Determining the Ordinary High Water Mark for Shoreline Management Act Compliance in Washington State

October 2016 Final Review
Publication no. 16-06-029

Publication and Contact Information

This report is available on the Department of Ecology's website at
https://fortress.wa.gov/ecy/publications/SummaryPages/1606029.html

For more information contact:

Shorelands and Environmental Assistance Program
P.O. Box 47600
Olympia, WA 98504-7600

Phone: 360-407-6000

Washington State Department of Ecology - www.ecy.wa.gov

- Headquarters, Olympia 360-407-6000
- Northwest Regional Office, Bellevue 425-649-7000
- Southwest Regional Office, Olympia 360-407-6300
- Central Regional Office, Yakima 509-575-2490
- Eastern Regional Office, Spokane 509-329-3400

__Accommodation Requests:__ To request ADA accommodation including materials in a format for the visually impaired, call Ecology at 360-407-6000. Persons with impaired hearing may call Washington Relay Service at 711. Persons with speech disability may call TTY at 877-833-6341.

Determining the Ordinary High Water Mark for Shoreline Management Act Compliance in Washington State

by;

Paul S. Anderson, Susan Meyer, Dr. Patricia Olson, Erik Stockdale

Shorelands and Environmental Assistance Program
Washington State Department of Ecology
Olympia, Washington

Table of Contents

Page

Acknowledgements....3

Executive Summary....4

Chapter 1 - Introduction....8
- 1.1 Importance of Accurate Ordinary High Water Mark Determinations....8
- 1.2 Purpose of the Document....9
- 1.3 Organization of This Document....10
- 1.4 Target Audience for This Document....11

Chapter 2 – Determining the OHWM....12
- 2.1 The Ordinary High Water Mark Defined....12
- 2.2 The Three Criteria of an Ordinary High Water Mark....13
- 2.3 Ordinary High Water Mark Considerations....15
- 2.4 Reasons for Systematically Determining the OHWM....18
- 2.5 How to Determine the OHWM....19
  - 2.5.1 Step 1: Office assessment of landscape and geomorphic features....19
  - 2.5.2 Step 2: Field assessment....19
  - 2.5.3 Step 3: Document findings....20
  - 2.5.4 Step 4: Hydrologic assessment (if needed)....21
- 2.6 Special Circumstances....21

Chapter 3 – Streams....22
- 3.1 Introduction....22
- 3.2 Definining the OHWM....23
  - 3.2.1 Field indicator descriptions....24
  - 3.2.2 Common misunderstandings of stream OHWM....33
  - 3.2.3 Special circumstances....38
- 3.3 Office Assessment....41
- 3.4 Field Assessment....59
- Set up transect(s) from the water's edge to the upland....60
- Identify vegetation and soil indicators along transect starting at water's edge....60

Chapter 4 – Tidal Waters....66
- 4.1 Introduction....66
- 4.2 Defining the Ordinary High Water Mark....67
  - 4.2.1 Field indicators descriptions....76
  - 4.2.2 Common misunderstandings....101
- 4.3 Office Assessment....103
- 3.4 Field Assessment....108

Chapter 5 – Lakes....110
- 5.1 Introduction....110
  - 5.1.1 Origin and patterns of lakes....111
- 5.2 Defining the OHWM....112
  - 5.2.1 Definition of lakes in the SMA....112

5.2.2 Field indicator descriptions 114
5.2.3 Common misunderstandings of lake OHWM 133
5.2.4 Special circumstances and considerations...134
5.3 Office Assessment 138
5.4 Field Assessment 139
5.4.1 General observations 139
5.4.2 Identify lower and upper boundaries of OHWM using transect(s): 140
5.4.3 Field verification of preliminary OHWM determination 140

Chapter 6 – Associated Wetlands and River Deltas 141
6.1 Introduction...141
6.2 Office Assessment 149
6.2.1 Step 1: Assess landscape and geomorphic features.................................150
6.2.2 Step 2: Choose potential locations for field survey.................................151
6.3 Field Assessment 151
6.3.1 Conducting the field assessment 151
6.3.2 Description and rationale for field indicators..152
6.3.3 Proximity indicators 153
6.3.4 Influence indicators 153

Appendices...155
Appendix A: Field data form 156
Appendix B: Plant species distribution across OHWM gradient..............................160
Appendix C: Useful internet links for making OHWM determinations....................177
Streams 177
Tidal Waters 178
Lakes...178
Wetlands 179
Soil..179
Plants 179
Aerial Photographs and Interactive Mapping...180
Appendix D: Geomorphic examples and indicators 182
Appendix E: Example report outline 198
Appendix F: Glossary 199
Appendix G: Comparison of different OHWM definitions in various statutes and rules
....215
Appendix H: References and suggested reading 216

Acknowledgements

The authors of this report would like to thank the following people for their contribution to this study:

- Hugh Shipman;
- Perry Lund;
- Jay Cook;
- Rick Mraz;
- Rebecca Rothwell; and especially
- Amelia Petersen.

Executive Summary

The marine waters, lakes, and streams of Washington are a public treasure vital to the economic, environmental, and aesthetic well-being of the state and its citizens. These shorelines are one of the paramount features of Washington that make this state such an attractive place to visit, live, and conduct business. When the legislature enacted the Shoreline Management Act (SMA) in 1971, they recognized the importance of our shorelines:

> "The legislature finds that the shorelines of the state are among the most valuable and fragile of its natural resources and that there is great concern throughout the state relating to their utilization, protection, restoration, and preservation…" (RCW 90.58.020 Legislative findings — State policy enunciated).

The SMA applies to all streams with a mean annual flow greater than 20 cubic feet per second (cfs); tidal waters; lakes, including reservoirs, greater than 20 acres; river deltas and wetlands associated with these waters, as well as all lands within 200 feet of the ordinary high water mark (OHWM). The SMA OHWM is defined as (RCW 90.58.030(2)(c)):

> "*Ordinary high water mark*" on all lakes, streams, and tidal water is that mark that will be found by examining the bed and banks and ascertaining where the presence and action of waters are so common and usual, and so long continued in all ordinary years, as to mark upon the soil a character distinct from that of the abutting upland, in respect to vegetation as that condition exists on June 1, 1971, as it may naturally change thereafter, or as it may change thereafter in accordance with permits issued by a local government or the department: PROVIDED, that in any area where the ordinary high water mark cannot be found, the ordinary high water mark adjoining salt water shall be the line of mean higher high tide and the ordinary high water mark adjoining fresh water shall be the line of mean high water.

The OHWM is used to identify the minimum shoreland extent regulated under the SMA.

The SMA OHWM is further refined for specific shoreline types in WAC 173-22-030(5) and includes definitions for the OHWM in high and low energy tidal waters: "… the line of vegetation…" and "…landward limit of salt tolerant vegetation…" respectively. The methods and indicators described below derive directly from these statutory definitions and reflect over 30 years of field experience by Ecology staff and other natural resource professionals in looking at the OHWM. Because vegetation plays such a key role in determining the OHWM, particularly in low-relief areas such as floodplains, we recommend that OHWM delineators be at least moderately familiar with the local flora and able to determine a plant's wetland indicator status. In relatively flat areas fringing a shoreline water the transition from wet tolerant (FACULTATIVE and wetter) to wet intolerant can be gradual, and other indicators, such as topographic breaks or substrate changes, may be very subtle. The lower the relief and hydraulic energy, the more important the role of vegetation as a field indicator.

Accurate and defensible OHWM determinations following standardized methods are essential to the fair and consistent regulation of state shorelines. This guidance, relying on decades of field experience, as well as legal decisions related to SMA OHWM determinations, has been developed to provide standardized methods (field and office) and rationale for SMA OHWM determinations. Except in those very rare cases where field indicators cannot be found, OHWM determinations should be based on a site-specific investigation, which relies on field indicators and is briefly described in a write-up that clearly documents the findings and methods used.

Too often, particularly on tidally-influenced waters, SMA OHWM determinations are solely based on readily available data (elevations; gage or tidal data) and not on field indicators, as specified in the SMA and implementing rules (see RCW 90.58.030; WAC 173-22-030 and 173-22-040). The unfortunate result of such an approach is that public resources, including critical habitats, are not protected, and structures may be placed too low on the shoreline, contributing to flooding and erosion that imperils the subject property, as well as neighboring properties, and necessitate the need for additional shoreline stabilization, further exacerbating impacts to the shoreline.

The OHWM is used to establish many legal and regulatory boundaries, such as property ownership. These methods and OHWM definitions are not meant to supersede the standards and methods used by licensed surveyors in determining property boundaries and ownership. The focus of this guidance is compliance with the SMA, and the methods described in this guidance are founded on the standards and goals of the SMA and its implementing rules. These methods are meant to be applied statewide, and this guidance is provided to assist property owners and their representatives, as well as staff in state and local agencies, in understanding the OHWM in relation to the SMA. Uniform application of these methods is essential to the fair and consistent regulation of state shorelines and will help ensure that public resources and private property are protected.

