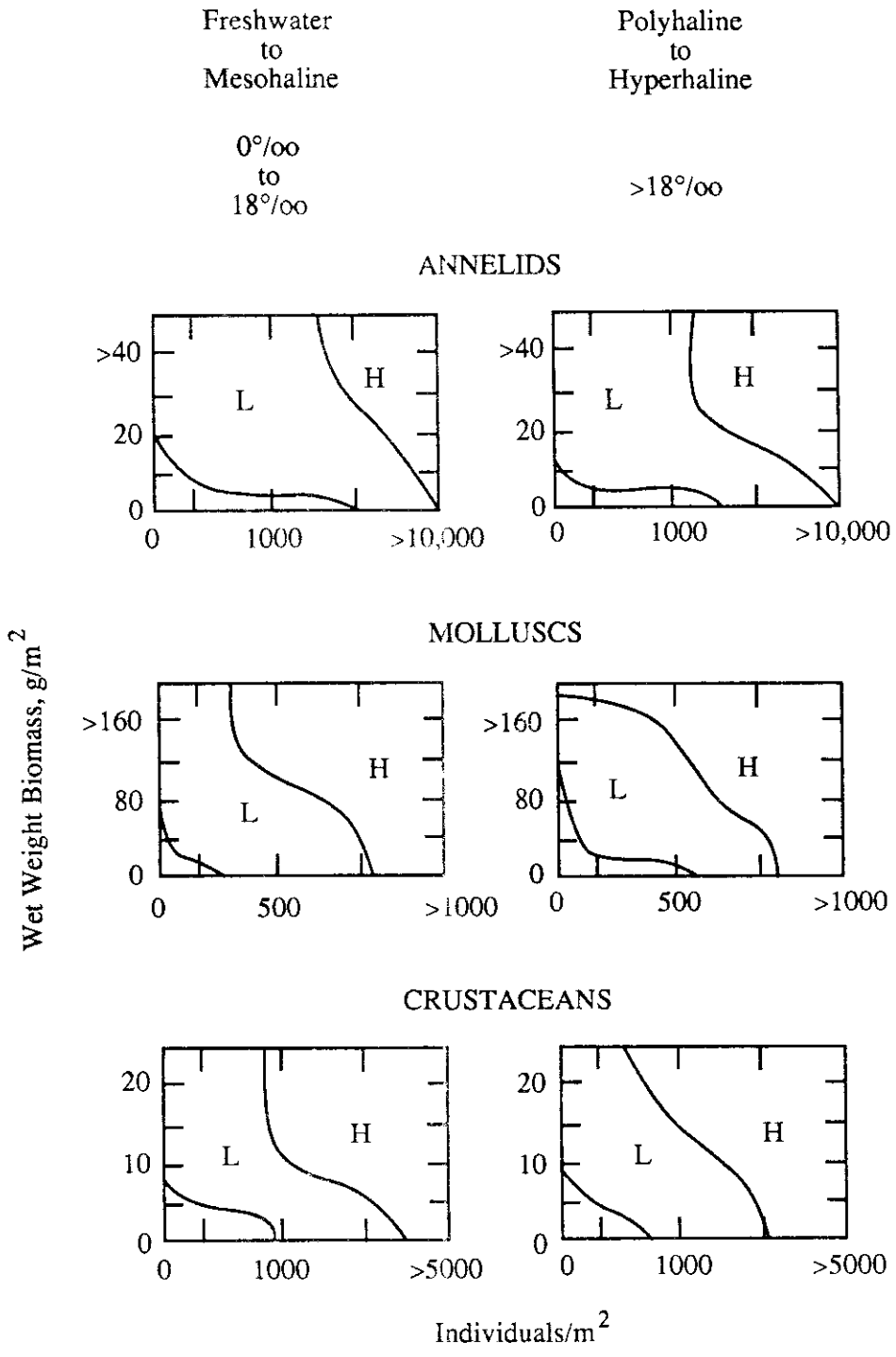

Figure E1.3. Benthic Invertebrate Populations of Estuarine Tidal Flats (after Adamus et al. 1987, from data reported by Diaz 1982)

TABLE E1.1. COMPARISON OF INVERTEBRATE DENSITIES IN SEVERAL WETLAND COMMUNITIES (AFTER LAMMERS 1977)

Community	Total Individuals per m^2	Dominant Taxa	Percent of Total
Minnesota fen	2,193	Diptera Collembola Hymenoptera	70.4[a] 14.0 9.1
Minnesota swamp	1,734	Diptera Collembola Colleoptera	77.4[b] 10.4 6.4
Minnesota sedge mat	944	Diptera Colleoptera Hymenoptera Collembola	61.4[c] 14.2 8.3 7.8
Ontario pond	7,080	Diptera	99.5[d]

[a]82.1% Chironomidae
[b]71.6% Chironomidae
[c]87.1% Chironomidae
[d]78.3% Chironomidae

and/or qualitative dip net survey information indicate that the wetlands being compared have equivalent invertebrate communities.

If the mitigation requirements are not met after the designated time, or doubt exists that they will be met as the time approaches, refer to the Diagnostic Procedures for guidance.

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TASK E2

FISH HABITAT SURVEY

OBJECTIVE

The objective of this task is to use the results of other tasks to draw inferences concerning the provision of fish habitat by the wetland.

BACKGROUND

Documentation of the fish populations in created wetlands is beyond the scope of a normal monitoring process. The analysis of the provision of fish habitat function may be best undertaken through indirect measurements of fish habitat parameters. For example, current studies documenting the functional value of the Lincoln Street (Tacoma) wetland from a fish population standpoint include studies of fish residence time, food habitats, and immigration and emigration rates (Simenstad, personal communication).

The fish populations in a given wetland are to a large extent determined by production of suitable foods and the availability of refuge from predators, assuming that other characteristics of the wetland are adequate (e.g., water temperature, quality and quantity, access, etc.). Functional value to fish is measured by physical growth of the individual and growth or persistence of the population. The simple presence of fish does not mean that habitat is adequate, as the fish may not be attaining growth rates comparable to the reference or pre-impact wetlands, or may be suffering higher predator rates because of a lack of cover.

Unfortunately, at this time there is no way to define the degree of provision of refuge from predators without conducting detailed population studies. Growth studies would require periodic, intensive sampling. Appendix E presents an electrofishing procedure that is recommended for fish sampling in freshwater if such a program is developed.

SAMPLING PROGRAM DESIGN

The habitat value of created wetlands for fish can be documented through evaluation of several of the other monitoring tasks, and a general review of the morphological and habitat features of the wetland.

1. Define the "as-built" physical character of the created and the replaced and/or reference wetlands being compared with regard to accessibility by fish, water depths, and water volume.
2. Inventory physical features that provide cover from predators in the wetlands being compared. These features include deep water areas, floating logs and tree branches, overhanging banks, etc.
3. Record the results of the following tasks:

   Task A2. Photographic Record

   Task A4. Water Level Gaging

   Task B1. Water Temperature and pH Measurement

   Task B2. Dissolved Oxygen Measurement

   Task B3. Specific Conductivity Measurements

   Task D1. Plant Community Assessment

   Task D2. Phytoplankton Biomass Measurement*

   Task D3. Habitat Suitability Evaluation

   Task E1. Aquatic Invertebrate Community Assessment

DATA INTERPRETATION

The mitigation requirements will be considered to be met if, within the period designated by the mitigation plan,

1. the created wetland exhibits habitat characteristics suitable for the fish species of interest, according to the criteria given in the Data Interpretation

* (if Detailed Analysis is performed)

sections of the Tasks listed above (because these criteria are not all-inclusive for the many species of fish that may inhabit different wetland types and for all life stages, a fisheries biologist should be consulted to assist in the interpretation); or

2. if the results are being compared between the created wetland and a reference or replaced wetland, the wetlands being compared are accessible to fish in a manner equal to the replaced and/or the reference wetland, and the fish habitat and forage parameters in the created wetland equal or exceed those of the replaced and/or reference wetland.

If the mitigation requirements are not met after the designated time, or doubt exists that they will be met as the time approaches, refer to the Diagnostic Procedures for guidance.

REFERENCE

Simenstad, C., University of Washington Fisheries Institute, Seattle, WA, personal communication.

TASK E3

WILDLIFE POPULATION CHARACTERIZATION

OBJECTIVE

The objective of this task is to document achievement of the wetland function of providing wildlife habitat through direct observation of wildlife presence.

BACKGROUND

This procedure quantifies the use of the wetland by wildlife populations. Monitoring of the effectiveness of the mitigation wetlands as wildlife habitat relies on the studies of bird populations and to a lesser extent other vertebrates. Birds are considered to be the most efficient species for monitoring habitat effectiveness, as they are excellent indicators of habitat quality (Council on Environmental Quality 1972, Morrison 1986) and are generally abundant. Also, they are readily observed, thus allowing systematic sampling with minimal impact on the species or its habitat.

Mammals, reptiles, and amphibians should also be sampled systematically. However, their use in evaluating wetland success is more limited.

EQUIPMENT AND SUPPLIES

1. Field guides (birds, mammals, reptiles, and amphibians)
2. Stop watch
3. Binoculars

SAMPLING PROGRAM DESIGN

Habitat use by wildlife (e.g., birds) should be characterized during different periods of the year, depending on the specific functions of the mitigation project. Breeding/rearing functions should be evaluated in late spring; refuge and feeding/foraging in the season(s) identified as important in the specific mitigation objectives for the project; wintering habitat in the winter; and migration in the winter (for over-wintering migratory species) or in the

fall and early spring (for transient migrants). Systematic observations of herpetofauna and mammals should be conducted incidental to the bird surveys.

OBSERVATIONAL PROCEDURE

Birds

1. Establish bird counting stations around the perimeter of the wetland, at locations with unlimited visibility, with all parts of the wetland equally sampled. Use a minimum of three stations per wetland. The maximum number of stations is established when a new station increases the total number of bird species observed by less than 10 percent. Assign stations a site designation, and mark them on a wetland map (see Task A1).
2. For each station, record the number of individuals of each species seen or heard during a five-minute (or longer, if few stations) counting period. Include low-flying (aerial-feeding) birds, but not birds flying high overhead. Station counts are to be conducted in the time period from 30 to 150 minutes after sunrise.
3. Each wetland should be sampled a minimum of three times per sampling period. Timing of sampling will depend on the habitat function evaluated (see discussion under Background). For example, for evaluation of all types of bird use, sampling should be conducted in all seasons, with sampling dates distributed across the migration and resident breeding periods. For evaluation of a specific use (e.g., breeding/rearing), with a defined time period (e.g., April to June), sampling should be concentrated in the period in question. For tidally influenced wetlands, sampling periods for the created and reference wetlands should occur during the same tidal stage.
4. Bird surveys should not be conducted on days with fog or when wind speed exceeds 13 km/h (Robbins 1981).

5. In areas affected by freeway noise, counts should be made both before and during the peak morning traffic period to determine the influence of this type of disturbance on results. The same censusing schedule should be applied to both created and reference wetlands.

6. For breeding bird surveys, note should be taken of the number of birds engaged in breeding display, territory marking, nest building, etc., in addition to the actual number of nests and young observed in the wetland.

Other Vertebrates

1. Use vegetation transect lines installed in connection with Task A2.

2. Traverse each transect line, noting any observations of vertebrates or their sign (i.e., tracks, scats, etc.) within 0.5 meter (1.6 feet) of the line on both sides.

3. Take note of any evidence of breeding in the wetland (e.g., egg masses).

CALCULATIONS

Birds

1. **Species richness**. Tally the total number of species observed in the wetland at all stations.

2. **Species diversity**. Compute the diversity index (H) based on all station counts by the following formula (Shannon and Weaver 1963):

$$H = -\sum_{i=1}^{S} p_i \log_2 p_i$$

where S = total number of species (richness)

p_i = proportional representation of the ith species in the total population (ratio of the number of individuals in the ith species group to the total number of individuals in all species groups)

$\log_2$ = logarithm to base 2

Other Vertebrates

1. Determine species richness for each wetland class (by taxonomic groups, such as mammals, amphibians, reptiles).

DATA INTERPRETATION

Birds

Compare results at the created wetland with those in the replaced or reference wetland, or to published values for similar wetland systems (see Table E3.1), to determine whether the criteria are met. Pay particular attention to the wetland-dependent species listed in Appendix F. The mitigation requirements will be considered to be met if, within the period designated by the mitigation plan, the data demonstrate the existence of such conditions as the following:

1. species richness for the created wetland is at least equal to that of the replaced or reference wetland, or within the range of values expected for this type of wetland system (see Table E3.1) (a statistical test of means can be conducted on the averages of the three species richness values for each wetland; see Zar 1984);
2. species diversity in the created wetland is at least equal to that of the replaced or reference wetland, or within the range of values expected for this type of wetland system (see Table E3.1) (use formulas 9.43 to 9.46 in Zar (1984), page 146, to test for statistically significant differences between two diversity indices); and
3. if breeding habitat is the mitigation objective, the number of breeding species in the created wetland is at least equal to that in the reference or replaced wetland, or within the range of values expected for this type of wetland system (see Table E3.1).

Table E3.1. Summary of Spring Diversity Index and Species Richness Values for Birds of Urban Freshwater Wetlands in the Puget Sound Lowlands (from Milligan 1985)

Parameter	Combination of Zones	Open Water Zone	Scrub-Shrub Zone
Species Richness[a]			
Mean	11.03	10.11	10.20
Standard error of the mean	0.82	1.13	0.48
Range[b]	7.3-15.6	7.3-16.3	9.3-11.7
Diversity Index			
Mean	1.95	1.72	2.03
Standard error of the mean	0.08	0.72	0.04
Range[b]	1.7-2.4	1.4-2.0	1.9-2.2

[a]Total species pool was 23.

[b]The range represents variation around the mean based on three spring bird censuses in each study wetland.

Other Vertebrates

1. The species richness values are similar for each taxonomic group for the two wetlands being compared.

If the mitigation requirements are not met after the designated time, or doubt exists that they will be met as the time approaches, refer to the Diagnostic Procedures for guidelines.

REFERENCES

Council on Environmental Quality, "Development of a Continuing Program to Provide Indicators and Indices of Wildlife and the Natural Environment," Ecology Program, Smithsonian Institution, Washington, D.C., 1972.

Milligan, D.A., "The Ecology of Avian Use of Urban Freshwater Wetlands in King County, Washington," M.S. Thesis, University of Washington, Seattle, WA, 1985.

Morrison, M.L., "Bird Populations as Indicators of Environmental Change," *Current Ornithology* 3:429-451, 1986.

Robbins, C.S., "Bird Activity Levels Related to Weather," *Studies in Avian Biol.* 6:301-310, 1981.

Zar, J., *Biostatistical Analysis*, 2nd Ed., Prentice-Hall, Englewood Cliffs, NJ, 1984.

APPENDIX A
INSTRUCTIONAL LETTER, WETLANDS

INSTRUCTIONAL LETTER

WETLANDS

221.01 GENERAL

This section provides guidance for wetland design and related procedures that should be followed when it is anticipated that a highway project may impact wetlands.

Federal and state laws require that the department avoid or minimize impacts to wetlands as much as practical.

Wetlands are valuable in flood conveyance and storage, storm water retention, water quality improvement, aquifer recharge, and in providing food and habitat for wildlife. Wetlands include: swamps, marshes, bogs, sloughs, potholes, wet meadows, river overflows, estuarine areas, tidal overflows, mud flats, and shallow lakes and ponds. Wetlands do not include deep reservoirs, deep lakes, and areas covered with water for such a short time that neither hydric soil or wetland vegetation is able to establish.

Highway related activities that may adversely impact wetlands include: sediment deposition, toxic runoff, alteration of natural drainage patterns, water level increases or decreases, wetland filling or displacing, and wetland draining due to channel straightening, deepening, or widening.

221.02 REFERENCES

(1) Clean Water Act of 1977, Public Law 95-217 - Section 404(b), and 40 CFR Part 230.

(2) FHWA Technical Advisory, T 6640.8A, October 30, 1987, Wetland Section.

(3) Presidential Executive Order 11990 "Protection of Wetlands," May 24, 1977.

(4) U.S. Department of Transportation Order (DOT 5660.1A) "Preservation of the Nation's Wetlands," August 24, 1978.

(5) U.S. Environmental Protection Agency - Region 10, 404 Mitigation Policy, September 4, 1985.

(6) U.S. Fish and Wildlife Service Mitigation Policy - Federal Register, January 23, 1981.

(7) U.S. Fish and Wildlife Service "Classification of Wetlands and Deepwater habitat of the United States," December, 1979.

(8) Shoreline Management Act - RCW 90.58.

(9) State Environmental Policy Act Rules, WAC 197-11-960.

221.03 DEFINITIONS

(1) Habitat. The sum of the environmental conditions that support a given species, population, or community. It includes environmental features such as climate, topography, vegetation, and soil characteristics, and water supply (including both surface water and groundwater) in an area.

(2) **In-kind Replacement.** Providing replacement wetlands that are physically and biologically similar to those that are lost.

(3) **Mitigation.** Wetland avoidance or improvement actions taken expressly for the purpose of compensating for unavoidable losses resulting from a project.

(4) **Wetlands.** Lands that are either permanently or seasonally "inundated by surface or ground water with a frequency sufficient to support and under normal circumstances does or would support a prevalence of vegetative or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction."

(Presidential Executive Order 11990). Wetlands can normally be placed in one of the following categories:

a. **Wetland Category 1.** A wetland determined to be unique, irreplaceable, and of high value (e.g., most saltwater tidal wetlands).

b. **Wetland Category 2.** A wetland determined to be of high value that is relatively scarce or becoming scarce.

c. **Wetland Category 3.** A wetland determined to be of high to medium value that is relatively abundant.

d. **Wetland Category 4.** A wetland determined to be of medium to low value that is relatively abundant (e.g., an existing fill slopes covered with wetland plant species).

(6) **Wetland Enhancement.** Raising the value of wetlands through improvement, augmentation, development, or diversification.

(7) **Wetland Banking.** The off-site creation, restoration, or enhancement of wetlands to compensate for unavoidable wetland losses in advance of a project. A wetland bank is a net gain in wetlands to be drawn upon to offset small wetland losses from several sites or projects.

(8) **Wetland Finding.** A finding required by Executive Order 11990 that there are no practicable alternatives to construction in wetlands.

221.04 OBJECTIVES

(1) **General.** All project designs should avoid, to the extent practical, short-term and long-term adverse impacts to wetlands.

When a project impacts wetlands, it must be shown that the construction or improvement within wetlands has no practicable alternative and that the proposal includes all practical measures to minimize harm to the wetland functions.

(2) **General Mitigation Measures.** Mitigation measures shall be considered in the following order of priority:

(a) **Avoid the Impact.** Design the project to avoid damage or loss of wetlands, including appropriate timing of activities, or structural features, such as highway realignment and water pollution control facilities.

(b) **Minimize the Impact.** At this level, the project's impacts on wetlands should be reduced as much as safety and capacity requirements of the facility will allow.

(c) **Rectify the Wetland Impact.** Rectify the project's impact to wetlands by:

- o Restoring existing wetlands to their original conditions.
- o Creating replacement wetlands from upland sites to mitigate for unavoidable wetland impacts.
- o Enhancing existing wetlands by improving the functions and services of existing low quality wetlands.
- o Creating a wetland bank to be used as credit for future wetland impacts (see Section 221.07).

(3) **Wetland Categories and Mitigation Goals.**

(a) **Wetland Category 1.** Wetlands in Category 1 should be avoided. The goal for wetland Category 1 is to avoid any loss of existing in-kind wetland value, as these unique areas generally cannot be replaced. Minor changes to the wetlands that do not result in adverse impacts on the wetland value may be acceptable provided no significant cumulative impact is anticipated. An estuarine wetland is an example of Category 1 wetland.

(b) **Wetland Category 2.** Wetlands in Category 2 should be avoided as much as practicable. The goal for these wetlands is to avoid net loss of in-kind wetland value. If unavoidable wetland losses are likely to occur, these losses should be compensated by construction of replacement wetlands of the same kind as the existing wetlands; enhancement of existing wetlands of the same kind as the ones to be impacted; or a combination of these measures.

(c) **Wetland Category 3.** Wetlands in Category 3 should be avoided as much as practicable. The mitigation goal for wetlands in this category is to avoid net loss of wetland value (not necessarily

in-kind wetland value). If unavoidable wetland losses are likely to occur, these losses should be compensated by construction of replacement wetlands. Compensation may also consider enhancement of existing wetlands or a combination of both measures.

(d) **Wetland Category 4.** Wetlands in Category 4 should be avoided as much as practicable. The mitigation goal of wetlands in this category is to minimize loss of wetland value. If unavoidable wetland losses are likely to occur, pursue ways to reduce the losses. Replacement of these wetlands are not required, but compensation for the losses should be considered.

221.05 PROCEDURES

The flow charts, Figures 1 and 2, show the order and relationship of activities for projects involving wetland impacts with other project development activities.

Figure 1 is for projects that are relatively simple and do not require federal permits. Figure 2 details the process for the more complex projects requiring federal permits. The activities are described in more detail as follows:

(1) **Identification.** During the development of the project prospectus, determine if wetlands are present within the existing or proposed project right of way. If there is potential or known impact to wetlands, it should be noted on the project prospectus.

(2) **Design Project Alternatives.** Design project alternatives that will avoid or minimize damage to or loss of wetlands. Consider, as a minimum, the following alternatives:

- o An alternative meeting appropriate geometric design standards for new construction, 3R, or 4R projects without regard to wetland impact.
- o An alternative avoiding all wetland impacts.
- o An alternative satisfying the project's purpose that provides a balanced approach of minimizing impacts to wetlands without jeopardizing design and funding goals critical to the project.

(3) **Biology/Wetland Report.** A biology/wetland report for all alternatives should be prepared by a person trained in wetland ecology.

The report should contain the following items:

- The wetland's category (1, 2, 3, or 4) and functional values.
- The relationship and the anticipated impacts of each project alternative to the wetland.
- The mitigation measures needed for each alternative, including measures to minimize impacts to wetlands.
- Recommendations on mitigation requirements for the wetland.

Normally, the biology/wetland report is prepared by a headquarter's biologist. It is then sent to the district for review and concurrence. The district reviews the draft report, and either accepts it and adjusts the project design, or discusses options with the headquarters biologists that would satisfy project needs and resource agency permit requirements.

The wetland report is then finalized, incorporating mitigation measures agreed upon by district and headquarters. The report is then sent to the district for use in coordinating with resource agencies for the preparation of project environmental documents.

(4) **Coordination With Resource Agencies.** The district meets with the appropriate resource agencies to discuss project alternatives, wetland impacts, and the mitigation proposal concept. The proposal should include a discussion of wetland goals, general location, size, revegetation and hydraulic proposals, and other elements that may be appropriate. Listed below are the resource agencies that may be contacted:

- Washington State Department of Wildlife.
- Washington State Department of Fisheries.
- Washington State Department of Ecology.
- U.S. Environmental Protection Agency.
- U.S. Fish and Wildlife Service.
- National Marine Fisheries Service.
- U.S. Army Corps of Engineers.
- Affected Indian Tribes.
- Local Planning Agencies.

Refer to design manual 217, "Permits and Approvals From Other Governmental Agencies," to determine which of these agencies are appropriate for the project.

The eventual management of created wetlands will normally be the department's responsibility when it is contiguous with WSDOT right of way. When the created wetland is separate from WSDOT's right of way, other agencies should be contacted to discuss a land transfer or a management agreement after a wetland has been created.

When an agency shows interest, an agreement should be developed with that agency. The agreement must ensure the wetland will exist permanently and meet agreed upon goals. The agreement should also include right of way turn-back provisions, wetland maintenance needs, cost participation, etc. The district initiates the agreement with approval from the Location-Design Engineer.

(5) **Draft Environmental Document.** Incorporate the content of the biology/wetland report, including comments from the resource agencies, into the appropriate environmental document for the project (e.g., checklist, environmental assessment, environmental impact statement). The environmental document should include quantified impacts of proposed project alternatives and a discussion of proposed wetland mitigation.

(6) **Design Report.** The design report for the main project should include information based on the biology/wetland report and the environmental document for the project to support the proposed design alternative

(7) **Wetland Mitigation Concepts Report** Wetland Mitigation Concepts Report is needed on projects requiring a Corps of Engineers Section 10 or 404 or other federal permit. When the finalized wetland report identifies that a project will cause wetland impacts, a wetland mitigation concept is prepared for inclusion in the final environmental document.

(a) **Procedures.** The steps listed below should be followed in preparing the wetland mitigation concepts:

1. The district, in consultation with headquarters landscape and biology staff, prepares the basic concepts.

2. The district submits the conceptual mitigation proposal to the headquarters Location-Design Engineer for coordinated headquarters review by the design, environmental, and maintenance offices.

3. The district incorporates appropriate headquarters' comments into the conceptual mitigation proposal.

(b) **Wetland Mitigation Concept Content.** The following items should be included in a conceptual mitigation proposal:

1. Project Description.
   - o Site location - township, range, and state route number.
   - o Description of the project.
   - o Need for the project.
2. Project Alternatives.
   - o General description of the project location and design alternatives to avoid wetlands. Include the no-build alternative.
   - o Explanation of reasons why the selected alternative is the most practical.
3. Wetland Impacts. Detailed discussion of the wetland impacts associated with the preferred alternative.
4. Mitigation Concepts: Discussion of the following items:
   - o Goals (e.g., restore wildlife habitat, storm water retention, nutrient recycling, etc.).
   - o Conceptual wetland mitigation site plan plus typical cross section. Refer to design manual sections 221.06 and 219 for wetland design considerations.
   - o Wetland revegetation, types and general location including natural revegetation.
   - o Any other mitigation elements that may be appropriate (e.g. berms).

(8) **Wetland Finding.** Federally funded projects impacting wetlands require a Wetland Finding. The Wetland Finding contains the following items:

(a) Identification of wetland locations and areas affected by the project, which must include:

- o Description of the type, function, and importance of each wetland.
- o Factors that contribute to the importance of each wetland.
- o Map of each wetland location.
- o Reference to EO 11990.

(b) Project Alternatives.

- o Description of the project location and the design alternatives considered.
- o Reasons why there are no practicable alternatives other than the selected alternative.
- o Impacts to the wetland, and degree of significance of the impacts.
- o Description of the proposed mitigation.
- o Conclusion based upon the above considerations.

Submit the Wetland Finding to headquarters for final approval and incorporation into the appropriate environmental document, which is submitted to FHWA for approval.

(9) **Final Environmental Document.** The final environmental document includes a more specific description of proposed project impacts, including a wetland finding, if required, and elements from the conceptual mitigation proposal that summarize the department's wetland mitigation intent. These elements, from 221.04(6), include only those unique to the mitigation of wetlands. The conceptual mitigation proposal is also incorporated into the project design report.

(10) **Wetland Mitigation Plan Development.**

(a) **Procedures.**

1. When the wetland mitigation plan is prepared, it needs to be incorporated into project documents and reviewed by the applicable resource agencies. This process must be coordinated between the district, headquarters, and the resource agencies. The process begins with the district preparing the wetland mitigation plan, including the elements in item (b).

2. During the development process, headquarters Location-Design coordinates a review of the plan and provides comments to the district.

3. At the conclusion of the 404 permit process (see Section 221.04(10)) the district modifies the final wetland mitigation plan based on any permit conditions and comments received from the circulation of the Corps Public Notice of Application for Permit. The corrected plan is submitted to headquarters Location-Design for final approval. After final approval, the district incorporates the wetland mitigation plan into the project PS&E.

(b) Content. The wetland mitigation plan includes the conceptual proposal plus enough additional detail so that the resource agencies can have a complete understanding of the department's wetland mitigation plan and can make permit decisions based on the plan. The final mitigation plan is used as a basis for obtaining federal permits on projects that impact wetlands. The following is the information to include:

1. Description of all wetlands in the project area, including their type, importance, function, the U.S. Fish and Wildlife Service (FWS) classification, and map showing their general location.
2. Wetland site plan that shows general contours identifying flatter shoreline areas and general shoreline configuration. (This plan may also contain the revegetation proposals.)
3. Wetland revegetation plan showing location of plant types (e.g. trees, shrubs, wetland plants, and seeded areas). Specific species and quantities are not required.
4. Standards of Success. Include a discussion of elements that will be evaluated to determine successful completion of the mitigation goals. Examples are:
   - o Revegetation of the Site. A percentage of plant coverage or plant survival that will be guaranteed to occur on the site within a given time period; methods used to achieve success of plantings, such as initial overplanting,

replacing dead plants, using plants well adapted to the local climate and soils, and irrigation.

- o A method to ensure that a hydrologic regime sufficient to support a functioning wetland will be established, measured by water depth or occurrence of wetland conditions on the site during the growing season.
- o Other hydrological or biological measures of success.
- o A contingency plan to correct deficiencies in the event of the failure of one or more of the elements of the mitigation goals; and
- o What actions will be taken if monitoring indicates the standards of success are not being achieved.

5. Maintenance and Operation. Include a discussion of:
   - o Maintenance activities proposed to aid in successful establishment of the site after initial contract completion.
   - o Long-term maintenance and operation activities after the goal is met (see Design Manual section 219); and
   - o Agency to be responsible for long-term maintenance and operation.
6. Monitoring. Annual monitoring will be conducted for up to five years or as determined by the rate of wetland development. Discuss:
   - o Details of the monitoring (who, when, and how);
   - o Items or elements to be included in the monitoring report;
   - o Who will receive copies of the report (example: COE, EPA and FWS); and
   - o Frequency of reports.

The final plan is presented to the resource agencies during the permit application process.

(11) Corps of Engineers' Permit. For projects that require a Corps of Engineers' permit, the wetland mitigation plan may be presented at a Corps pre-application meeting. The following steps are needed for processing a Corps' permit:

(a) The district Environmental Coordinator sends the mitigation plan to the Corps, requesting to be on their monthly meeting agenda. The request needs to be made four weeks prior to the meeting. The request should also identify specific agencies to be invited. After the Corps reviews the plan, they will notify the district if a pre-application meeting would be beneficial or if a 404 permit is indeed needed. When pre-application meeting is not required, go to step (f). In that case, the district should coordinate with each applicable resource agency.

(b) Approximately ten days prior to the meeting, the district prepares and sends out information packages to invited resource agencies so they can study the proposal prior to the meeting. Pertinent environmental documentation may be sent with the information package. Additional copies should also be brought to the pre-application meeting for use and reference.

(c) The district makes telephone contact with all invited agencies prior to the meeting and answers any questions about the project.

(d) The district develops the presentation for the Corps pre-application meeting, being prepared to answer agencies' questions on wetland and mitigation and design trade-offs. The presentation at the pre-application meeting should include:

- o Need for the project.
- o Location of the project.
- o Topography of the project site.
- o Existing alignment.
- o Proposed alternatives.
- o Wetland analysis.
- o Selection of preferred alternative.
- o Wetland impacts of the preferred alternative.
- o Wetland mitigation proposal.

Photographs, maps, and other graphics that clearly depict the department's proposal should be used. Well done video film may augment other graphics. Video film should be narrated and referenced to an aerial photo or map.

(e) The district modifies the final wetland mitigation plan in response to the resource agencies' comments, coordinating revisions with district maintenance.

(f) The district applies for a Corps 404 Permit, including a copy of the final wetland mitigation plan with the application.

(g) The district initiates a right of way revision identifying the wetland mitigation area that is to become a part of the department right of way. When a turn back agreement for the wetland parcel is also proposed, the right of way revision should so identify.

(12) **Project Commitment Documentation.** For each project involving wetland impact, the commitments from the Wetland Mitigation Plan should be entered into the project file prior to the development of the PS&E. This will provide a reference source for the project's PS&E preparation, construction, and maintenance.

(13) **Right of Way Plan.** For wetland sites that are adjacent to the highway's right of way, the area for the proposed wetland site should be incorporated into the right of way plan and labeled "Wetland Mitigation Area - Do not Surplus".

(14) **Sundry Site Plan.** For wetland sites that are separated from the highway's right of way, a sundry site plan should be developed, labeling the site as "Wetland Mitigation Area". Refer to Plans Preparation Manual.

(15) **Conservation Signs.** Conservation signs should be installed at proposed wetland sites to alert field crews to take special precautions and to maintain the site identity. A conservation sign is illustrated in Figure 3.

221.06 WETLAND DESIGN

Generally when an adequate source of water is available, a wetland can be established. However, the amount and kind of biological productivity of a wetland is determined by a variety of factors. The design of new wetlands should consider the type of wetland desired and the specific parameters that must be controlled.

(1) **Wetland Site Selection.** In selecting sites for a new wetland, the following factors should be considered:

(a) Locations for created wetlands, in order of preference, are:

- o Within WSDOT right of way contiguous to the project.
- o On other public agency property contiguous to the project.
- o On WSDOT property beyond the limits of the project.
- o On purchased property adjacent to the project.
- o On purchased property beyond the limits of the project.

(b) Close proximity to the impacted wetland.

(c) Relative ease of wetland establishment at the proposed site.

(d) Availability of a reliable water source from stream, surface runoff, tidal source, or relatively high water table.

(e) Availability of adequate water quality (pH of 5.5 to 9.0) for freshwater wetlands.

(f) Existence of bordering woody trees or shrubs, or areas in which these can be planted.

(2) **Wetland Design Considerations.** When designing a new wetland, all potential sites should be located beyond the recovery area or designed so they do not become a roadside hazard. In addition, future transportation needs should be considered when selecting wetland locations. The following objectives should be pursued:

(a) Maintain wetland water regime at an acceptable level by:

1. Allowing excess to escape along natural drainage courses, by use of culverts, or waterway openings.
2. Intercept and dispose of excess surface runoff, without damage by erosion or flooding, by use of vegetated ditches, riprap ditch, etc.
3. Impound or retain water, trap sediment, and prevent flooding by use of earth or rock-filled embankment.

(b) Create a shallow water level where none previously existed.

1. Impound or retain water by use of an earth embankment with riprap and subdrains or excavated catchment area (basin) located in lowlands.
2. Direct or control runoff by land form contouring, etc.

(c) Divert toxic runoff and/or prevent road salt intrusion into wetlands.

1. Provide adequate storage for accumulations of plowed snow, and facilitate runoff collection in separate drainage systems, e.g., by use of appropriate placement of catch basins, and curbing.
2. Detain highway runoff and prevent potential downstream pollution, e.g., by use of impervious earth dikes, a basin excavated below ground surface.
3. Provide vegetated channels that filter runoff prior to entering the wetland.