There are three physical criteria within the OHWM definition that apply to all shoreline types: "Presence and action of *waters*… mark upon the *soil*… in respect to *vegetation*… distinct from that of the abutting upland…" The OHWM is the dynamic boundary between the aquatic and terrestrial environments and, in most cases, is not a static elevation. Regular (ordinary) inundation produces visible abiotic (change in topography or substrate) and biotic (change in vegetation) signs on the landscape. In those cases where an OHWM determination is required, this guidance recommends a systematic approach that involves reviewing available information prior to a site visit (office assessment), visiting the site to locate the OHWM based on field indicators (field assessment), and clearly documenting the methods used and results of the investigation. Review of available information (aerial photographs, LiDAR, and gage data) is always recommended prior to a site visit in order to have a clearer understanding of site conditions and to make the visit more efficient.

Of the three principle water types regulated under the SMA, streams (mean annual flow greater than 20 cfs) are perhaps the most variable and, at some sites, challenging in terms of identifying the OHWM. Chapter 3 describes the methods and field indicators to be used in determining a stream OHWM, as well as detailed guidance on how to assess hydrologic data. At complex or contentious sites and where adequate gage data are available, a hydrologic assessment should be done prior to the site visit to help narrow the range of expected OHWM flows and related stages (elevations). For streams, SMA OHWM flows are expected to occur between the 1-year and 2-year events. The most frequently encountered stream OHWM indicators include geomorphic (change in slope, change in substrate, drainage patterns) and biologic (change in vegetation or presence of aquatic species).

Common stream OHWM misunderstandings include: (1) misinterpreting the relationship between bankfull width and OHWM and (2) assuming that mean high water is OHWM. Special circumstances on streams include braided channels and deltas where a stream enters another body of water, such as a lake or tidal waters. On braided channels the OHWM is defined as the outermost channels (WAC 173-22-030(5)(c)). At stream deltas, the OHWM extends upstream to the upper limits of influence from the water body, and a combination of OHWM methods and indicators (e.g., stream and lake) may be needed.

Lakes, defined in the SMA as bodies of standing water at least twenty acres in size, are found throughout the state in a variety of landscapes. Chapter 4 discusses OHWM determinations on lakes. Many of the field indicators described in the streams chapter are also found in lakes. Common misunderstandings in determining lake OHWMs include: (1) assuming that the OHWM is limited to the area of open water and not following the continuous and contiguous water surface elevation to its landward limit within fringing wetlands and, (2) in lakes with a significant groundwater input, not accounting for a seasonal lag time in the highest water levels; high water does not necessarily occur at the wettest time of year. In those rare circumstances on lakes (and streams) where the OHWM cannot be determined from field indicators, the SMA directs that the OHWM shall be the line of mean high water (RCW 90.58.030(2)(c)).

Tidal waters regulated by the SMA in Washington include estuarine/marine (salinities > 0.5 parts per thousand (ppt)) and fresh water (salinities < 0.5 ppt) to the upstream limit of tidal influence. Chapter 5 includes methods and field indicators for determining the OHWM on high and low energy tidal environments. When determining the OHWM on tidal waters the SMA rules define high-energy environments, where vegetation is not established below mean higher high water (MHHW), and low-energy environments, where vegetation is established below MHHW. Where field indicators cannot be found the SMA specifies that on tidal waters the OHWM shall be the MHHW although, as with lakes and streams, sites without discernible indicators are rare. Field experience has shown that, for most sites, tidal inundation eight to 12 times per year is sufficient to leave a mark upon the soil with respect to vegetation. In the central Salish Sea, the OHWM is typically found between 12 and 18 inches above the MHHW elevation. The line of persistent vegetation is the principal OHWM indicator in high-energy environments, while the landward limit of salt-tolerant vegetation (tolerant of interstitial salinities > 0.5 ppt) defines the OHWM in low-energy environments. Frequently seen field indicators in high-energy environments include the line of persistent vegetation (perennial species), topographic breaks on rocky or armored shorelines, the transition from lichens (black lichens; *Hydropunctaria* spp.) that are regularly inundated to lichens that are rarely inundated (orange lichens; *Caloplaca* spp.). For low-energy tidal environments, the salt-tolerant vegetation should also be tolerant of regular soil saturation or inundation, typically FACULTATIVE WETLAND or OBLIGATE species.

On tidal waters common misunderstandings include: (1) assuming that the OHWM is defined by a datum (i.e., MHHW), often without first conducting a field determination, and (2) not following a continuous water surface to its landward limit in low-energy estuarine settings (stream confluence with tidal waters), which may extend well landward of the limit of salt-tolerant vegetation. On tidally-influenced waters where field indicators of the OHWM are not discernible, the SMA states that the MHHW shall be used for the OHWM (RCW 90.58.030(2)(c)).

Associated wetlands (Chapter 6), those wetlands "…in proximity to and either influence or are influenced by…" shoreline waters (WAC 173-22-030(1)), are the last type of shoreline water addressed in this guidance. From a regulatory perspective, any wetlands within 200 feet of the OHWM (or floodway) are considered to be in proximity and within shoreline jurisdiction. For those wetlands, the entire wetland is considered associated even if it extends beyond 200 feet from the OHWM. For wetlands found beyond 200 feet of the OHWM, influence, such as hydraulic continuity, must be documented in order to consider those wetlands associated (WAC 173-22-040). When wetlands abut a shoreline water, the first step in determining regulatory boundaries is to establish the OHWM (a contiguous and continuous water surface), which may extend well into the wetland, and then defining the wetland-upland boundary. We strongly recommend that experienced, qualified professionals do wetland boundary determinations. Ecology staff are available to verify challenging wetland boundary and OHWM determinations.

The following sections provide an overview of the SMA regulatory context for the OHWM; Chapter 1 includes a general discussion of the document's organization. Chapter 2 addresses the importance of accurately locating the OHWM, as well as the general approach to be used for any OHWM determination. Subsequent chapters describe in detail the methods and applicable indicators for each of the four principle shoreline waters: streams (Chapter 3), tidal waters (Chapter 4), lakes (Chapter 5), and associated wetlands (Chapter 6). We recommend that Chapters 1 and 2 are read first, and then read through the entire chapter that is applicable to the water type being evaluated.

Sections for each of the shoreline waters in this guidance follow the same format: a brief introduction, OHWM definition specific to that water type and a regulatory summary, a description of the most commonly seen field indicators, common misunderstandings in interpreting the OHWM, and finally, how to conduct the office and field assessments. For those situations where it is needed the stream and marine waters chapters describe how to do a hydrological assessment, the methods of which would also be applicable to gaged lakes and reservoirs.

Careful documentation of conditions seen during the site visit, including sketches and photographs, is also essential to writing up the findings in a clear and concise report. Chapter 2 includes some general recommendations for documenting your findings. A sample field form is included in Appendix A, and an example outline for an OHWM report is found in Appendix E. Some of the other useful resources in the appendices include a table of plant species distribution across the OHWM gradient (Appendix B), geomorphic examples and indicators (Appendix D), and a glossary (Appendix F), as well as references and a suggested reading list (Appendix H).

Chapter 1 - Introduction

1.1 Importance of Accurate Ordinary High Water Mark Determinations

The state law that governs land use and development along shorelines, one of the policies of the SMA is to foster "reasonable and appropriate uses" and

> "... contemplates protecting against adverse effects to the public health, the land and its vegetation and wildlife, and the waters of the state and their aquatic life…". (RCW 90.58.020)

In terms of protecting shorelines, it states

> " … [the Act] shall be liberally construed to give full effect to the objectives and purposes for which it was enacted." (RCW 90.58.900)

Under the SMA, shoreline waters include streams with a mean annual flow greater than 20 cfs; tidal waters; lakes, including reservoirs, greater than 20 acres; and river deltas and wetlands associated with these waters. This guidance will discuss the methods and rationale for accurately determining the OHWM on each of the three shoreline types (streams, tidal waters, and lakes) and associated wetlands for implementation of the SMA.

The OHWM, as the mark between the aquatic and terrestrial environments, is a critical component of the SMA. Determining the location of the OHWM plays a significant role in achieving the goals and carrying out the policies of the SMA. Documented and legally defensible determinations of the OHWM are of key importance in delineating shoreline jurisdiction under the SMA and in applying its regulations. At a minimum, shoreline jurisdiction extends 200 feet landward of the OHWM. Therefore, all uses and development within shoreline jurisdiction must be consistent with the SMA and with the local comprehensive plans for shorelines, called Shoreline Master Programs.

Developments requiring shoreline permits often must be set back from the shoreline, and these "setbacks" are usually measured from the OHWM. Defensible and documented determinations of the OHWM are also equally pertinent to other state and local rules and regulations. The Washington State Department of Ecology (Ecology) and local governments may require OHWM delineations for shoreline permit approvals. When there is a question as to the location of the OHWM for SMA implementation (and the state Water Pollution Control Act; RCW 90.48), Ecology is the state agency responsible for OHWM verification.

The OHWM provides the starting line for critical land-use decisions that affect state shorelines. An accurate determination is essential to protect against improper and possibly risky development. Poor OHWM determinations can result in damage to public resources, construction of unsafe structures, and life-threatening conditions for people. In some cases, incorrect OHWM determinations have led to the construction of inappropriate bank stabilization projects, resulting in significant cumulative impacts and hazards to downstream, upstream, and across-stream property.

1.2 Purpose of the Document

The purpose of this document is to provide consistent, technically sound, and legally defensible methods for determining the location of the regulatory OHWM on Washington State shorelines. The methods in this document are recommendations for practitioners and those who may need to review OHWM determinations for SMA consistency. These methods provide an orderly course to follow. We based these methods on the collective experiences of people working in the field over many years. Ecology has openly solicited feedback for the past several years as we developed this written record of our field methods. Hearing boards and courts have consistently upheld results based on these methods, supporting the value of a clearly documented OHWM determination.

We recognize that there are many different definitions and purposes (e.g., boundary line surveys) for determining the OHWM. Although the methods and use of field indicators are broadly applicable to many different regulatory situations, the focus of this OHWM guidance is for SMA consistency and compliance.

In reviewing shoreline applications and assisting local governments, Ecology staff either conduct OHWM determinations or review those done by others. Given the number of shoreline decisions made every year in the state and the limited staff resources available at Ecology, it is impractical for Ecology staff to field verify every determination made in the state. It is our hope that this guidance document will assist professionals who conduct OHWM determinations in making repeatable and defensible determinations. Although Ecology staff use these methods, please note that their use is not required by rule. Practitioners can follow other methods so long as they are consistent with the definitions and provisions in the SMA and its implementing rules.

Determining the OHWM is not a precise practice[1]. The definition clearly indicates that an OHWM determination results from the consideration of various geomorphic, biologic, and hydrologic factors, observations, and measurements and may even include an assessment of historical patterns (more discussion on this is in subsequent sections). The OHWM on any particular site is not a static line or elevation and may change over time due to natural events or permitted actions. The level of effort and documentation provided to support a defensible OHWM determination should be proportionate to the risk to the resource, environment, adjacent properties, and infrastructure from the proposed action and the geomorphic complexity of the site.

Project proponents may want to provide detailed documentation when a project may be contentious or controversial. Defensible OHWM delineations require documentation of the method followed and the field indicators used to make a determination. Hearings boards and courts have generally supported well-documented OHWM determinations, based on the SMA.

---

[1] Refer to Thompson versus Ecology, Shorelines Hearings Board decision No. 03-005, Section VII.

This document provides guidance to professionals making regulatory OHWM determinations (and for those reviewing determinations) to define the extent of the shoreline management area under the SMA. The appendices contain a field form and descriptions of stream indicators, which should aid in understanding the evidence viewed at the site. Since documentation of a proposed project's location and impacts is required for permit review by state or local reviewing agencies, we also provide the reporting recommendations for justifying an OHWM determination. The SMA definition requires that the OHWM be based on the physical and biological indicators on the site. Other resources, such as gage data and aerial photographs, can corroborate the field findings but are only tools to help focus the on-site evaluation of indicators. These tools are subsidiary to OHWM indicators for SMA compliance and should not be the sole basis of the determination.

Please note that this document does not amend or change the methods by which licensed surveyors make OHWM or riparian boundary determinations concerning property boundaries and ownerships under state law. *The regulatory OHWM may or may not be related to the OHWM or other property boundaries determined for purposes of land ownership.* As with all property boundaries, the OHWM or other line that defines the extent of aquatic land ownership requires determination by a licensed surveyor. Please consult with a licensed surveyor if you need a property ownership boundary established.

This document is intended to provide helpful guidance for projects that are subject to state regulation. It does not change existing laws or regulations nor does it define what kinds of projects are exempt from permits. Many activities are exempt or allowed under current statutes, e.g., maintenance of existing roads and facilities; these exemptions and allowed uses are not changed by this document. For more information on aquatic regulations, please contact the Governor's Office for Regulatory Innovation and Assistance at www.oria.wa.gov.

1.3 Organization of This Document

This document provides a process for making an OHWM determination at a site for each of the principal shoreline types. We have organized each part to address various aspects of the OHWM, which together will support a defensible determination. The basic approach to determining the OHWM is the same for each of the shoreline types; there may be differences in the use of a particular field indicator or background data reviewed, but the process is the same for all shorelines.

The approach outlined in this document is:

(1) Develop an understanding of site conditions and history.
(2) Complete a field assessment to find key OHWM indicators.
(3) If needed, complete a hydrologic assessment using stream gage data where appropriate data are available. Sometimes, more complex or controversial sites need multiple site visits, including visits during high flows. In more complex cases interdisciplinary cooperation among professionals in hydrology, soils, geomorphology, and plant ecology may be necessary.
(4) Document findings.

This guidance addresses the OHWM methods and indicators for the principal types of shoreline waters found in the state, as well as associated wetlands. Following the introductory chapters that apply to all shorelines, a chapter is devoted to each of the four shoreline types (streams, tidal waters, lakes, and associated wetlands) focusing on the regulatory definitions, office assessments, and methods and rationale for identifying field indicators. *The following chapters are organized as follows:*

Chapter Two discusses the definition and criteria of ordinary high water, and the basic approach to OHWM determinations.

Chapter Three provides guidance on determining the OHWM on streams.

Chapter Four provides guidance on determining the OHWM on tidal waters.

Chapter Five provides guidance on determining the OHWM on lakes.

Chapter Six discusses how to identify associated wetlands under SMA jurisdiction.

The chapter for each shoreline type includes recommendations for documenting and reporting OHWM findings. The *appendices* include substantial supporting materials. Recommendations for reporting OHWM findings are listed in call out boxes within the pertinent sections:

Reporting recommendations from the office assessment:

- Site description, project proposal, land ownership.
- Summary of landscape and geomorphologic conditions.
- Floodplains, flood history, wetlands, and soil survey.
- Copies of photos and maps used (including vicinity map).
- Data sources.
- Any observed special conditions.

1.4 Target Audience for This Document

We hope that anyone interested in shoreline and natural resource management (e.g., landowners, consultants, or agency staff) will find this guidance useful. Since local governments are typically the first point of contact for SMA permitting, we are especially hopeful that this guidance proves useful to local government staff and their on-call consultants. Natural resource professionals who will be making or verifying OHWM verifications for compliance with the SMA should be familiar with the methods and indicators found within this guidance. While many of the methods and field indicators we list are easily recognizable and can be used by most people, experienced natural resource professionals best apply the more technical aspects of hydrologic analyses or wetland delineations.

Since 2002, Ecology has regularly offered an OHWM determination course through the Coastal Training Program. We have relied extensively on materials from that training course in this guidance document.

Chapter 2 – Determining the OHWM

2.1 The Ordinary High Water Mark Defined

The SMA defines the OHWM as a physical and ecological feature on the landscape. However, a distinct OHWM line may not be evident. Often the OHWM is a transition zone between the aquatic and terrestrial environments. The aquatic environment includes the riparian environment that thrives on or withstands inundation by ordinary high water. The frequency and duration of that high water and some field indicators differs for each of the shoreline types discussed in this guidance. In some places, the transition zone occurs in a narrow band and can be easily identified. In other places, it can be a broad and gradual change that may be difficult to determine without a detailed review.

There are several definitions for the OHWM in state statutes. The SMA applies to actions relating to waters and land within shoreline jurisdiction. Thus, the definition used in this guidance is from the SMA (RCW 90.58.030(2)(c) and WAC 173-22-030(5)) and is the only definition that may be used for administering the SMA:

> "*Ordinary high water mark*" on all lakes, streams, and tidal water is that mark that will be found by examining the bed and banks and ascertaining where the presence and action of waters are so common and usual, and so long continued in all ordinary years, as to mark upon the soil a character distinct from that of the abutting upland, in respect to vegetation as that condition exists on June 1, 1971, as it may naturally change thereafter, or as it may change thereafter in accordance with permits issued by a local government or the department: PROVIDED, that in any area where the ordinary high water mark cannot be found, the ordinary high water mark adjoining salt water shall be the line of mean higher high tide and the ordinary high water mark adjoining fresh water shall be the line of mean high water.