(d) Control sedimentation.

1. Collect storm runoff from collection ditches, trap major amounts of sediments, and divert flow to a piping system by use of inlet sediment traps, etc.
2. Trap runoff to settle out sediments and filter out fines; release runoff through a filter at non-erosive flow rates by use of earth dikes constructed at or near the low point of the site.
3. Restrict flow velocity to non-erosive rate; detain runoff to settle out sediment by use of a pervious dam (e.g., consisting of broken rock, cobbles, or boulders) constructed in a channel or drainage ditch.

(e) Control leachates that may adversely affect wetlands. Prevent contamination of drainage systems and natural water courses (caused by the leaching of contaminants) by use of bituminous seal coats, bentonite slurry seal, or impervious clay blanket.

(f) Reduce noise and visual impacts on wetland wildlife species at sensitive wetlands by using plantings, earth berms, or structural barriers, located between the highway and the wetlands.

(g) Provide food and habitat for wildlife by maintaining the balance of open areas for feeding and dense vegetation for hiding from predators and by using plants that produce edible fruits, leaves, or bark of high value to wildlife.

(h) Salvage soil from impacted wetland and place in created wetland.

(3) Potential Wetland Sites.

(a) **Basin Wetlands.** Basin wetlands can be located in most waste or borrow pit sites which are fed by adequate rainfall, surface runoff, or groundwater to sustain wetland plants.

The slope on the bottom of all wetlands should be no more than 3 percent. The basins should be shallow (less than 6 feet deep). Depths in the basin should vary throughout to provide for better vegetative diversity. Side slopes of 5:1 or flatter are desirable for all sides, creating a saucer-type depression. The flatter the surface of the waste areas, the larger and more valuable will be the wetland that is created.

(b) **Old Stream Beds.** Where a stream originally meandered in wide bends, the highway is sometimes placed across such a bend and the stream relocated to the opposite side of the highway. The original stream bed often receives surface runoff, or is fed by a small tributary stream. This area may be developed into a wetland with little additional work.

(c) **Parallel Drainage Channels.** Highway fill sometimes modifies the drainage pattern of an area, resulting in drainage channels developing parallel to the highways that might further lead to a wetland formation.

With slight modification, the size of these wetlands can be increased, and their value improved. Small earth dams constructed along these narrow drainage areas will create a string of small impoundments.

As with other wetlands, these should have side slopes of 5:1 or flatter on the water side to provide diversity of vegetation. Water depth should be no more than 2 feet. Such wetlands can be located on the outside of the highway fill or in wide medians.

(e) **Interchanges.** Interchange sites for wetland mitigation should only be considered as a last alternative since they are frequently being modified to respond to changing traffic needs. When interchanges are used, water depth should be no greater than 2 feet because of safety consideration.

Many interchanges are designed with low areas between ramps and the main lanes. These usually have drainage courses and culverts that carry the water under the highway to a nearby stream. These low areas can be potential wetland sites.

(f) **Other Potential Sites.** Other potential sites include retention basins, low areas on state right of way, and flat bottomed borrow area. These sites can sometimes be improved to create a satisfactory wetland site.

221.07 WETLAND BANKING

When banking is the mitigation alternative, the following apply:

(1) A wetland bank may be established as a credit reservoir for several small impacts on a single project or on closely related projects. These impacts normally range from .01 acre to 1.00 acre.

(2) Wetland Bank Criteria:

(a) Wetland bank sites would generally be in the same drainage system or Water Resource Inventory Area (WRIA) as the project.

(b) Wetland bank sites must be established (designed and constructed) before credit could be charged.

(c) Banks could be used for multiple impacts caused by one or more projects.

(3) Procedures:

If a district determines that on-site mitigation was impracticable, the wetland banking option can be pursued. The next step is to form an interagency evaluation team to set up the wetland banking program. The team should consist of the district environmental coordinator and project engineer, headquarters biologist, and representatives of U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, Environmental Protection Agency and Department of Ecology.

The wetland banking program should include:

- Impact areas for which wetland banking may be considered.
- Location and development of a wetland bank.
- Criteria for charging against the wetland bank.
- Evaluation methods.
- Record keeping.
- Schedule for the wetland bank creation.

The wetland banking program set by the team should be covered in an agreement between WSDOT and U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, Environmental Protection Agency, and Department of Ecology.

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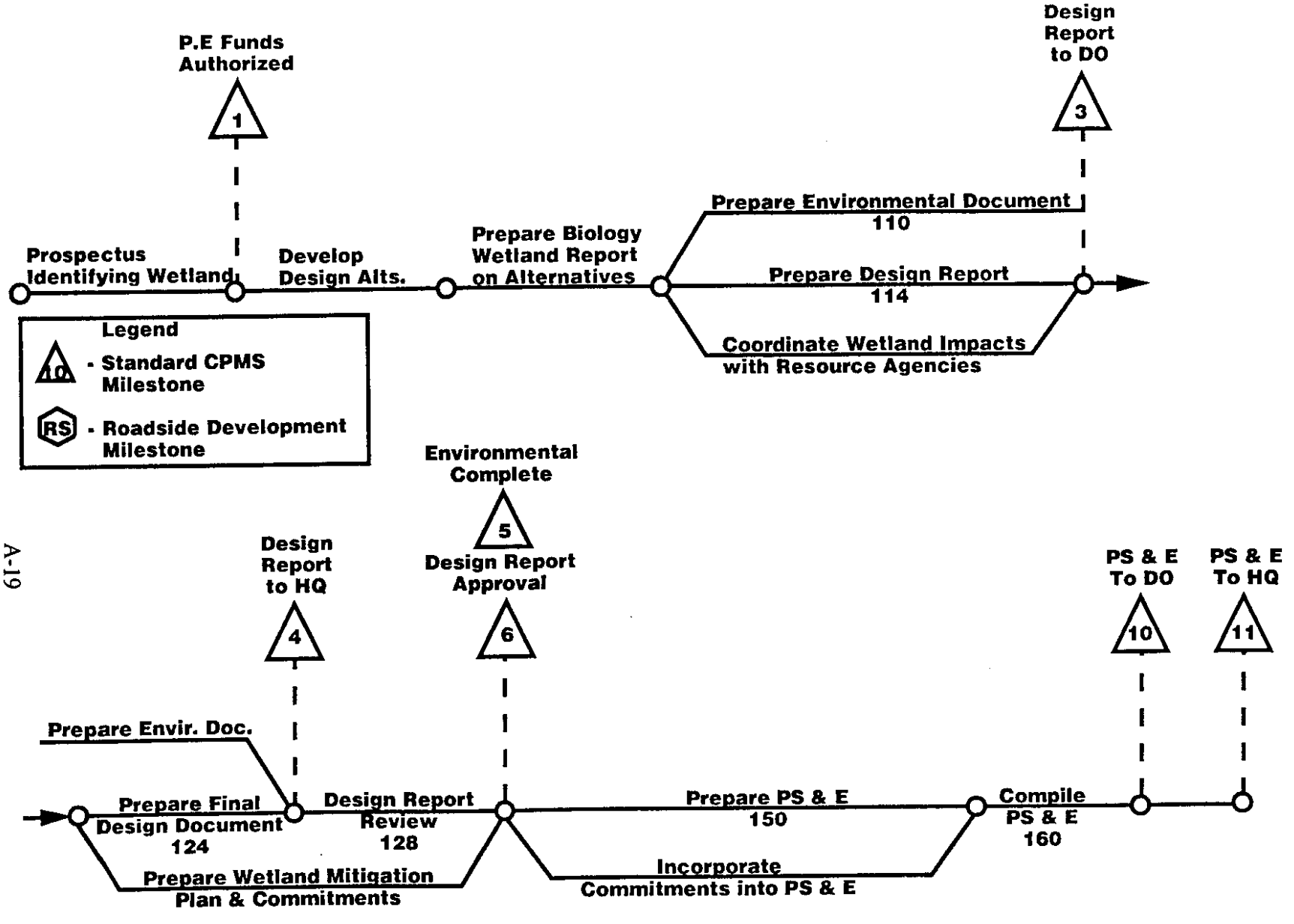
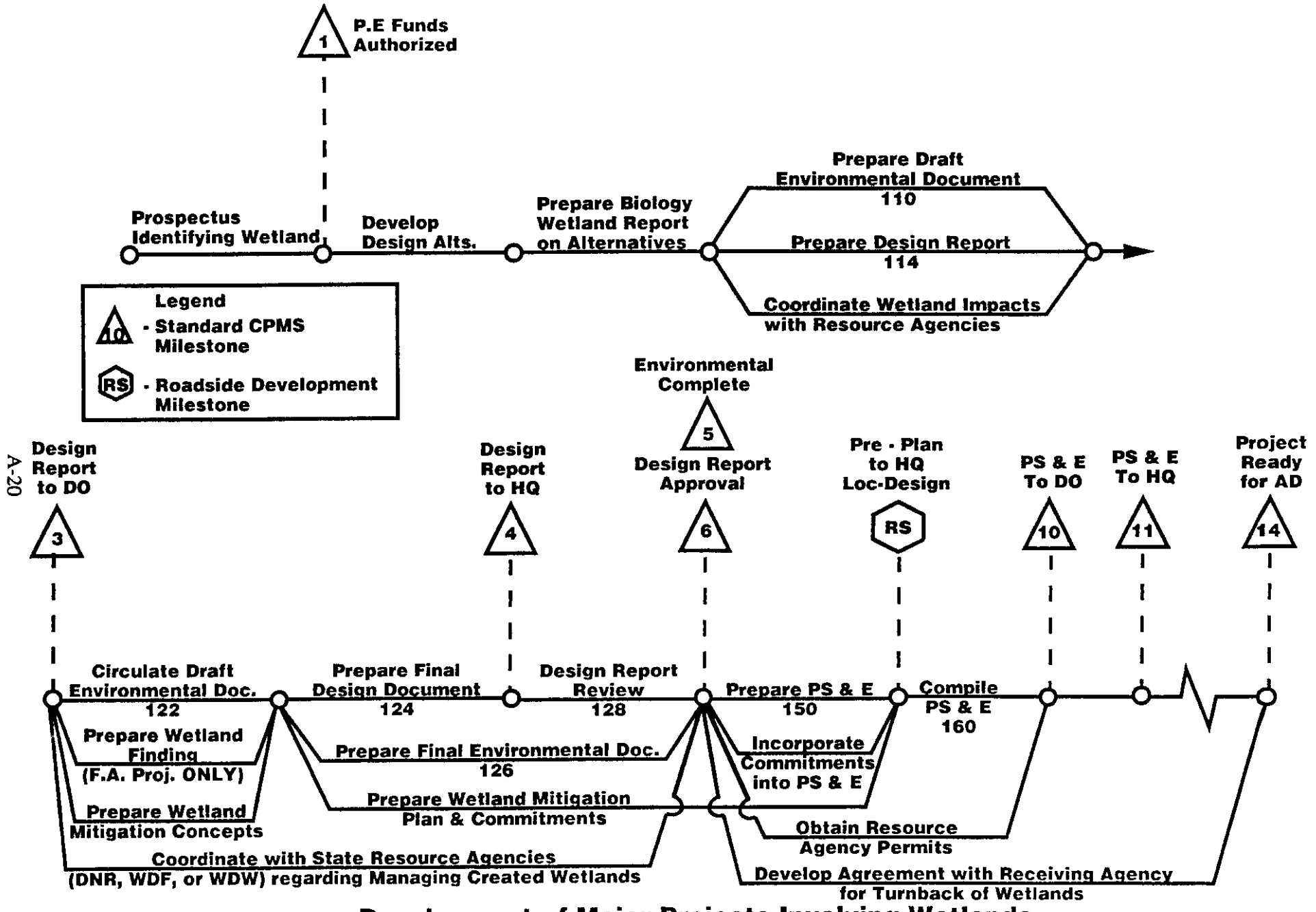


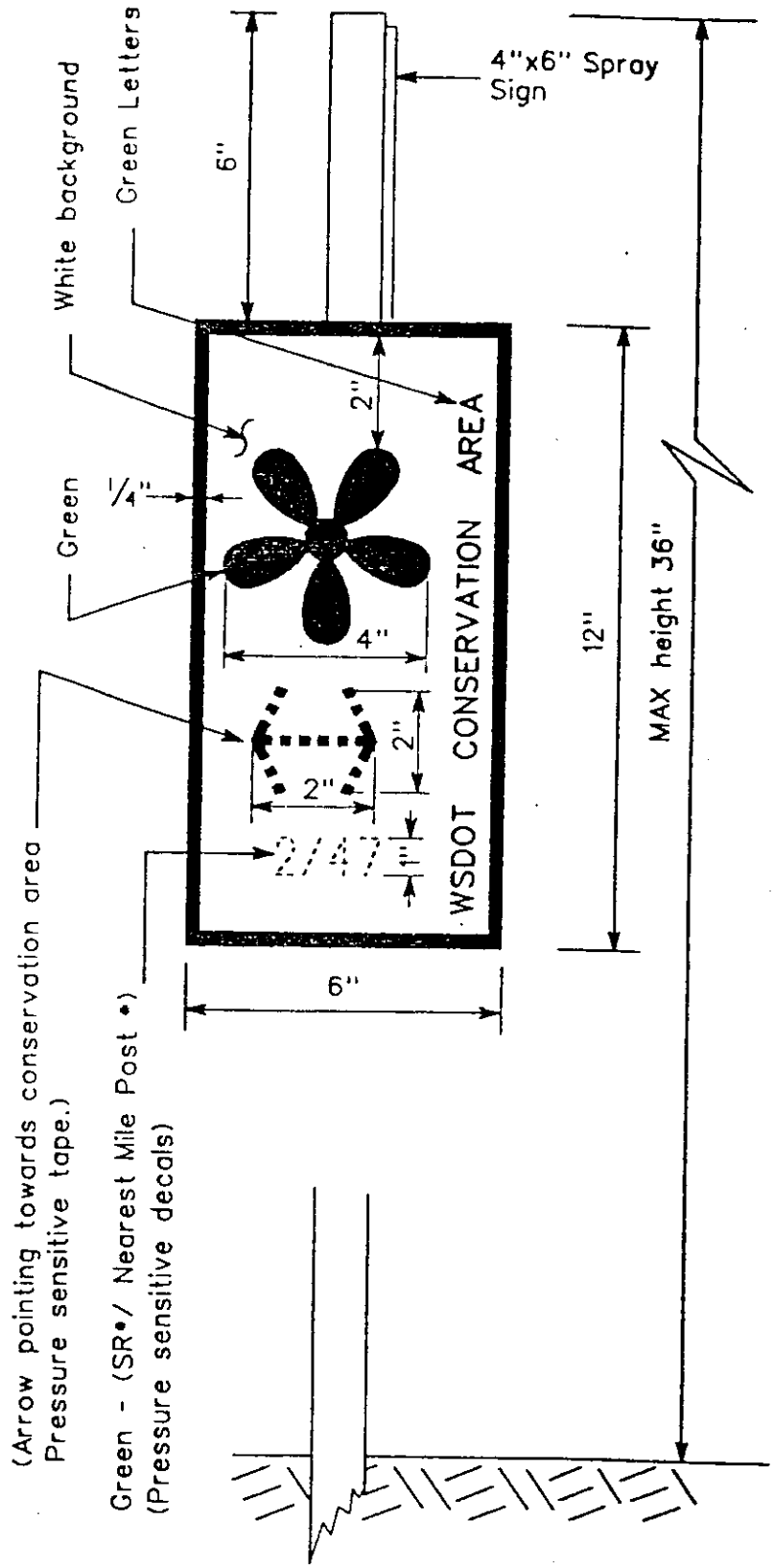
Development of Minor Projects Involving Wetlands (No Federal Permits)

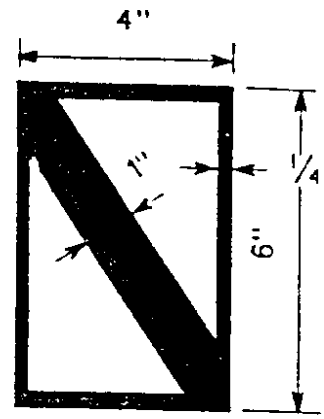
Figure 1



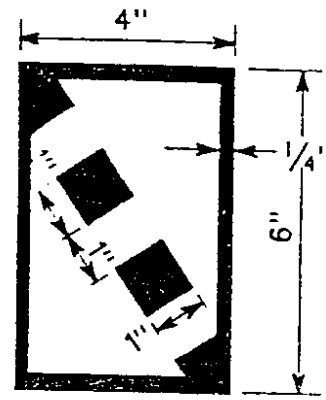
Development of Major Projects Involving Wetlands (Federal Permits Required)

Figure 2





Red or Yellow
Spray Sign



Green
Spray Sign

APPENDIX B
TYPICAL WSDOT WETLAND MITIGATION PLAN

SR 528

4th STREET EXTENSION

COLUMBIA AVENUE/MARYSVILLE TO SR 9

L-8108

WETLAND MITIGATION PLAN

SR 528 MARYSVILLE TO SR 9 - WEST END

WETLAND MITIGATION PLAN

As a result of the construction of this project there will be a loss of approximately 1.7 acres of existing wetland area in the Allen Creek floodplain. The attached biological review describes in detail the impacted area.

WETLAND AVOIDANCE

WSDOT has investigated various other options to avoid or minimize wetland impacts including:

1. The investigation of 7 route alternatives including a no-build option. All of the options had some wetland impact.

   The preferred alternative succeeds in connecting SR 5 to SR 9 in the most efficient manner while at the same time providing a high service level to two critical areas within Marysville, the central business district and the Marysville East Annexation. None of the other alternatives meet these goals.

2. The use of structures to bridge the wetland was investigated.

   Originally the preferred alternative called for a culvert containing Allen Creek under the roadway fill. The FEIS for this project was adopted and amended by WSDOT to replace the culvert with a 100 foot structure. Other bridge lengths were proposed including a 750 foot structure to cross the entire wetland. It was determined as the length and cost of the structure increased, that the costs far exceeded the benefit of lessening the impact. For example a 750 foot structure would eliminate most wetland impacts at a cost of $13.93 million compared with the proposed $1.68 million for the entire project including mitigation.

3. The roadway slopes have been steepened, and the height of embankment kept as low as practicable in order to minimize the width of the roadway fill through the wetland area.

WETLAND MITIGATION

Commitments

Since wetland impacts cannot be avoided, WSDOT is committed to the following various kinds of mitigation to replace at least acre-for-acre those wetlands lost to transportation development.

- Establish clearing and grubbing limits that preserve the maximum amount of riparian and wetland vegetation.

- Specify and identify in contract documents that wetlands not directly impacted by construction will be preserved in their existing condition.
- Replace 1.7 acres of wetlands impacted by the project by creating 1.9 acres of replacement wetland on a 2.8 acre site.
- Replant appropriate species to replace lost wetland vegetation.

Goals

The goal of this wetland area is to:

1. Plant native species which will encourage and aid in speeding the natural process of wetland development.
2. Restore and improve the following wetland functions: flood storage, sediment trapping, food chain support, wildlife habitat.

Wetland Mitigation Site

This wetland mitigation plan will replace the impacted area by creating a new wetland area on a 2.8 acre site approximately 1,400 feet upstream from the new roadway. This site is adjacent to the Allen Creek floodplain and consists of grassy, gently rolling terrain.

The site will be excavated to an elevation designed to allow the wet areas of the site to be flooded during the peak of the rainy season and saturated during the majority of the year. The contour grading plan is attached.

The existing topsoil of the site will be stripped, stockpiled and spread over the site upon completion of the excavation process. This will provide an appropriate substrate for beginning the wetland due to the organic content of the topsoil.

Wetland Plant Material

The plant materials for the wetland revegetation are selected to promote a compatible environment which blends to the adjacent areas. They are native species, considered adaptable to the area and have a high potential of survivial. It is recognized that some of the plant species existing in the area will naturally encroach on the mitigation site, ie. Red Alder. Some of the existing species we will attempt to somewhat discourage the encroachment, ie. Canary Grass. The attached revegetation plan shows the designated planting areas for the plant types selected.

Along Allen Creek areas are designated to be planted with native Willow, providing bank stabilization, and Cattails, which help to purify the water by taking up nutrients. Both of these plant types will provide refuge and habitat for native wildlife.

The lowland areas of the wetland mitigation site will be planted with wetland plants using roots or field collected starts. These grasses are selected for their ability to survive wet areas, encourage wildlife habitat, provide a food source for wildlife, compete against the Canary Grass prevalent to the area, and provide erosion control.

The upland areas of the mitigation site will be treated with a hydro seed, fertilizer and mulch containing a blend of grasses which provide erosion control. Combinations of shrubs and deciduous and evergreen trees will also be planted as shown on the plan. These plants will establish a visual screen from future development, provide wildlife habitat and food source, and provide shading to encourage the growth of selected grass species of the wetland and discourage the encroachment of Canary Grass.

Lists of the grass mix and plant combinations are provided below. The plant species could be substituted subject to availability.

PLANT MATERIAL LIST

Plant combination for lowland area:

Botanical Name / Common Name	Size Condition	% of Total Quantity in Combination
Scirpus acutus / Hardstem Bulrush	Roots	30 %
Sparganium eurycarpum / Burreed	Roots	30 %
Carex obnupta / Slough Sedge	Culms	40 %

Grass seed mix for upland area:

Kind and Variety of Seed in Mixture	% By Weight	Minimum % Pure Seed	Minimum % Germination
Colonial Bentgrass	10%	9.80% (min)	85%
Red Fescue	40%	39.20% (min)	90%
Perennial Rye	40%	39.20% (min)	90%
White Dutch Clover (pre-inoculated)	10%	9.80% (min)	90%
Weed Seed		.50% (max)	
Inert and Other Crop		1.50% (max)	
TOTAL		100.00%	

Shrub Combination:

Botanical Name / Common Name	Size / Condition	% of Total Quantity in Combination
Rosa nutkana / Wild Rose	15 - 18" / BR	25 %
Cornus stolonifera / Red Osier Dogwood	15 - 18" / BR	25 %
Mahonia nervosa / Oregon Grape	12 - 15" / BR	35 %
Acer circinatum / Vine Maple	12 - 15" / BR	15 %

Deciduous Tree Combination:

Botanical Name / Common Name	Size / Condition	% of Total Quantity in Combination
Acer macrophyllum / Bigleaf Maple	18 - 24" / BR - Whip	50 %
Populus trichocarpa / Cottonwood	18 - 24" / BR - Whip	50 %

Evergreen Tree Combination:

Botanical Name / Common Name	Size / Condition	% of Total Quantity in Combination
Thuja plicata / Western Red Cedar	2 - 1 / BR Seedling	45 %
Tsuga heterophylla / Western Hemlock	2 - 1 / BR Seedling	40 %
Pseudotsuga menziesii / Douglas fir	2 - 1 / BR Seedling	15 %

Other Plant types in designated areas:

Botanical Name / Common Name	Size Condition	% of Total Quantity in Combination
Salix sp. / Willow - native species	18 - 24" BR	100 %
Typha latifolia / Cattail	Roots	100 %

STANDARDS OF SUCCESS

The key to accomplishing the goals of this mitigation site is in the allocation of space for that purpose and contour grading to appropriate elevations. Success will be measured by the survival and growth of plant materials appropriate to a wetland area. Natural succession will ultimately determine the plant community.

Wetland Areas:

At the end of the first year of monitoring the survival of 50% of the wetland plant species indicated on the revegetation plan will be guaranteed by the WSDOT.

By the 5th year of monitoring the site, success will be determined by the measurement of 90% areal coverage of wetland plant species comparable to those in adjacent areas.

WSDOT will achieve these standards in the wetland by any of the following three methods:

1. By replacing plants with native plants of the same or different species.
2. By initial overplanting anticipating some mortality.
3. By transplanting from local established stands of wetland plants.

Plant survival and areal coverage will be determined by a recognized sampling method.

Upland Areas:

Initially, the upland area will be over planted anticipating some mortality. Every effort will be made to ensure a favorable environment for initial growth including mulching, fertilizing and inspection of all plant materials for vitality.

Agency Coordination will occur during the development of the wetland to ensure the finished wetland excavation meets expectations as far as final grading, configuration and substrate suitability.

MAINTENANCE AND OPERATION

WSDOT is committed to establish vegetation as described in this mitigation plan. The plant materials are species we consider to be adaptable to the area, and have the highest potential for survival. The planting site is intended to become a natural area where natural succession will be allowed to occur. The area will receive required maintenance to ensure survival, beginning after construction is complete and lasting for five years. At the completion of the five year maintenance period, the goal is to have established vegetation and a functioning wetland. If it is determined that any part of this goal is not achieved, WSDOT will consult with resource agencies to coordinate an appropriate course of action.

Once the goal is met, maintenance and operational activities will be confined to repairing vandalism, repairing damage caused by errant vehicles and doing other maintenance or minor revegetation (minor defined as vegetated areas of 2,500 square feet or less). Vegetation loss due to major catastrophic events, such as fire, will be corrected through cooperative efforts and or agreements between resource agencies, local concerned agencies and WSDOT. WSDOT will be an active participant in revegetation efforts but not assume total planning or financial responsibility.

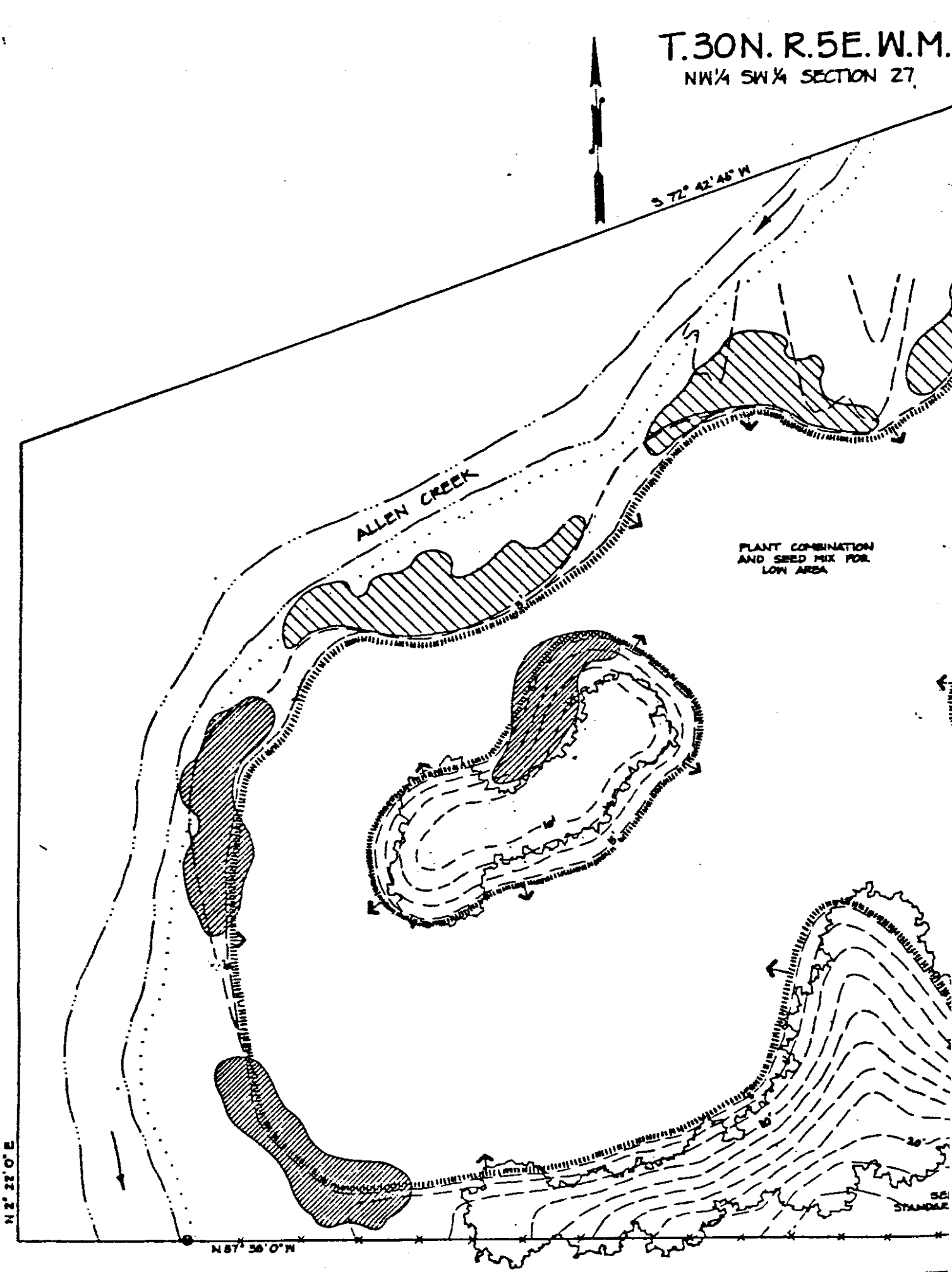
MONITORING

Annual Monitoring of the wetland site and the riparian plantings will be initiated during the first growing season after planting. Monitoring will consist of measuring coverage and species composition of plants by a recognized sampling technique.

The wetland site will also be evaluated for functional values by using the Adamus (FHWA) Method of Wetland Functional Assessment by the WSDOT biologist.

Monitoring of the wetland site and riparian vegetation will be conducted for five years.

A report will be prepared each year by the WSDOT biologist for the Army Corp of Engineers so that the success of the planting and wetland recovery can be assessed.



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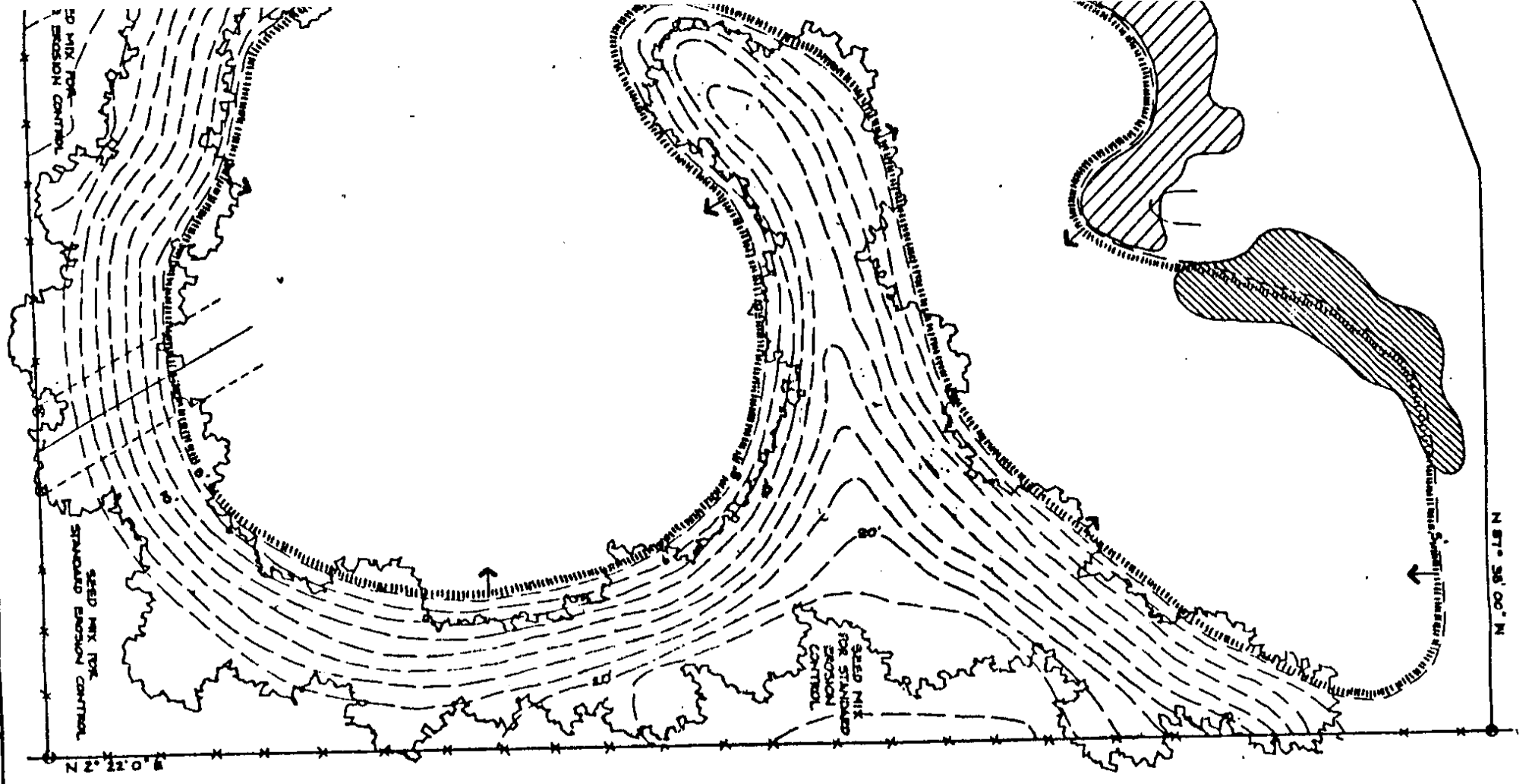
Washington State Department of Transportation



PLANT MATERIAL LEGEND:

SYMBOL	SIZE, CONDITION	QUANTITY	SPACING	COMMENTS
PLANT COMBINATION FOR UPLAND AREA: ·EVERGREEN TREE COMBINATION	SEEDLING	390	14'0" O.C.	SEE SPECIAL
·DECIDUOS TREE COMBINATION	BR, WHIPS	780	11-0" O.C.	" " " "
·SHRUB COMBINATION	" "	800	9'-0" O.C.	" " " "
PACIFIC WILLOW	BR, WHIPS	250	5'-0" O.C.	
CATTAIL	ROOT	2,200	18" O.C.	
PLANT COMBINATION FOR LOW AREA	ROOTS OR STEMMED CUTTINGS	8550	3'-0" O.C.	
SEED MIX FOR UPLANDS & HAUL ROAD (STD. ROADSIDE SEEDING)	SEED	150 LB.	60 LB PER ACRE	TO COVER AREA ABOVE 5' ELEV.