The OHWM on any particular site is not a static line or level, such as a surveyed mean tidal elevation or mean high water elevation, but rather is the dynamic edge of the water body under legal jurisdiction of the act. As such, the OHWM may change over time due to natural events or because of permitted actions.

The Washington Administrative Code (WAC) contains rules for the administration of the SMA on tidal, riverine, and lake shorelines[2]. Definitions of OHWM for each of the shoreline types may be found in WAC 173-22-030(5), and clarifying OHWM language is found in several of the

[2] For specific guidance on a particular shoreline type, please refer to WAC 173-22 and the pertinent section of this guidance document.

other definitions within this section of the rules (see WAC 173-22-030(6) or WAC 173-22-030(9)).

The Shorelines Hearings Board (SHB) has jurisdiction over SMA-related disputes, and it has heard a number of cases related to OHWM issues. In the Thompson vs. Ecology case (SHB No. 03-005), the Board summarized several cases confirming the definition of the OHWM, including:

> "Ordinary high water mark is defined in terms of ordinary as opposed to extraordinary years." (citing Pacific Topsoils v. Ecology and Snohomish County, SHB 94-69(1995)).
>
> "The definition of OHWM is premised upon the establishment of a mark on the soil over a period of time, based on ordinary events" (citing Cassinelli et al and Ecology v. City of Seattle, SHB 93-46 & 47 (1994)).
>
> "Evidence of the OHWM includes the type of vegetation and soil core samples." (citing Osborne v. Mason Co., SHB 88-37 (1989)).
>
> "Factors to look at to determine the OHWM include differences in soils above and below the OHWM, presence or absence of wetland or hydric vegetation[3], aerial photos, interviews with residents, markings on pilings and docks, and records of water levels" (citing Herron v. Ecology, SHB 97-28 and 29 (1998)).

Other definitions of the OHWM include those found in the Hydraulic Code Rules (WAC 220-110-020(31)) administered by the Department of Fish and Wildlife, the Department of Natural Resources (DNR) General Rules (WAC 332-30-106(46)), and the DNR Forest Practice Rules (WAC 222-16-010). These definitions for "ordinary high water mark" are similar to the SMA definition and can be found in Appendix G.

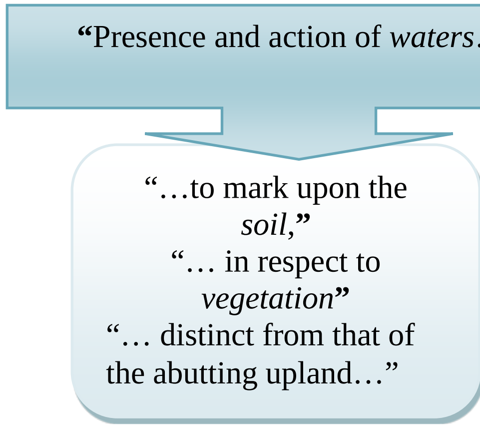
2.2 The Three Criteria of an Ordinary High Water Mark

Proper understanding and interpretation of the criteria in the definition is the first step in making a defensible determination. The OHWM is determined by looking at the three distinct but interrelated criteria mentioned in the definition:

The water (or hydrologic) criterion is the driving force that in turn influences the soil (or geomorphic) and vegetation (or biologic). All three criteria are important for determining the OHWM. However, it is not always possible to find indicators for all the criteria. *Documenting the process and the key indicators you use is an essential part of the determination.*

---

[3] Hydric soil is seldom a reliable indicator of area at or below the OHWM along streams. Exceptions may include riparian wetlands or oxbow channels that are partially connected during flows meeting the OHWM definition or tidally influenced stream reaches.



If this sounds similar to the wetland delineation process, it is. Wetland and OHWM determinations are similar in that they both rely on the use of field indicators of the three criteria (water, soils, and vegetation). They are also similar in that hydrologic indicators may be only seasonally visible, requiring reliance on geomorphic and biologic indicators. Wetland and OHWM determinations differ in that they both have distinct and separate definitions with different objectives. Wetland hydrology needs to be established during the growing season. For the OHWM on streams and lakes, indicators are typically established during winter and spring high water. On tidal waters, the highest storm surges typically occur during the winter (Finlayson 2006). Duration of hydrology is also different: wetland hydrology needs to be established for a minimum of two continuous weeks, while duration for OHWM can be as little as three days in streams and a few hours (several times a year in ordinary years) for tidal waters (more on this below). Finally, soil indicators also differ for wetlands and OHWM in low-energy systems (driven primarily by *biochemical* anoxia) versus OHWM in high-energy systems (driven primarily by *physical* gain-loss of mineral and organic material). Remember that these are general guidelines and may not apply in environments that are more arid.

Differences between OHWM and wetland determinations		
	OHWM	Wetlands
Minimum duration of surface water level or hydroperiod	3-7 days on streams; 14 days on lakes (humid temperate climate); hours a day for tidal waters	2 weeks
Time of year (hydrology)	any time of year (driven by high water levels)	growing season
Soil indicator drivers	primarily *physical* (loss-gain of sediment; topographic) in high energy systems and *bio-chemical* in low energy systems	primarily bio-chemical anoxia

2.3 Ordinary High Water Mark Considerations

Since the OHWM is caused by presence and action of water, we use hydrologic terms in this document to describe some physical characteristics of the OHWM. We also use them to describe the potential location of site indicators in relation to the hydrologic characteristics that create the mark on the soil in respect to vegetation. For example, the presence and action of water that creates a mark on the soil in respect to vegetation on streams may be described by a range of stream discharges (flow) and associated water depth (hereafter referred to as stage). Thus, we may use terms such as ordinary high water discharge, event, or stage to identify and describe the timing, frequency, duration, or magnitude of stream water related to a mark on the soil in respect to vegetation. *These are hydrologic descriptive terms, not legal terms. They do not replace legal language or change the meaning of the law or the methods previously used by Ecology.*

The term “ordinary high” water mark can be confusing. Often the ordinary component is emphasized, and the high component is ignored. Identifying the OHWM should rely primarily on indicators seen in the field. Some of those indicators, such as a wrack line (bank location where floating debris is deposited) or recent erosion, may result from a single event. The indicators used to determine the OHWM should be the result of regular, repeated events. The frequency and duration of high water associated with ordinary is somewhat specific to each of the shoreline types. In terms of stream flow, ordinary implies average stream discharge or water stage[4]. For tidal waters, ordinary means the expected frequency and elevation of the higher high tides for a tidal epoch (see “National Tidal Datum Epoch” definition in Appendix F for a definition). Field studies indicate that six to 12 high tides a year (approximately 1.5 feet higher than MHHW) are sufficient to leave a discernible mark upon the soil in respect to vegetation. Defining the duration and frequency of high water for lakes is more variable than in streams or tidal waters. On lakes, particularly smaller lakes, the duration and frequency of high water that will leave recognizable OHWM indicators can be approximated by the wetland hydrology definition: 14 consecutive days of inundation. However, “high” indicates that water elevation or stage associated with the OHWM is higher than those characteristics associated with the average water levels.

Hydrologically, runoff events, such as storms or snowmelt, produce naturally occurring high water, which creates a mark on the soil in respect to vegetation. Lakes strongly influenced by groundwater may show a seasonally delayed high water response. On tidal waters, atmospheric conditions such as El Niño events may contribute to high water. When available, annual and daily gage data (stream or tidal) provide information on these high water events. The annual peak stream flow data are used in flood-frequency analysis to determine the likely occurrence of annual peak floods, such as the high magnitude low-frequency floods (e.g., the one percent probability flood; “100-year flood”) to the very small, high frequency, peak flow events. These high frequency, lower-magnitude, peak flows that can occur several times a year and do not overflow the outer banks of a channel are those we evaluate in relation to the OHWM. In other words, these events ordinarily create the mark on the soil in respect to vegetation along streams.

[4] The term "average" is generally reserved for average of record. Mean discharge is the arithmetic mean of individual daily mean discharges during a specific period.

For many plants the mere presence of water in (saturation) or on the soil (inundation) is a stressor. Decades of wetland research has determined that 14 consecutive days of soil saturation or inundation are sufficient to establish wetland (hydrophytic) vegetation (US Army Corps of Engineers; 2008, 2010). Plants intolerant of wet soils or salinity will not persist in these environments. Water in motion (…the presence and *action* of waters…), such as a flowing stream or waves on a shore, will produce even more striking changes in respect to vegetation. Changes in the dominant plant community (wetness or salinity tolerance) along a shoreline can be an important indicator of the OHWM location. The transition from non-vegetated or sparsely vegetated to well-established, persistent vegetation is another important field indicator.