SCALE IN FEET: 0, 20, 40

PLAN LEGEND:

- PROPOSED CONTOURS (2' INTERVALS)
- EDGE OF CREEK
- BOUNDARY
- WIRE FENCE TYPE 2

ABBREVIATIONS:

BR BARE ROOT
ELEV. ELEVATION
LB. POUND
O.C. ON CENTER

NOTES:

1. FOR PLANT COMBINATIONS AND DETAILED INFORMATION ON PLANT MATERIALS, SEE SPECIAL PROVISIONS.

APPENDIX C
HYDRIC SOILS OF THE STATE OF WASHINGTON

United States Department of Agriculture

Soil Conservation Service

Hydric Soils of the State of Washington 1985

In cooperation with the National Technical Committee for Hydric Soils

National Technical Committee for Hydric Soils:

Keith Young, Chairman, Soil Survey Division, SCS, Washington, DC
P. R. Johnson, Soils Staff, MWNTC, SCS, Lincoln, NE
Arville Touchet, State Soil Scientist, SCS, Alexandria, LA
W. B. Parker, National Wetlands Inventory, FWS, St. Petersburg, FL
Del Fanning, Department of Agronomy, University of Maryland, College Park, MD
W. H. Patrick, Jr., Laboratory for Wetland Soils and Sediments, Louisiana State University, Baton Rouge, LA
Carl Thomas, Ecological Sciences Division, SCS, Washington, DC
Keith Schmude, Resources Inventory Division, SCS, Washington, DC
Richard Guthrie, Department of Agronomy and Soils, Auburn University, Auburn, AL
Bill Sipple, Environmental Protection Agency, Washington, DC
D. R. Sanders, Waterways Experiment Station, USAE, Vicksburg, MS
Dick Kover, Head, Soils Staff, WNTC, SCS, Portland, OR
Oliver Rice, Soils Staff, NNTC, SCS, Chester, PA

PROCEDURE FOR ADDING OR DELETING SOILS FROM THE LIST OF HYDRIC SOILS

If soils are on the list of hydric soils that should be removed or soils that are not on the list that should be listed, gather supporting data to make your case and either:

(1) submit the rational and the proposed changes in the hydric soil criteria along with your supporting data to Keith Young, Chairman, National Technical Committee for Hydric Soils, SCS, P.O. Box 2890, Washington, D.C. 20013, or

(2) submit the rational and proposed changes in the SOI-5 data or definition of the soil series to the state soil scientist in the state that has the responsibility for the series. The state soil scientist will follow the normal SCS update procedures (see National Soils Handbook, section 603.12(c)(2)).

REVISED EDITIONS OF THE LIST OF HYDRIC SOILS

The list of hydric soils will be updated as changes in the criteria are initiated or changes in the soil interpretations (SOI-5 data) or soil series are made. A revised edition will be printed as needed.

First Edition
October 1985

INTRODUCTION

The list of hydric soils contains soils that are sufficiently wet under undrained conditions to support the growth and regeneration of hydrophytic vegetation. The list includes hydric soils that are either drained or undrained; therefore, not all areas of hydric soils support predominantly hydrophytic vegetation and thus are not wetland. In some soil series only those phases that are ponded or are frequently flooded for long or very long duration meet the criteria for hydric soils.

This list of hydric soils was created by computer using criteria that was developed by the National Technical Committee for Hydric Soils and reviewed by the agencies making up the committee. The criteria are selected soil properties that are documented in Soil Taxonomy and Soil Interpretations Records (SOI-5).

This list will have a number of agricultural and non-agricultural applications. These include assistance in land-use planning, conservation planning, mapping, classifying and delineating wetlands, mitigation planning, and assessment of potential wildlife habitat. This list, used in conjunction with the list of hydrophytes, is part of the procedure for classifying wetland as described in "Classification of Wetlands and Deepwater Habitats of the United States," U.S. Fish and Wildlife Service, December 1979.

DEFINITION OF HYDRIC SOIL

A hydric soil is a soil that in its undrained condition is saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions that favor the growth and regeneration of hydrophytic vegetation.

CRITERIA FOR HYDRIC SOILS

1. All Histosols except Folists, or

2. Soils in Aquic suborders, Aquic subgroups, Albolls suborder, Salorthids great group, or Pell great groups of Vertisols that are:

   a. somewhat poorly drained and have water table less than 0.5 ft. from the surface at some time during the growing season, or

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

      (1) water table at less than 1.0 ft. from the surface at some time during the growing season if permeability is equal to or greater than 6.0 in/hr in all layers within 20 inches, or

      (2) water table at less than 1.5 ft. from the surface at some time during the growing season if permeability is less than 6.0 in/hr in any layer within 20 inches, or

3. Soils that are ponded during any part of the growing season, or

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

GLOSSARY OF TERMS USED IN DEFINING HYDRIC SOILS

anaerobic: a situation in which molecular oxygen is absent from the environment.

drained: a condition in which ground or surface water has been removed by artificial means.

flooded: a condition in which the soil surface is temporarily covered with flowing water from any source, such as streams overflowing their banks, runoff from adjacent or surrounding slopes, inflow from high tides, or any combination of sources.

frequently flooded: a class of flooding in which flooding is likely to occur often under usual weather conditions (more than 50 percent chance of flooding in any year, or more than 50 times in 100 years).

growing season: the portion of the year when soil temperatures are above biologic zero (5 degrees C), as defined by Soil Taxonomy. The following growing season months are assumed for each of the soil temperature regimes:

Isohyperthermic:	January-December
Hyperthermic:	February-December
Isothermic:	January-December
Thermic:	March-October
Isomesic:	January-December
Mesic:	April-October
Frigid:	June-September
Cryic:	June-August
Pergelic:	July-August

hydrophytic vegetation: plant life growing in water or on a substrate that is at least periodically deficient in oxygen as a result of excessive water content.

long duration (flooding): a duration class in which innundation for a single event ranges from 7 days to 1 month.

permeability: the quality of the soil that enables water to move downward through the profile, measured as the number of inches per hour that water moves downward through the saturated soil.

phase, soil: a subdivision of a soil series based on features (e.g. slope, surface texture, stoniness, and thickness).

ponded: a condition in which water stands in a closed depression. The water is removed only by percolation, evaporation, or transpiration.

poorly drained: water is removed from the soil so slowly that the soil is saturated periodically during the growing season or remains wet for long periods.

saturated: a condition in which all voids (pores) between soil particles are filled with water.

soil series: a group of soils having horizons similar in differentiating characteristics and arrangements in the soil profile, except for texture of the surface layer.

somewhat poorly drained: water is removed slowly enough that the soil is wet for significant periods during the growing season.

very long duration (flooding): a duration class in which innundation for a single event is greater than 1 month.

very poorly drained: water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season.

water table: the zone of saturation at the highest average depth during the wettest season. It is at least six inches thick and persists in the soil for more than a few weeks.

Hydric Soils

The intent of the definition of hydric soils is to identify soils that favor the production and regeneration of hydrophytic vegetation. Hydric soils are saturated or flooded long enough to produce anaerobic conditions (lacking oxygen) that affect the growth of plants. There is a high degree of correlation between present hydrophytic plant communities and hydric soils. The presence of free water in or on the soil for extended periods, accompanied by a virtual absence of oxygen, are key attributes of hydric soils. In identifying hydric soils, hydrology, land management, and observable soil properties as well as elements of the definition are evaluated. Soils that were wet at one time but that have been drained or protected through natural or man-made means are not considered hydric soils. Neither are soils that are naturally not wet but that are periodically flooded or saturated for specific management purposes. For example, some soils with morphological properties of wet soils are no longer wet because the natural groundwater level has dropped since they formed. Other soils such as those covered by recent impoundments like beaver ponds do not have the morphology of wet soils but are considered to be hydric soils. A national list of hydric soils, consisting of phases of soil series identified as hydric soils by National Cooperative Soil Survey cooperators in each State, will be used in connection with a list of hydrophytes prepared by the Fish and Wildlife Service to identify wetlands. "Soil" in this context refers to a technical grouping, which consists of phases of soils and not to the names of map units on a soil survey map; consequently the operational use of soil maps to assist in designating areas of hydric soils may need additional guidelines.

Definition

Hydric soils have:

1. Either

   a. The soil is saturated at or near the soil surface with water that is virtually lacking free oxygen (O_2) for significant periods during the growing season, or

   b. The soil is flooded frequently for long periods during the growing season.

Procedure for identifying hydric soils

Accessory properties of soils that are related to attributes of the definition can be used to infer a hydric condition. Morphological properties that are routinely observed in describing and classifying soils that are most directly related to conditions which are characteristic of wetlands are gray colors, the presence of iron and manganese concretions near the surface, and wetness state. In addition, position in the landscape, known flooding or ponding history, and evidences of natural

SOILS WITH HYDRIC CONDITIONS

A hydric soil condition exists when the soil in its natural undrained state is saturated at or near the surface during much of the growing season. Features frequently associated with hydric conditions include:

1. Aquic moisture regime - as defined in Soil Taxonomy, Agriculture Handbook 436,
2. A deficiency of oxygen at or near the surface during much of the growing season, or
3. Flooding or ponding of long duration during the growing season.

Field study is needed before soils on this list can be classified as "hydric" in the context of the definition of wetlands; however, those marked with an "X" almost always support predominantly hydrophytes.

The other soil series on the list may or may not be associated with wetlands unless field investigation determines that they support predominantly hydrophytes.

(THE "HYDRIC CRITERIA NUMBER" COLUMN INDICATES WHAT CAUSED THE SOIL TO BE INCLUDED IN THE HYDRIC LIST. SEE THE "CRITERIA FOR HYDRIC SOILS" TO DETERMINE THE MEANING OF THIS COLUMN.)

SERIES AND SUBGROUP	TEMPERATURE	DRAINAGE CLASS	HIGH WATER TABLE		PERM. WITHIN 20 INCHES	FLOODING			HYDRIC CRITERIA NUMBER	CAPABILITY	
			DEPTH	MONTHS		FREQUENCY	DURATION	MONTHS		CRITICAL PHASE CRITERIA	CLASS AND SUBCLASS
AHTANUM (WA0177) TYPIC DURAQUOLLS	MESIC	SP	0 -1.5	JAN-MAY	<6.0	RARE-FREQUENT	BRIEF	JAN-APR	2A	FREQ	6W
										RARE	4W
ALVOR (WA0230) CUMULIC HAPLAQUOLLS	MESIC	P	0.5-1.5	NOV-MAR	<6.0	FREQUENT	BRIEF	NOV-MAR	2B2	ALL	5W
BELLINGHAM (WA0858) MOLLIC HAPLAQUEPTS	MESIC	P	0 -1.0	NOV-APR	<6.0	NONE			2B2	ALL	6W
BELLINGHAM, PONDED (WA0015) MOLLIC HAPLAQUEPTS	MESIC	P	+1.-0	NOV-APR	<6.0	NONE			2B2	ALL	6W
BOSSBURG (WA0262) MOLLIC ANDAQUEPTS	MESIC	VP	0 -1.0	FEB-MAY	<6.0	FREQUENT	LONG	FEB-MAY	2B2	ALL	6W
BOSSBURG, DRAINED (WA0802) MOLLIC ANDAQUEPTS	MESIC		1.5-3.0	FEB-MAY	<6.0	FREQUENT	LONG	FEB-MAY	4	ALL	4W
BRIDGESON (WA0363) FLUVAQUENTIC HAPLAQUOLLS	MESIC	P	0.5-1.5	FEB-JUN	<6.0	OCCASIONAL	LONG	FEB-APR	2B2	ALL	3W
BRISCOT, FREQUENTLY FLOODED (WA1372) AERIC FLUVAQUENTS	MESIC	P	0 -0.5	NOV-MAY	<6.0	FREQUENT	BRIEF	NOV-APR	2B2	ALL	6W
BUCKLEY (WA0055) TYPIC HUMAQUEPTS	MESIC	P	0 -1.5	NOV-JUN	<6.0	NONE			2B2	ALL	6W
CAPLES (WA0805) MOLLIC FLUVAQUENTS	MESIC	P	1.0-2.0	OCT-JUN	<6.0	COMMON	BRIEF	DEC-APR	2B2	ALL	6W
COCOLALLA (WA0304) MOLLIC ANDAQUEPTS	MESIC	P	+1 -1.5	DEC-JUN	<6.0	NONE-RARE			2B2	ALL	5W
COCOLALLA, FREQUENTLY FLOODED (WA1281) MOLLIC ANDAQUEPTS	MESIC	P	+1 -1.5	DEC-JUN	<6.0	COMMON	V.LONG	DEC-MAY	2B2	ALL	5W
COLVILLE (WA0141) FLUVAQUENTIC HAPLAQUOLLS	MESIC	P	0 -1.5	FEB-JUN	<6.0	OCCASIONAL	LONG	JAN-MAY	2B2	ALL	4W

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SERIES AND SUBGROUP	TEMPERATURE	DRAINAGE CLASS	HIGH WATER TABLE DEPTH	HIGH WATER TABLE MONTHS	PERM. WITHIN 20 INCHES	FLOODING FREQUENCY	FLOODING DURATION	FLOODING MONTHS	HYDRIC CRITERIA NUMBER	CAPABILITY CRITICAL PHASE CRITERIA	CAPABILITY CLASS AND SUBCLASS
CONROY (WA0463)	MESIC	P	+1 -1.0	DEC-JUL	<6.0	FREQUENT	V.LONG	DEC-JUN	2B2	ALL	5W
HUMAQUEPTIC FLUVAQUENTS											
COVE (OR0806)	MESIC	P	0 -1.0	DEC-JUN	<6.0	COMMON	BRIEF	DEC-APR	2B2	SICL	4W
VERTIC HAPLAQUOLLS										C	3W
										SICL,THICK SURF	3W
COVELAND (WA0854)	MESIC	SP	0 -1.5	NOV-APR	<6.0	NONE			2A	0-8%	3W
AGUIC PALEXERALFS										8+%	3E
COVELAND, STONY (WA1415)	MESIC	SP	0 -1.5	NOV-APR	<6.0	NONE			2A	ALL	6S
AGUIC PALEXERALFS											
CUSTER (WA0305)	MESIC	P	1.0-1.5	NOV-MAR	<6.0	NONE			2B2	ALL	4W
TYPIC SIDERAQUODS											
DECKERVILLE (WA0908)	MESIC	P	0 -1.0	NOV-JUN	<6.0	NONE			2B2	ALL	6W
CUMULIC HUMAQUEPTS											
DUPONT (WA0010)	MESIC	VP	+1 -1.0	OCT-JUN	<6.0	NONE			1	ALL	5W
LIMNIC MEDISAPRISTS											
DUPONT, DRAINED (WA0810)	MESIC	A	0.5-2.0	DEC-MAY	<6.0	NONE			1	ALL	3W
LIMNIC MEDISAPRISTS											
EARLMONT (WA0950)	MESIC	P	0 -1.0	NOV-APR	<6.0	COMMON	BRIEF	NOV-APR	2B2	ALL	5W
TYPIC FLUVAQUENTS											
EDMONDS (WA0843)	MESIC	SP	+1 -1.0	NOV-MAY	<6.0	NONE			2A	ALL	6W
TYPIC SIDERAQUODS											
ELIZA (WA1375)	MESIC	VP	0 -1.0	NOV-APR	<6.0	FREQUENT	LONG	DEC-APR	2B2	ALL	6W
SULFIC FLUVAQUENTS											
EMDENT (WA0144)	MESIC	SP	+.5-0	JAN-JUN	<6.0	NONE-RARE			2A	ALL	6W
MOLLIC HALAQUEPTS											
EMDENT, POORLY DRAINED (WA1501)	MESIC	P	+1 -1.5	FEB-JUN	<6.0	RARE			2B2	ALL	6W
MOLLIC HALAQUEPTS											
EVERSON (WA0006)	MESIC	P	0 -1.0	NOV-MAY	<6.0	NONE			2B2	ALL	6W
TYPIC HUMAQUEPTS											
FISHTRAP (WA1321)	MESIC	VP	+1 -0	OCT-MAY	<6.0	NONE			1	ALL	6W
TERRIC MEDISAPRISTS											

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SERIES AND SUBGROUP	TEMPERATURE	DRAINAGE CLASS	HIGH WATER TABLE DEPTH	HIGH WATER TABLE MONTHS	PERM. WITHIN 20 INCHES	FLOODING FREQUENCY	FLOODING DURATION	FLOODING MONTHS	HYDRIC CRITERIA NUMBER	CAPABILITY CRITICAL PHASE CRITERIA	CAPABILITY CLASS AND SUBCLASS
FISHTRAP, DRAINED (WA1321) TERRIC MEDISAPRISTS	MESIC		0.5-1.5	OCT-MAY	<6.0	NONE			1	ALL	2W
GODFREY (WA092O) TYPIC FLUVAQUENTS	MESIC	P	0 -1.0	OCT-APR	<6.0	COMMON	BRIEF	NOV-MAR	2B2	ALL	6W
GRAYLAND (WA043F) TYPIC HAPLAQUOLLS	MESIC	P	0 -1.0	JAN-APR	<6.0	FREQUENT	V. LONG	JAN-APR	2B2	ALL	5W
GRAYLAND, DRAINED (WA080I) TYPIC HAPLAQUOLLS	MESIC	P	1.5-3.0	JAN-MAR	<6.0	FREQUENT	V. LONG	JAN-APR	4	ALL	4W
GUMBOOT (WA0E12) TYPIC HUMAQUEPTS	MESIC	P	0 -1.5	DEC-APR	<6.0	NONE			2B2	ALL	6W
HALBERT (WA0563) HISTIC PLACAQUEPTS	MESIC	P	+1 -0.5	OCT-MAY	<6.0	NONE			2B2	ALL	6W
HOODOO (ID0869) MOLLIC ANDAQUEPTS	FRIGID	P	0 -1.0	FEB-MAY	<6.0	FREQUENT	V. LONG	FEB-JUN	2B2	ALL	5W
HOODOO, DRAINED (ID0533) MOLLIC ANDAQUEPTS	FRIGID	P	1.0-2.0	FEB-MAY	<6.0	OCCASIONAL	LONG	FEB-MAY	2B2	ALL	4W
HOYDE (WA0904) AERIC HAPLAQUENTS	MESIC	P	0 -0.5	NOV-APR	<6.0	FREQUENT	BRIEF	NOV-APR	2B2	ALL	6W
JOSEPH (WA1384) AQUIC XEROFLUVENTS	MESIC	MW	3.0-5.0	DEC-JUN	>=6.0	FREQUENT	LONG	DEC-JUN	4	ALL	7W
KLABER (WA0234) TYPIC GLOSSAQUALFS	MESIC	P	+1 -0.5	NOV-MAY	<6.0	NONE			2B2	ALL	6W
KOSMOS (WA14EP) TYPIC HUMAQUEPTS	MESIC	SP	0 -2.0	NOV-MAY	<6.0	NONE-RARE			2A	ALL	3W
KYDAKA (WA0585) TYPIC HUMAQUEPTS	MESIC	P	0 -2.0	OCT-JUL	<6.0	NONE			2B2	ALL	6W
LABOUNTY (WA112E) TYPIC HUMAQUEPTS	MESIC	P	0 -1.0	NOV-MAY	<6.0	NONE			2B2	ALL	6W
LACAMAS (WA021R) TYPIC GLOSSAQUALFS	MESIC	P	0 -0.5	NOV-MAY	<6.0	NONE			2B2	ALL	6W

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SERIES AND SUBGROUP	TEMPERATURE	DRAINAGE CLASS	HIGH WATER TABLE DEPTH	HIGH WATER TABLE MONTHS	PERM. WITHIN 20 INCHES	FLOODING FREQUENCY	FLOODING DURATION	FLOODING MONTHS	HYDRIC CRITERIA NUMBER	CAPABILITY CRITICAL PHASE CRITERIA	CAPABILITY CLASS AND SUBCLASS
LEMOLO (WA1267) TYPIC HUMAQUEPTS	MESIC	P	0 -1.0	NOV-MAY	<6.0	RARE			2B2	ALL	6W
LOGY (WA0488) TORRIFLUVENTIC HAPLOXEROLLS	MESIC	W	> 6.0		<6.0	FREQUENT	LONG	JAN-APR	4	SIL.FREQ CB.FREQ	6W 6W
LUMMI (WA0586) FLUVAQUENTIC HAPLAQUOLLS	MESIC	P	0.5-2.0	OCT-JUN	<6.0	RARE			2B2	ALL	5W
MCKENNA (WA0028) MOLLIC HAPLAQUEPTS	MESIC	P	+1 -0.5	NOV-APR	<6.0	NONE			2B2	ALL	6W
MCMURRAY (WA0945) TYPIC MEDIHEMISTS	MESIC	VP	+1 -0	SEP-MAY	<6.0	NONE			1	ALL	6W
MCMURRAY, DRAINED (WA0946) TYPIC MEDIHEMISTS	MESIC		1.5-3.0	OCT-MAY	<6.0	NONE			1	ALL	2W
MINNIECE (OR0439) TYPIC UMBRAQUALFS	MESIC	SP,P	0 -2.0	NOV-MAY	<6.0	NONE-RARE			2A	ALL	6W
MINNIECE, BEDROCK SUBSTRATUM (WA1379) TYPIC UMBRAQUALFS	MESIC	P	0 -2.0	NOV-MAY	<6.0	NONE			2B2	0-3% 3+%	5W 6W
MUKILTEO (WA0006) TYPIC MEDIHEMISTS	MESIC	VP	+1 -0	OCT-MAY	<6.0	NONE			1	ALL	5W
MUKILTEO, DRAINED (WA0817) TYPIC MEDIHEMISTS	MESIC		1.5-3.0	OCT-MAY	<6.0	NONE			1	ALL	2W
MUKILTEO, PONDED (WA1180) TYPIC MEDIHEMISTS	MESIC	VP	+1 -0	JAN-DEC	<6.0	NONE			1	ALL	7W
MUNSET (WA1027) ULTIC HAPLOXERALFS	MESIC	MW	+1 -1.0	APR-MAY	<6.0	NONE			3	ALL	6S
NEMAH (WA0350) HUMIC HAPLAQUEPTS	MESIC	P	+1 -0.5	OCT-APR	<6.0	NONE			2B2	ALL	6W
NEWBERG, WET (OR0207) FLUVENTIC HAPLOXEROLLS	MESIC		2.5-4.5	NOV-APR	<6.0	FREQUENT	LONG	DEC-MAR	4	ALL	4W

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SERIES AND SUBGROUP	TEMPERATURE	DRAINAGE CLASS	HIGH WATER TABLE DEPTH	HIGH WATER TABLE MONTHS	PERM. WITHIN 20 INCHES	FLOODING FREQUENCY	FLOODING DURATION	FLOODING MONTHS	HYDRIC CRITERIA NUMBER	CAPABILITY CRITICAL PHASE CRITERIA	CAPABILITY CLASS AND SUBCLASS
NOOKACHAMPS (WA0676) TYPIC FLUVAQUENTS	MESIC	P	0 -1.5	NOV-MAY	<6.0	OCCASIONAL	BRIEF	DEC-APR	2B2	ALL	6W
NORMA (WA0012) MOLLIC HAPLAQUEPTS	MESIC	P	+1 -1.0	NOV-APR	<6.0	NONE			2B2	ALL	6W
NORMA, GRAVELLY SUBSTRATUM (WA0820) MOLLIC HAPLAQUEPTS	MESIC	P	+1 -1.0	NOV-APR	<6.0	NONE			2B2	ALL	6W
NORMA, TILL SUBSTRATUM (WA1408) MOLLIC HAPLAQUEPTS	MESIC	P	+1 -1.0	NOV-APR	<6.0	NONE			2B2	ALL	3W
NUBY (WA0199) TYPIC FLUVAQUENTS	MESIC	P	0 -0.5	OCT-APR	<6.0	OCCASIONAL	V. BRIEF	NOV-APR	2B2	ALL	6W
OCOSTA (WA0200) TYPIC FLUVAQUENTS	MESIC	P	+1 -0.5	JAN-DEC	<6.0	FREQUENT	V. BRIEF	NOV-JUN	2B2	ALL	6W
ODNE (WA0824) TYPIC OCHRAQUALFS	MESIC	P	0 -1.5	OCT-APR	<6.0	NONE			2B2	ALL	6W
OKANOGAN (WA0145) FLUVENTIC HAPLOXEROLLS	MESIC	W	> 6.0		<6.0	FREQUENT	LONG	JAN-MAY	4	FREQ	4W
OKANOGAN, GRAVELLY SUBSTRATUM (WA0150) FLUVENTIC HAPLOXEROLLS	MESIC	W	> 6.0		<6.0	FREQUENT	LONG	JAN-MAY	4	FREQ	4W
ORCAS (WA0367) TYPIC SPHAGNOFIBRISTS	MESIC	VP	+1 -1.0	NOV-MAY	>=6.0	NONE			1	ALL	6W
ORCAS, DRAINED (WA0826) TYPIC SPHAGNOFIBRISTS	MESIC		0.5-1.5	JAN-DEC	>=6.0	NONE			1	ALL	6W
ORIDIA (WA0827) AERIC FLUVAQUENTS	MESIC	P	0.5-1.5	NOV-APR	<6.0	COMMON	BRIEF	NOV-APR	2B2	ALL	5W
ORIDIA, FLOODED (WA1373) AERIC FLUVAQUENTS	MESIC	P	0 -0.5	NOV-MAY	<6.0	FREQUENT	BRIEF	NOV-APR	2B2	ALL	6W
PANCORN (WA1226) TYPIC MEDISAPRISTS	MESIC	VP	+1.-0	OCT-MAY	<6.0	NONE			1	ALL	6W

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SERIES AND SUBGROUP	TEMPERATURE	DRAINAGE CLASS	HIGH WATER TABLE		PERM. WITHIN 20 INCHES	FLOODING			HYDRIC CRITERIA NUMBER	CAPABILITY	
			DEPTH	MONTHS		FREQUENCY	DURATION	MONTHS		CRITICAL PHASE CRITERIA	CLASS AND SUBCLASS
PANGBORN, DRAINED (WA1227) TYPIC MEDISAPRISTS	MESIC		0.5-1.5	OCT-MAY	<6.0	NONE			1	ALL	2W
PASCO (WA0943) CUMULIC HAPLAQUOLLS	MESIC	P	0 -1.0	NOV-APR	<6.0	OCCASIONAL	BRIEF	NOV-MAR	282	ALL	6W
PEDIGO (WA0027) CUMULIC HAPLOXEROLLS	MESIC	SP	2.5-3.5	JAN-MAY	<6.0	FREQUENT	LONG	NOV-MAY	4	FREQ	4W
PEDIGO, HARDPAN SUBSTRATUM (WA1109) CUMULIC HAPLOXEROLLS	MESIC	SP	2.5-5.0	JAN-MAY	<6.0	FREQUENT	V.LONG	NOV-APR	4	ALL	6W
PEOH (WA0268) CUMULIC HAPLAQUOLLS	MESIC	P	0 -1.0	JAN-DEC	<6.0	RARE			282	ALL	5W
PEONE (WA0394) ANDAQUEPTIC FLUVAQUENTS	MESIC	P	0.5-1.5	FEB-MAY	<6.0	FREQUENT	BRIEF	FEB-MAY	282	ALL	4W
PUGET (WA0013) AERIC FLUVAQUENTS	MESIC	P	+1 -1.0	NOV-APR	<6.0	FREQUENT	LONG	DEC-MAR	282	ALL	5W
PYWELL (ID0769) TYPIC BOROSAPRISTS	NOT USED	VP	+1 -1.0	SEP-JUN	<6.0	RARE-OCCASIONAL			1	ALL	5W
PYWELL, DRAINED (ID0014) TYPIC BOROSAPRISTS	NOT USED	VP	0 -4.0	JAN-DEC	<6.0	RARE			1	ALL	4W
PYWELL, FREQUENTLY FLOODED (ID1041) TYPIC BOROSAPRISTS	NOT USED	VP	0 -4.0	JAN-DEC	<6.0	FREQUENT	V.LONG	DEC-JUN	1	ALL	5W
PYWELL, OCCASIONALLY FLOODED (ID1040) TYPIC BOROSAPRISTS	NOT USED		0 -4.0	JAN-DEC	<6.0	OCCASIONAL	LONG	DEC-JUN	1	ALL	4W
PYWELL, PROTECTED (ID1042) TYPIC BOROSAPRISTS	NOT USED		0 -2.0	FEB-MAY	<6.0	OCCASIONAL	LONG	DEC-JUN	1	ALL	4W
RALSEN (WA1473) FLUVAQUENTIC HAPLAQUOLLS	MESIC	P	0.5-2.0	FEB-JUN	<6.0	OCCASIONAL	BRIEF	MAR-MAY	282	ALL	4W

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SERIES AND SLEGROUP	TEMPERATURE	DRAINAGE CLASS	HIGH WATER TABLE DEPTH	HIGH WATER TABLE MONTHS	PERM. WITHIN 20 INCHES	FLOODING FREQUENCY	FLOODING DURATION	FLOODING MONTHS	HYDRIC CRITERIA NUMBER	CAPABILITY CRITICAL PHASE CRITERIA	CLASS AND SUBCLASS
REED (WA0001) VERTIC ARGIAQUOLLS	MESIC	P	+1 -0.5	NOV-MAY	<6.0	FREQUENT	BRIEF	NOV-MAR	2B2	ALL	5W
RENNIE (WA0341) MOLLIC FLUVAQUENTS	MESIC	P	+1 -0.5	OCT-MAY	<6.0	FREQUENT	BRIEF	NOV-APR	2B2	ALL	6W
RENTON (WA0933) MOLLIC FLUVAQUENTS	MESIC	P	0 -1.0	NOV-APR	<6.0	COMMON	BRIEF	NOV-APR	2B2	ALL	5W
SALTESE (WA0400) TYPIC MEDISAPRISTS	MESIC	VP	+1 -0.5	FEB-MAY	<6.0	NONE			1	ALL	5W
SALTESE, DRAINED (WA0679) TYPIC MEDISAPRISTS	MESIC		0.5-3.0	FEB-MAY	<6.0	COMMON	LONG	FEB-MAY	1	OCCAS FREQ	3W 4W
SALZER (WA0342) VERTIC HAPLAQUEPTS	MESIC	VP	+1 -0.5	OCT-MAY	<6.0	FREQUENT	LONG	NOV-APR	2B2	ALL	6W
SALZER, DRAINED (WA0830) VERTIC HAPLAQUEPTS	MESIC		1.5-3.0	OCT-MAY	<6.0	FREQUENT	LONG	NOV-APR	4	ALL	4W
SAMISH (WA0668) TYPIC FLUVAQUENTS	MESIC	SP	0 -1.0	NOV-MAY	<6.0	OCCASIONAL	BRIEF	NOV-APR	2A	ALL	5W
SAMMAMISH (WA0937) FLUVAQUENTIC HUMAQUEPTS	MESIC	P	0 -1.0	NOV-APR	<6.0	COMMON	BRIEF	NOV-APR	2B2	ALL	5W
SAUVIE (OR0457) FLUVAQUENTIC HAPLAQUOLLS	MESIC	P	0 -1.0	MAY-JUN	<6.0	FREQUENT	LONG	DEC-JUN	2B2	ALL	6W
SCHOOLEY (WA0227) ANDAQUEPTIC FLUVAQUENTS	MESIC	P	+1 -0.5	NOV-APR	<6.0	FREQUENT	BRIEF	NOV-MAR	2B2	ALL	5W
SEASTRAND (WA0516) TERRIC MEDIHEMISTS	MESIC	VP	0 -0.5	JAN-DEC	<6.0	NONE			1	ALL	6W
SEASTRAND, DRAINED (WA0831) TERRIC MEDIHEMISTS	MESIC		0.5-1.5	JAN-DEC	<6.0	NONE			1	ALL	6W
SEATTLE (WA0366) TYPIC MEDIHEMISTS	MESIC	P	+1 -0.5	OCT-MAY	<6.0	NONE			1	ALL	5W

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SERIES AND SUBGROUP	TEMPERATURE	DRAINAGE CLASS	HIGH WATER TABLE		PERM. WITHIN 20 INCHES	FLOODING			HYDRIC CRITERIA NUMBER	CAPABILITY	
			DEPTH	MONTHS		FREQUENCY	DURATION	MONTHS		CRITICAL PHASE CRITERIA	CLASS AND SUBCLASS
SEATTLE, DRAINED (WA0832) TYPIC MEDIHEMISTS	MESIC		1.5-3.0	OCT-MAY	<6.0	NONE			1	ALL	2W
SEGIDAL (WA0443) TYPIC SIDERAQUODS	MESIC	P	0.5-2.0	JAN-APR	<6.0	NONE			2B2	ALL	4W
SEGIDAL, PONDED (WA1034) TYPIC SIDERAQUODS	MESIC	P	+1 -1.0	NOV-JUN	<6.0	FREQUENT	V.LONG	NOV-JUN	2B2	ALL	6W
SEKIU (WA0640) HUMIC HAPLAQUEPTS	MESIC	VP	+.5-0.5	OCT-JUL	<6.0	NONE			2B2	ALL	6W
SEMIAHMOO (WA0009) TYPIC MEDISAPRISTS	MESIC	VP	+1 -0	NOV-MAY	<6.0	NONE-RARE			1	ALL	5W
SEMIAHMOO, DRAINED (WA0833) TYPIC MEDISAPRISTS	MESIC		1.5-3.0	NOV-MAY	<6.0	NONE-RARE			1	ALL	2W
SHALCAR (WA0061) TERRIC MEDISAPRISTS	MESIC	VP	+1 -0	NOV-MAY	<6.0	NONE			1	ALL	5W
SHALCAR (WA1145) TERRIC MEDISAPRISTS	MESIC	VP	+1 -1.5	OCT-MAY	<6.0	NONE			1	ALL	6W
SHALCAR, DRAINED (WA0834) TERRIC MEDISAPRISTS	MESIC		1.5-3.0	NOV-MAY	<6.0	NONE			1	ALL	2W
SHALCAR, DRAINED (WA1146) TERRIC MEDISAPRISTS	MESIC		0.5-1.5	OCT-MAY	<6.0	NONE			1	ALL	2W
SKAGIT, DRAINED (WA0852) TYPIC FLUVAQUENTS	MESIC	P	0.5-2.0	NOV-MAR	<6.0	RARE			2B2	ALL	2W
SKOKOMISH (WA0525) MOLLIC FLUVAQUENTS	MESIC	P	0 -1.0	OCT-MAY	<6.0	COMMON	BRIEF	NOV-APR	2B2	ALL	5W
SNOHOMISH (WA0059) THAPTO-HISTIC FLUVAQUENTS	MESIC	P	0 -1.0	NOV-MAY	<6.0	RARE			2B2	ALL	5W
STIMSON (WA0204) TYPIC HUMAQUEPTS	MESIC	P	0 -0.5	OCT-APR	<6.0	NONE			2B2	ALL	6W

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SERIES AND SUBGROUP	TEMPERATURE	DRAINAGE CLASS	HIGH WATER TABLE DEPTH	HIGH WATER TABLE MONTHS	PERM. WITHIN 20 INCHES	FLOODING FREQUENCY	FLOODING DURATION	FLOODING MONTHS	HYDRIC CRITERIA NUMBER	CAPABILITY CRITICAL PHASE CRITERIA	CAPABILITY CLASS AND SUBCLASS
SUMAS (WA0536) AERIC FLUVAQUENTS	MESIC	P	0 -0.5	NOV-MAY	<6.0	FREQUENT	BRIEF	NOV-APR	2B2	ALL	6W
TACOMA (WA0007) SULFIC FLUVAQUENTS	MESIC	VP	+1 -0	JAN-DEC	<6.0	FREQUENT	BRIEF	JAN-DEC	2B2	ALL	5W
TACOMA, FLOODED (WA1377) SULFIC FLUVAQUENTS	MESIC	VP	+1 -0	NOV-JUN	<6.0	FREQUENT	LONG	NOV-JUN	2B2	ALL	6W
TANWAX (WA0050) MOLLIC FLUVAQUENTS	MESIC	VP	+1 -1.0	OCT-MAY	<6.0	NONE			2B2	ALL	5W
TEALWHIT (WA0556) AERIC HAPLAQUEPTS	MESIC	P	0.5-1.0	OCT-MAY	<6.0	RARE			2B2	ALL	6W
THORNTON (WA0759) AQUIC XEROCHREPTS	MESIC	SP	0 -1.0	DEC-MAR	<6.0	NONE			2A	ALL	4W
TISCH (WA0049) MOLLIC ANDAQUEPTS	MESIC	VP	+1 -1.0	DEC-JUN	<6.0	NONE			2B2	ALL	5W
TOPPENISH (WA0495) FLUVAQUENTIC HAPLAQUOLLS	MESIC	SP	1.0-2.0	JUN-NOV	<6.0	FREQUENT	LONG	JAN-APR	4	ALL	6W
TRACK (WA0497) FLUVAQUENTIC HAPLAQUOLLS	MESIC	SP	1.0-2.0	JUN-NOV	<6.0	FREQUENT	LONG	JAN-APR	4	ALL	6W
TUKWILA (WA0839) LIMNIC MEDISAPRISTS	MESIC	VP	+1 -1.0	OCT-MAY	<6.0	NONE			1	ALL	5W
TUKWILA, DRAINED (WA0840) LIMNIC MEDISAPRISTS	MESIC		1.5-3.0	NOV-MAR	<6.0	NONE			1	ALL	2W
UNCAS (WA0778) MOLLIC ANDAQUEPTS	FRIGID	VP	0.5-1.5	DEC-APR	<6.0	FREQUENT	LONG	MAR-MAY	4	ALL	4W
WAMBA (WA0526) TYPIC HAPLAQUOLLS	MESIC	SP	+.5-0	APR-NOV	<6.0	NONE			2A	ALL	6W
WANSER (WA0415) TYPIC PSAMMAQUENTS	MESIC	P	0.5-1.0	MAY-NOV	>=6.0	RARE-OCCASIONAL	BRIEF	JAN-MAY	2B1	ALL	6W

(THE "HYDRIC CRITERIA NUMBER" COLUMN INDICATES WHAT CAUSED THE SOIL TO BE INCLUDED IN THE HYDRIC LIST.
SEE THE "CRITERIA FOR HYDRIC SOILS" TO DETERMINE THE MEANING OF THIS COLUMN.)

SERIES AND SUBGROUP	TEMPERATURE	DRAINAGE CLASS	HIGH WATER TABLE DEPTH	HIGH WATER TABLE MONTHS	PERM. WITHIN 20 INCHES	FLOODING FREQUENCY	FLOODING DURATION	FLOODING MONTHS	HYDRIC CRITERIA NUMBER	CAPABILITY CRITICAL PHASE CRITERIA	CAPABILITY CLASS AND SUBCLASS
WAPATO (ORD827) FLUVAQUENTIC HAPLAQUOLLS	MESIC	P	+1 -1.0	NOV-MAY	<6.0	FREQUENT	BRIEF	DEC-APR	2B2	ALL	3W
WEIRMAN (WA0479) TORRIFLUVENTIC HAPLOXEROLLS	MESIC	E	3.0-5.0	APR-NOV	<6.0	FREQUENT	LONG	JAN-APR	4	0-2% 2-5% 0-5% GR SIL 0-5% CHANNELED	6W 6W 6W 6W 6W
WEIRMAN, WET (WA0397) TORRIFLUVENTIC HAPLOXEROLLS	MESIC		1.0-2.0	APR-NOV	<6.0	FREQUENT	LONG	JAN-APR	4	ALL	6W
WENAS (WA0502) CUMULIC HAPLAQUOLLS	MESIC	SP	0 -1.0	JUN-NOV	<6.0	COMMON	BRIEF	JAN-MAR	2A	ALL	6W
WHITEHORN (WA1232) TYPIC HUMAQUEPTS	MESIC	P	+1 -1.0	NOV-MAY	<6.0	NONE			2B2	ALL	6W
WOLDALE (WA0947) TYPIC HAPLAQUOLLS	MESIC	P	0 -1.0	JAN-DEC	<6.0	RARE			2B2	ALL	5W
WOLFESON, WET (WA0409) AQUIC XEROCHREPTS	MESIC	P	1.0-2.0	FEB-MAY	<6.0	NONE			2B2	ALL	4W
WOODINVILLE (WA0841) TYPIC FLUVAQUENTS	MESIC	P	0 -1.0	OCT-APR	<6.0	COMMON	BRIEF	OCT-MAY	2B2	ALL	6W
WOODLYN (WA1131) TYPIC SIDERAQUODS	MESIC	P	+1.-1.0	NOV-MAY	<6.0	NONE			2B2	ALL	6W
YAKIMA (WA0501) CUMULIC HAPLOXEROLLS	MESIC	W	> 6.0		<6.0	FREQUENT	LONG	JAN-MAR	4	0-3% 3+%	4W 4S
YAKIMA, STONY (WA1156) CUMULIC HAPLOXEROLLS	MESIC	W	> 6.0		<6.0	FREQUENT	LONG	JAN-MAR	4	ALL	6S
YAQUINA (OR0643) AQUIC HAPLORTHODS	MESIC	SP	+2 -2.0	NOV-APR	<6.0	NONE			2A	ALL	4W
YOST (WA0527) TYPIC PELLOXERERTS	MESIC	SP	+.5-1.0	MAR-NOV	<6.0	NONE			2A	ALL	6W
ZILLAH (WA0502) FLUVAQUENTIC HAPLAQUOLLS	MESIC	SP	0 -1.0	APR-NOV	<6.0	COMMON	LONG	JAN-MAR	2A	SL SIL	6W 6W

WASHINGTON

SOILS NOT INCLUDED ON THE HYDRIC LIST BECAUSE OF WATER TABLE

REVISED AUGUST 6, 1985

(THE SOILS IN THIS TABLE ARE POORLY OR VERY POORLY DRAINED AND MEET THE HYDRIC CRITERIA EXCEPT FOR HIGH WATER TABLE DEPTH OR MONTHS.)

SERIES AND SUBGROUP	TEMPERATURE	DRAINAGE CLASS	HIGH WATER TABLE		PERM. WITHIN 20 INCHES	FLOODING			HYDRIC CRITERIA NUMBER	CAPABILITY	
			DEPTH	MONTHS		FREQUENCY	DURATION	MONTHS		CRITICAL PHASE CRITERIA	CLASS AND SUBCLASS
COVE, DRAINED (CR0203) VERTIC HAPLAQUOLLS	MESIC	P	0 -2.0	DEC-FEB	<6.0	COMMON	BRIEF	DEC-APR	H	SICL	3W
										IC	4W
										SICL, THICK SURF	3W
HENNINGSEN, WET (NV0464) AQUIC HAPLOXEROLLS	MESIC	P	2.0-3.0	DEC-MAY	<6.0	COMMON	BRIEF	DEC-MAR	H	ALL	
SAUVIE, PROTECTED (OR0456) FLUVAQUENTIC HAPLAQUOLLS	MESIC	P	> 6.0		<6.0	RARE			H	ALL	2W
TONATA (WA0837) ANDIC CRYAQUEPTS	NOT USED	P	0 -1.5	JAN-APR	<6.0	NONE			H	ALL	4W
WAPATO, DRAINED (CR0281) FLUVAQUENTIC HAPLAQUOLLS	MESIC	P	+.5-1.0	DEC-FEB	<6.0	FREQUENT	BRIEF	DEC-FEB	H	ALL	3W

APPENDIX D

NATIONAL LIST OF PLANT SPECIES THAT OCCUR IN WETLANDS:

1988 — NORTHWEST (REGION 9)

PLANT LIST

SCIENTIFIC NAME	COMMON NAME	INDICATOR	COLLECTED	WPPNW	SHORT LIST
Abies amabilis	PACIFIC SILVER FIR	FACU	No	No	No
Abies lasiocarpa	SUBALPINE FIR	FACU	No	No	No
Acer circinatum	VINE MAPLE	FACU+	No	No	No
Acer glabrum	ROCKY MOUNTAIN MAPLE	FAC	No	No	No
Acer macrophyllun	BIGLEAF MAPLE	FACU	No	No	No
Acer negundo	BOX ELDER	FAC+	No	No	No
Acer rubrum	RED MAPLE	UPL	No	No	No
Acer saccharinum	SILVER MAPLE	UPL	No	No	No
Acer saccharum	SUGAR MAPLE	UPL	No	No	No
Achillea millefolium	YARROW	FACU	No	No	No
Aconitum columbianum	COLUMBIA MONKSHOOD	FACW	No	No	No
Acorus calamus	SWEETFLAG	OBL	No	No	No
Adiantum pedatum	MAIDENHAIR FERN	FAC	No	No	No
Adoxa moschatellina	MUSK ROOT	FAC-	No	No	No
Agoseris aurantiaca	ORANGE AGOSERIS	FAC	No	No	No
Agoseris elata	TALL AGOSERIS	FAC	No	No	No
Agoseris glauca	PALE AGOSERIS	FAC	No	No	No
Agrimonia striata	ROADSIDE AGRIMONY	FACU	No	No	No
Agrohordeum X macounii	MACOUN WILDRYE	FACU	No	No	No
Agropyron caninum	CUTTING WHEATGRASS	FAC-	No	No	No
Agropyron dasystachyum	THICKSPIKE WHEATGRASS	FACU-	No	No	No
Agropyron repens	QUACKGRASS	FACU	Yes	No	No
Agropyron smithii	WESTERN WHEATGRASS	FACU	No	No	No
Agropyron spicatum	BLUEBUNCH WHEATGRASS	FACU-	No	No	No
Agropyron trachycaulum	SLENDER WHEATGRASS	FAC	No	No	No
Agrostis alba	REDTOP	FACW	Yes	No	Yes
Agrostis borealis	ARCTIC BENTGRASS	FACU	No	No	No
Agrostis exarata	SPIKE BENTGRASS	FACW	No	No	No
Agrostis hyemalis	TICKLEGRASS	FAC	No	No	No
Agrostis idahoensis	IDAHO BENTGRASS	FAC+	No	No	No
Agrostis longiligula	LONG-TONGUE BENTGRASS	OBL	No	No	No
Agrostis microphylla	SMALL-LEAVED BENTGRASS	FACW	No	No	No
Agrostis oregonensis	OREGON BENTGRASS	FAC	No	No	No
Agrostis scabra	ROUGH BENTGRASS	FAC	No	No	No
Agrostis semiverticillata	WATER BENTGRASS	FACW	No	No	No
Agrostis stolonifera	CARPET BENTGRASS	FAC+	No	No	No
Alisma gramineum	NARROW-LEAF WATERPLANTAIN	OBL	No	No	No
Alisma lanceolatum	AMERICAN WATER PLAINTAIN	OBL	No	No	No
Alisma plantago-aquatica	COMMON WATERPLANTAIN	OBL	No	Yes	No
Allenrolfea occidentalis	IODINE BUSH	FACW+	No	No	No
Allium bisceptrum	TWINCREST ONION	FAC	No	No	No
Allium douglasii	DOUGLAS ONION	FAC+	No	No	No
Allium geyeri	GEYER ONION	FACU	No	No	No
Allium madidum	SWAMP ONION	OBL	No	No	No
Allium schoenoprasum	CHIVE ONION	FACW+	No	No	Yes
Allium validum	PACIFIC ONION	OBL	No	No	No
Allophyllum gilioides	STRAGGLING GILIA	FAC	No	No	No
Alnus incana	SPECKLED ALDER	FACW	No	No	No

PLANT LIST

SCIENTIFIC NAME	COMMON NAME	INDICATOR	COLLECTED	WPPNW	SHORT LIST
Alnus rhombifolia	WHITE ALDER	FACW	No	No	No
Alnus rubra	RED ALDER	FAC	No	Yes	Yes
Alnus rugosa	SPECKLED ALDER	OBL	No	No	No
Alnus sinuata	SITKA ALDER	FACW	No	No	No
Alnus tenuifolia	THINLEAF ALDER	FACW	No	No	No
Alopecurus aequalis	SHORT-AWN FOXTAIL	OBL	No	No	Yes
Alopecurus alpinus	ALPINE FOXTAIL	FACW	No	No	No
Alopecurus carolinianus	CAROLINA FOXTAIL	FAC+	No	No	No
Alopecurus geniculatus	WATER FOXTAIL	FACW+	Yes	No	Yes
Alopecurus howellii	HOWELL FOXTAIL	FACW	No	No	No
Alopecurus myosuroides	MOUSE FOXTAIL	FACW	No	No	No
Alopecurus pratensis	MEADOW FOXTAIL	FACW	No	No	No
Alopecurus saccatus	PACIFIC FOXTAIL	FACW+	No	No	No
Amaranthus albus	AMARANTH TUMBLEWEED	FACU	No	No	No
Amaranthus blitoides	TUMBLEWEED	FACW	No	No	No
Amaranthus californicus	CALIFORNIA AMARANTH	FACW,DR	No	No	No
Amaranthus retroflexus	GREEN AMARANTH	FACU+	No	No	No
Ambrosia artemisiifolia	COMMON RAGWEED	FACU+	No	No	No
Ambrosia psilostachya	WESTERN RAGWEED	FACU+	No	No	No
Ambrosia trifida	GIANT RAGWEED	FAC	No	No	No
Amelanchier alnifolia	SASKATOON SERVICEBERRY	FACU	No	No	No
Amerorchis rotundifolia	SMALL ROUND-LEAVED ORCHIS	OBL	No	No	No
Ammannia coccinea	PURPLE AMMANNIA	OBL	No	No	No
Ammophila arenaria	EUROPEAN BEACHGRASS	FACU	No	No	No
Amsinckia spectabilis	COAST FIDDLENECK	FACU	No	No	No
Anagallis arvensis	SCARLET PIMPERNEL	FAC	No	No	No
Andromeda polifolia	BOG ROSEMARY	OBL	No	No	Yes
Andropogon gerardii	BIG BLUESTEM	FACU	No	No	No
Androsace chamaejasme	DWARF ROCK-JASMINE	FACU	No	No	No
Androsace filiformis	SLENDER ROCK-JASMINE	FACW	No	No	No
Androsace occidentalis	WESTERN ROCK-JASMINE	FACU	No	No	No
Androsace septentrionalis	PIGMY-FLOWER ROCK-JASMINE	FAC-	No	No	No
Anemone oregana	OREGON ANEMONE	FACU	No	No	No
Anemone parviflora	ARCTIC ANEMONE	FACW-	No	No	No
Anemone piperi	PIPER ANEMONE	FACU-	No	No	No
Angelica ampla	GIANT ANGELICA	FACW	No	No	No
Angelica arguta	LYALL ANGELICA	FACW	No	No	No
Angelica dawsonii	DAWSON ANGELICA	FACW	No	No	No
Angelica genuflexa	KNEELING ANGELICA	FACW	No	No	No
Angelica lucida	SEAWATCH ANGELICA	FAC	No	No	Yes
Angelica pinnata	SMALL-LEAF ANGELICA	FACW	No	No	No
Antennaria arcuata	BOX PUSSYTOES	FACW	No	No	No
Antennaria corymbosa	FLATTOP PUSSYTOES	FAC-	No	No	No
Antennaria pulcherrima	SHOWY PUSSYTOES	FACU	No	No	No
Antennaria umbrinella	UMBRINELLA PUSSYTOES	FACU	No	No	No
Anthemis cotula	MAYWEED DOG-FENNEL	FACU	No	No	No
Anthoxanthum odoratum	SWEET VERNAL-GRASS	FACU	No	No	No
Apargidium boreale	COMMON APARGIDIUM	OBL	No	No	No

PLANT LIST

SCIENTIFIC NAME	COMMON NAME	INDICATOR	COLLECTED	WPPNW	SHORT LIST
Apocynum cannabinum	CLASPING-LEAF DOGBANE	FAC+	No	No	Yes
Apocynum sibiricum	PRAIRIE DOGBANE	FAC-	No	No	No
Aquilegia coerulea	COLORADO COLUMBINE	FAC	No	No	No
Aquilegia formosa	SITKA COLUMBINE	FAC	No	No	No
Arabis crucisetosa	WETSOIL ROCKCRESS	FAC	No	No	No
Arabis divaricarpa	SPREADINGPOD ROCKCRESS	FACU	No	No	No
Arabis drummondii	DRUMMOND ROCKCRESS	FACU	No	No	No
Arabis hirsuta	HAIRY ROCKCRESS	FACU	No	No	No
Arabis holboellii	HOLBOELL ROCKCRESS	FACU-	No	No	No
Arabis lemmonii	LEMMON ROCKCRESS	FACU-	No	No	No
Arabis lyrata	LYRE-LEAF ROCKCRESS	FACU	No	No	No
Aralia californica	CALIFORNIA ARALIA	FAC+	No	No	No
Aralia nudicaulis	WILD SARSAPARILLA	FACU	No	No	No
Arctostaphylos uva-ursi	BEARBERRY	FACU-	No	No	No
Arenaria paludicola	ARENARIA	OBL	No	No	No
Arenaria serpyllifolia	THYMELEAF SANDWORT	FACU	No	No	No
Armeria maritima	SEA-PINK	FACU	No	No	No
Arnica amplexicaulis	CLASPING ARNICA	FACW	No	No	No
Arnica chamissonis	CHAMISSO ARNICA	FACW	No	No	No
Arnica diversifolia	RAYLESS ARNICA	FACW	No	No	No
Arnica latifolia	BROADLEAF ARNICA	FAC-	No	No	No
Arnica longifolia	LONG-LEAF ARNICA	FACW	No	No	No
Arnica mollis	HAIRY ARNICA	FAC	No	No	No
Arrhenatherum elatius	TALL OATGRASS	UPL	No	No	No
Artemisia annua	SWEET WORMWOOD	UPL	No	No	No
Artemisia biennis	BIENNIAL WORMWOOD	FACW	No	No	No
Artemisia cana	SILVER SAGEBRUSH	FAC	No	No	No
Artemisia douglasiana	DOUGLAS SAGEWORT	FACW	No	No	No
Artemisia lindleyana	COLUMBIA RIVER MUGWORT	OBL	No	No	No
Artemisia ludoviciana		UPL	No	No	No
Aruncus dioicus	GOAT'S BEARD	FACU+	No	No	No
Asclepias fascicularis	NARROW-LEAVED MILKWEED	FAC-	No	No	No
Asclepias speciosa	SHOWY MILKWEED	FAC+	No	No	No
Asclepias subverticillata	WESTERN WHORLED MILKWEED	UPL	No	No	No
Asparagus officinalis	GARDEN ASPARAGUS	FACU	No	No	No
Asplenium trichomanes-ramosum	MAIDENHAIR SPLEENWORT	FACU	No	No	No
Aster alpigenus	ANDERSON ASTER	UPL	No	No	No
Aster brachyactis	SHORTRAY ASTER	FACW	No	No	No
Aster chilensis	PACIFIC ASTER	FAC	No	No	No
Aster eatonii	EATON ASTER	FAC+	No	No	No
Aster ericoides	HEATH ASTER	UPL	No	No	No
Aster falcatus	WHITE PRAIRIE ASTER	FACU-	No	No	No
Aster foliaceus	LEAFY-BRACT ASTER	FACW-	No	No	No
Aster frondosus	LEAFY ASTER	FACW+	No	No	Yes
Aster hesperius	SISKIYOU ASTER	OBL	No	No	No
Aster junciformis	RUSH ASTER	OBL	No	No	No
Aster modestus	FEW-FLOWER ASTER	FAC+	No	No	No
Aster occidentalis	WESTERN ASTER	FAC	No	No	No

PLANT LIST

SCIENTIFIC NAME	COMMON NAME	INDICATOR	COLLECTED	WPPNW	SHORT LIST
Aster pansus	MANY-FLOWERED ASTER	FAC+	No	No	Yes
Aster pauciflorus	FEW-HEAD ASTER	FACW	No	No	No
Aster subspicatus	DOUGLAS ASTER	FACW	No	Yes	Yes
Astragalus agrestis	FIELD MILKVETCH	FACW-	No	No	No
Astragalus alpine	ALPINE MILKVETCH	FAC-	No	No	No
Astragalus americanus	AMERICAN MILKVETCH	FAC	No	No	No
Astragalus bodinii	BODIN MILKVETCH	FACW-	No	No	No
Astragalus canadensis	CANADA MILKVETCH	FACW-	No	No	No
Astragalus diaphanus	TRANSPARENT MILKVETCH	FACU+	No	No	No
Astragalus eucosmus	SUBALPINE MILKVETCH	FACU	No	No	No
Astragalus lemmoni	LEMMON MILKVETCH	FACW	No	No	No
Astragalus robbinsii	ROBBINS MILKVETCH	FAC+	No	No	No
Athyrium distentifolium	ALPINE LADYFERN	FAC	No	No	No
Athyrium filix-femina	SOUTHERN LADYFERN	FAC	No	Yes	Yes
Atriplex argentea	SILVERSCALE SALTWEED	FAC-	No	No	No
Atriplex canescens	FOUR-WING SALTBUSH	UPL	No	No	No
Atriplex falcata	NUTTALL'S SALTWEED	UPL	No	No	No
Atriplex hortensis	GARDEN ORACH SALTWEED	FAC	No	No	No
Atriplex patula	FAT-HEN SALTBUSH	FACW	Yes	Yes	Yes
Atriplex pusilla	SMALLER SALTBUSH	FAC+	No	No	No
Atriplex rosea	TUMBLING ORACH	FACU-	No	No	No
Atriplex truncata	WEDGESCALE SALTBUSH	FACU+	No	No	No
Azolla filiculoides	PACIFIC AZOLLA	OBL	No	No	Yes
Azolla mexicana	MEXICAN AZOLLA	OBL	No	No	No
Baccharis douglasii	SALTMARSH BACCHARIS	OBL	No	No	No
Bacopa rotundifolia	DISK WATER HYSSOP	OBL	No	No	No
Barbarea orthoceras	ERECTPOD WINTERCRESS	FACW+	No	No	Yes
Barbarea vulgaris	BITTER WINTERCRESS	FAC-	No	No	No
Bassia hyssopifolia	FIVE-HOOK BASSIA	FACW	No	No	No
Beckmannia syzigache	AMERICAN SLOUGHGRASS	OBL	No	No	No
Bensoniella oregana	OREGON BENSONIELLA	FAC+	No	No	No
Bergia texana	TEXAS BERGIA	OBL	No	No	No
Berula erecta	WATER PARSNIP	OBL	No	No	Yes
Beta vulgaris	BEET	UPL	No	No	No
Betula glandulosa	BOG BIRCH	OBL	No	No	Yes
Betula occidentalis	WATER BIRCH	FACW	No	No	Yes
Betula papyrifera	PAPER BIRCH	FACU	No	No	No
Betula pumila	LOW BIRCH	OBL	No	No	No
Bidens X amplissima		FACW+	No	No	No
Bidens cernua	NODDING BEGGARTICKS	FACW+,D	Yes	Yes	No
Bidens comosa	LEAFY BRACT BEGGARTICKS	FACW	No	No	No
Bidens frondosa	DEVILS BEGGARTICKS	FACW+ D	No	No	No
Bidens tenuisecta	BEGGARTICKS	FAC	No	No	No
Bidens tripartita	BUR BEGGARTICKS	FACW	No	No	No
Blechnum spicant	DEER FERN	FAC+	No	No	Yes
Boisduvalia densiflora	DENSE SPIKEPRIMROSE	FACW-	No	No	No
Boisduvalia glabella	SMOOTH SPIKEPRIMROSE	FACW+	No	No	No
Boisduvalia macrantha	LARGE-FLOWERED BOISDUVALIA	FAC+	No	No	No

PLANT LIST

SCIENTIFIC NAME	COMMON NAME	INDICATOR	COLLECTED	WPPNW	SHORT LIST
Boisduvalia stricta	BROOK SPIKEPRIMROSE	FACW	No	No	No
Bolandra oregana	OREGON BOLANDRA	FACW	No	No	No
Boltonia asteroides	STAR BOLTONIA	OBL	No	No	No
Botrychium boreale	NORTHERN GRAPEFERN	FAC	No	No	No
Botrychium lanceolatum	LANCE-LEAFED GRAPEFERN	FACW	No	No	No
Botrychium lunaria	MOONWORT	FAC	No	No	No
Botrychium matricariifolium	MATRICARY GRAPEFERN	FACU	No	No	No
Botrychium multifidum	LEATHERY GRAPE FERN	FAC	No	No	No
Botrychium simplex	LITTLE GRAPEFERN	FACU	No	No	No
Botrychium virginianum	RATTLESNAKE-FERN	FACU	No	No	No
Boykinia elata	SANTA LUCIA BOYKINIA	FACW	No	No	No
Boykinia major	STREAM BOYKINIA	FACW	No	No	No
Brasenia schreberi	WATERSHIELD	OBL	No	No	Yes
Brickellia californica	CALIFORNIA BRICKELLBUSH	FACU-	No	No	No
Brickellia greenei	GREENE BRICKELLBUSH	FACU	No	No	No
Briza minor	LITTLE QUAKINGGRASS	FAC	No	No	No
Brodiaea elegans	HARVEST BRODIAEA	FACU	No	No	No
Bromus ciliatus	FRINGED BROME	FAC+	No	No	No
Bromus japonicus	JAPANESE BROME	FACU	No	No	No
Bromus mollis	SOFT CHESS	UPL	No	No	No
Bromus vulgaris	COLUMBIA BROME	FACU-	No	No	No
Butomus umbellatus	FLOWERING RUSH	OBL	No	No	No
Cakile edentula	AMERICAN SEA ROCKET	FACU	No	No	No
Cakile maritima	EUROPEAN SEA ROCKET	FACU	No	No	No
Calamagrostis canadensis	BLUEJOINT	FACW+	No	No	Yes
Calamagrostis crassiglumis	THURBER'S REEDGRASS	OBL	No	No	No
Calamagrostis inexpansa	NORTHERN REEDGRASS	FACW	No	No	No
Calamagrostis neglecta	SLIM-STEM REEDGRASS	FACW	No	No	No
Calamagrostis nutkaensis	PACIFIC REEDGRASS	FACW	No	No	No
Calamagrostis scribneri	SCRIBNER REEDGRASS	FACW	No	No	No
Callitriche anceps	TWO-HEADED WATER-STARWORT	OBL	No	No	No
Callitriche heraphroditica	SECRET WATER-STARWORT	OBL	No	No	No
Callitriche heterophylla	LARGER WATER-STARWORT	OBL,DRA	No	No	No
Callitriche marginata	WATER-STARWORT	OBL,DRA	No	No	No
Callitriche stagnalis	POND WATER-STARWORT	OBL	No	No	No
Callitriche verna	GREEN WATER-STARWORT	OBL	No	No	No
Calochortus uniflorus	MONTEREY MARISPOSA-LILY	FACW+	No	No	No
Caltha leptosepala	ELKSLIP MARSH-MARIGOLD	OBL	No	No	Yes
Caltha palustris	MARSH MARIGOLD	OBL	No	No	No
Calypso bulbosa	FAIRYSLIPPER ORCHID	FAC+	No	No	No
Calyptridium roseum	ROSY CALYPTRIDIUM	FACU	No	No	No
Calystegia sepium	HEDGE BINDWEED	FAC	No	No	No
Camassia leichtlinii	LEICHTLIN CAMAS	FACW-	No	No	No
Camassia quamash	COMMON CAMAS	FACW	No	No	No
Camelina sativa	LARGESEED FALSEFLAX	FAC-	No	No	No
Camissonia breviflora	FEW-FLOWER EVENING PROMROSE	FAC-	No	No	No
Camissonia subacaulis	SUN-CUP	FACW-	No	No	No
Campanula lasiocarpa	BEHERING BELLFLOWER	FACU	No	No	No

PLANT LIST

SCIENTIFIC NAME	COMMON NAME	INDICATOR	COLLECTED	WPPNW	SHORT LIST
Campanula parryi	PARRY BELLFLOWER	FAC	No	No	No
Campanula rotundifolia	ALPINE HAREBELL	FACU+	No	No	No
Campanula uniflora	SINGLEFLOWERED BELLFLOWER	FAC	No	No	No
Cannabis sativa	HEMP	FACU	No	No	No
Capsella bursa-pastoris	SHEPHERDS PURSE	FAC-	No	No	No
Cardamine angulata	ANGLED BITTER-CRESS	FACW	No	No	No
Cardamine breweri	BREWER BITTER-CRESS	FACW+	No	No	No
Cardamine constancei	CONSTANCE'S BITTER-CRESS	FAC	No	No	No
Cardamine cordifolia	HEARTLEAF BITTER-CRESS	FACW	No	No	No
Cardamine gemmata	YELLOW-TUBERED TOOTHWORT	FACW+	No	No	No
Cardamine integrifolia	MILK-MAIDS	FACW	No	No	No
Cardamine lyallii	LYALL BITTER-CRESS	FACW	No	No	No
Cardamine occidentalis	WESTERN BITTER-CRESS	FACW+	No	No	Nc
Cardamine oligosperma	FEW-SEEDED BITTER-CRESS	FACW	No	No	No
Cardamine penduliflora	WILLAMENTTE VALLEY BITTER-CRESS	OBL	No	No	No
Cardamine pensylvanica	PENNSYLVANIA BITTER-CRESS	FACW	No	No	No
Cardamine rupicola	BITTER-CRESS	FAC-	No	No	No
Carex X stipata	STALK-GRAIN SEDGE	OBL	No	No	No
Carex X tincta	SEDGE	FAC	No	No	No
Carex albonigra	BLACK AND WHITE SEDGE	FACU	No	No	No
Carex amplifolia	BIGLEAF SEDGE	FACW+	No	No	No
Carex aperta	APERTA SEDGE	FACW	No	No	No
Carex aquatilis	WATER SEDGE	OBL	No	No	No
Carex arcta	NORTHERN CLUSTERED SEDGE	FACW+	No	No	No
Carex atherodes	SLOUGH SEDGE	OBL	No	No	No
Carex athrostachya	SLENDER BEAK SEDGE	FACW	No	No	No
Carex atrata	BLACK-SCALE SEDGE	FAC	No	No	No
Carex aurea	GOLDEN SEDGE	FACW+	No	No	No
Carex barbarae	SANTA BARBARA SEDGE	FAC+	No	No	No
Carex bebbii	BEBB SEDGE	OBL	No	No	No
Carex bigelowii	BIGELOW SEDGE	FAC	No	No	No
Carex bipartita	TWOTIPPED SEDGE	OBL	No	No	No
Carex bolanderi	BOLANDER SEDGE	FAC	No	No	No
Carex breviligulata	SHORT-LIGULED SEDGE	FACW+	No	No	No
Carex brevior	BREVOIR SEDGE	OBL	No	No	No
Carex brunnescens	BROWNISH SEDGE	OBL	No	No	No
Carex buxbaumii	BUXBAUM SEDGE	OBL	No	No	No
Carex californica	CALIFORNIA SEDGE	OBL	No	No	No
Carex campylocarpa	CRATERLIKE SEDGE	FACW	No	No	No
Carex canescens	SILVERY SEDGE	FACW+	No	No	No
Carex capillaris	HAIRLIKE SEDGE	FACW	No	No	No
Carex capitata	CAPITATE SEDGE	FAC	No	No	No
Carex comosa	LONG-HAIR SEDGE	OBL	No	No	No
Carex concinna	LOW NORTHERN SEDGE	FAC-	No	No	No
Carex crawei	CRAWE SEDGE	FACW	No	No	No
Carex crawfordii	CRAWFORD SEDGE	FACU	No	No	No
Carex cusickii	CUSICK SEDGE	OBL	No	No	No