Previous Ecology OHWM determinations suggest a range of high tides and peak flow frequencies and durations that create the mark on the soil in respect to vegetation. Generally, the discharge or stage of ordinary high water that creates a mark on the soil in respect to vegetation is less than the two-year recurrence or 50 percent probability peak flow[5]. Statistically the two-year peak flow has *on average* a 50 percent chance of occurring in any given year. The 1.01-year flood has *on average* a 99.9 percent chance of occurring in a year. However, the "on average" part of the recurrence or probability of occurring definition means that these high water flows or water stages may not occur in every year (Figure 2-1). Even ordinary high water is dependent on the amount of water available for runoff. For example, in dry years with little snowfall or precipitation the water presence and action associated with creating the mark on soil in respect to vegetation may not occur.

Climatic, geologic, and topographic variation in Washington precludes defining any one flow statistic, such as duration and frequency, which describes the location of the OHWM on the soil in respect to vegetation. In western Washington, there is less variation between different high flow statistics than in eastern Washington (Figure 2-2). In addition, tidal ranges vary between the north and south Salish Sea[6] and the outer coast; the timing and duration of high water in groundwater-fed lakes may vary significantly from lakes fed by surface water.

The "ordinariness" of high water is also defined by the duration that the water stays at a discharge or water stage sufficient to make a mark on the soil in respect to vegetation. Chapin et al (2002) suggests that the frequency of high flows controls vegetation indicators for drier climates, such as east of the Cascades, whereas the duration of high flows may be more important for wetter climates, such as west of the Cascades. Ecology's stream OHWM determinations suggest that a high stream flow or water stage must have a duration of at least three continuous days in order for the water to create a mark on the soil in respect to vegetation. For tidal waters, frequency of inundation is a more reliable metric for "ordinary" than duration.

---

[5] see for example discussion on Federal Highway Administration NEPA site: http://nepa.fhwa.dot.gov/ReNEPA/ReNepa.nsf/discussionDisplay?Open&id=025B88C63E14808285257276005C3DE9&Group=Natural%20Environment&tab=DISCUSSION

[6] On October 30, 2009, the State Board on Geographic Names to identify inland marine waters approved the use of "Salish Sea". In Washington state, the Salish Sea includes Puget Sound as well as the waters of the San Juan Islands, Strait of Georgia, and Strait of Juan de Fuca [http://www.dnr.wa.gov/ResearchScience/News/Pages/nr09_177.aspx].

The OHWM definition in the SMA also states, “In any area where the ordinary high water mark cannot be found, the ordinary high water mark adjoining salt water shall be the line of mean higher high tide and the ordinary high water mark adjoining fresh water shall be the line of mean high water (emphasis added).” (Please see the executive summary for the definition of MHHW). The sites or shoreline reaches where a trained investigator cannot find OHWM indicators are a rarity, and it is unlikely that these alternative OHWM definitions would apply. Calculating mean high (or mean higher high) is a statistical exercise requiring gage data. While gage data are available for virtually all tidal waters in the state, the same cannot be said for lakes and streams. Calculating mean high water for a non-gaged lake or stream is problematic.

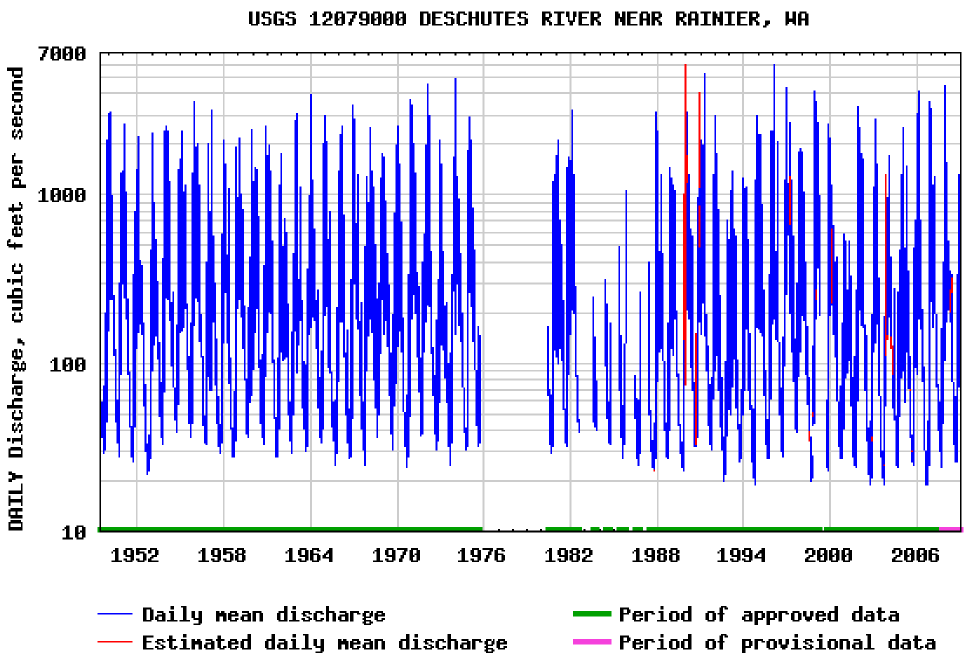


Figure 2-1: A hydrograph of daily mean discharge on the Deschutes River shows the variability and range of flows that have occurred over 50 years of flow record. The red line is the 1.01-year peak flow and illustrates that small, frequent peaks are common (and ordinary) occurrences, but do not occur every year (e.g., early 2000s).

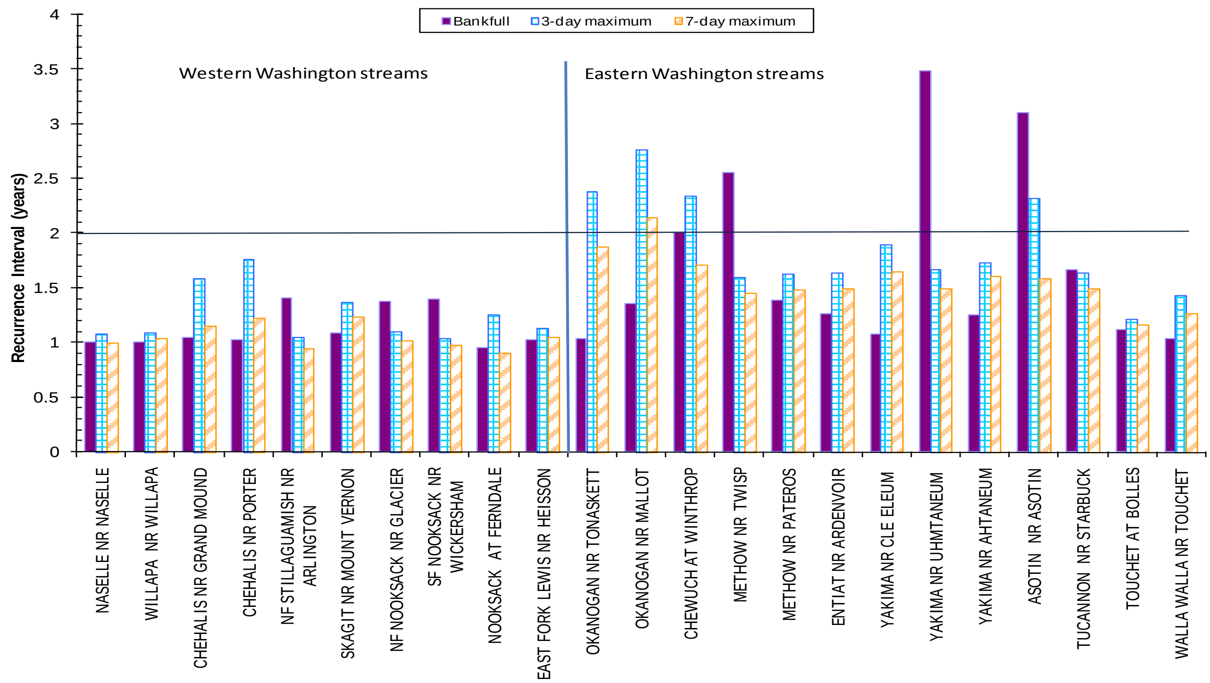


Figure 2-2: The recurrence interval for bankfull, 3-day maximum and 7-day maximum flows, in comparison to the 2-year recurrence interval (black horizontal line), illustrates the variability in frequency and duration of potential streamflow ranges that create the mark on the soil in respect to vegetation. Eastern Washington streams have more variability.