PLANT LIST

SCIENTIFIC NAME	COMMON NAME	INDICATOR	COLLECTED	WPPNW	SHORT LIST
Carex densa	DENSE SEDGE	OBL	No	No	No
Carex deweyana	SHORT-SCALE SEDGE	FAC+	No	No	No
Carex diandra	LESSER-PANICLED SEDGE	OBL	No	No	No
Carex disperma	SORT LEAVED SEDGE	FACW	No	No	No
Carex douglasii	DOUGLAS SEDGE	FAC-	No	No	No
Carex eleusinoides	GOOSE-GRASS SEDGE	FACW	No	No	No
Carex emoryi	EMORY SEDGE	OBL	No	No	No
Carex eurycarpa	WILD FRUIT SEDGE	FACW+	No	No	No
Carex exsiccata	WESTERN INFLATED SEDGE	OBL	No	No	No
Carex feta	FETA SEDGE	FACW	No	No	No
Carex fissuricola	CLEFT SEDGE	FACW	No	No	No
Carex flava	YELLOW SEDGE	OBL	No	No	No
Carex garberi	GARBER SEDGE	FACW-	No	No	No
Carex gynocrates	NORTHERN BOG SEDGE	OBL	No	No	No
Carex gynodynama	OLNEY'S HAIRY SEDGE	FAC	No	No	No
Carex hallii	HALL SEDGE	FAC+	No	No	No
Carex hassei	HASSE'S SEDGE	FACW	No	No	No
Carex haydeniana	HAYDEN'S SEDGE	FAC-	No	No	No
Carex heteroneura	VARIOUS-NERVED SEDGE	FAC	No	No	No
Carex hindsii	HINDS SEDGE	OBL	No	No	No
Carex hystricina	PORCUPINE SEDGE	OBL	No	No	No
Carex idahoa	PARRY SEDGE	FACW	No	No	No
Carex illota	SHEEP SEDGE	FAC	No	No	No
Carex interior	INLAND SEDGE	FACW-	No	No	No
Carex interrupta	GREEN-FRUITED SEDGE	OBL	No	No	No
Carex jonesii	JONES SEDGE	FACW+	No	No	No
Carex kelloggii	KELLOGG SEDGE	FACW+	No	No	No
Carex laeviconica	SMOOTH-CONE SEDGE	OBL	No	No	No
Carex laeviculmis	SMOOTH-STEM SEDGE	FACW	No	No	No
Carex lanuginosa	BULL SEDGE	OBL	No	No	Yes
Carex lasiocarpa	WOOLFRUIT SEDGE	OBL	No	No	Yes
Carex lenticularis	SHORE SEDGE	FACW+	No	No	Yes
Carex leporina	HARESFOOT SEDGE	FAC	No	No	No
Carex leptalea	BRISTLE STALKED SEDGE	OBL	No	No	No
Carex leptopoda	SHORT-SCALE SEDGE	FAC	No	No	No
Carex limnophila	APPRESSED SEDGE	FACW	Yes	No	No
Carex limosa	MUD SEDGE	OBL	No	No	No
Carex livida	LIVID SEDGE	OBL	No	No	No
Carex luzulina	WOODRUSH SEDGE	OBL	No	No	No
Carex lyngbyei	LYNGBYE SEDGE	OBL	Yes	Yes	Yes
Carex macrocephala	LARGEHEADED SEDGE	FAC-	No	No	No
Carex macrochaeta	ALASKA LONGAWNED SEDGE	FACW-	No	No	No
Carex media	INTERMEDIATE SEDGE	FACW	No	No	No
Carex medocinensis	MENDOCINO SEDGE	FACW	No	No	No
Carex mertensii	MERTENS SEDGE	FACW	No	No	No
Carex microglochin	FALSE UNCINIA SEDGE	FACW+	No	No	No
Carex microptera	SMALL-WING SEDGE	FAC	No	No	No
Carex misandra	SHORT-LEAVED SEDGE	FACU	No	No	No

PLANT LIST

SCIENTIFIC NAME	COMMON NAME	INDICATOR	COLLECTED	WPPNW	SHORT LIST
Carex miserabilis	STARVED SEDGE	FACW	No	No	No
Carex nardina	HEPBURN'S SEDGE	FACU	No	No	No
Carex nebrascensis	NEBRASKA SEDGE	OBL	No	No	No
Carex nelsonii	NELSON'S SEDGE	FAC	No	No	No
Carex nervina	SIERRA NERVED SEDGE	FACW-	No	No	No
Carex neurophora	ALPINE NERVED SEDGE	FACW	No	No	No
Carex nigricans	BLACK ALPINE SEDGE	FACW	No	No	No
Carex norvegica	SCANDINAVIAN SEDGE	FACW	No	No	No
Carex nova	NEW SEDGE	FACW-	No	No	No
Carex nudata	TORRENT SEDGE	FACW	No	No	No
Carex obnupta	SLOUGH SEDGE	OBL	No	Yes	Yes
Carex ormantha	WESTERN STELLATE SEDGE	OBL	No	No	Yes
Carex pachystachya	CHAMISSO SEDGE	FAC	No	No	No
Carex pansa	SAND-DUNE SEDGE	FACU	No	No	No
Carex parryana	PARRYANA SEDGE	FAC+	No	No	No
Carex pauciflora	FEW-FLOWERED SEDGE	OBL	No	No	No
Carex paupercula	BOG SEDGE	OBL	No	No	No
Carex paysonis	PAYSON SEDGE	FACU	No	No	No
Carex pelocarpa	DUSKY-SEED SEDGE	FAC	No	No	No
Carex phaeocephala	DUNHEAD SEDGE	FACU	No	No	No
Carex phyllomanica	COASTAL STELLATE SEDGE	OBL	No	No	No
Carex plectocarpa	MOOSE-GRASS SEDGE	FACW+	No	No	No
Carex pluriflora	MANY-FLOWER SEDGE	OBL	No	No	No
Carex podocarpa	SHORT-STALKED SEDGE	FAC	No	No	No
Carex praeceptorum	EARLY SEDGE	FACW+	No	No	No
Carex praegracilis	CLUSTERED FIELD SEDGE	FACW	No	No	Yes
Carex prairea	PRAIRIE SEDGE	OBL	No	No	No
Carex praticola	MEADOW SEDGE	FACW	No	No	No
Carex preslii	PRESL SEDGE	FACU	No	No	No
Carex prionophylla	FIRE-THREAD SEDGE	FACW	No	No	No
Carex pseudoscirpoidea	WESTERN SINGLE-SPIKED SEDGE	FACU	No	No	No
Carex pyrenaica	PYRENEAN SEDGE	FAC	No	No	No
Carex raynoldsii	RAYNOLDS SEDGE	FACU	No	No	No
Carex retrorsa	RETRORSE SEDGE	FAC	No	No	No
Carex rostrata	BEAKED SEDGE	OBL	No	No	Yes
Carex rupestris	ROCK SEDGE	FACU	No	No	No
Carex sartwellii	SARTWELL SEDGE	FACW+	No	No	No
Carex saxitilis	RUSSET SEDGE	FACW+	No	No	No
Carex scirpoidea	NORTHERN SINGLESPIKE SEDGE	FACU+	No	No	No
Carex scoparia	BROOM SEDGE	FACW	No	No	No
Carex scopulorum	HOLM'S ROCKY MOUNTAIN SEDGE	FACW	No	No	No
Carex serratodens	BIFID SEDGE	FACW	No	No	No
Carex sheldonii	SHELDON SEDGE	OBL	No	No	No
Carex simulata	ANALOGNE SEDGE	OBL	No	No	No
Carex sitchensis	SITKA SEDGE	OBL	No	No	No
Carex spectabilis	SHOWY SEDGE	FACW	No	No	No
Carex sprengelii	SPRENGEL SEDGE	FAC	No	No	No
Carex stylosa	VARIEGATED SEDGE	FACW+	No	No	No

PLANT LIST

SCIENTIFIC NAME	COMMON NAME	INDICATOR	COLLECTED	WPPNW	SHORT LIST
Carex subfusca	RUSTY SEDGE	FACU	No	No	No
Carex subnigricans	NEARLY BLACK SEDGE	FAC	No	No	No
Carex synchocephala	DENSE LONG-BEAKED SEDGE	FACW	No	No	No
Carex tenera	SLENDER SEDGE	FACU+	No	No	No
Carex torreyi	TORREY'S SEDGE	FAC	No	No	No
Carex tribuloides	BRISTLEBRACT SEDGE	FACW	No	No	No
Carex unilateralis	LATERAL SEDGE	FACW	No	No	No
Carex vernacula	VERNACULAR SEDGE	FAC+	No	No	No
Carex vesicaria	INFLATED SEDGE	OBL	Yes	No	No
Carex vicaria	WESTERN FOX SEDGE	OBL	No	No	No
Carex viridula	GREEN SEDGE	FACW+	No	No	No
Carex vulpinoidea	FOX SEDGE	OBL	No	No	No
Cassiope mertensiana	MERTENS CASSIOPE	FACU+	No	No	No
Cassiope tetragona	LAPLAND CASSIOPE	FACU+	No	No	No
Castilleja elata	SISKIYOU INDIAN-PAINTBRUSH	FACW	No	No	No
Castilleja exilis	SMALL INDIAN-PAINTBRUSH	OBL	No	No	Yes
Castilleja gracillima	SLENDER INDIAN-PAINTBRUSH	FACU	No	No	No
Castilleja miniata	SCARLET INDIAN-PAINTBRUSH	FAC	No	No	No
Castilleja occidentalis	WESTERN INDIAN-PAINTBRUSH	FAC+	No	No	No
Castilleja parviflora	SMALL-FLOWERED INDIAN-PAINTBRUSH	FAC	No	No	No
Castilleja rhexifolia	SPLITLEAF INDIAN-PAINTBRUSH	FAC	No	No	No
Castilleja suksdorfii	SUKSDORF INDIAN-PAINTBRUSH	FACW	No	No	No
Castilleja sulphurea	SULPHUR INDIAN-PAINTBRUSH	FACW-	No	No	No
Catabrosa aquatica	BROOK GRASS	OBL	No	No	No
Celtis reticulata	WETLEAF HACKBERRY	FAC-	No	No	No
Centaurium exaltatum	WESTERN CENTAURY	FACW	No	No	No
Centaurium muehlenbergii	MUHLENBERG'S CENTAURY	FACW	No	No	No
Centaurium umbellatum	CENTAURY	FAC-	No	No	No
Centunculus minimus	CHAFFWEED	FACW	No	No	No
Cerastium arvense	FIELD CHICKWEED	FACU	No	No	No
Cerastium beeringianum	BERING CERASTIUM	FACU	No	No	No
Cerastium brachypodum	SHORT-STALKED CHICKWEED	FAC	No	No	No
Cerastium nutans	NODDING CHICKWEED	FACU	No	No	No
Cerastium viscosum		UPL	No	No	No
Cerastium vulgatum	COMMON MOUSE-EAR CHICKWEED	FACU	No	No	No
Ceratophyllum demersum	COONTAIL	OBL	No	No	Yes
Chamaecyparis lawsoniana	PORT-ORFORD CEDAR	FACU+	No	No	No
Chamaecyparis nootkatensis	ALASKA CEDAR	FAC	No	No	No
Chenopodium album	LAMB'S QUARTERS	FAC	No	No	No
Chenopodium ambrosioides	MEXICAN TEA	FAC	No	No	No
Chenopodium botrys	JERUSALEM-OAK	FACU	No	No	No
Chenopodium chenopodioides	BUTTERED GOOSEFOOT	FAC+	No	No	No
Chenopodium fremontii	FREMONT GOOSEFOOT	FACU	No	No	No
Chenopodium glaucum	OAKLEAF GOOSEFOOT	FAC	No	No	No
Chenopodium humile	ALKALI BLITE	FAC+	No	No	No
Chenopodium leptophyllum	NARROW-LEAFED GOOSEFOOT	FACU	No	No	No
Chenopodium rubrum	RED GOOSEFOOT	FACW+	No	No	No

PLANT LIST

SCIENTIFIC NAME	COMMON NAME	INDICATOR	COLLECTED	WPPNW	SHORT LIST
Chenopodium salinum	SALINE GOOSEFOOT	FACU	No	No	No
Chrysoplenium glechomifolium	PACIFIC WATER CARPET	OBL	No	No	No
Chrysoplenium tetrandrum	GOLDEN CARPET	OBL	No	No	No
Cicuta bulbifera	POISON WATER-HEMLOCK	OBL	No	No	No
Cicuta douglasii	DOUGLAS WATER-HEMLOCK	OBL	No	No	Yes
Cimicifuga laciniata	MOUNT HOOD BUGBANE	FACW	No	No	No
Cinna latifolia	DROOPING WOODREED	FACW	No	No	No
Circaea alpina	ALPINE CIRCAEA	FACW	No	No	No
Cirsium arvense	CANADIAN THISTLE	FACU+	No	No	No
Cirsium douglasii	SWAMP THISTLE	OBL	No	No	No
Cirsium edule	INDIAN THISTLE	FACW-	No	No	No
Cirsium foliosum	ELK THISTLE	FAC-	No	No	No
Cirsium magnificum	SHOWY THISTLE	OBL	No	No	No
Cirsium undulatum	WAVYLEAF THISTLE	FACU+	No	No	No
Cirsium vulgare	BULL THISTLE	FACU	No	No	No
Claytonia cordifolia	HEARTLEAF MINERSLETTUCE	FACW+	No	No	No
Claytonia lanceolata	LANCELEAF SPRING-BEAUTY	FAC-	No	No	No
Claytonia megarhiza	ALPINE SPRING-BEAUTY	FACU	No	No	No
Claytonia nevadensis	NEVADA SPRINGBEAUTY	FAC	No	No	No
Claytonia perfoliata	MINERSLETTUCE SPRING-BEAUTY	FAC	No	No	No
Claytonia sibirica	WESTERN SPRING-BEAUTY	FACW	No	No	No
Clematis ligusticifolia	WESTERN VIRGIN'S BOWER	FACU	No	No	No
Cleome lutea	YELLOW BEEPLANT	FACU	No	No	No
Cleome serrulata	ROCKY MOUNTAIN BEE-PLANT	FACU	No	No	No
Cochlearia officinalis	SCURVY-GRASS	FACW	No	No	No
Coeloglossuum viride	LONG-BRACTED ORCHID	FAC	No	No	No
Coleanthus subtilis	COMMON MUDGRASS	OBL	No	No	No
Collomia linearis	SLENDER LEAF COLLOMIA	FACU	No	No	No
Comandra umbellata	BASTARD TOADFLAX	UPL	No	No	No
Conioselinum chinense	APPALACHIAN HEMLOCK-PARSLEY	FAC	No	No	No
Conioselinum gmelinii	WESTERN HEMLOCK-PARSLEY	FAC	No	No	No
Conioselinum scopulorum	HEMLOCK-PARSLEY	FAC	No	No	No
Conium maculatum	POISON HEMLOCK	FACW-	No	No	No
Conyza canadensis	CANADA HORSEWEED	FACU	No	No	No
Coptis aspleniifolia	FENNY GOLDTHREAD	FAC	No	No	No
Coptis laciniata	CUTLEAF GOLDTHREAD	FAC	No	No	No
Corallorrhiza maculata	SPOTTED CORALROOT	FAC-	No	No	No
Corallorrhiza striata	STRIPED CORALROOT	FACU	No	No	No
Corallorrhiza trifida	NORTHERN CORALROOT	FAC	No	No	No
Corallorrhiza wisteriana	SPRING CORAL ROOT	FAC	No	No	No
Cordylanthus maritimus	SALTMARSH BIRD-BEAK	OBL	No	No	No
Coreopsis tinctoria	PLAINS TICKSEED	FACU	No	No	No
Corispermum hyssopifolium	HYSSOPP-LEAF BUGSEED	FACU	No	No	No
Cornus canadensis	BUNCHBERRY DOGWOOD	FAC-	No	No	No
Cornus glabrata	BROWN DOGWOOD	FACW	No	No	No
Cornus stolonifera	RED-OSIER DOGWOOD	FACW	Yes	Yes	Yes
Corydalis aquae-gelidae	CLACKAMAS CORYDALIS	OBL	No	No	No
Corydalis caseana	FITWEED CORYDALIS	FACW+	No	No	No

PLANT LIST

SCIENTIFIC NAME	COMMON NAME	INDICATOR	COLLECTED	WPPNW	SHORT LIST
Corydalis scouleri	SCOULER CORYDALIS	FAC+	No	No	No
Cotula coronopifolia	BIRD BRASS BUTTONS	FACW+,D	No	Yes	Yes
Crassula aquatica	WATER PIGMY-WEED	OBL	No	No	No
Crassula erecta	ERECT PIGMY-WEED	UPL	No	No	No
Crataegus douglasii	DOUGLAS HAWTHORN	FAC	No	No	No
Crepis runcinata	DANDELION HAWKSBEARD	FACU	No	No	No
Cressa truxillensis	ALKALIWEED	FACW	No	No	No
Crytogramma stelleri	STELLER ROCKBRAKE	FACU	No	No	No
Cycloloma atriplicifolium	WINGED PIGWEED	FACU-	No	No	No
Cynodon dactylon	BERMUDA GRASS	FACU	No	No	No
Cynosurus cristatus	CRESTED DOGTAIL	UPL	No	No	No
Cyperus acuminatus	TAPERLEAF FLATSEDGE	OBL,DRA	No	No	No
Cyperus aristatus	BEARDED FLATSEDGE	OBL,DRA	No	No	No
Cyperus erythrorhizos	REDROOT FLATSEDGE	OBL,DRA	No	No	No
Cyperus esculentus	CHUFA FLATSEDGE	FACW	No	No	No
Cyperus filiculmis	NERVED FLATSEDGE	UPL	No	No	No
Cyperus rivularis	SLENDER FLATSEDGE	OBL	No	No	No
Cyperus schweinitzii	SCHWEINITZ FLATSEDGE	FAC	No	No	No
Cyperus strigosus	STRAWCOLORED NUTSEDGE	FACW	No	No	No
Cypripedium calceolus	LARGE LADY'S-SLIPPER	FACW-	No	No	No
Cypripedium californicum	CALIFORNIA LADY'S SLIPPER	OBL	No	No	No
Cypripedium fasciculatum	BROWNIE LADY'S SLIPPER	FAC	No	No	No
Cypripedium montanum	LADY'S SLIPPER	FACU	No	No	No
Cypripedium passerinum	NORTHERN LADY'S-SLIPPER	FACW	No	No	No
Cystopteris fragilis	BRITTLE BLADDERFERN	FACU	No	No	No
Cystopteris montana	MOUNTAIN BLADDERFERN	FAC	No	No	No
Dactylis glomerata	COMMON ORCHARDGRASS	FACU	Yes	No	No
Danthonia californica	CALIFORNIA OATGRASS	FACU-	No	No	No
Danthonia intermedia	TIMBER DANTHONIA	FACU+	No	No	No
Darlingtonia californica	CALIFORNIA PITCHER-PLANT	OBL	No	No	No
Delphinium barbeyi	BARBEY LARKSPUR	FAC+	No	No	No
Delphinium burkei	BURK LARKSPUR	FACU-	No	No	No
Delphinium glaucescens	SMOOTH LARKSPUR	FACU	No	No	No
Delphinium glaucum	SIERRA LARKSPUR	FACW	No	No	No
Delphinium leucophaeum	WHITE ROCK LARKSPUR	FACU	No	No	No
Delphinium occidentale	DUNECAP LARKSPUR	FACU-	No	No	No
Delphinium sonnei	SONNE LARKSPUR	FAC	No	No	No
Deschampsia caespitosa	TUFTED HAIRGRASS	FACW	Yes	Yes	Yes
Deschampsia danthonioides	ANNUAL HAIRGRASS	FACW-	Yes	No	No
Deschampsia elongata	SLENDER HAIRGRASS	FACW-	No	No	No
Dichanthelium acuminatum	WOOLLY PANICUM	FAC,DRA	No	No	No
Dichanthelium oligosanthes	SCRIBNER PANICUM	FACU	No	No	No
Digitaria ischaemum	SMOOTH CRABGRASS	FACU	No	No	No
Digitaria sanguinalis	HAIRY CRABGRASS	FACU	No	No	No
Distichlis spicata	SALTGRASS	FACW	Yes	Yes	Yes
Distichlis spicata var. stricta	ISLANDS SALTGRASS	FAC+	No	No	No
Dodecatheon alpinum	ALPINE SHOOTING-STAR	FACW+	No	No	No

PLANT LIST

SCIENTIFIC NAME	COMMON NAME	INDICATOR	COLLECTED	WPPNW	SHORT LIST
Dodecatheon conjugens	SAILORCAPS SHOOTING-STAR	FAC-	No	No	No
Dodecatheon dentatum	WHILTE SHOOTING-STAR	FAC-	No	No	No
Dodecatheon jeffreyi	JEFFREYI SHOOTING-STAR	FACW	No	No	No
Dodecatheon pauciflorum	DARK-THROAT SHOOTING-STAR	FACW	No	No	No
Dodecatheon poeticum	NARCISSUS SHOOTING-STAR	FAC	No	No	No
Dodecatheon pulchellum	BEAUTIFUL SHOOTING-STAR	FACW	No	No	No
Downingia bicornuta	TWOHORNED DOWNINGIA	OBL	No	No	No
Downingia elegans	DOWNINGIA	OBL,DRA	No	No	No
Downingia laeta	GREAT BASIN DOWNINGIA	OBL	No	No	No
Downingia yina	CASCADE DOWNINGIA	OBL	No	No	No
Draba aurea	GOLDEN DRABA	UPL	No	No	No
Dracocephalum parviflorum	AMERICAM DRAGON-HEAD	FACU	No	No	No
Drosera angelica	ENGLISH SUNDEW	OBL	No	No	No
Drosera longifolia	NARROW-LEAF SUNDEW	OBL	No	No	No
Drosera rotundifolia	ROUND-LEAVED SUNDEW	OBL	No	No	No
Dryas drummondii	DRUMMOND MOUNTAINAVENS	FACU	No	No	No
Dryas integrifolia	ENTIRE-LEAVED MOUNTAIN AVENS	FACU	No	No	No
Dryopteris cristata	CRESTED WOODFERN	FACW	No	No	No
Dryopteris dilatata	MOUNTAIN WOODFERN	FACW	No	No	No
Dryopteris intermedia	INTERMEDIATE WOODFERN	FAC	No	No	No
Dryopteris spinulosa	TOOTHED WOODFERN	FAC+	No	No	No
Duchesnea indica	INDIAN STRAWBERRY	UPL	No	No	No
Dugaldia hoopesii	ORANGE SNEEZEWEED	FAC	No	No	No
Dulichium arundinaceum	THREE-WAYSEDGE	OBL	No	No	Yes
Echinochloa colona	JUNGLE-RICE	FAC	No	No	No
Echinochloa crus-pavonis	ALKALI BARNYARD-GRASS	FACW	No	No	No
Echinochloa crusgalli	WILD MILLET	FACW,DR	No	No	No
Echinochloa muricata	BRAZIZIAN WATERWEED	FACW	No	No	No
Echinocystis lobata	WILD CUCUMBER	FACU	No	No	No
Egeria densa	SOUTH AMERICAN ELODEA	OBL	No	No	No
Elaeagnus angustifolia	RUSSIAN OLIVE	FAC	No	No	Yes
Elatine brachysperma	SHORTSEED WATERWORT	OBL	No	No	No
Elatine californica	CALIFORNIA WATERWORT	OBL	No	No	No
Elatine triandra	THREE STAMEN WATERWORT	OBL	No	No	No
Eleocharis acicularis	NEEDLE SPIKERUSH	OBL	No	No	No
Eleocharis atropurpurea	PURPLE SPIKERUSH	FACW	No	No	No
Eleocharis bella	BEAUTIFUL SPIKERUSH	FACW	No	No	No
Eleocharis bolanderi	BOLANDER SPIKERUSH	FACW	No	No	No
Eleocharis coloradoensis	DWARF SPIKERUSH	OBL	No	No	No
Eleocharis engelmanni	ENGELMANN'S SPIKERUSH	OBL	No	No	No
Eleocharis erythropoda	BALD SPIKERUSH	OBL	No	No	No
Eleocharis flavescens	YELLOW SPIKERUSH	OBL	No	No	No
Eleocharis macrostachya	CREEPING SPIKERUSH	OBL	No	No	No
Eleocharis mamillata	SPIKERUSH	OBL	No	No	No
Eleocharis obtusa	BLUNT SPIKESEDGE	OBL	No	No	No
Eleocharis ovata	OVATE SPIKESEDGE	OBL	No	No	No
Eleocharis palustris	COMMON SPIKERUSH	OBL	Yes	Yes	No
Eleocharis parishii	PARISH SPIKERUSH	FACW+	No	No	No

PLANT LIST

SCIENTIFIC NAME	COMMON NAME	INDICATOR	COLLECTED	WPPNW	SHORT LIST
Eleocharis parvula	SMALL SPIKERUSH	OBL	No	Yes	No
Eleocharis pauciflora	FEW-FLOWERED SPIKERUSH	OBL	No	No	No
Eleocharis rostellata	BEAKED SPIKERUSH	OBL	No	No	No
Eleocharis smallii	SMALL'S SPIKERUSH	OBL	No	No	No
Eleocharis tenuis	KILL-COW	FACW	No	No	No
Eleocharis uniglumis	ONE-SCALE SPIKESEDGE	OBL	No	No	No
Eleusine indica	GOOSEGRASS	UPL	No	No	No
Ellisia nyctelea	FALSE BABYBLUEEYES	FACU	No	No	No
Elodea canadensis	COMMON WATERWEED	OBL	No	No	No
Elodea longivaginata	LONG-SHEATH WATERWEED	OBL	No	No	No
Elodea nutallii	WESTERN WATERWEED	OBL	No	No	No
Elymus triticoides	CREEPING WILDRYE	FAC,DRA	No	No	No
Elymus arenarius	SEA LYME-GRASS	FACU	No	No	No
Elymus canadensis	CANADA WILDRYE	FAC	No	No	No
Elymus condensatus	GIANT WILDRYE	FACU	No	No	No
Elymus glaucus	BLUE WILDRYE	FACU	No	No	No
Elymus jundeus	RUSSIAN WILDRYE	FAC	No	No	No
Elymus virginicus	VIRGINIA WILDRYE	FACW	No	No	No
Elyna bellardii	BELLARD ALPINESEDGE	UPL	No	No	No
Empetrum nigrum	BLACK CROWBERRY	FAC	No	No	No
Epilobium X treleasianum	ALPINE WILLOW-HERB	FAC	No	No	No
Epilobium anagallidifolium	PIMPERNEL WILLOW-HERB	FACU-	No	No	No
Epilobium angustifolium	COMMON FIREWEED	FACU+	No	Yes	No
Epilobium brachycarpum	AUTUM WILLOW-WEED	UPL	No	No	No
Epilobium ciliatum (=watsonii)	HAIRY WILLOW-WEED	FACW-	No	No	Yes
Epilobium clavatum	CLAVATE-FRUIT WILLOW-HERB	FACU+	No	No	No
Epilobium glaberrimum	SMOOTH WILLOW-WEED	FACW	No	No	No
Epilobium halleanum	HALL'S WILLOW-HERB	FACW	No	No	No
Epilobium hornemanni	HORNEMANN WILLOW-HERB	FACW-	No	No	No
Epilobium lactiflorum	WHITE-FLOWER WILLOW-HERB	FACW	No	No	No
Epilobium latifolium	RED WILLOW-WEED	FACW-	No	No	No
Epilobium leptophyllum	LINEAR-LEAVED WILLOW-HERB	FACW	No	No	No
Epilobium luteum	YELLOW WILLOW-HERB	FACW	No	No	No
Epilobium obcordatum	HEART WILLOW-WEED	FACU	No	No	No
Epilobium oreganum	GRANT'S PASS WILLOW-HERB	OBL	No	No	No
Epilobium oregonense	ALPINE WILLOW-WEED	FACW	No	No	No
Epilobium palustre	DWARF WILLOW-WEED	OBL	No	No	No
Epilobium saximontaum	GLANDULAR WILLOW-HERB	FACW	No	No	No
Epilobium siskiyouense	SISKIYOU WILLOW-HERB	FACW	No	No	No
Epilobium suffruticosum	SHRUB WILLOW-WEED	FACU	No	No	No
Epipactis gigantea	GIANT HELLOBORINE	FACW+	No	No	No
Equisetum arvense	FIELD HORSETAIL	FAC	No	No	Yes
Equisetum fluviatile	WATER HORSETAIL	OBL	No	No	Yes
Equisetum hyemale	SCOURING-RUSH HORSETAIL	FACW	No	No	Yes
Equisetum laevigatum	SMOOTH HORSETAIL	FACW	No	No	No
Equisetum palustre	MEADOW HORSETAIL	FACW	No	No	No
Equisetum pratense	SEDGELIKE HORSETAIL	FACW	No	No	No
Equisetum scirpoides	DWARF SCOURING-RUSH	FAC	No	No	No

PLANT LIST

SCIENTIFIC NAME	COMMON NAME	INDICATOR	COLLECTED	WPPNW	SHORT LIST
Equisetum sylvaticum	SWAMP HORSETAIL	FACW	No	No	No
Equisetum telmateia	GIANT HORSETAIL	FACW	No	No	No
Equisetum variegatum	VARIEGATED HORSETAIL	FACW	No	No	No
Eragrostis cilianensis	STINK LOVEGRASS	FACU,DR	No	No	No
Eragrostis hypnoides	TEAL LOVEGRASS	OBL,DRA	No	No	No
Eragrostis mexicana	MEXICAN LOVEGRASS	FAC	No	No	No
Eragrostis pectinacea	CAROLINA LOVEGRASS	FAC,DRA	No	No	No
Eragrostis pilosa	INDIA LOVEGRASS	FACU	No	No	No
Erigeron acris	BITTER FLEABANE	FACU	No	No	No
Erigeron annuus	ANNUAL FEABANE	FACU+	No	No	No
Erigeron coulteri	COULTER FLEABANE	FACW	No	No	No
Erigeron flagellaris	TRAILING FLEABANE	FACU+	No	No	No
Erigeron formosissimus	BEAUTIFUL FLEABANE	UPL	No	No	No
Erigeron glaucus	BEACH FLEABANE	FACU-	No	No	No
Erigeron howellii	HOWELL FLEABANE	FACW	No	No	No
Erigeron humilis	LOW FLEABANE	FACW-	No	No	No
Erigeron lanatus	LANATUS FLEABANE	FACU	No	No	No
Erigeron lonchophyllus	SPEARLEAF FLEABANE	-	No	No	No
Erigeron melanocephalus	BLACKHEADED FLEABANE	FAC	No	No	No
Erigeron peregrinus	PEREGRINE FLEABANE	FACW	No	No	No
Erigeron philadelphicus	PHILADELPHIA FLEABANE	FACU	No	No	No
Erigeron strigosus	ROUGH FLEABANE	FACU	No	No	No
Eriophorum alpinum	ALPINE COTTONGRASS	OBL	No	No	No
Eriophorum angustifolium	NARROW-LEAF COTTONSEDGE	OBL	No	No	No
Eriophorum brachyantherum	NORTHLAND COTTONSEDGE	OBL	No	No	No
Eriophorum chamissonis	CHAMISSO COTTONSEDGE	OBL	No	No	No
Eriophorum crinigerum	SUBALPINE COTTONSEDGE	OBL	No	No	No
Eriophorum gracile	SLENDER COTTONSEDGE	OBL	No	No	No
Eriophorum polystachion	COLDSWAMP COTTONSEDGE	OBL	No	No	No
Eriophorum scheuchzeri	SCHEUCHZER'S COTTON-GRASS	OBL	No	No	No
Eriophorum viridicarinatum	GREENSEED COTTONSEDGE	OBL	No	No	No
Eryngium articulatum	COYOTE-THISTLE	OBL	No	No	No
Eryngium petiolatum	OREGON ERYNGO	OBL	No	No	No
Erysimum cheiranthoides	WORMSEED MUSTARD	FACU	No	No	No
Erythronium grandiflorum	LAMBSTONGUE TROUTLILY	FAC-	No	No	No
Erythronium revolutum	MOHOGANY TROUTLILY	FAC+	No	No	No
Eupatoriadelphus maculatus	SPOTTED JOEPYEWEED	OBL	No	No	No
Euphorbia maculata	SPOTTED SPURGE	UPL	No	No	No
Euthamia graminifolia	GRASS-LEAVED GOLDENROD	FAC	No	No	No
Euthamia occidentalis	WESTERN GOLDENROD	FACW	No	No	No
Fauria crista-galli	DEER CABBAGE	OBL	No	No	No
Festuca altaica	ROUGH FESCUE	UPL	No	No	No
Festuca arundinacea	TALL FESCUE	FACU-	Yes	No	No
Festuca californica	CALIFORNIA FESCUE	FACU	No	No	No
Festuca pratensis	MEADOW FESCUE	FACU+	No	No	No
Festuca rubra	RED FESCUE	FAC	Yes	No	Yes
Festuca subulata	BEARDED FESCUE	FAC	No	No	No
Filaginella uliginosa	LOW CUDWEED	FAC+	No	No	No

PLANT LIST

SCIENTIFIC NAME	COMMON NAME	INDICATOR	COLLECTED	WPPNW	SHORT LIST
Floerkea proserpinacoides	FALSE MERMAID	FAC,DRA	No	No	No
Foeniculum vulgare	FENNEL	FACU	No	No	No
Fragaria virginiana	WILD STRAWBERRY	UPL	No	No	No
Fraxinus latifolia	OREGON ASH	FACW	No	Yes	Yes
Fraxinus pennsylvanica	GREEN ASH	FAC	No	No	No
Frittillaria camschatcensis	KAMCHATKA FRITILLARY	FACW	No	No	No
Galium aparine	CLEAVERS	FACU	No	No	No
Galium boreale	NORTHERN BEDSTRAW	FACU	No	No	No
Galium cymosum	PACIFIC BEDSTRAW	FACW	No	No	No
Galium mexicanum	ROUGH BEDSTRAW	FAC	No	No	No
Galium parisiense	WALL BEDSTRAW	UPL	No	No	No
Galium trifidum	SMALL BEDSTRAW	FACW+	No	No	No
Galium triflorum	SWEET-SCENTED BEDSTRAW	FACU	No	No	No
Gastridium ventricosum	NITGRASS	FACU	No	No	No
Gaultheria hispidula	CREEPING SNOWBERRY	FACW	No	No	No
Gaultheria humifusa	WESTERN WINTERGREEN	FAC+	No	No	No
Gaultheria ovatifolia	OREGON WITERGREEN	FAC	No	No	No
Gentiana affinis	OREGON GENTIAN	FACU	No	No	No
Gentiana algida	WHITISH GENTIAN	FACW	No	No	No
Gentiana aquatica	MOSS GENTIAN	FACW+	No	No	No
Gentiana bisetaea	WALDO GENTIAN	OBL	No	No	No
Gentiana calycosa	RAINIER PLEATED GENTIAN	FACW-	No	No	Yes
Gentiana douglasiana	SWAMP GENTIAN	OBL	No	No	No
Gentiana glauca	SMOOTH GENTIAN	FAC	No	No	No
Gentiana parryi	PARRY GENTIAN	FAC	No	No	No
Gentiana prostrata	PROSTRATE GENTIAN	FACW	No	No	No
Gentiana sceptrum	PACIFIC GENTIAN	OBL	No	No	No
Gentiana setigera	MENDOCINO GENTIAN	OBL	No	No	No
Gentianella amarella	NORTHERN GENTIAN	FACW-	No	No	No
Gentianella propinqua	FOUR-PARTED GENTIAN	FACW	No	No	No
Gentianella tenella	DANES' GENTIAN	FACW-	No	No	No
Gentianopsis barbellata	PERENNIAL FRINGED GENTIAN	FACW	No	No	No
Gentianopsis detonsa	SHEARED GENTIAN	FACW	No	No	No
Gentianopsis simplex	ONE-FLOWERED GENTIAN	FACW	No	No	No
Gentianopsis thermalis	ROCKY MOUNTAIN FRINGED GENTIAN	OBL	No	No	No
Geocaulon lividum	NORTHERN COMANDRA	FAC+	No	No	No
Geranium richardsonii	RICHARDSON GERANIUM	FACU+	No	No	No
Geranium viscosissimum	STICKY GERANIUN	FACU+	No	No	No
Geum aleppicum	ALLEPO AVENS	FACW-	No	No	No
Geum macrophyllum	BIG-LEAF AVENS	FACW+	No	No	No
Geum rivale	WATER AVENS	FACW	No	No	No
Geum rossii	ALPINE AVENS	FACU	No	No	No
Geum triflorum	PRAIRIE-SMOKE AVENS	FACU	No	No	No
Glaux maritima	SEA MILKWORT	FACW+	Yes	No	Yes
Glecoma hederacea	GROUND IVY	FACU+	No	No	No
Gleditsia triacanthos	HONEYLOCUST	FAC-	No	No	No
Glyceria borealis	NORTHERN MANNAGRASS	OBL	Yes	No	No
Glyceria elata	TALL MANNAGRASS	FACW+	Yes	No	No

PLANT LIST

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Glyceria fluitans	WATER MANNAGRASS	OBL	No	No	No
Glyceria leptostachya	SLIM-HEAD MANNAGRASS	OBL	No	No	No
Glyceria maxima	AMERICAN MANNAGRASS	OBL	No	No	No
Glyceria occidentalis	NORTHWESTERN MANNAGRASS	OBL	No	No	No
Glyceria striata	FOWL MANNAGRASS	OBL	No	No	No
Glycyrrhiza lepidota	WILD LICORICE	FAC+,DR	No	No	No
Gnaphalium chilense	COTTON-BATTING CUDWEED	FAC+	No	No	No
Gnaphalium palustre	LOWLAND CUDWEED	FAC+,DR	No	No	No
Goodyera oblongifolia	GIANT RATTLESNAKE-PLANATAIN	FACU-	No	No	No
Goodyera repens	DWARF RATTLESNAKE-PLANTAIN	FACU-	No	No	No
Gratiola ebracteata	BRACTED HEDGE-HYSSOP	OBL	No	No	No
Gratiola neglecta	CLAMMY HEDGE-HYSSOP	OBL,DRA	No	No	No
Grindelia columbiana	COLUMBIA GORGE GUMWEED	FAC?	No	No	No
Grindelia integrifolia	PACIFIC GRINDELIA	FACW	No	Yes	Yes
Grindelia nana	LOW GUMWEED	FACU+	No	No	No
Grindelia squarrosa	CURLYCUP GUMWEED	FACU,DR	No	No	No
Gymnocarpium dryoperis	OAK FERN	FAC	No	No	No
Hackelia floribunda	WESTERN STICKSEED	FACU-	No	No	No
Haplopappus hirtus	HAIRY GOLDENWEED	UPL	No	No	No
Haplopappus lanceolatus	LANCELEAF GOLDENWEED	FAC	No	No	No
Haplopappus racemosus	CLUSTER GOLDENWEED	FACU	No	No	No
Haplopappus uniflorus	PLANTAIN GOLDENWEED	FAC+	No	No	No
Harrimanella stellerana	ALASKA MOSS HEATH	FACU	No	No	No
Hedysarum alpinum	ALPINE SWEET-VETCH	FACU	No	No	No
Helensium autumnale	SNEEZEWEED	FACW	No	No	Yes
Helensium bigelovii	BIGELOW SNEEZEWEED	FACW+	No	No	No
Helensium bolanderi	COAST SNEEZEWEED	FACW	No	No	No
Helensium puberulum	ROSILLA	FACW	No	No	No
Helianthella quinquenervis	FIVE-NERVE HELIANTHELLA	FACU	No	No	No
Helianthus annuus	COMMON SUNFLOWER	FACU+	No	No	No
Helianthus maximiliani	MAXIMILIAN SUNFLOWER	UPL	No	No	No
Helianthus nuttallii	NUTTALL SUNFLOWER	FACW-	No	No	No
Helianthus tuberosus	JERUSALEM ARTICHOKE	FAC	No	No	No
Heliotropium curassavicum	SEASIDE HELIOTROPE	OBL,DRA	No	No	No
Hemicarpha aristulata	AWNED HEMICARPHA	FACW	No	No	No
Hemicarpha micrantha	COMMON HEMICARPHA	FACW	No	No	No
Hemicarpha occidentalis	WESTERN HEMICARPHA	FACW	No	No	No
Hemizonia pungens	COMMON SPIKEWEED	UPL	No	No	No
Heracleum lanatum	COMMON COWPARSNIP	FAC	No	No	Yes
Hesperochiron californicus	CALIFORNIA HESPERICHIRON	FACU	No	No	No
Hesperochiron pumilus	DWARF HESPEROCHIRON	FAC	No	No	No
Heterocodon rariflorum	HETEROCODON	FAC	No	No	No
Heuchera chlorantha	ALUMROOT	FAC?	No	No	No
Heuchera richardsonii	ROUGH HEUCHERA	FAC	No	No	No
Heuchera rubescens	PINK ALUMROOT	UPL	No	No	No
Hierochloe odorata	VANILLA GRASS	FACW	No	No	No
Hippuris montana	MOUNTAIN MARE'S-TAIL	FACW+	No	No	No
Hippuris vulgaris	MARE'S-TAIL	OBL,DRA	No	No	Yes

PLANT LIST

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Holcus lanatus	VELVET GRASS	FAC	Yes	No	No
Honkenya peploides	SEA-BEACHSANDWORT	FACU	No	Nc	No
Hordeum brachyantherum	MEADOW BARLEY	FACW	Yes	Yes	Nc
Hordeum californicum	CALIFORNIA BARLEY	FACU	No	Nc	Nc
Hordeum hystrix	MEDITERRANEAN BARLEY	FACU	No	No	No
Hordeum jubatum	FOXTAIL BARLEY	FAC+	No	No	No
Hordeum pusillum	LITTLE BARLEY	FAC	No	Nc	No
Howellia aquatilis	HOWELLIA	OBL	No	Nc	No
Hydrocotyle ranunculoides	FLOATING PENNYWORT	OBL	No	No	No
Hydrocotyle umbellata	WATER PENNYWORT	OBL	No	No	No
Hydrophyllum fendleri	FENDLER WATERLEAF	FAC	No	No	No
Hydrophyllum occidentale	WESTERN WATERLEAF	FACW	No	No	No
Hypericum anagalloides	BOG ST. JOHNSWORT	OBL	No	No	No
Hypericum formosum	SOUTHWESTERN ST.JOHNSWORT	FAC	No	No	No
Hypericum majus	MARSH ST. JOHNSWORT	FAC	No	No	No
Iliamna rivularis	WILD HOLLYHOCK	FAC-	No	No	No
Impatiens aurella	PALE-YELLOW TOUCH-ME-NOT	FACW	No	No	No
Impatiens capensis	SPOTTED TOUCH-ME-NOT	FACW	No	No	No
Impatiens ecalcarata	WESTERN TOUGH-ME-NOT	FACW	No	No	No
Impatiens noli-tangere	TOUCH-ME-NOT	FACW	No	Yes	No
Ipomoea purpurea		UPL	No	No	No
Iris missouriensis	ROCKY MOUNTAIN IRIS	FACW+	No	No	Yes
Iris pseudacorus	YELLOW IRIS	OBL	No	Yes	Yes
Isoetes bolanderi	BOLANDER QUILLWORT	OBL	No	No	No
Isoetes echinopsora	BRAUN'S QUILLWORT	OBL	No	No	No
Isoetes howellii	HOWELL'S QUILLWORT	OBL	No	No	No
Isoetes lacustris	WESTERN QUILLWORT	OBL	No	No	No
Isoetes nuttallii	NUTTALL QUILLWORT	OBL	No	No	No
Iva axillaris	POVERTY WEED	FAC,DRA	No	No	No
Iva xanthifolia	RAG SUMPWEED	FAC,DRA	No	No	No
Jamesia americana	CLIFF JAMESIA	FACU-	No	No	No
Jaumea carnosa	FLESHY JAUMEA	OBL	Yes	Yes	Yes
Juncus abjectus	ANNUAL RUSH	OBL	No	No	No
Juncus acuminatus	TAPERTIP RUSH	OBL	No	No	No
Juncus albnescens	NORTHERN WHITE RUSH	OBL	No	No	No
Juncus alpinus	ALPINE RUSH	OBL	No	No	No
Juncus articulatus	JOINTED RUSH	OBL	No	No	No
Juncus balticus	BALTIC RUSH	OBL	Yes	No	Yes
Juncus biglumis	TWO-FLOWERED RUSH	OBL	No	No	No
Juncus bolanderi	BOLANDER'S RUSH	OBL	No	No	No
Juncus bufonius	TOAD RUSH	FACW+	Yes	No	No
Juncus bulbosus	BULBOUS RUSH	OBL	No	No	No
Juncus castaneus	CHESTNUT RUSH	FACW	No	No	No
Juncus compressus	FLATTENED RUSH	OBL	No	No	No
Juncus confusus	COLORADO RUSH	FAC	No	No	No
Juncus covillei	COVILLE RUSH	FACW	No	No	No
Juncus drummondii	DRUMMOND RUSH	FACW-	No	No	No
Juncus effusus	SOFT RUSH	FACW+	Yes	Yes	Yes

PLANT LIST

SCIENTIFIC NAME	COMMON NAME	INDICATOR	COLLECTED	WPPNW	SHORT LIST
Juncus ensifolius	SWORDLEAF RUSH	FACW	Yes	No	No
Juncus falcatus	SICKLE-LEAVED RUSH	FACW-	No	No	No
Juncus filiformis	THREAD RUSH	FACW+	No	No	No
Juncus gerardii	BLACK GRASS	FACW+	Yes	No	No
Juncus hallii	HALL'S RUSH	FAC	No	No	No
Juncus hemiendytus	BLOODRUSH	FACW+	No	No	No
Juncus interior	INLAND RUSH	FAC	No	No	No
Juncus kelloggii	KELLOGG'S RUSH	FACW	No	No	No
Juncus lesueurii	SALT RUSH	FACW-	No	No	Yes
Juncus longistylis	LONG-STYLE RUSH	FACW	No	No	No
Juncus mertensianus	MERTENS RUSH	OBL	No	No	No
Juncus nevadensis	NEVADA RUSH	FACW	No	No	No
Juncus nodosus	KNOTTED RUSH	OBL	No	No	No
Juncus orthophyllus	STRAIGHTLEAF RUSH	FACW	No	No	No
Juncus oxymeris	POINTED RUSH	FACW+	No	No	No
Juncus parryi	PARRY'S RUSH	FAC+	Yes	No	No
Juncus patens	SPREADING RUSH	FACW	No	No	No
Juncus regelii	REGEL RUSH	FACW	No	No	No
Juncus saximontanus	ROCKY MOUNTAIN RUSH	FACW	No	No	No
Juncus supiniformus	HAIRY-LEAVED RUSH	OBL	No	No	No
Juncus tenuis	SLENDER RUSH	FAC	No	No	No
Juncus torreyi	TORREY RUSH	FACW	No	No	No
Juncus tracyi	TRACY RUSH	FACW	No	No	No
Juncus triglumis	THREE HULLED RUSH	FACW	No	No	No
Juncus tweedyi	TWEEDY RUSH	OBL	No	No	No
Juncus uncialis	TWELFTH RUSH	FACW+	No	No	No
Juncus vaseyi	VASEY RUSH	FACW	No	No	No
Juncus xiphioides	IRIS-LEAVED RUSH	OBL	No	No	No
Juniperus horizontalis	CREEPING JUNIPER	FACU-	No	No	No
Kalmia microphylla	ALPINE BOG KALMIA	FACW+	No	No	No
Kalmia polifolia	BOG LAUREL	OBL	No	No	Yes
Kickxia elatine	SHARPPOINT FLUVELLIN	UPL	No	No	No
Kobresia myosuroides	KOBRESIA	FAC	No	No	No
Kobresia sibirica	SIBERIAN KOBRESIA	FAC+	No	No	No
Kobresia simpliciuscula	SIMPLE ALPINESEDGE	FAC	No	No	No
Kochia americana	GREEN MOLLY KOCHIA	FACU	No	No	No
Kochia scoparia	SUMMER CYPRESS	FAC,DRA	No	No	No
Lactuca biennis	ANNUAL LETTUCE	FAC+	No	No	No
Lactuca canadensis	CANADA LETTUCE	FACU+	No	No	No
Lactuca ludoviciana	BIANNUAL LETTUCE	FAC	No	No	No
Lactuca pulchella	CHICORY LETTUCE	FAC	No	No	No
Lactuca saligna	WILLOW LEAF LETTUCE	UPL	No	No	No
Lactuca serriola	PRICKLY LETTUCE	FAC-	No	No	No
Larix occidentalis	WESTERN LARCH	FACU+	No	No	No
Lasthenia chrysostoma	GOLDFIELDS	UPL	No	No	No
Lasthenia glabberima	SMOOTH LASTHENIA	OBL	No	No	No
Lasthenia minor	HAIRY LASTHENIA	FAC	No	No	No
Lathyrus japonicus	BEACH PEA	FACU-	No	No	No

PLANT LIST

SCIENTIFIC NAME	COMMON NAME	INDICATOR	COLLECTED	WPPNW	SHORT LIST
Lathyrus lanzwertii	THICKLEAF PEAVINE	UPL	No	No	No
Lathyrus palustris	VETCHLING	OBL	No	No	No
Lathyrus pratensis	YELLOW VETCHLING	UPL	No	No	No
Ledum columbianum	COLUMBIAN LEDUM	OBL	No	No	No
Ledum glandulosum	LABRADOR TEA	FACW+	No	No	No
Ledum groenlandicum	LABRADOR TEA	OBL	No	No	Yes
Leersia oryzoides	RICE CUTGRASS	OBL	No	No	Yes
Lemna gibba	SWOLLEN DUCKWEED	OBL	No	No	No
Lemna minima	LEAST DUCKWEED	OBL	No	No	No
Lemna minor	LESSER DUCKWEED	OBL	No	Yes	Yes
Lemna obscura	DUCKWEED	OBL	No	No	No
Lemna triscula	STAR DUCKWEED	OBL	No	No	No
Lemna valdiviana	VALDIVIA DUCKWEED	OBL	No	No	No
Leontodon leysseri	HAIRY HAWKBIT	UPL	No	No	No
Lepidium densiflorum	PRAIRIE PEPPERWEED	FAC-	No	No	No
Lepidium dictyotum	NET PEPPERWEED	FACW	No	No	No
Lepidium latifolium	PERENNIAL PEPPERWEED	FAC	No	No	No
Lepidium perfoliatum	CLASPING-LEAF PEPPERWEED	FACU+,D	No	No	No
Lepidium virginicum	VIRGINIA PEPPERWEED	FACU	No	No	No
Leptarrhena pyrolifolia	FIRELEAF LEPTARRHENA	FACW	No	No	No
Leptochloa fascicularis	BEARDED SPRANGLETOP	FACW	No	No	No
Leucothoe davisiae	SIERRA LAUREL	FACW	No	No	No
Lewisia pygmaea	NEVADA LEWISSIA	FACU	No	No	No
Lewisia triphylla	THREELEAF LEWISIA	UPL	No	No	No
Liatris ligulistylus	ROCKY MOUNTAIN GAYFEATHER	FAC-	No	No	No
Ligusticum canbyi	CANBY LOVAGE	FAC	No	No	No
Ligusticum tenuifolium	SLENDER LEAF LOVAGE	FACW	No	No	No
Ligusticum verticillatum	IDAHO LOVAGE	FACW	No	No	No
Lilaea scilloides	FLOWERING QUILLWORT	OBL	No	No	Yes
Lilaeopsis occidentalis	WESTERN LILAEOPSIS	OBL	No	Yes	Yes
Lilium bolanderi	BOLANDER LILY	FACW	No	No	No
Lilium canadense	CANADA LILY	FAC	No	No	No
Lilium occidentale	EUREKA LILY	FACW+	No	No	No
Lilium pardalinum	LEOPARD LILY	FACW+	No	No	No
Lilium parvum	SMALL TIGERLILY	OBL	No	No	No
Lilium philadelphicum	WOOD LILY	FAC-	No	No	No
Lilium vollmeri	VOLLMER'S LILY	OBL	No	No	No
Lilium wigginsii	WIGGIN'S LILY	FACW	No	No	No
Limnanthes douglasii	DOUGLAS MEADOWFOAM	OBL	No	No	No
Limnanthes floccosa	WOOLLY MEADOW-FOAM	OBL	No	No	No
Limnanthes gracilis	SLENDER MEADOW-FOAM	OBL	No	No	No
Limosella acaulis	OWYHEE MUDWORT	OBL	No	No	No
Limosella aquatica	NORTHERN MUDWORT	OBL	No	No	Yes
Linanthus nuttallii	NUTTALL'S GILIA	FACU-	No	No	No
Lindernia anagallidea	FALSE PIMPERNEL	OBL	No	No	No
Lindernia dubia	MOISTBANK PIMPERNEL	OBL	No	No	No
Linnaea borealis	TWINFLOWER	FACU-	No	No	No
Liparis loeselii	LOESEL TWAYBLADE	FACW	No	No	No

PLANT LIST

SCIENTIFIC NAME	COMMON NAME	INDICATOR	COLLECTED	WPPNW	SHORT LIST
Listera borealis	NORTHERN LISTERA	FACW	No	No	No
Listera caurina	NORTHWESTERN LISTERA	FACW	No	No	No
Listera convallariodes	TWAYBLADE LISTERA	FACU	No	No	No
Listera cordata	HEARTLEAF TWAYBLADE	FACW	No	No	No
Lloydia serotina	ALP LILY	FAC	No	No	No
Lobelia dortmanna	DORTMAN CARDINALFLOWER	OBL	No	No	Yes
Lobelia kalmii	ONTARIO LOBELIA	OBL	No	No	No
Lolium perenne	PERENNIAL RYEGRASS	FACU	No	No	No
Lomatium bradshawii	BRADSHAW LOMATIUM	FACW	No	No	No
Lomatogonium rotatum	MARSH FELTWORT	OBL	No	No	No
Lonicera caerulea	SWEETBERRY HONEYSUCKLE	FAC	No	No	No
Lonicera conjugialis	PURPLEFLOWER HONEYSUCKLE	FAC	No	No	No
Lonicera dioica	LIMBER HONEYSUCKLE	FACU	No	No	No
Lonicera involucrata	BEARBERRY HONEYSUCKLE	FAC	No	No	Yes
Lonicera utahensis	UTAH HONEYSUCKLE	FACU+	No	No	No
Lotus corniculatus	BIRDSFOOT TREFOIL	FAC	No	No	Yes
Lotus formosissimus	COAST DEERVETCH	FACW+	No	No	No
Lotus oblongifolius	STREAM DEERVETCH	OBL	No	No	No
Lotus pinnatus	MEADOW BIRDSFOOT TREFOIL	FACW	No	No	No
Ludwigia palustris	MARSH PURSLANE	OBL,DRA	No	No	Yes
Ludwigia uraguayensis	URAGUAY WATERPRIMROSE	OBL	No	No	No
Luetkea pectinata	LUETKEA	FACU-	No	No	No
Lupinus polyphyllus	WASHINGTON LUPINE	FAC+	No	No	No
Lupinus prunophilus	HAIRY BIGLEAF LUPINE	FACU	No	No	No
Lupinus rivularis	STREAM LUPINE	FAC	No	No	No
Luzula arcuata	ALPINE WOOD-RUSH	UPL	No	No	No
Luzula multiflora	COMMON WOODRUSH	FACU	No	No	No
Luzula parviflora	SMALL-FLOWERED WOODRUSH	FAC-	No	No	No
Luzula spicata	SPIKED WOODRUSH	FACU	No	No	No
Luzula wahlenbergii	WAHLENBURG WOODRUSH	FACW	No	No	No
Lycopidium alpinum	ALPINE CLUBMOSS	FAC	No	No	No
Lycopidium annotinum	NORTHERN CLUBMOSS	FAC	No	No	No
Lycopidium clavatum	ACIDSOIL CLUBMOSS	FAC	No	No	No
Lycopidium complanatum	GROUND CEDAR	FAC	No	No	No
Lycopidium inundatum	INNUNDATED CLUBMOSS	OBL	No	No	No
Lycopidium obscurum	RARE CLUBMOSS	FACU-	No	No	No
Lycopidium selago	SELAGO CLUBMOSS	FACU	No	No	No
Lycopus americanus	AMERICAN BUGLEWEED	OBL	No	No	Yes
Lycopus asper	ROUGH BUGLEWEED	OBL	No	No	No
Lycopus uniflorus	ONE-FLOWER BUGLEWEED	OBL	No	No	No
Lysichitum americanum	AMERICAN YELLOW SKUNKCABBAGE	OBL	No	Yes	Yes
Lysimachia ciliata	FRINGED LOOSESTRIFE	FACW+	No	No	No
Lysimachia hybrida	NARROW-LEAVED LOOSESTRIFE	OBL	No	No	No
Lysimachia nummularia	MONEYWORT LOOSESTRIFE	FACW	No	No	No
Lysimachia terrestris	EARTH LOOSESTRIFE	OBL	No	No	No
Lysimachia thyrsiflora	WATER LOOSESTRIFE	OBL	No	No	Yes
Lythrum adsurgens	WALLOW POLY	FACW	No	No	No
Lythrum hyssopifolia	HYSSOP LYTHRUM	OBL	No	No	No

PLANT LIST

SCIENTIFIC NAME	COMMON NAME	INDICATOR	COLLECTED	WPPNW	SHORT LIST
Lythrum salicaria	PURPLE LOOSESTRIFE	OBL	No	Yes	No
Machaerocarpus californicus	CALIFORNIA DAMASONIUM	OBL	No	No	No
Maclura pomifera	OSAGE ORANGE	UPL	No	No	No
Madia glomerata	CLUSTER TARWEED	FACU-	No	No	No
Maianthemum dilatatum	FALSE LILY-OF-THE VALLEY	FAC-	No	No	No
Malus fusca	OREGON CRAB APPLE	FAC+	No	No	No
Malvella leprosa	ALKALI MALLOW	FACU	No	No	No
Marrubium vulgare	COMMON HOREHOUND	FACU+	No	No	No
Marsilea vestitia	HAIRY PEPPERWORT	OBL	No	No	Yes
Matricaria maritima	WILD CAMOMILE	FACU	No	No	No
Matricaria matricarioides	PINE APPLEWEED	FACU	No	No	No
Mazus japonicus	JAPANESE MAZUS	FACW	No	No	No
Medicago lupulina	BLACK MEDIK	FAC	No	No	No
Megalodonta beckii	WATER MARIGOLD	OBL	No	No	No
Melampyrum lineare	COW-WHEAT	FAC	No	No	No
Melica bulbosa	ONION GRASS	FACU	No	No	No
Melica spectabilis	PURPLE ONIONGRASS	FAC	No	No	No
Melilotus alba	WHITE SWEETCLOVER	FACU	No	No	No
Melilotus indica	INDIAN SWEETCLOVER	FACU	No	No	No
Melilotus officinalis	YELLOW SWEETCLOVER	FACU	No	No	No
Mentha X piperita	PEPPERMINT	FACW+	No	No	No
Mentha arvensis	FIELD MINT	FAC	No	No	No
Mentha cirtata	BERGAMOT MINT	FACW	No	No	No
Mentha pulegium	PENNYROYAL	OBL	No	No	No
Mentha spicata	SPEARMINT	OBL	No	No	No
Menyanthes trifoliata	BUCKBEAN	OBL	No	No	Yes
Menziesia ferruginea	RUSTY MENZIESIA	FACU+	No	No	No
Mertensia bella	BEAUTIFUL BLUEBELLS	FACW	No	No	No
Mertensia ciliata	MOUNTAIN BLUEBELLS	FACW+	No	No	No
Mertensia paniculata	PANICLE BLUEBELLS	FAC	No	No	No
Microsteris gracilis	SLENDER FALSE FLOX	FACU	No	No	No
Mimetanthe pilosa	FALSE MONKEYFLOWER	FACW	No	No	No
Mimulus alsinoides	CHICKWEED MONKEY-FLOWER	OBL	No	No	No
Mimulus breviflorus	SHORT-FLOWERED MONEY-FLOWER	FACW	No	No	No
Mimulus cardinalis	CRIMSON MONKEYFLOWER	FACW	No	No	No
Mimulus dentatus	TOOTHED-LEAVED MONKEY-FLOWER	OBL	No	No	No
Mimulus douglasii	PURPLE MOUSE-EARS	FACW	No	No	No
Mimulus floribundus	FLORIFEROUS MONKEY-FLOWER	OBL	No	No	No
Mimulus glabratus	YELLOW MONKEY-FLOWER	OBL	No	No	No
Mimulus guttatus	COMMON MONKEY-FLOWER	OBL	No	No	Yes
Mimulus jungermannoides	MONKEY FLOWER	FAC?	No	No	No
Mimulus lewisii	LEWIS MONKEY-FLOWER	FACW+	No	No	No
Mimulus moschatus	MUSKFLOWER	FACW+	No	No	No
Mimulus nasutus	NASUT MONKEY-FLOWER	FACW	No	No	No
Mimulus primuloides	PRIMROSE MONKEY-FLOWER	FACW+	No	No	No
Mimulus ringens	SQUARE-STEMMED MONKEY-FLOWER	OBL	No	No	No
Mimulus rubellus	CILIOLATE-TOOTHED MONKEYFLOWER	FAC	No	No	No
Mimulus suksdorfii	SUKSDORF'S MONKEY-FLOWER	FAC-	No	No	No

PLANT LIST

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Mimulus tilingii	TILINGS MONKEYFLOWER	OBL	No	No	No
Mimulus tricolor	TRICOLOR MONKEYFLOWER	OBL	No	No	No
Mimulus washingtonensis	WASHINGTON MONKEYFLOWER	OBL	No	No	No
Minuartia obtusiloba	TWINFLOWER SANDWORT	FACU-	No	No	No
Minuartia rubella	REDDISH SANDWORT	FACU-	No	No	No
Mirabilis nuctaginea	HEARTLEAF FOUR-O-CLOCK	UPL	No	No	No
Mitella breweri	BREWER'S MITREWORT	FACW+	No	No	No
Mitella diversifolia	ANGLE-LEAVED MITREWORT	FAC+	No	No	No
Mitella nuda	NAKED MITERWORT	FACW	No	No	No
Mitella ovalis	COASTAL MITREWORT	OBL	No	No	No
Mitella pentandra	FIVE-STEMMED MITERWORT	FACW+	No	No	No
Mitella stauropetala	SMALL-FLOWER MITERWORT	FAC	No	No	No
Moehringia lateriflora	BLUNTLEAF MOEHRINGIA	FAC	No	No	No
Mollugo verticillata	CARPETWEED	FAC,DRA	No	No	No
Monarda fistulosa	WILD BERGAMOT	FACU	No	No	No
Monardella odoratissima	PACIFIC MONARDELLA	FACU-	No	No	No
Monolepis nuttalliana	NUTTALL MONOLEPIS	FAC-	No	No	No
Monotropa uniflora	INDIAN PIPE	FACU	No	No	No
Montia chamissoi	CHAMISSO MINERSLETTUCE	OBL	No	No	No
Montia dichotoma	DWARF MONTIA	FAC	No	No	No
Montia fontana	WATER MINERSLETTUCE	OBL	No	No	No
Montia hallii	HALL'S MONTIA	OBL	No	No	No
Montia howellii	HOWELL'S MONTIA	FACW-	No	No	No
Montia lamprosperma	BLINKS	OBL	No	No	No
Montia parvifolia	LITTLELEAF MINERSLETTUCE	FACW-	No	No	No
Muhlenbergia andina	FOXTAIL MUHLY	FAC+	No	No	No
Muhlenbergia asperifolia	SCRATCHGRASS	FACW,DR	No	No	Yes
Muhlenbergia filiformis	PULLUP MUHLY	FACW	No	No	No
Muhlenbergia glomerata	BRISTLY MUHLY	FACW	No	No	No
Muhlenbergia mexicana	MEXICAN MUHLY	FAC	No	No	No
Muhlenbergia minutissima	ANNUAL MUHLY	FAC,DRA	No	No	No
Muhlenbergia montana	MOUNTAIN MUHLY	UPL	No	No	No
Muhlenbergia racemosa	MARSH MUHLY	FAC	No	No	No
Muhlenbergia richardsonis	MAT MUHLY	FACW	No	No	No
Myosotis alpestris	ALPINE FORGETMENOT	FAC-	No	No	No
Myosotis arvensis	FIELD SCORPION-GRASS	FAC	No	No	No
Myosotis discolor	YELLOW AND BLUE SCORPION GRASS	FACW	No	No	No
Myosotis laxa	SMALLER FORGET-ME-NOT	OBL	No	No	No
Myosotis macrosperma	WHITE FORGET-ME-NOT	FAC	No	No	No
Myosotis scorpioides	TRUE FORGET-ME-NOT	FACW	No	No	No
Myosotis sylvatica	GARDEN FORGET-ME-NOT	FAC	No	No	No
Myosotis verna	SPRING FORGET-ME-NOT	FAC-	No	No	No
Myosurus aristatus	SEDGE MOUSE-TAIL	OBL,DRA	No	No	No
Myosurus minimus	TINY MOUSE-TAIL	OBL,DRA	No	No	No
Myrica californica	PACIFIC WAXMYRTLE	FACW	No	No	No
Myrica gale	SWEETGALE	OBL	No	No	Yes
Myriophyllum brasiliense	PARROT'S FEATHER	OBL	No	No	No
Myriophyllum elatinoides	ANDEAN WATERMILFOIL	OBL	No	No	No

PLANT LIST

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Myriophyllum hippuroides	WESTERN WATERMILFOIL	OBL	No	No	No
Myriophyllum spicatum	EURASIAN WATERMILFOIL	OBL	No	Yes	Yes
Myriophyllum verticillatum	WHORLED WATERMILFOIL	OBL	No	No	No
Najas flexilis	SLENDER NAIAD	OBL	No	No	No
Najas guadalupensis	SOUTHERN NAIAD	OBL	No	No	No
Narthecium californicum	CALIFORNIA BOG-ASPHODEL	OBL	No	No	No
Nasturtium officinale	WATER CRESS	OBL	No	No	Yes
Navarretia intertexta	NEEDLE-LEAVED NAVARRETIA	FACW	No	No	No
Navarretia leucocephala	WHITE HEAD GILIA	OBL	No	No	No
Navarretia minima	SMALL NAVARRETIA	FAC	No	No	No
Navarretia propinqua	GREAT BASIN NAVARRETIA	FAC	No	No	No
Nemophila pedunculata	MEADOW NEMOPHILA	FAC	No	No	No
Nepeta cataria	CATNIP	FAC	No	No	No
Nicotiana attenuata	CAYOTE TOBACCO	FACU	No	No	No
Nicotiana begelovii	INDIAN TOBACCO	FACU	No	No	No
Nitrophila occidentalis	BORAX WEED	FACW	No	No	No
Nuphar polysepalum (=luteum)	SPATTERDOCK	OBL	No	Yes	Yes
Nymphaea odorata	WHITE WATERLILY	OBL	No	Yes	Yes
Nymphaea tetragona	PIGMY WATERLILY	OBL	No	No	No
Oenanthe sarmentosa	WATER-PARSLEY	OBL	No	Yes	Yes
Oenothera biennis	COMMON EVENING PRIMROSE	FACU,DR	No	No	No
Oenothera elata	HOOKER EVENING PRIMROSE	FACW-	No	No	No
Oenothera flava	YELLOW EVENING PRIMROSE	FAC+	No	No	No
Oenothera villosa	EVENING PRIMROSE	FAC+	No	No	No
Ophioglossum vulgatum	ADDER'S-TONGUE	FACW	No	No	No
Oplopanax horridus	DEVIL'S-CLUB	FAC	No	No	No
Orobanche uniflora	ONE-FLOWERED BROOMRAPE	FACU	No	No	No
Orthocarpus campestris	FIELD ORTHOCARPUS	FACU	No	No	No
Orthocarpus castillejoides	JOHNNYNIP	FACW+	No	Yes	Yes
Orthocarpus hispidus	BRISTLE OWLCLOVER	FACU-	No	No	No
Orthocarpus luteus	YELLOW OWLCLOVER	FACU-	No	No	No
Oryzopsis hymenoides	INDIAN RICEGRASS	UPL	No	No	No
Osmorhiza longistylis	ANISE-ROOT	FACU	No	No	No
Osmorhiza purpurea	PURPLE SWEET CICELY	FAC+	No	No	No
Oxalis corniculata	LADY'S SORREL	FACU	No	No	No
Oxalis trillifolia	TRILLIUM-LEAVED WOOD-SORREL	FAC	No	No	No
Oxyposis fendleri	FENDLER COWBANE	FACW	No	No	No
Oxyposis occidentalis	WESTERN COWBANE OXYPOLIS	OBL	No	No	No
Oxyria digyna	ALPINE MOUNTAIN SORREL	FACU-	No	No	No
Oxytropis deflexa	HANGPOD CRAZYWEED	FACU	No	No	No
Oxytropis lambertii	LAMBERT CRAZYWEED	UPL	No	No	No
Oxytropis parryi	PARRY CRAZYWEED	FACU	No	No	No
Panicum capillare	WITCHGRASS	FAC	No	No	Yes
Panicum dichotomiflorum	FALL PANICUM	FACW	No	No	No
Panicum occidentale	PACIFIC PANICUM	FACW	No	No	Yes
Panicum virgatum	SWITCHGRASS	FAC+	No	No	No
Papaver lapponicum	ARTIC POPPY	UPL	No	No	No
Parapholis incurva	SICKLEGRASS	FACW	No	No	No