2.4 Reasons for Systematically Determining the OHWM

The fundamental purpose of the SMA is to protect the shorelines of the state as fully as possible. When making OHWM determinations on difficult sites, practitioners should heed the liberal construction policy and "give full effect to the objectives and purposes of the SMA" by erring on the side of safety. *Some advantages of this approach include*:

- Lessening potential for disputes between landowners and regulatory agencies.
- Avoiding potential liability and disclaiming the legal certainty of the determination.
- Increasing efficiency and providing a less costly determination.
- Ensuring protection of public resources potentially affected by development.
- Reducing the risk of locating the project in a hazardous area such as an actively eroding, often flooded, channel migration area.

2.5 How to Determine the OHWM

This section outlines the basic methods and rationale in determining the OHWM. These basic methods apply to each of the three shoreline types, as well as associated wetlands. Specific methods and refinements are presented in the pertinent section of the guidance. There are three steps common to any OHWM determination (office assessment, field assessment, documenting findings) and a fourth step used in many OHWM determinations (hydrologic assessment). While there may be differences in the use of a particular field indicator or background data reviewed for a particular shoreline type, the process is the same for all shoreline types.

Reporting recommendations from the office assessment:
- Site description, project proposal, land ownership.
- Summary of landscape and geomorphologic conditions.
- Floodplains, flood history, wetlands, and soil survey.
- Copies of photos and maps used (including vicinity map).
- Data sources.
- Any observed special conditions.

2.5.1 Step 1: Office assessment of landscape and geomorphic features

Before conducting the field survey, develop an understanding of site location, conditions, and history. This basic office assessment provides information to help identify resources available for the site or reach of interest (e.g., aerial photographs, topographic maps, flood maps, tidal or gage data). Review of background resources will also help locate areas of interest and key features to investigate in the field. During the office assessment, you should be reviewing the landscape features and geomorphic characteristics of the assessment site and basin.

The Washington Coastal Atlas can be a valuable resource for the office assessment and can be accessed at https://fortress.wa.gov/ecy/coastalatlas. It is often useful to assess a much older set of aerial photographs or maps to provide some context of the changes occurring at the site or watershed. Other important online resources for the Puget Trough include the Puget Sound River History Project (http://riverhistory.ess.washington.edu/) and Puget Sound LiDAR Consortium (http://pugetsoundlidar.ess.washington.edu/).
Specifics on background information for a particular shoreline type are listed in the applicable chapters that follow. The office assessment will also help avoid some of the common errors in determining the OHWM. During this first step is when you can begin organizing information for the OHWM determination report.

2.5.2 Step 2: Field assessment

After establishing a basic understanding of site conditions from photos and maps, a field survey can be scheduled. The intent of the field assessment is to develop and follow an orderly approach to making an OHWM determination, and it is the primary means for making that determination. The methods described below rely on development of site transects or profiles as a means of establishing a defensible OHWM delineation. In easier cases with a few strong indicators that support one another, the field component may be simple, and the detailed process outlined below may not be necessary.

As stated previously, the methods followed should be driven by site needs. A more rigorous methodology and documentation may be needed for sites where the determination is difficult and the site is complex or the project is controversial. Several field visits (at different times of the year, and optimally after a high water event) may be necessary. Additionally, collection of transect information is recommended for difficult sites. Use of hydrologic data is recommended and may be required for sites that are more complex.

An assessment of hydrologic data can also make the field assessment more effective since these data can be used to develop an understanding of the timing and elevation of high water that creates the mark on the soil with respect to vegetation and recent higher water events. This information can provide clues to on-site indicators. For example, it can be used to decide whether an OHW event or a peak flow of higher magnitude occurred recently or whether a prolonged drought may be influencing deposition or vegetation patterns. The information can be used to schedule the field survey during—or recently after—high flow events.

Principal elements of the field assessment include general observations of the site conditions; identifying lower and upper boundaries of the OHWM using transects; establishing the preliminary OHWM boundaries; and finally, narrowing the bookends. Field indicators are a key component of the onsite OHWM determination. These indicators can be broadly classed as geomorphic (for example, changes in substrate, slope, or landforms) or biologic (for example, changes in dominant vegetation). While many field indicators are common to all of the shoreline types, some are specific to the shoreline type.

Reporting recommendations:

Draw a sketch of the shoreline‘s cross-sectional profile.

Mark the locations of your transects on an aerial photo.

Document **in the field** the indicators and rationale (hydrologic, soils, vegetation, other) used for your OHWM determination. You may not remember it when you get back to the office.

2.5.3 Step 3: Document findings

Clearly and concisely documenting the study findings and methods used is an essential step in completing the OHWM determination. Presenting these findings in an orderly manner with a description of the conditions and indicators found, along with drawings and photographs of the site, will allow outside reviewers to understand how you reached your conclusions. If the findings are challenged, a well-documented OHWM determination will be easier to interpret and defend.

2.5.4 Step 4: Hydrologic assessment (if needed)

Assessing hydrologic characteristics is not required. However, Ecology uses hydrologic assessment methods to help determine the OHWM. Using available hydrologic data is useful in refining the expected stream and lake water levels or marine tidal datums for those shoreline OHWM determinations. The method Ecology uses is described in the pertinent section for each of the shoreline types. Where appropriate hydrologic data are available, they provide information on recent high water events with water stages greater than the OHWM water stage. These high water occurrences may obscure field indicators. Hydrologic information also indicates where the OHWM might be in relation to the water stage on your site visit day. For example, it can signify whether you should look above or below the water line present during your field visit. In combination with the tidal or stage data, it provides a rough estimate of how much higher or lower in elevation you should be looking for OHWM indicators. Although the SMA definition of OHWM requires the use of field indicators, an assessment of hydrologic data can be quite useful when determining the OHWM.

However, not all sites have suitable hydrologic data. In addition, hydrologic assessments do not add value at some sites because of simple geomorphic characteristics and lack of hazards. Questions based on geomorphic conditions, hydrologic data availability, and potential hazard to resources, environment, and infrastructure provide the decision points. Where sites are complex or controversial or if proper gage data are not available, multiple site visits, including visits during high water, may be useful.

Reporting recommendations:

- Gage location information and relationship to project site;
- Gage data, its period of record, and the portion of the record used for the analysis;
- Graphs and calculations; and
- Relationship of water levels observed during the field day(s) and the estimated OHW.

2.6 Special Circumstances

There are circumstances where more than one shoreline type may be found at a site. Two such situations are addressed in the WAC: where a stream enters a lake and where a tidally influenced stream enters tidal waters. Determining the OHWM at these sites may require evaluating a combination of stream and lake or stream and tidal OHWM indicators. In addition, river deltas with multiple channels are a special circumstance addressed in the WAC that may require modifying the methods used to establish the OHWM. For specific examples and methods to use at these sites, please refer to the pertinent shoreline type.

For streams entering lakes, the OHWM definition in the WAC is: “A lake is bounded by the ordinary high water mark or, where a stream enters a lake, the extension of the elevation of the lake's ordinary high water mark within the stream;" [WAC 173-22-030(4)]. There is a similar definition for streams entering tidal waters: "…Where a stream enters the tidal water, the tidal water is bounded by the extension of the elevation of the marine ordinary high water mark within the stream;**"**

For river deltas/estuaries that have distributary channels (braided), the WAC provides the following guidelines:

- The OHWM is found on the banks forming the outer limits of the depression within which the braiding occurs [WAC 173-22-030(5)(c)].
- The upstream extent of a river delta is that limit where it no longer forms distributary channels [WAC 173-22-030(6)].

Chapter 3 – Streams

3.1 Introduction

Of the three principal shoreline types regulated under the SMA, streams are perhaps the most diverse and dynamic. Streams with a mean annual flow greater than 20 cfs are designated as shorelines (RCW 90.58.030(d)). Shoreline streams vary in size from creeks with a mean annual flow of greater than 20 cfs, such as Swamp Creek in Snohomish County to the Columbia River, the largest river in the state with a mean annual flow of approximately 190,000 cfs at The Dalles, Oregon (Ecology 2010 *Columbia River Facts and Maps*). Streams provide: essential fish and wildlife habitat, including for species listed under the Endangered Species Act; important commercial services, including domestic water and hydroelectric supply and shipping and port facilities; recreational opportunities (camping, boating, or fishing); and often, desirable home sites.

Watershed size, climatic patterns, topography, landscape position, and geology are factors contributing to the diversity of streams. For shoreline regulated streams, the lower you are in the basin, the more likely that you are within shoreline jurisdiction. More than lakes and marine waters, streams have the potential to move across the landscape (channel migration areas). Correctly identifying the stream OHWM will help protect stream functions and resources as well as infrastructure and private property.

Landscape position and underlying geology are important determinants in stream characteristics (channel type and pattern) that influence the OHWM location. When determining the OHWM on streams, it is important to understand where you are on the landscape, how the stream responds to high flow events, and where you would expect to find OHWM indicators. Where the "mark upon the soil" occurs and the applicable OHWM indicators along a confined, high-gradient channel will vary significantly from an unconfined channel with a broad floodplain. Geography is also an important consideration, particularly given the geologic and climatic variability between western Washington and eastern Washington.

Braided streams (multiple channels) and river deltas are two special types of stream conditions identified in the SMA rules (WAC 173-22-030(5)(c) and 173-22-030(6), respectively) that require extra attention when determining the OHWM. Methods for OHWM determinations at these sites are described below in section 3.2.3.

The steps in determining a stream OHWM are the same as those described in the introduction of this manual: conduct an office assessment, a hydrologic assessment in many cases, visit the site for the field assessment, and document your findings. Gage data, which provides important historical information on stream flows, is available for many of the larger streams in Washington. This data are used in the hydrologic assessment discussed in section 3.3.1, below.

3.2 Defining the OHWM

As discussed in Chapter 2, the OHWM is a physical and ecological mark on the ground due to the presence of periodic and regular (i.e., ordinary) inundation. At many sites, it is found in the transition zone between the aquatic and terrestrial environments. Depending on location, the transition may be very narrow and easily discernible or may be broad and subtle. The OHWM is typically not a line or static elevation, and for compliance with the SMA water elevations should not be used as the sole basis for establishing the OHWM. Over time, the OHWM can and often does change due to the presence and actions of water or through authorized projects. For purposes of the SMA, the OHWM is defined as (RCW 90.58.030(2)(c):

> "*Ordinary high water mark*" on all lakes, streams, and tidal water is that mark that will be found by examining the bed and banks and ascertaining where the presence and action of waters are so common and usual, and so long continued in all ordinary years, as to mark upon the soil a character distinct from that of the abutting upland, in respect to vegetation as that condition exists on June 1, 1971, as it may naturally change thereafter, or as it may change thereafter in accordance with permits issued by a local government or the department: PROVIDED, that in any area where the ordinary high water mark cannot be found, the ordinary high water mark adjoining salt water shall be the line of mean higher high tide and the ordinary high water mark adjoining fresh water shall be the line of mean high water.

Streams under SMA jurisdiction are those with a mean annual flow greater than 20 cfs and associated river deltas and wetlands (RCW 90.58.030(2)(d) and (e)). Further clarification on the SMA OHWM can be found in WAC 173-22-030 and WAC 173-22-040. As discussed in Chapter 2, the essential elements of the OHWM are a mark upon the soil with respect to vegetation due to the presence and actions of waters. Recognizable field indicators should identify the OHWM at a given site. Permit applications should include a brief narrative of the methods used and indicators seen in establishing the OHWM, as well as drawings depicting the OHWM on site plans. Field observations should be corroborated by supporting data, such as aerial photographs, LiDAR, and gage data.

The frequency and duration of inundation are two key elements in determining what constitutes an ordinary high water event. Although the SMA does include a proviso that the mean high water line may be used on sites where the OHWM cannot be found at the coastline, mean high water for streams, depending on the definition used, will often be above the elevation where we would expect to see OHWM indicators. Statistically, streams will equal or exceed the mean annual peak flow on average once every 2.33 years (Leopold et al., 1964). Ecology personnel who have determined stream OHWMs have observed that the 2.33-year peak flow does not occur frequently enough or with long enough duration to create a mark on the soil in respect to vegetation. Moreover, the mean annual peak flow often is an overbank flood. The OHWM is usually not created by overbank flows. Observers have noted that the two-year annual peak flow, which is the median annual peak flow, has created the mark in some cases. For these reasons, we have chosen to use the median (two-year) rather than the mean annual peak flow (2.33-year) as the upper limit where the stream OHWM will occur.

As the state agency responsible for implementing the SMA and state Water Pollution Control Act (RCW 90.48), Ecology staff frequently review OHWM determinations and, when necessary, field verify those determinations. Providing a clearly written OHWM determination using the methods and indicators listed in this guidance will help ensure a timely review of SMA permit applications.

3.2.1 Field indicator descriptions

Description and rationale for field indicators

The following contains a description of key field indicators along with rationale for their interpretation in relation to the OHWM. When making a determination, consider the preponderance of evidence that supports it. This could mean the number of indicators present and/or the strength (absent, weak, moderate, strong) of key indicators. Consider, also, the time of year and seasonal impacts on the expected strength of the indicators. Remember that a lack of obvious field indicators during drier times of the year does not mean the OHWM is the edge of water during that site visit. Adjacent areas within the reach may provide indicators that can be linked back to the site. Since many of the indicators are related to recent high flow events, their interpretation in relation to the OHWM is dependent upon the magnitude of that event.
You can find a summary of key stream field indicators at the end of this chapter following the section on conducting the site assessment (Section 3.4).

Sediment bars

Description: Sediment deposition forms bars within channels. Bars can induce channel movement and formation of meanders. Meanders or bends also allow sediment deposition through energy dissipation. They form where stream gradient decreases behind wood debris and other obstructions that cause backwater effects.

Relation to the OHWM: The tops of active sediment bars are below the OHWM. Substrate on active bars will be relatively clean and unvegetated.

Scour line

Description: The scour line (orange arrow) is the landward evidence of frequent sediment transport and sorting, area of concentrated erosive action, and the upper line in a streambed swept clean by swift current. Little vegetation will grow below the scour line.

Relation to the OHWM: Scour lines are usually created by swift currents or flows that are much more frequent and smaller in magnitude than the OHW flow. Therefore, they are typically below the OHWM. In steeper streams, scour lines may be more indicative of OHW or larger force in channels with steep slopes compared to channels that have slopes less than two to four percent.

Clean cobbles/boulders

Description: Devoid of dirt and moss, but may contain fine channel deposits such as sand and silt.

Relation to the OHWM: If there is no moss or dirt built up, on, and around cobbles and boulders, then they are within the zone of frequent inundation and below the OHWM.

Bank erosion/channel scour

Description: Signs of erosion by water on the bank or edge of the channel, often marked by exposed sediment, substrate, or roots. If streambank has been hardened or diked, look for scour of dike material.

Relation to the OHWM: Scour-related features are an indicator of frequent sediment transport and sorting, which is generally lower than OHWM. OHWM can be at the top of eroded banks consisting of sandy, recently deposited material. Secondary channels with evidence of scour and other flow indicators are also below the OHWM.

Bank scour on Deschutes River at Pioneer Park, Lacey, WA

Exposed roots/root scour

Description: Exposure of tree and shrub roots from erosive flows.

Relation to the OHWM: Adventitious roots are formed in response to the deposition of sediments. Exposed roots are an indicator frequently located below OHWM.

Recently scoured adventitious roots in a side channel of the Snoqualmie River at Three Forks Park.

Stratified sediment deposits

Description: Stratified sediment deposits result from two processes: (1) in-channel processes that sort and wash large cobble and gravel, and (2) floodplain overbank deposits created by vertical and horizontal accretion (bar formation) during floods.

Relation to the OHWM: Scoured and clean channel bed and bank deposits are found below the OHWM. On banks, finer deposits overlaying coarser deposits are generally within the ordinary high water (see figure at right). Vertically accreted floodplain deposits may be streamward or landward of the OHWM depending on the magnitude of recent floods. High-magnitude floods (> five-year floods) will have overbank deposits that are landward of the OHWM. Floodplain areas with conditions conducive to revegetation by upland species are likely landward of the OHWM.

Caution: Large magnitude floods may obscure (i.e., scour away or deposit sediment over) sediment deposited by OHW events. Digging into floodplain deposits may provide clues. Sediment deposits overlying organic soil suggest they are landward of OHWM. In gravel-bedded rivers, coarse sediment overlain by deep fine deposits may indicate that you are landward of the OHWM but require supporting evidence from other indicators.

Flood or overbank deposits

Fresh silt deposits on previous year's maple leaf on floodplain surface

Description: When a flooding stream overtops the bank and deposits materials on the floodplain (vertical accretion). These materials typically include sand, silt, clay, and woody debris but may include coarse material.

Relation to the OHWM: Unless there has been a recent flood that is larger than the OHW event, the outer or landward edge of these deposits is often at or just below the OHWM. Criteria to distinguish overbank deposits below or at the OHWM include substantially less organic matter and less soil stratification than deposits landward of the OHWM. Overbank deposits representative of OHWM are generally silt or sand and may contain woody debris that is not decomposed. The deposits may also show evidence of erosion and deposition. If reach has been diked, look for evidence of recent dike overtopping. Look for sand and silt deposits on previous year's leaf fall for indication of recent high flow.