PLANT LIST

SCIENTIFIC NAME	COMMON NAME	INDICATOR	COLLECTED	WPPNW	SHORT LIST
Parentucellia viscosa	YELLOW PARENTUCELLIA	FAC-	No	No	No
Parietaria pensylvanica	PENNSYLVANIA PELLITORY	FACU	No	No	No
Parnassia fimbriata	FRINGED GRASS-OF-PARNASSUS	OBL	No	No	No
Parnassia kotzebuei	KOTZEBUE'S GRASS-OF-PARNASSUS	OBL	No	No	No
Parnassia palustris	NORTHERN GRASS-OF-PARNASSUA	OBL	No	No	No
Parnassia parviflora	SMALL-FLOWER PARNASSIA	OBL	No	No	No
Paspalum distichum	KNOTGRASS	FACW,DR	No	No	No
Pedicularis attolens	LITTLE ELEPHANTS HEAD	OBL	No	No	No
Pedicularis contorta	COILED LOUSEWORT	FACU+	No	No	No
Pedicularis crenulata	MEADOW LOUSEWORT	FACW	No	No	No
Pedicularis groenlandica	ELEPHANT'S HEAD	OBL	No	No	Yes
Pedicularis parryi	PARRY LOUSEWORT	FACU	No	No	No
Peltiphyllum peltatum	UMBRELLA SALIFRAGE	OBL	No	No	No
Penstemon attenuatus	SULFUR PENSTEMON	FAC	No	No	No
Penstemon globosus	GLOBE PENSTEMON	FAC+	No	No	No
Penstemon gracilis	SLENDER PENSTEMON	UPL	No	No	No
Penstemon lyallii	LYALL PENSTEMON	FACU	No	No	No
Penstemon rydbergii	RYDBERG PENSTEMON	FACU	No	No	No
Penstemon serrulatus	CASCADE PENSTEMON	FACW	No	No	No
Penstemon whippleanus	WHIPPLE PENSTEMON	FACU-	No	No	No
Perideridia gairdneri	YAMPA	FACU	No	No	No
Perideridia parishii	PARISH'S YAMPAH	FAC	No	No	No
Petasites frigidus	ARCTIC SWEET COLTSFOOT	FACW	No	No	No
Petasites palmatus	SWEET COLTSFOOT	FAC	No	No	No
Petasites sagittatus	ARROW-LEAF SWEET COLTSFOOT	FACW+	No	No	No
Phacelia heterophylla	VARILEAF PHACELIA	FACU	No	No	No
Phacelia procera	TALL PHACELIA	FAC+	No	No	No
Phalaris aquatica	HARDING GRASS	FACW+	No	No	No
Phalaris arundinacea	REED CANARYGRASS	FACW.	No	Yes	Yes
Phalaris californica	CALIFORNIA CANARYGRASS	FAC	No	No	No
Phalaris canariensis	COMMON CANARY GRASS	FACU	No	No	No
Phalaris caroliniana	CAROLINA CANARY GRASS	FACW	No	No	No
Phalaris tuberosa	HARDING GRASS	FACU	No	No	No
Phippsia algida	COMMON ICEGRASS	FACW+	No	No	No
Phleum alpinum	ALPINE TIMOTHY	FAC	No	No	No
Phleum pratense	TIMOTHY	FACU	Yes	No	No
Phragmites communis (=australis)	COMMON REED	FACW+	Yes	No	Yes
Phyllodoce empetriformis	PINK MOUNTAIN HEATHER	FAC	No	No	No
Phyllodoce glanduliflora	YELLOW MOUNTAIN HEATHER	FAC	No	No	No
Phyllospadix scouleri	SCOULER SURFGRASS	OBL	No	No	No
Phyllospadix torreyi	TORREY SURFGRASS	OBL	No	No	No
Physocarpus capitatus	PACIFIC NINEBARK	FAC+	No	Yes	Yes
Physocarpus monogynus	MOUNTAIN NINEBARK	UPL	No	No	No
Physostegia parviflora	PURPLE DRAGON-HEAD	FACW	No	No	No
Picea engelmannii	ENGELMANN SPRUCE	FAC	No	No	No
Picea pungens	BLUE SPRUCE	FAC-	No	No	No
Picea sitchensis	SITKA SPRUCE	FAC	No	Yes	Yes

PLANT LIST

SCIENTIFIC NAME	COMMON NAME	INDICATOR	COLLECTED	WPPNW	SHORT LIST
Pilularia americana	AMERICAN PILLWORT	OBL	No	No	No
Pinguicula macroceras	CALIFORNIA BUTTERWORT	OBL	No	No	No
Pinguicula vulgaris	COMMON BUTTERWORT	OBL	No	No	No
Pinus contorta	LODGEPOLE PINE	FAC-	No	No	No
Pinus monticola	WESTERN WHITE PINE	FACU	No	No	No
Pinus ponderosa	PONDEROSA PINE	FACU-	No	No	No
Piperia unalascensis	ALASKA ORCHID	FAC	No	No	No
Plagiobothrys bracteatus	BRACTED ALLOCARYA	FACW*	No	No	No
Plagiobothrys figuratus	FRAGRANT ALLOCARYA	FACW	No	No	No
Plagiobothrys greenei	GREENE'S ALLOCARYA	FACW	No	No	No
Plagiobothrys hirtus	ROUGH ALLOCARYA	OBL	No	No	No
Plagiobothrys leptocladus	SLENDER BRANCHED POPCORN-FLOWER	FACW	No	No	No
Plagiobothrys mollis	SOFT POPCORN-FLOWER	FACW	No	No	No
Plagiobothrys nothofulvus	REDSTAIN POPCORNFLOWER	FAC,DRA	No	No	No
Plagiobothrys salsus	SALTY ALLOCARYA	FACW	No	No	No
Plagiobothrys scouleri	SCOULER POPCORNFLOWER	FACW	No	No	No
Plagiobothrys stipitatus	SLENDER POPCORN-FLOWER	FACW	No	No	No
Plagiobothrys tenellus	SLENDER POPCORN-FLOWER	FAC,DRA	No	No	No
Plantago bigelovii	ANNUAL COAST PLANTAIN	OBL	No	No	No
Plantago coronopus	CROWFOOT PLANTAIN	FACW	No	No	No
Plantago elongata	SLENDER PLANTAIN	FACW	No	No	No
Plantago eriopoda	REDWOOL PLANTAIN	FACW	No	No	No
Plantago hirtella	MEXICAN PLANTAIN	FACW	No	No	No
Plantago lanceolata	ENGLISH PLANTAIN	FACU+	Yes	No	No
Plantago macrocarpa	ALASKA PLANTAIN	OBL	No	No	No
Plantago major	COMMON PLANTAIN	FAC+	No	No	No
Plantago maritima	SEASIDE PLANTAIN	FACW+	No	Yes	Yes
Plantago patagonica	WOOLLY PLANTAIN	UPL	No	No	No
Plantago pusilla	DWARF PLANTAIN	FACU+	No	No	No
Plantago virginica	PALE-SEED PLANTAIN	FACU	No	No	No
Platanthera X clavellata	GREEN REIN-ORCHID	OBL	No	No	No
Platanthera chorisiana	CHORIS BOG-ORCHID	OBL	No	No	No
Platanthera dilatata	TALL LEAFY WHITE ORCHARD	FACW+	No	No	No
Platanthera hyperborea	NORTHERN GREEN ORCHID	FACW+	No	No	No
Platanthera obtusata	BLUNT LEAF ORCHID	FACW	No	No	No
Platanthera orbiculata	ROUND-LEAVED ORCHID	FACW	No	No	No
Platanthera sparsiflora	SPARSELY-FLOWERED BOG-ORCHID	FACW	No	No	No
Platanthera stricta	SLENDER BOG-ORCHID	FACW	No	No	No
Plectritis ciliosa	LONG-SPURRED PLECTRITIS	FACU	No	No	No
Plectritis congesta	PINK PLECTRITIS	FACU	No	No	No
Plectritis macrocera	LONG-HORN PLECTRITIS	FACU-	No	No	No
Pleuropogon oregonus	OREGON SEMAPHORE GRASS	OBL	No	No	No
Pleuropogon refractus	NODDING SEMAPHOREGRASS	OBL	No	No	No
Poa alpina	ALPINE BLUEGRASS	FAC	No	No	No
Poa ampla	BIG BLUEGRASS	FACU	No	No	Nop
Poa annua	ANNUAL BLUEGRASS	FAC-	No	No	No
Poa arctica	ARCTIC BLUEGRASS	FACU	No	No	No

ANT LIST

SCIENTIFIC NAME	COMMON NAME	INDICATOR	COLLECTED	WPPNW	SHORT LIST
Poa arida	PLAINS BLUEGRASS	FACU+	No	No	No
Poa compressa	CANADA BLUEGRASS	FACU	No	No	No
Poa curta	WASATCH BLUEGRASS	FACU-	No	No	No
Poa douglasii	DOUGLAS BLUEGRASS	FACU-	No	No	No
Poa fendlerana	MUTTON GRASS	UPL	No	No	No
Poa glaucifolia	SWALLEN BLUEGRASS	FAC	No	No	No
Poa gracillima	SLENDER BLUEGRASS	FACU-	No	No	No
Poa juncifolia	ALKALI BLUEGRASS	FACU+	No	No	No
Poa leibergii	LIEBERG BLUEGRASS	FACU	No	No	No
Poa leptocoma	NODDING BLUEGRASS	FACW+	Yes	No	No
Poa marcida	WITHERED BLUEGRASS	FACW	No	No	No
Poa nemoralis	INLAND BLUEGRASS	FAC	No	No	No
Poa nervosa	WHEELER BLUEGRASS	FACU-	No	No	No
Poa nevadensis	NEVADA BLUEGRASS	FACU-	No	No	No
Poa palustris	FOWL BLUEGRASS	FAC	No	No	No
Poa pattersonii	PATTERSON BLUEGRASS	FACU	No	No	No
Poa pratensis	KENTUCKY BLUEGRASS	FACU+	No	No	No
Poa stenantha	NORTHERN BLUEGRASS	FACU	No	No	No
Poa trivialis	ROUGH BLUEGRASS	FACW-	Yes	No	No
Poa unilateralis	SAN FRANCISCO BLUEGRASS	FACU-	No	No	No
Podagrostis aequivalis	ALASKA BENT	OBL	No	No	No
Podagrostis humilis	ALPINE BENTGRASS	FACW	No	No	No
Podagrostis thurberana	THURBER BENTGRASS	FACW	No	No	No
Polanisia dodecandra	ROUGHSEED CLAMMYWEED	FACU-	No	No	No
Polemonium foliosissimum	LEAFY POLEMONIUM	FAC-	No	No	No
Polemonium occidentale	WESTERN POLEMONIUM	FACW	No	No	No
Polygala verticillata	WHORLED MUGWORT	FACU-	No	No	No
Polygonum achoreum	LEATHERY KNOTWEED	FACU	No	No	No
Polygonum amphibium	WATER SMARTWEED	OBL	No	No	No
Polygonum aviculare	PROSTRATE KNOTWEED	FACW-	No	No	No
Polygonum bistortoides	AMERICAN BISTORT	FACW+	No	No	No
Polygonum confertiflorum	DENSE-FLOWERED KNOTWEED	FACW+,D	No	No	No
Polygonum convolvulus	BLACK BINDWEED	FACU-	No	No	No
Polygonum douglasii	DOUGLAS KNOTWEED	FACU	No	No	No
Polygonum erectum	ERECT KNOTWEED	FACU-	No	No	No
Polygonum fowleri	FOWLERS KNOTWEED	FACW	No	No	No
Polygonum hydropiper	WATER PEPPER	OBL	No	No	No
Polygonum hydropiperoides	MILD WATER PEPPER	OBL	Yes	No	No
Polygonum kelloggii	KELLOGG KNOTWEED	FAC	No	No	No
Polygonum lapathifolium	WILLOW-WEED	FACW+	No	No	No
Polygonum minimum	BROADLEAF KNOTWEED	FACU+	No	No	No
Polygonum parryi	PARRY'S KNOTWEED	FAC	No	No	No
Polygonum pennsylvanicum	PICKLEWEED	FACW,DR	No	No	No
Polygonum persicaria	LADY'S THUMB	FACW,DR	No	No	No
Polygonum phytolaccifolium	POKE KNOTWEED	FAC-	No	No	No
Polygonum polygaloides	POLYGALA KNOTWEED	FACW-	No	No	No
Polygonum polystachyum	CULTIVATED KNOTWEED	FAC	No	No	No
Polygonum punctatum	DOTTED SMARTWEED	OBL	No	No	No

PLANT LIST

SCIENTIFIC NAME	COMMON NAME	INDICATOR	COLLECTED	WPPNW	SHORT LIST
Polygonum ramosissimum	BUSHY NOTWEED	FAC-	No	No	No
Polygonum vivaparum	VIVI PAROUS KNOTWEED	FAC	No	No	No
Polypogon interruptus	DITCH POLYPOGON	FACW	No	No	No
Polypogon monspeliensis	RABBITFOOT GRASS	FACW+	No	No	Yes
Polystichum lonchitis	HOLLY-FERN	FACU	No	No	No
Populus X acuminata	LANCELEAF COTTONWOOD	FAC	No	No	No
Populus angustifolia	NARROW-LEAF COTTONWOOD	FACW	No	No	Yes
Populus deltoides	EASTERN COTTONWOOD	FAC	No	No	No
Populus tremula	QUAKING ASPEN	FAC+	No	No	Yes
Populus trichocarpa (=balsamifera)	BLACK COTTONWOOD BALSAM POPLAR	FAC	No	No	Yes
Porterella carnosula	PORTERELLA	OBL	No	No	No
Portulaca oleracea	PURSLANE	FAC	No	No	No
Potamogeton alpinus	ALPINE PONDWEED	OBL	No	No	No
Potamogeton amplifolius	LARGELEAF PONDWEED	OBL	No	No	No
Potamogeton crispus	CURLY PONDWEED	OBL	No	No	No
Potamogeton diversifolius	WATERTHREAD PONDWEED	OBL	No	No	No
Potamogeton epihydrus	RIBBONLEAF PONDWEED	OBL	No	No	No
Potamogeton filiformis	FINELEAF PONDWEED	OBL	No	No	No
Potamogeton foliosus	LEAFY PONDWEED	OBL	No	No	No
Potamogeton friesii	FRIES PONDWEED	OBL	No	No	No
Potamogeton gramineus	VARIABLELEAF PONDWEED	OBL	No	No	No
Potamogeton illinoensis	ILLINOIS PONDWEED	OBL	No	No	No
Potamogeton latifolius	BROADLEAF PONDWEED	OBL	No	No	No
Potamogeton natans	FLOATING-LEAF PONDWEED	OBL	No	No	No
Potamogeton nodosus	LONG-LEAF PONDWEED	OBL	No	No	No
Potamogeton obtusifolius	BLUNT-LEAF PONDWEED	OBL	No	No	No
Potamogeton pectinatus	SAGO PONDWEED	OBL	No	No	No
Potamogeton praelongus	WHITE STEM PONDWEED	OBL	No	No	No
Potamogeton pusillus	BABY PONDWEED	OBL	No	No	No
Potamogeton richardsonii	RICHARDSON PONDWEED	OBL	No	No	No
Potamogeton robbinsii	ROBBINS PONDWEED	OBL	No	No	No
Potamogeton strictifolius	NARROW-LEAF PONDWEED	OBL	No	No	No
Potamogeton vaginatus	SHEATHED PONDWEED	OBL	No	No	No
Potamogeton zosteriformis	FLATSTEM PONDWEED	OBL	No	No	No
Potentilla anserina	SILVERWEED	OBL	No	No	No
Potentilla argentea	SILVERY CINQUEFOIL	FAC-	No	No	No
Potentilla arguta	TALL CINQUEFOIL	FACU	No	No	No
Potentilla biennis	BIENNIAL CINQUEFOIL	FACW	No	No	No
Potentilla diversifolia	VARILEAF CINQUEFOIL	FACU	No	No	No
Potentilla drummondii	DRUMMOND CINQUEFOIL	FAC	No	No	No
Potentilla flabellifolia	FANSHAPED CINQUEFOIL	FAC?	No	No	No
Potentilla fruticosa	SHRUBBY CINQUEFOIL	FAC-	No	No	No
Potentilla glandulosa	GLAND CONQUEFOIL	FAC-	No	No	No
Potentilla gracilis	NORTHWEST CINQUEFOIL	FAC	No	No	No
Potentilla millegrana	DIFFUSE CINQUEFOIL	FAC+	No	No	No
Potentilla newberryi	NEWBERRY CINQUEFOIL	OBL,DRA	No	No	No
Potentilla norvegica	NORWEGIAN CINQUEFOIL	FAC	No	No	No

PLANT LIST

SCIENTIFIC NAME	COMMON NAME	INDICATOR	COLLECTED	WPPNW	SHORT LIST
Potentilla pacifica (=anserina)	SILVERWEED	OBL	Yes	Yes	Yes
Potentilla palustris	MARSH CINQUEFOIL	OBL,DRA	No	No	Yes
Potentilla paradoxa	BUSHY CINQUEFOIL	FACW	No	No	No
Potentilla plattensis	PLATTE CINQUEFOIL	FACW	No	No	No
Potentilla rivalis	BROOK CINQUEFOIL	FACW	No	No	No
Prenanthes racemosa	GLAUCOUS WHITE-LETTUCE	FAC	No	No	No
Primula cusickiana	CUSICK PRIMROSE	FAC	No	No	No
Primula incana	AMERICAN PRIMROSE	OBL	No	No	No
Primula parryi	PARRY PRIMROSE	FAC	No	No	No
Proboscidea louisianica	UNICORN PLANT	FACU-	No	No	No
Prunella vulgaris	HEAL-ALL	FACU+	No	No	No
Prunus americana	WILD PLUM	FACU	No	No	No
Prunus pensylvanica	FIRE CHERRY	FAC-	No	No	No
Prunus virginiana	COMMON CHOKECHERRY	FACU	No	No	No
Psilocarphus brevissimus	ROUND WOOLY-HEAD	FACW+	No	No	No
Psilocarphus elatior	TALL WOOLLY-HEADS	FACW	No	No	No
Psilocarphus oregonus	OREGON WOOLLY-HEADS	FACW	No	No	No
Psilocarphus tenellus	SLENDER WOOLY-HEAD	FACW	No	No	No
Pteridium aquilinum	BRACKENFERNF	FACU	No	No	No
Puccinellia airoides	NUTTALL ALKALI GRASS	OBL	No	No	No
Puccinellia distans	WEEPING ALKALIGRASS	OBL	No	No	No
Puccinellia erecta	SPIKE MANNAGRASS	OBL	No	No	No
Puccinellia fernaldii	LOW MANNAGRASS	OBL	No	No	No
Puccinellia grandis	LARGE ALKALI GRASS	OBL	No	No	No
Puccinellia langeana	SWARK ALKALI GRASS	OBL	No	No	No
Puccinellia lemmonii	LEMMON ALKALIGRASS	FAC	No	No	No
Puccinellia lucida	SHINING ALKALI GRASS	OBL	No	No	No
Puccinellia maritima	SEASHORE ALKALIGRASS	OBL	No	No	No
Puccinellia nutkaensis	NOOTKA ALKALIGRASS	OBL	No	No	No
Puccinellia nuttalliana	NUTTALL'S ALKALI GRASS	OBL	No	No	No
Puccinellia pauciflora	WEAK MANNAGRASS	OBL	No	No	No
Puccinellia pumila	ARCTIC ALKALIGRASS	FACW+	No	No	No
Pyrola asarifolia	PINK PYROLA	FACU	No	No	No
Pyrola chlorantha	GREENISH-FLOWERED WINTERGREEN	FAC	No	No	No
Pyrola minor	LESSER WINTERGREEN	FACU+	No	No	No
Pyrola secunda	ONE-SIDED WINTERGREEN	FACU	No	No	No
Pyrola uliginosa	BOG WINTERGREEN	FACW-	No	No	No
Pyrola uniflora	ONE-FLOWERED WINTERGREEN	FACU	No	No	No
Ranunculus abortivus	SUBALPINE BUTTERCUP	FACW-	No	No	No
Ranunculus acriformis	SHARP BUTTERCUP	FACW-	No	No	No
Ranunculus acris	TALL BUTTERCUP	FACW-	No	No	No
Ranunculus adoneus	ALPINE BUTTERCUP	FACW	No	No	No
Ranunculus alismifolius	DWARF BUTTERCUP	FACW	No	No	No
Ranunculus aquatilis	WATER BUTTERCUP	OBL,DRA	No	No	Yes
Ranunculus arvensis	CORN BUTTERCUP	UPL	No	No	No
Ranunculus californicus	CALIFORNIA BUTTERCUP	FAC	No	No	No
Ranunculus cardiophyllus	HEARTLEAF BUTTERCUP	FACW	No	No	No

PLANT LIST

SCIENTIFIC NAME	COMMON NAME	INDICATOR	COLLECTED	WPPNW	SHORT LIST
Ranunculus cooleyae	COOLEY BUTTERCUP	FACW	No	No	No
Ranunculus cymbalaria	SEASIDE CROWFOOT	OBL	No	No	No
Ranunculus eschscholtzii	ESCHSCHOLZ BUTTERCUP	FACW	No	No	No
Ranunculus flabellaris	YELLOW WATER BUTTER-CUP	OBL	No	No	No
Ranunculus flammula	SPEARWORT BUTTERCUP	FACW	No	No	No
Ranunculus gelidus	GRAY'S BUTTERCUP	UPL	No	No	No
Ranunculus glabberrimus	SAGEBRUSH BUTTERCUP	FAC	No	No	No
Ranunculus gmelinii	SMALL YELLOW WATER BUTTER-CUP	FACW	No	No	No
Ranunculus gormanii	GORMAN'S BUTTERCUP	FACW+	No	No	No
Ranunculus hyperboreus	ARTIC BUTTERCUP	OBL	No	No	No
Ranunculus inamoenus	PLEASANT BUTTERCUP	FACW	No	No	No
Ranunculus jovis	UTAH BUTTERCUP	FAC+	No	No	No
Ranunculus lobbii	LOBB BUTTERCUP	OBL	No	No	No
Ranunculus longirostris	LONG-BEAK WATER BUTTER-CUP	OBL	No	No	No
Ranunculus macounii	MACOUN'S BUTTERCUP	OBL	No	No	No
Ranunculus muricatus	ROUGHSEED BUTTERCUP	FACW	No	No	No
Ranunculus natans	NODDING BUTTERCUP	OBL	No	No	No
Ranunculus nivalis	SNOW BUTTERCUP	FACW	No	No	No
Ranunculus occidentalis	WESTERN BUTTERCUP	FACW	No	No	No
Ranunculus orthorhynchus	STRAIGHTBEAK BUTTERCUP	FACW-	No	No	No
Ranunculus pedatifidus	SUREFOOT BUTTERCUP	FAC	No	No	No
Ranunculus pensylvanicus	PENNSYLVANIA BUTTERCUP	FACW	No	No	No
Ranunculus populago	POPULAR BUTTERCUP	FACW	No	No	No
Ranunculus pygmaeus	DWARF BUTTERCUP	FAC+	No	No	No
Ranunculus repens	CREEPING BUTTERCUP	FACW	Yes	No	No
Ranunculus sceleratus	CELERYLEAF BUTTERCUP	OBL	No	No	No
Ranunculus subrigidus	POND BUTTERCUP	OBL	No	No	No
Ranunculus trichophyllus	WHITE WATER-CROWFOOT	OBL	No	No	No
Ranunculus uncinatus	HOOKED BUTTERCUP	FAC	No	No	No
Ranunculus verecundus	WETSLOPE BUTTERCUP	FACW-	No	No	No
Rhamnus alnifolia	ALDER-LEAVED BUCKTHORN	FACU	No	No	No
Rhinanthus crista-galli	CRISTA RHINANTHUS	FACU+	No	No	No
Rhododendron albiflorum	CASCADES AZALEA	FAC	No	No	No
Rhododendron occidentale	WESTERN RHODODENDRONI	FAC	No	No	No
Rhynchospora alba	WHITE BEAKED RUSH	OBL	No	No	No
Rhynchospora capitellata	BROWNISH BEAKED-RUSH	OBL	No	No	No
Ribes americanum	BLACK CURRANT	FAC	No	No	No
Ribes aureum	GOLDEN CURRANT	FAC+	No	No	No
Ribes bracteosum	STINK CURRANT	FAC	No	No	No
Ribes hudsonianum	HUDSON BAY CURRANT	OBL	No	No	No
Ribes inerme	WHITE STEM CURRANT	FAC	No	No	No
Ribes klamathense	KLAMATH GOOSEBERRY	FAC+	No	No	No
Ribes lacustre	PRICKLY CURRANT	FAC+	No	No	No
Ribes triste	AMERICAN RED CURRANT	FAC	No	No	No
Robinia pseudoacacia	BLACK LOCUST	FACU-	No	No	No
Romanzoffia californica	CALIFORNIA MISTMAIDEN	FAC	No	No	No
Romanzoffia sitchensis	SITKA MISTMAIDEN	FACW-	No	No	No
Rorippa calycina	PERSISTENT-SEPAL YELLOW-CRESS	FACW	No	No	No

PLANT LIST

SCIENTIFIC NAME	COMMON NAME	INDICATOR	COLLECTED	WPPNW	SHORT LIST
Rorippa columbiae	COLUMBIA YELLOW-CRESS	OBL	No	No	No
Rorippa curvipes	ROCKY MOUNTAIN YELLOW-CRESS	FACW	No	No	No
Rorippa curvisiliqua	WESTERN YELLOW-CRESS	FACW+,D	No	No	No
Rorippa palustris	BOG YELLOW-CRESS	OBL	No	No	No
Rorippa sinuata	SPREADING YELLOW CRESS	FAC+	No	No	No
Rorippa sphaerocarpa	ROUND-FRUITED CRESS	FAC+	No	No	No
Rorippa sylvestris	CREEPING YELLOW-CRESS	OBL	No	No	No
Rorippa teres	MARSH YELLOW-CRESS	FACW	No	No	No
Rosa acicularis	PRICKLY ROSE	FACU	No	No	No
Rosa pisocarpa	PEARFRUIT ROSE	FACU	No	No	No
Rosa woodsii	WOODS ROSE	FACU	No	No	No
Rotala romosior	TOOTH-CUP	OBL	No	No	No
Rubus acaulis	ARCTIC RASPBERRY	FAC+	No	No	No
Rubus discolor	HIMALAYAN BLACKBERRY	FACU-	No	No	No
Rubus idaeus	COMMON RED RASPBERRY	FACU	No	No	No
Rubus laciniatus	EVERGREEN BLACKBERRY	FACU+	No	No	No
Rubus occidentalis	BLACK RASPBERRY	FAC-	No	No	No
Rubus parviflorus	THIMBLEBERRY	FACU+	No	No	No
Rubus pedatus	STRAWBERRYLEAF RASPBERRY	FAC-	No	No	No
Rubus pubescens	DWARFED BLACKBERRY	FAC	No	No	No
Rubus spectabilis	SALMONBERRY	FAC	No	No	Yes
Rubus strigosus	RED RASPBERRY	FACU	No	No	No
Rudbeckia californica	CALIFORNIA CONEFLOWER	FACU+	No	No	No
Rudbeckia hirta	BLACK-EYED SUSAN	FACU	No	No	No
Rudbeckia laciniata	TALL CONEFLOWER	FAC	No	No	No
Rudbeckia occidentalis	WESTERN CONEFLOWER	FAC-	No	No	No
Rumex acetosella	SHEEP SORREL	FACU	Yes	No	No
Rumex conglomeratus	CLUSTERED DOCK	FACW	No	No	No
Rumex crispus	CURLED DOCK	FACW	No	Yes	No
Rumex densiflorus	DENSE-FLOWERED DOCK	FACW	No	No	No
Rumex fueginus	SEA-SIDE DOCK	FACW+	No	No	No
Rumex lacustris	DOCK	OBL	No	No	No
Rumex maritimus	GOLDEN DOCK	FACW+	No	No	No
Rumex mexicanus	MEXICAN DOCK	FAC	No	No	No
Rumex obtusifolius	BITTER DOCK	FAC	No	No	No
Rumex occidentalis	WESTERN DOCK	FACW+	No	No	No
Rumex paucifolius	FEW-LEAVED DOCK	FAC-	No	No	No
Rumex pulcher	FIDDLE DOCK	FAC-	No	No	No
Rumex salicifolius	WILLOW DOCK	FACW	No	No	No
Rumex stenophyllus	NARROW-LEAVED DOCK	FACW-	No	No	No
Rumex triangulivalvis	WILLOW-LEAVED DOCK	FAC	No	No	No
Rumex venosus	VEINY DOCK	FACU+	No	No	No
Ruppia cirrhosa	DITCH GRASS	OBL	No	No	No
Ruppia maritima	WIDGEON GRASS	OBL	No	No	Yes
Sagina decumbens	TRAILING PEARLWORT	FACU+	No	No	No
Sagina maxima	BEACH PEARLWORT	FAC-	No	No	No
Sagina procumbens	PROCUMBERT PEARLWORT	FAC	No	No	No
Sagina saginoides	ARCTIC PEARLWORT	FACW-	No	No	No

PLANT LIST

SCIENTIFIC NAME	COMMON NAME	INDICATOR	COLLECTED	WPPNW	SHORT LIST
Sagittaria cuneata	NORTHERN ARROWHEAD	OBL	No	No	No
Sagittaria latifolia	BROADLEAF ARROWHEAD	OBL	No	No	No
Sagittaria subulata	AWLLEAF ARROWHEAD	OBL	No	No	No
Salicornia europaea	SLENDER GLASSWORT	OBL	No	No	No
Salicornia perennis	WOODY GLASSWORT	OBL	No	No	No
Salicornia rubra	ROCKY MOUNTAIN GLASSWORT	OBL,DRA	No	No	No
Salicornia virginica	VIRGINIA GLASSWORT	OBL	Yes	Yes	Yes
Salix alba	WHITE WILLOW	FACW	No	No	No
Salix amygdaloides	PEACHLEAF WILLOW	FACW	No	No	No
Salix arctica	ALPINE WILLOW	FACW-	No	No	No
Salix babylonica	WEEPING WILLOW	FAC+	No	No	No
Salix barclayi	BARCLAY WILLOW	FACW	No	No	No
Salix barrattiana	BARRATT WILLOW	FACW	No	No	No
Salix bebbiana	BEEB WILLOW	FACW	No	No	No
Salix boothii	WILLOW	OBL	No	No	No
Salix brachycarpa	BARRENGROUND WILLOW	FACW+	No	No	No
Salix candida	HOARY WILLOW	OBL	No	No	No
Salix commutata	UNDERGREEN WILLOW	OBL	No	No	No
Salix discolor	PUSSY WILLOW	FACW	No	No	No
Salix drummondiana	DRUMMOND WILLOW	FACW	No	No	No
Salix eastwoodiae	MOUNTAIN WILLOW	FACW	No	No	No
Salix exigua	SANDBAR WILLOW	OBL,DRA	No	No	No
Salix farriae	FARR WILLOW	OBL,DRA	No	No	No
Salix fluviatilis	RIVER WILLOW	OBL	No	No	No
Salix geyerana	GEYER WILLOW	FACW+	No	No	No
Salix glauca	GRAYLEAF WILLOW	FACW	No	No	No
Salix hookerana	HOOKER WILLOW	FACW-	No	No	No
Salix lasiandra	PACIFIC WILLOW	FACW+	No	No	No
Salix lasiolepis	ARROYO WILLOW	FACW	No	No	No
Salix lemmonii	LEMMONS WILLOW	FACW+	No	No	No
Salix lutea	YELLOW WILLOW	OBL	No	No	No
Salix melanopsis	DUSKY WILLOW	FACW	No	No	No
Salix monochroma	ONE-COLORED WILLOW	FACW-	No	No	No
Salix monticola	SERVICEBERRY WILLOW	OBL	No	No	No
Salix myrtillifolia	BLUEBERRY WILLOW	FACW+	No	No	No
Salix pedicellaris	BIG WILLOW	OBL	No	No	No
Salix piperi	PIPER WILLOW	FACW	No	No	No
Salix planifolia	MONO WILLOW	OBL	No	No	No
Salix pseudomonticola	PARK WILLOW	FACW	No	No	No
Salix reticulata	NETLEAF WILLOW	FACU	No	No	No
Salix rigida	ERECT WILLOW	OBL	No	No	No
Salix scoulerana	SCOULER WILLOW	FAC	No	No	No
Salix sessilifolia	NORTHWEST WILLOW	FACW	No	No	No
Salix sitchensis	SITKA WILLOW	FACW	No	No	No
Salix tracyi	TRACY WILLOW	FACW	No	No	No
Salix tweedyi	TWEEDY WILLOW	FACW+	No	No	No
Salix vestita	ROCK WILLOW	FAC	No	No	No
Salix wolfii	WOLF WILLOW	FACW+	No	No	No

PLANT LIST

SCIENTIFIC NAME	COMMON NAME	INDICATOR	COLLECTED	WPPNW	SHORT LIST
Salsola kali	RUSSIAN THISTLE	FACU,DR	No	No	No
Salsola pestifer	RUSSIAN THISTLE	FACU,DR	No	No	No
Sambucus canadensis	AMERICAN ELDER	UPL	No	No	No
Sambucus cerulea	BLUE ELDERBERRY	FAC-	No	No	No
Sambucus melanocarpa	BLACK BEAD ELDER	FACU	No	No	No
Sambucus racemosa	EUROPEAN RED ELDER	FACU	Yes	No	No
Sanguisorba canadensis	AMERICAN BURNET	FACW	No	No	No
Sanguisorba menziesii	MENZIES BURNET	OBL	No	No	No
Sanguisorba minor	SMALL BURNET	UPL	No	No	No
Sanguisorba officinalis	GREAT BURNET	FACW+	No	No	Yes
Saponaria officinalis	BOUNCING BET	UPL	No	No	No
Sarcobatus vermiculatus	GREASEWOOD	FACU+	No	No	No
Saxifraga adscendens	ROCK SAXIFRAGE	FAC	No	No	No
Saxifraga aizoides	YELLOW MOUNTAIN SAXIFRAGE	FACW	No	No	No
Saxifraga aprica	SIERRA SALIFRAG	FAC	No	No	No
Saxifraga arguta	BROOK SAXIFRAGE	FACW+	No	No	No
Saxifraga bronchialis	YELLOWDOT SAXIFRAGE	FACU-	No	No	No
Saxifraga cernua	NODDING SAXIFRAGE	FACW-	No	No	No
Saxifraga cespitosa	TUFTED SAXIFRAGE	FAC	No	No	No
Saxifraga chrysantha	GOLDBLOOM SAXIFRAGE	FACU	No	No	No
Saxifraga debilis	PIGMY SAXIFRAGE	FACW-	No	No	No
Saxifraga ferruginea	RUSTYHAIR SAXIFRAGE	FAC	No	No	No
Saxifraga hallii	SAXIFRAGE	FACW	No	No	No
Saxifraga howellii	HOWELL'S SAXIFRAGE	FAC+	No	No	No
Saxifraga integrifolia	COLUMBIAN SAXIFRAGE	FACW	No	No	No
Saxifraga lyallii	LYALL SAXIFRAGE	FACW	No	No	No
Saxifraga marshallii	MARSHALL SAXIFRAGE	FACW	No	No	No
Saxifraga mertensiana	MERTENS SAXIFRAGE	FACW	No	No	No
Saxifraga nidifica	PEAK SAXIFRAGE	FACW	No	No	No
Saxifraga nuttallii	NUTTALL'S SAXIFRAGE	OBL	No	No	No
Saxifraga occidentalis	WESTERN SAXIFRAGE	FAC	No	No	No
Saxifraga oppositifolia	TWINLEAF SAXIFRAGE	FACU-	No	No	No
Saxifraga oregana	OREGON SAXIFRAGE	FACW+	No	No	No
Saxifraga punctata	DOTTED SAXIFRAGE	FAC+	No	No	No
Saxifraga rhomboidea	DIAMONDLEAF SAXIFRAGE	FAC	No	No	No
Saxifraga rivularis	ALPINE BROOK SAXIFRAGE	FAC+	No	No	No
Scheuchzeria palustris	POD-GRASS	OBL	No	No	No
Schizachne purpurascens	FALSE MELIC	UPL	No	No	No
Schizachyrium scopartium	BROOM BEARDGRASS	FACU,DR	No	No	No
Schoenolirion album	WHITE FLOWERED SCHOENOLIRION	OBL	No	No	No
Schoenolirion bracteosum	BRACTED SCHOENOLIRION	OBL	No	No	No
Scirpus acutus	HARDSTEM BULRUSH	OBL	Yes	Yes	No
Scirpus americanus	OLNEY'S BULRUSH	OBL	No	Yes	No
Scirpus atrocinctus	BLACKSCALE BULRUSH	OBL	No	No	No
Scirpus atrovirens	GREEN BULRUSH	OBL	No	No	No
Scirpus cernuus	LOW BULRUSH	OBL	No	No	No
Scirpus cespitosus	TUFTED BULRUSH	OBL	No	No	No
Scirpus congdonii	CONGDON'S BULRUSH	FACW	No	No	No

PLANT LIST

SCIENTIFIC NAME	COMMON NAME	INDICATOR	COLLECTED	WPPNW	SHORT LIST
Scirpus fluviatilis	RIVER BULRUSH	OBL	No	No	No
Scirpus heterochaetus	SLENDER BULRUSH	OBL	No	No	No
Scirpus maritimus (=robustus)	ALKAI BULRUSH	OBL	Yes	Yes	No
Scirpus microcarpus	PANICLED BULRUSH	OBL	No	Yes	No
Scirpus nevadensis	NEVADA BULRUSH	OBL	No	No	No
Scirpus pallidus	CLOAKED BULRUSH	OBL	No	No	No
Scirpus pungens	THREE-SQUARE	OBL	No	No	No
Scirpus rollandii	ROLLAND'S BULRUSH	FACW	No	No	No
Scirpus subterminalis	SUBTERMINATE BULRUSH	OBL	No	No	No
Scirpus triqueter	BULRUSH	OBL	No	No	No
Scirpus validus	SOFTSTEM BULRUSH	OBL	No	No	No
Scleranthus annuus	KNAWEL	UPL	No	No	No
Sclerolinum digynum	NORTHWESTERN YELLOW FLAX	FAC	No	No	No
Scolochloa festucacea	SPRANGLED-TOP	OBL	No	No	No
Scrophularia californica	CALIFORNIA FIGWORT	FACW-	No	No	No
Scrophularia lanceolata	LANCELEAF FIGWORT	FAC	No	No	No
Scutellaria galericulata	COMMON SKULLCAP	OBL	No	No	No
Scutellaria lateriflora	BLUE SKULLCAP	FACW+	No	No	No
Sedum rhodanthum	REDTOP STONECROP	FACW	No	No	No
Sedum rosea	ROSEROOT STONECROP	FACU	No	No	No
Selaginella selaginoides	CLUB SPIKEMOSS	FACW+	No	No	No
Senecio crassulus	THICKLEAF GROUNDSEL	FACU	No	No	No
Senecio cymbalarioides	CLEFT-LEAF GROUNDSEL	FACW+	No	No	No
Senecio debilis	WEAK BUTTERWEED	FACW	No	No	No
Senecio eremophilus	DESERT GROUNDSEL	FACU	No	No	No
Senecio foetidus	SWEET-MARSH BUTTERWEED	FACW-	No	No	No
Senecio hydrophilus	WATER GROUNDSEL	OBL	No	No	No
Senecio indecorus	ELEGANT GROUNDSEL	FACW	No	No	No
Senecio integerrimus	LAMBSTONGUE GROUNDSEL	FAC	No	No	No]
Senecio lugens	BLACK-TIPPED GROUNDSEL	FAC	No	No	No
Senecio maccunii	PUGET BETTERWEED	FACU	No	No	No
Senecio pauciflorus	PAYLESS ALPINE BUTTERWEED	FAC	No	No	No
Senecio pauperculus	BALSAM GROUNDSEL	FACW	No	No	No
Senecio pseudaureus	GOLDEN GROUNDSEL	FACW	No	No	No
Senecio serra	BUTTERWEED GROUNDSEL	FAC	No	No	No
Senecio sphaerocephalus	MOUNTAIN-MARSH BUTTERWEED	FACW	No	No	No
Senecio streptanthifolius	CUTLEAF GROUNDSEL	FACU	No	No	No
Senecio triangularis	ARROW-LEAF GROUNDSEL	FACW+	No	No	No
Senecio vulgaris	COMMON GROUNDSEL	FACU	No	No	No
Senecio werneriifolius	HOARY GROUNDSEL	UPL	No	No	No
Setaria glauca	YELLOW FOXTAIL	FAC	No	No	No
Setaria verticillata	BUR BRISTLEGRASS	FACU	No	No	No
Sidalcea candida	WHITE CHECKERMALLOW	FACW	No	No	No
Sidalcea hendersonii	HENDERSON CHECKMALLOW	FACW+	No	No	Yes
Sidalcea neomexicana	NEW MEXICO CHECKERMALLOW	FACW	No	No	No
Sidalcea oregana	OREGON CHECKERMALLOW	FACW-	No	No	No
Silene acaulis	MOSS CAMPION	UPL	No	No	No
Silene menziesii	MENZIES SILENE	FAC	No	No	No

PLANT LIST

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Silene uralensis	HODDING CAMPION	FACW-	No	No	No
Sisymbrium altissimum	TUMBLEMUSTARD	FACU-	No	No	No
Sisyrinchium angustifolium	SHOUT BLUE-EYED GRASS	FACW-	No	No	No
Sisyrinchium bellum	WESTERN BLUE-EYED GRASS	FACW-	No	No	No
Sisyrinchium californicum	GOLDEN BLUE-EYED GRASS	FACW+	No	No	Yes
Sisyrinchium douglasii	PRUPLE-EYED GRASS	FACU	No	No	No
Sisyrinchium idahoense	IDAHO BLUE-EYED GRASS	FACW	No	No	No
Sisyrinchium sarmentosum	SARMENTOS BLUE-EYED GRASS	OBL	No	No	No
Sisyrinchium septentrionale	SUKSDORF'S BLUE-EYED GRASS	FACW+	No	No	No
Sitanion hystrix	BOTTLEBRUSH SQUIRRELTAIL	FACU-	No	No	No
Sium suave	WATERPARSNIP	OBL	No	No	Yes
Smilacina racemosa	FALSE SPIKENARD	FAC-	No	No	No
Smilacina stellata	STAR-FLOWERED SOLOMON SEAL	FAC-	No	No	No
Solanum americanum	NIGHTSHADE	FACU-	No	No	No
Solanum carolinense	CAROLINA NIGHTSHADE	UPL	No	No	No
Solanum douglasii	DOUGLAS NIGHTSHADE	FACU	No	No	No
Solanum dulcamara	BITTERSWEET NIGHTSHADE	FAC	No	No	Yes
Solanum nigrum	BLACK NIGHTSHADE	FACU	No	No	No
Solidago altissima	TALL GOLDENROD	FACU+	No	No	No
Solidago canadensis	CANADA GOLDENROD	FACU	No	No	No
Solidago elongata	CREEK GOLDENROD	FAC-	No	No	No
Solidago gigantea	LATE GOLDENROD	FACW-	No	No	No
Solidago multiradiata	MOUNTAIN GOLDENROD	FACU	No	No	No
Solidago rigida	STIFF GOLDENROD	FACU	No	No	No
Solidago spathulata	COAST GOLDENROD	FACU	No	No	No
Solidago spectabilis	NEVADA GOLDENROD	FACW	No	No	No
Sonchus arvensis	FIELD SOWTHISTLE	FACU+	No	No	No
Sonchus asper	PRICKLY SOWTHISTLE	FAC-	No	No	No
Sonchus oleraceus	COMMON SOW THISTLE	UPL	No	No	No
Sorghum halepense	JOHNSON GRASS	FACU	No	No	No
Sparganium androcladum	BRANCHING BURREED	OBL	No	No	No
Sparganium chlorocarpum	GREENFRUIT BURREED	OBL	No	No	No
Sparganium emersum	NARROW-LEAVED BURREED	OBL	No	No	No
Sparganium eurycarpum	GIANT BURREED	OBL	No	No	No
Sparganium fluctuans	FLOATING BURREED	OBL	No	No	No
Sparganium minimum	SMALL BURREED	OBL	No	No	No
Spartina X townsendii	TOWNSEND CORDGRASS	OBL	No	No	No
Spartina alterniflora	SMOOTH CORDGRASS	OBL	No	Yes	No
Spartina gracilis	ALKALI CORDGRASS	FACW	No	No	No
Spartina pectinata	PRAIRIE CORDGRASS	OBL	No	No	No
Spergularia canadensis	NORTHERN SAND SPURRY	FACW	No	No	Yes
Spergularia diandra	ALKALI SAND SPURRY	FACW	No	No	No
Spergularia macrotheca	BEACH SAND SPURRY	FAC	No	No	No
Spergularia marina	SALTMARSH SAND SPURRY	OBL,DRA	No	Yes	No
Spergularia media	MIDDLE-SIZED SAND SPURRY	FAC	No	No	No
Spergularia rubra	RED SANDSPURRY	FAC-	No	No	No
Sphaeromeria potentilloides	CINQUEFOIL TANSY	FAC-	No	No	No
Sphaeromeria salsula	SALT GLOBEPEA	UPL	No	No	No

PLANT LIST

SCIENTIFIC NAME	COMMON NAME	INDICATOR	COLLECTED	WPPNW	SHORT LIST
Sphenopholis obtusata	PRAIRIE WEDGEGRASS	FAC	No	No	No
Sphenoscialdium capitellatum	SWAMP WHITE HEADS	FACW	No	No	No
Spiraea douglasii	DOUGLAS SPIRAEA	FACW	Yes	Yes	Yes
Spiranthes romanzoffiana	HOODED LADIES TRESSES	OBL	No	No	Yes
Spirodela polyrhiza	BIG DUCKWEED	OBL	No	No	No
Sporobolus airoides	ALKALI SACATON	FAC-	No	No	No
Sporobolus asper	TALL DROPSEED	UPL	No	No	No
Sporobolus cryptandrus	SAND DROPSEED	FACU,DR	No	No	No
Sporobolus microspermus	SIXWEEKS DROPSEED	FAC-	No	No	No
Sporobolus neglectus	PUFFSHEATH DROPSEED	UPL	No	No	No
Stachys ciliata	OREGON BETONY	FACW	No	No	No
Stachys emersonii	EMERSON'S HEDGE NETTLE	FACW	No	No	No
Stachys palustris	WOUNDWORT	FACW+	No	No	Yes
Stachys rigida	RIGID HEDGE NETTLE	FACW-	No	No	No
Stellaria alsine	DOG STARWORT	FACW	No	No	No
Stellaria calycantha	NORTHERN STITCHWORT	FACW+	No	No	No
Stellaria crassifolia	FLESHY STITCHWORT	FACW	No	No	No
Stellaria crispa	CRISPED STARWORT	FAC+	No	No	No
Stellaria graminea	COMMON STITCHWORT	FAC-	No	No	No
Stellaria humifusa	LOW CHICKWEED	OBL	No	No	Yes
Stellaria longifolia	LONG-LEAFED STITCHWORT	FACW	No	No	No
Stellaria longipes	LONG-STALK STARWORT	FACW-	No	No	No
Stellaria media	CHICKWEED STARWORT	UPL	No	No	No
Stellaria monantha	ONE-FLOWER STARWORT	FAC	No	No	No
Stellaria obtusa	BLUNT STARWORT	FACW	No	No	No
Stellaria simcoei	WASHINGTON STARWORT	FACW-	No	No	No
Stellaria sitchana	MANY-FLOWER STARWORT	FACW-	No	No	No
Stellaria umbellata	UMBELLATE STITCHWORT	FAC+	No	No	No
Stenanthium occidentale	WESTERN STENANTHIUM	FACW	No	No	No
Streptopus amplexifolius	LIVERBERRY	FAC-	No	No	No
Suaeda depressa	PURSH SEEPWEED	FACW-	No	No	No
Suaeda intermedia	ALKALI SEEPWEED	FAC	No	No	No
Suaeda maritima	SEA SEEPWEED	FACW+	No	No	No
Suaeda nigra	BLACK SEEPWEED	FACW,DR	No	No	No
Suaeda occidentalis	WESTERN SEEPWEED	FACW	No	No	No
Suaeda torreyana	TORREY SEEPWEED	FAC	No	No	No
Subularia aquatica	WATER AWLWORT	OBL	No	No	Yes
Suckleya suckleyana	POISON SUCKLEYA	FACW,DR	No	No	No
Suksdorfia ranunculifolia	BUTTERCUP SUKSDORFIA	FAC	No	No	No
Suksdorfia violacea	VIOLET SUKSDORFIA	FAC	No	No	No
Swertia perennis	ALPINEBOG SWERTIA FELWORT	FACW	No	No	No
Swertia radiata	DEER EARS	UPL	No	No	No
Symphoricarpos albus	SNOWBERRY	FACU	No	No	No
Symphoricarpos oreophilus	MOUNTAIN SNOWBERRY	UPL	No	No	No
Tamarix chinensis	CHINESE TAMARISK	FACW	No	No	No
Tamarix gallica	FRENCH TAMARISK	FACW	No	No	No
Tamarix ramosissima	TAMARISK	FACW	No	No	No
Taraxacum officinale	DANDELION	FACU	No	No	No

PLANT LIST

SCIENTIFIC NAME	COMMON NAME	INDICATOR	COLLECTED	WPPNW	SHORT LIST
Tauschia stricklandii	STRICKLAND'S LOMATIUM	FAC?	No	No	No
Tauschia tenuissima	LEIBERG'S LOMATIUM	FAC+	No	No	No
Taxus brevifolia	PACIFIC YEW	FACU-	No	No	No
Teucrium canadense	AMERICAN GERMANDER	FAC+	No	No	No
Thalictrum alpinum	ALPINE MEADOWRUE	FACW-	No	No	No
Thalictrum dasycarpum	PURPLE MEADOWRUE	FACW	No	No	No
Thalictrum fendleri	FENDLER MEADOWRUE	FAC	No	No	No
Thalictrum occidentale	WESTERN MEADOWRUE	FACU	No	No	No
Thalictrum sparsiflorum	FEW-FLOWER MEADOWRUE	FAC	No	No	No
Thelypodium integrifolium	ENTIRE-LEAVED THELYPODY	FACW	No	No	No
Thelypteris nevadensis	SIERRA WOOD-FERN	FACU+	No	No	No
Thermopsis rhombifolia	PRAIRIE THERMOPSIS	FACU	No	No	No
Thuja plicata	WESTERN REDCEDAR	FAC	No	No	Yes
Tiarella trifoliata	THREELEAF FOAMFLOWER	FAC-	No	No	No
Tofieldia glutinosa	GLUTIN TOFIELDIA	OBL	No	No	Yes
Tolmiea menziesii	YOUTH-ON-AGE	FAC	No	No	No
Toxicodendron quercifolia	POISON OAK	FACU	No	No	No
Toxicodendron radicans	POISON-IVY	FACU	No	No	No
Toxicodendron rydbergii	RYDBERG'S POISON IVY	FACW-	No	No	No
Tradescantia occidentalis	PRAIRIE SPIDER-WORT	FACW	No	No	No+
Trautvetteria carolinensis	CAROLINA BUABANE	FAC	No	No	No
Trientalis arctica	ARCTIC STARFLOWER	OBL	No	No	Yes
Trientalis latifolia	BROADLEAF STARFLOWER	FAC-	No	No	No
Trifolium beckwithii	BECKWITH CLOVER	FAC	No	No	No
Trifolium cyathiferum	CUP CLOVER	FAC	No	No	No
Trifolium dasyphyllum	WHIPROOT CLOVER	UPL	No	No	No
Trifolium douglasii	DOUGLAS CLOVER	FACW	No	No	No
Trifolium dubium	DUCKLING CLOVER	UPL	No	No	No
Trifolium eriocephalum	WOOLYHEAD CLOVER	FAC-	No	No	No
Trifolium fragiferum	STRAWBERRY CLOVER	FACU	No	No	No
Trifolium fucatum	SOUR CLOVER	FACU+	No	No	No
Trifolium haydenii	HAYDEN CLOVER	FAC-	No	No	No
Trifolium howellii	BIGLEAF CLOVER	FACW-	No	No	No
Trifolium hybridum	ALSIKE CLOVER	FACU+	No	No	No
Trifolium kingii	KINGS CLOVER	FAC-	No	No	No
Trifolium longipes	LONG-STALK CLOVER	FAC-	No	No	No
Trifolium macrocephalum	BIGHEAD CLOVER	FACU-	No	No	No
Trifolium microcephalum	LITTLEHEAD CLOVER	FAC	No	No	No
Trifolium nanum	DWARF CLOVER	UPL	No	No	No
Trifolium obtusiflorum	CLAMMY CLOVER	FAC	No	No	No
Trifolium parryi	PARRY CLOVER	FAC	No	No	No
Trifolium pratense	RED CLOVER	FACU	No	No	No
Trifolium repens	WHITE CLOVER	FACU+	No	No	No
Trifolium resupinatum	PERSIAN CLOVER	UPL	No	No	No
Trifolium variegatum	WHITE TIP CLOVER	FAC+	No	No	No
Trifolium wormskioldii	COW CLOVER	FACW+	No	Yes	Yes
Triglochin concinnum	UTAH ARROWGRASS	OBL	No	No	No
Triglochin maritimum	SEASIDE ARROWGRASS	OBL	Yes	Yes	Yes

PLANT LIST

SCIENTIFIC NAME	COMMON NAME	INDICATOR	COLLECTED	WPPNW	SHORT LIST
Triglochin palustre	MARSH ARROWGRASS	OBL	No	No	No
Triglochin striatum	RIDGED ARROWGRASS	OBL	No	No	No
Triodanis perfoliata	VENIS LOOKING-GLASS	UPL	No	No	No
Trisetum cernuum	NODDING TRISETUM	FACU	No	No	No
Trisetum spicatum	SPIKE TRISETUM	FACU-	No	No	No
Trisetum wolfii	WOLF TRISETUM	FACU-	No	No	No
Triteleia hyacinthina	HYACINTH BRODIAEA	FACU	No	No	No
Trollius laxus	AMERICAN GLOBEFLOWER	OBL	No	No	No
Tsuga heterophylla	WESTERN HEMLOCK	FACU-	No	No	No
Tsuga mertensiana	MOUNTAIN HEMLOCK	FACU	No	No	No
Tussilago farfara	COMMON COLTSFOOT	FACU	No	No	No
Typha angustifolia	NARROW-LEAVED CATTAIL	OBL	No	Yes	No
Typha domingensis	SOUTHERN CATTAIL	OBL	No	No	No
Typha latifolia	COMMON CATTAIL	OBL	No	Yes	Yes
Umbellularia californica	CALIFORNIA -LAUREL	FAC-	No	No	No
Urtica dioca	STINGING NETTLE	FAC+	No	No	No
Utricularia gibba	HUMPED BLADDERWORT	OBL	No	No	No
Utricularia intermedia	FLAT-LEAVED BLADDERWORT	OBL	No	No	No
Utricularia macrorhiza	COMMON BLADDERWORT	OBL	No	No	No
Utricularia minor	LESSER BLADDERWORT	OBL	No	No	No
Vaccinium cespitosum	DWARF BILBERRY	FACU	No	No	No
Vaccinium macrocarpum	LARGE CRANBERRY	OBL	No	No	No
Vaccinium membranaceum	MOUNTAIN HUCKLEBERRY	FACU+	No	No	No
Vaccinium myrtilloides	CANADA BLUEBERRY	FACU	No	No	No
Vaccinium occidentale	WESTERN HUCKLEBERRY	FAC+	No	No	No
Vaccinium ovalifolium	EARLY BLUEBERRY	UPL	No	No	No
Vaccinium oxycoccos	SMALL CRANBERRY	OBL	No	No	No
Vaccinium scoparium	GROUSEBERRY	FACU-	No	No	No
Vaccinium uliginosum	BOG BILBERRY	FACW+	No	No	No
Vahlodea atropurpurea	MOUNTAIN HAIRGRASS	FACW-	No	No	No
Valeriana dioica	MARSH VALERIAN	FACW	No	No	No
Valeriana edulis	EDIBLE VALERIAN	FAC	No	No	No
Valeriana occidentalis	WESTERN VALERIAN	FAC	No	No	No
Valeriana scouleri	SCOULER VALERIAN	FAC	No	No	No
Valeriana sitchensis	SITKA VALERIAN	FAC	No	No	No
Vallisneria americana	WILD CELERY	OBL	No	No	No
Veratrum californicum	SKUNK-CABBAGE	FACW+	No	No	No
Veratrum caudatum	LAILED FALSE HELLEBORE	OBL	No	No	No
Veratrum viride	INDIAN POKE	OBL	No	No	No
Verbasoum blattaria	NUTH MULLEIN	UPL	No	No	No
Verbena bracteata	PROSTRATE VERBENA	FACU+ D	No	No	No
Verbena hastata	BLUE VERBENA	FAC+	No	No	No
Verbena lasiostachys	WESTERN VERBENA	FAC-	No	No	No
Veronica americana	AMERICAN BROCKLINE	OBL	Yes	No	No
Veronica anagallis-aquatica	WATER SPEEDWELL	OBL	No	No	No
Veronica catenata	PINK WATER SPEEDWELL	OBL	No	No	No
Veronica cusickii	CUSICK SPEEDWELL	FACW	No	No	No
Veronica officinalis	COMMON SPEEDWELL	UPL	No	No	No

PLANT LIST

SCIENTIFIC NAME	COMMON NAME	INDICATOR	COLLECTED	WPPNW	SHORT LIST
Veronica peregrina	PURSLANE SPEEDWELL	OBL,DRA	No	No	No
Veronica scutellata	MARSH SPEEDWELL	OBL	No	No	No
Veronica serpyllifolia	THYME-LEAF SPEEDWELL	FAC	No	No	No
Veronica wormskjoldii	ALPINE SPEEDWELL	FAC+	No	No	No
Viburnum edule	SQUASHBERRY	FACW	No	No	No
Viburnum trilobum	HIGHBUSH CRANBERRY	FAC+	No	No	No
Vicia sativa	COMMON VETCH	UPL	No	No	No
Viola adunca	HOOKEDSPUR VIOLET	FAC	No	No	No
Viola bellidifolia	DAISYLEAF VOILET	FACW	No	No	No
Viola bicolor	FIELD PANSY	FAC	No	No	No
Viola cascadensis	CASCADE VIOLET	FACU	No	No	No
Viola glabella	STREAM VIOLET	FACW+	No	No	No
Viola hallii	HALL'S VIOLET	FAC	No	No	No
Viola lanceolata	LANCE LEAVE VIOLET	OBL	No	No	No
Viola langsdorffii	ALASKA VIOLET	FACW	No	No	No
Viola macloskeyi	SMALL WHITE VIOLET	OBL	No	No	No
Viola nephrophylla	NORTHERN BOG VIOLET	FACW	No	No	No
Viola pallens	NORTHERN WHITE VIOLET	OBL	No	No	No
Viola palustris	MARSH VIOLET	OBL	No	No	No
Viola renifolia	KIDNEY-LEAVED VIOLET	FACW	No	No	No
Viola septentrionalis	NORTHERN BLUE VIOLET	FACU	No	No	No
Vitis californica	CALIFORNIA WILD GRAPE	FACU	No	No	No
Vitis riparia	RIVERBANK GRAPE	FACU	No	No	No
Vulpia bromoides	BROME	FACU-	No	No	No
Vulpia myuros	RATTAIL FESCUE	FAC,DRA	No	No	No
Vulpia octoflora	SIX-WEEKS FESCUE	UPL	No	No	No
Wolffia columbiana	COLUMBIA WATER-MEAL	OBL	No	No	No
Wolffia punctata	DOTTED WATER-MEAL	OBL	No	No	No
Woodwardia fimbriata	GIANT CHAIN-FERN	FACW	No	No	No
Wyethia angustifolia	NARROW-LEAF WYETHIA	FACU	No	No	No
Wyethia amplexicaulis	MULEEARS WYETHIA	FAC-	No	No	No
Wyethia helianthoides	WHITE HEAD WYETHIA	FACW	No	No	No
Xanthium spinosum	SPINY COCKLEBUR	FACU DR	No	No	No
Xanthium strumarium	COCKLEBUR	FAC DRA	No	No	No
Yabea microcarpa	CALIFORNIA HEDGE PARSLEY	FACU+	No	No	No
Zannichellia palustris	HORNED PONDWEED	OBL	No	No	No
Zigadenus elegans	MOUNTAIN DEATHCAMAS	FAC+	No	No	No
Zigadenus venenosus	DEATHCAMAS	FAC	No	No	No
Zizania aquatica	WILD RICE	OBL	No	No	No
Zizia aptera	HEART-LEAVED ALEXANDERS	FAC+	No	No	No
Zostera marina	EELGRASS	OBL	No	Yes	No
Zostera nana	DWARF EELGRASS	OBL	No	No	No
Zosterella dubia	WATER STARGRASS	OBL	No	No	No

CHANGES TO 02/09/89 PLANT LIST

Additions:

Typha X glauca	BLUE CATTAIL	OBL

Missing Common Names:

Artemisia ludoviciana	WESTERN MUGWORT
Bidens X amplissima	VANCOUVER ISLAND BEGGAR-TICK
Cerastium viscosum	STICKY CHICKWEED
Ipomoea purpurea	COMMON MORNING GLORY

APPENDIX E
ELECTROFISHING PROCEDURE

APPENDIX E

ELECTROFISHING PROCEDURE

SAMPLING PROGRAM DESIGN

The following procedure is consistent with the population estimation method presented by Zippin (1958).

1. It is best to electrofish the entire open water area of the wetland. If its area, depth, or both make full coverage impossible, isolate a portion with block nets. The area of this portion should be sufficient to represent the fish habitats that are present in the wetland and to produce a catch of adequate, but not excessive, numbers. Therefore, the nets may have to be adjusted after a trial electrofishing pass. Block nets may also be necessary to stop fish mobility during electrofishing if the wetland is an open system (e.g., flowing like a stream).
2. Take sufficient measurements with a tape to estimate the surface area of the water to be electrofished.
3. Make a thorough electrofishing pass through the defined area, and place the catch in a holding container or area isolated by netting.
4. After completing the pass, identify all fish to the species level.
5. Optional: Weigh and measure the lengths of the entire catch, or an adequate subset, to obtain the frequency distributions of weight and length.
6. Exclude the fish caught from the defined area while second and third passes are made, either by placing them outside the block nets, if used, or in a holding container or area.
7. Repeat steps 3 to 6 for the second and third passes.

CALCULATIONS

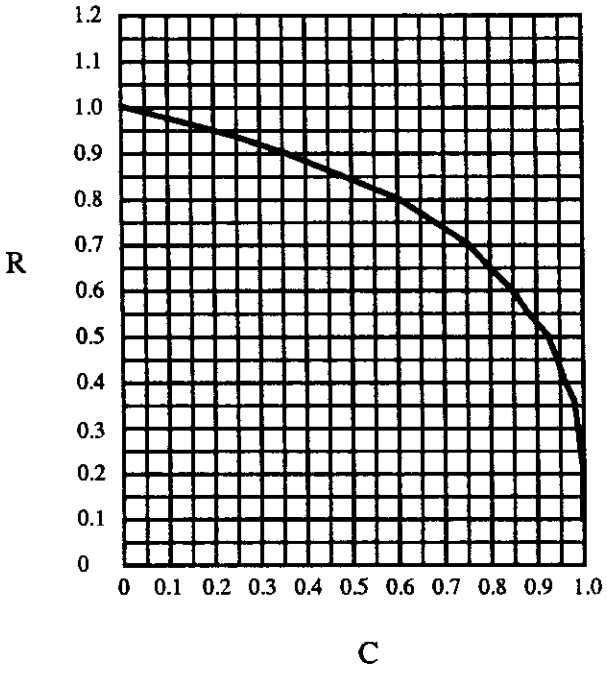
Perform the following calculation for each species (after Zippin 1958).

1. Add the catches from the three passes to get a total (T).

2. Compute a variable, A = (catch from second pass) + 2x (catch from third pass).

3. Compute the ratio, $R = \frac{A}{T}$.

4. Use the graph to find the statistical correction factor (C) for the computed R:



5. Find the estimated population size, $P = \frac{T}{C}$.

6. Optional (if weights and lengths are measured):

   a. Group the data from all the passes to construct frequency distributions of weight and length. To construct these distributions, tabulate the numbers of specimens falling in ranges of weight and length appropriate for the fish populations.

   b. Compute the condition factor (K) for each fish:

$$K = \frac{\text{Weight (in grams)} \times 10^5}{\text{Length}^3 \text{ (in mm}^3\text{)}}$$

   Average for all the specimens of each species.

DATA INTERPRETATION

1. Compare trends in population sizes over time or among wetlands.

2. Optional (if weights and lengths are measured):

   a. Compute the medians of the frequency distributions (see Zar 1984, or another statistical text). Compare trends over time or among wetlands.

   b. Test the significance of differences in mean condition factors over time or among wetlands. The appropriate procedure may be a Student's t-test, if the assumptions of the test are upheld. Otherwise, data may have to logarithmically transformed, or a nonparametric test may have to be performed (again, see Zar 1984, or an alternative reference). Making the proper choice of a test procedure may require the advice of a statistician.

REFERENCES

Zar, J., *Biostatistical Analysis*, 2nd Ed., Prentice-Hall, Englewood Cliffs, NJ, 1984.

Zippin, C., "The Removal Method of Population Estimation," *J. Wildlife Manage.* 22:82-91, 1958.

APPENDIX F
EVALUATION SPECIES FOR WETLAND MONITORING

APPENDIX F

EVALUATION SPECIES FOR WETLAND MONITORING

F.1. BIRDS

Bird species dependent on wetland systems have been identified in Wetland Evaluation Technique (WET) Volume II, Table 9 (Adamus et al. 1987). Those listed include species that are known to depend on wetlands for food and/or cover throughout most of their range in the United States. The WET volume should be consulted for natural history information regarding wetland use by these species. The following list contains those species listed by Adamus et al. (1987) in Table 9 that occur in Washington state, omitting those that are rare or uncommon.

Avocet, American
Dipper
Dowitcher; long-billed and short-billed
Dunlin
Flycatcher, willow
Godwit, marbled
Grebe; pied-billed, horned, and western
Gull; California, herring, Bonaparte's, and ring-billed
Hawk, marsh (now called northern harrier)
Heron; Black-crowned night, great blue, and green-backed
Kingfisher, belted
Knot, red
Loon, common
Oystercatcher, black
Pelican; brown and white
Phalarope; northern and Wilson's
Plover; black-bellied, semi-palmated, and snowy
Rail; sora, yellow and Virginia
Sanderling
Sandpiper; spotted, least, western, and pectoral
Snipe, common
Stilt, black-necked
Surfbird
Swallow; rough-winged and tree
Tattler, wandering
Tern; black, Caspian, common, and Forster's
Turnstone; black and ruddy
Whimbrel
Wren, long-billed
Yellowlegs; greater and lesser

Following is a list of waterfowl present in Washington state that are dependent on wetlands.

Swan; tunda and trumpeter	Canvasback
Brant	Scaup; greater and lesser
Goose; white-fronted, Canada, and snow	Ring-necked duck
Mallard	Goldeneye; common and Barrow's
Gadwall	Bufflehead
Pintail	Oldsquaw
Teal; green-winged, blue-winged, and cinnamon	Harlequin duck
Wigeon; Eurasian and American	Scoter; white-winged, surf, and black
Shoveler, northern	Ruddy duck
Wood duck	Merganser; hooded, common, and red-breasted
Redhead	

F.2 MAMMALS

The most comprehensive review of mammal affinities for the various habitats in Washington state was by Guenther and Kucera (1978). They classified habitat according to general use patterns and noted whether a species was dependent on a particular habitat type, including wetlands. Two lists are provided below: first, a list of species dependent on wetlands or riparian habitats; and second, species that find primary habitat in wetlands or riparian areas.

Wetland Dependent Species	Species that Use Wetlands as Primary Habitat
Beaver	Shrew; Preble, vagrant, Pacific water, and Pacific
Muskrat	Townsend's pocket gopher
Nutria	Northern bog lemming
River otter	Mink

F.3 REPTILES AND AMPHIBIANS

As with mammals, reptiles and amphibians are listed according to Guenther and Kucera (1978): those that are dependent on wetlands and riparian habitats, and those that use these areas as primary habitat.

Wetland-Dependent Species	Species that Use Wetlands as Primary Habitat
Rough-skinned newt	Salamander; Northwest, long-toed, Dunn's, Van Dyke's, and western red-back
Salamander; Pacific giant and Olympic	Ensatina
Frog; tailed, Cascade's, green, bull, leopard, and spotted	Toad; western and Woodhouse's
Great Basin spadefoot	Pacific tree frog
	Turtle; painted and western pond[a]
	Snake; ring-necked, western garter, northwestern garter, and common garter

[a]Guenther and Kucera (1978) listed these species as using wetlands as primary habitat, whereas many other biologists would consider them to be wetland-dependent species.

REFERENCES

Adamus, P.R., E.J. Clairain, Jr., R.D. Smith, and R.E. Young, "Wetland Evaluation Technique (WET), Vol. II: Methodology," Waterways Experiment Station, Corps of Engineers, Vicksburg, MS, 1987.

Guenther, K., and T. Kucera. "Wildlife of the Pacific Northwest," U.S. Forest Service, Pacific Northwest Region, Portland, OR, 1978.