Top of bank

Description: The streambank is the rising ground bordering the stream channel. The top of the bank is the intersection between the bank and the more level valley surface or higher magnitude floodplain (e.g., the 100-year floodplain).

Relation to the OHWM: See discussion for flood or overbank deposits. Top of bank may be much higher than OHWM for streams that have cohesive sediments, are incising, or represent higher magnitude floodplains.

Water stains/marks

Description: Discolorations or stains on the bark of woody vegetation, rocks, bridge pillars, bulkheads, tree trunks, buildings, fences, culverts, or other fixed objects that result from frequent inundation. When several water marks are present, the highest typically reflects the maximum extent of recent inundation. Water marks along mountain and northwest coastal areas may be more reliable indicators of typical high flow than those in the Arid West. Therefore, water marks along mountain and northwest coastal streams are more likely to reflect typical high flows.

Relation to the OHWM: If multiple stain lines are present, the darkest line on fixed objects is usually below the OHWM as it demarcates a longer period of inundation. Use caution with interpreting water marks if there has been a recent extreme flooding event since these marks can be made after even brief flooding. (Note barnacles on lower parts of these pilings.)

Sediment lines, flood lines

Description: Thin layers or coatings of fine-grained mineral material (silt or clay) or organic matter (e.g., pollen), sometimes mixed with detritus, which remain on tree bark or tree moss, plant stems, leaves, rocks, and other objects after surface water recedes. A hand lens may be useful for looking at moss to determine whether the silt is recent, i.e., on top of the moss, or old, i.e., the moss has grown over the silt. Sediment deposits generally occur when water has stood for sufficient time to allow suspended sediment to settle, i.e., ponded conditions. These deposits can remain for a considerable time until removed by precipitation or subsequent inundation.

Relation to the OHWM: These deposits indicate the minimum inundation level of recent floods. If these floods were close to OHW flow in magnitude, then these lines may indicate OHWM.

Sediment lines on cedar tree in Snoqualmie River floodplain. Line from a 25-year high flow.

Caution: Sediment lines may also indicate much higher peak flows. A 25-year flood on the Snoqualmie River caused the sediment line shown in the photo (right) on the buttressed trunk. We found the OHWM approximately four inches below the recently deposited sediment.

Flood debris and wrack accumulation

Description: Items such as twigs, branches, sediment, trash, and other water-borne materials that are caught up in shrubs or trees or other objects. Lines of wrack can occur on the ground parallel to the flow of water and mark high flow events. Drift material may be piled against the upstream side of trees, rocks, and other fixed objects or widely distributed within the dewatered area.

Relation to the OHWM: Whether this is at or above the OHWM is dependent upon the size of the last flood in relation to the OHWM. Although debris is usually an indicator of the height of the last flood event, debris is deposited as floodwaters recede and can underestimate the water surface elevation of the flood peak. Use caution with drift lines that may have been caused by extreme or infrequent events. Drift materials can persist for many years.

Drainage patterns, flattened vegetation

Description: Consists of flow patterns visible on the soil surface or eroded into the soil, flattened vegetation in direction of flow, absence of leaf litter or small woody debris due to flowing water, and similar evidence that water flowed across the ground surface. Drainage patterns are usually seen in areas where water flows broadly over the surface and is not confined to a channel.

Relation to the OHWM: Unless there have been recent flood events above the OHW, this is typically below the OHWM.

Caution: Flattened vegetation is best observed during early part of growing season before becoming obscured by new growth. Look very carefully under new growth for evidence of past high flows when new growth is obscuring flattened vegetation.

Toe of lowest terrace (if terrace has organic material in soil horizon)

Description: A terrace is a relatively level bench or step-like surface and its associated front slope. Stream terraces are most likely remnants of stream floodplains that have been incised by their stream. Vertical accretion on floodplains, channel movement, and channel abandonment also form terraces. The lowest terrace is the most recently formed terrace. The toe is the break in gradient between the lowest terrace face and floodplain.

Relation to the OHWM: The intersection between the terrace toe and floodplain indicates a transition between OHWM and higher magnitude water elevations. The toe may be the OHWM but should be based on the existence of other indicators. Stream processes, such as incision, may place the toe above the OHWM. Floodplain deposition may place the OHWM at or somewhere above the toe.

Hillslope toe

Description: The break in gradient between valley wall and valley floor. In confined valleys, the hillslope toe may occur at the streambank.

Relation to the OHWM: In confined streams, where there are no floodplain surfaces, this may be below the OHWM. Where there are small floodplains this may be *at* the OHWM. In moderate to unconfined streams, a migrating stream may intersect the hillslope toe. Where the hillslope is the limit of the stream channel, the scour line on the hillslope is likely the OHWM unless other indicators show otherwise.

Organic material or duff layer accumulating on the soil or pedogenic development of soil horizons

Description: Accumulation of organic matter and duff on alluvial deposits and A- and B-horizon development. Alluvial deposits are material deposited in stream floodplains composed mostly of parent material. Alluvial soils are characterized by little soil development (most are entisols), an irregular decrease in organic carbon with depth, and landscape position.

Relation to the OHWM: The accumulation and decomposition of leaf litter and other organic deposits or soil horizon development does not occur in areas that are "ordinarily" flooded in riverine landscapes because of frequent physical disturbance by flowing water. Therefore, this occurs above the OHWM. Look for indicators of recent removal of previous years' leaf fall and duff accumulation.

Juvenile salmonids in floodplain depressions

Description: High flows can flush and strand juvenile salmonids into floodplain depressions.

Relation to the OHWM: The presence of juvenile salmonids in floodplain depressions can be correlated to the high flow records. This allows an estimate to be made about which event carried the fish. Documentation may require netting of fish to determine age class and species. Be sure to obtain necessary permits to handle fish.

1+ year Coho salmon juvenile trapped in floodplain depression after high flow (below)

Floodplain depression 200+ feet from main channel of Pilchuck River, Snohomish County, WA

3.2.2 Common misunderstandings of stream OHWM

Several common misunderstandings may occur when determining the OHWM on streams. One common misunderstanding is the relationship between OHWM indicators and bankfull indicators[7]. In this document, bankfull indicators are bankfull discharge and stage. Bankfull discharge is the most effective stream-channel-forming flood, which is the minimum discharge required to transport bedload sediment (Williams 1978). Bankfull stage is the height of water or water level at bankfull discharge[8]. A stream's ability to transport sediment is a function of sediment size, channel gradient, and water depth relative to sediment size. Given two streams with similar channel gradient, bankfull water stage will be less for the stream with the smaller sediment size. This commonly used geomorphic definition suggests that bedload sediment transport may occur at flows or water stages below the top of the highest bank.

---

[7] There are at least 11 possible definitions of the bankfull, which could give 11 different locations of bankfull (see Williams 1978 for detailed discussion). The definition used also varies with the professional discipline. Hydraulic engineers or hydrologists evaluating flood risks may consider bankfull to occur when high water overflows channel banks. Geomorphologists may be more interested in definitions that include the active channel, imply sediment transport, and channel changing flows.

[8] In this document, we define bankfull discharge as the most effective channel-forming flood with a recurrence interval seldom greater than the 2-year flood in undisturbed channels. The bankfull discharge may be greater than the 2-year flood for incised channels. Bankfull discharge occurs at the maximum product of flow frequency and sediment transport. Bankfull discharge may be exceeded multiple times within a given year. This may occur in a single event, or it might occur in different isolated events.

Sometimes the term bankfull width is used as an indicator of bankfull location because it does not require discharge or water stage measurements. Bankfull width is the wetted channel width at bankfull discharge. Often the term bankfull width is used to describe the active stream channel (Figure 3-1). The active stream channel does not typically include nearby vegetation except those that can sustain frequent channel scour or grow at or below water's edge for very long durations.

OHWMs, on the other hand, are often found next to a stream channel on land that is inundated often and with enough duration to limit soil horizon development and/or the build-up of organic material at the surface but still allow riparian plant growth. The OHWM water stage may be higher than the bankfull stage for streams that migrate or have multiple channels. In straight, single channels or steep and confined channels the OHWM and bankfull water stage may be the same. For incised streams the OHWM may be below the bankfull stage (see Figure 3-2 and Appendix D, Geomorphic indicators of OHWM on streams). In summary, bankfull indicators are related to water flows that move bedload sediment. The OHWM indicators include soil and vegetation, in addition to channel indicators.

Other common misunderstandings in establishing the OHWM on streams include:

- Assuming the OHWM is the same as "mean high water" (MHW). The SMA definition of OHWM directs the use of MHW only in rare cases when you cannot find an OHWM. Mean high water on streams is usually greater than the two-year flood recurrence interval.
- Assuming that discharge associated with ordinary high water marks equates to the mean annual discharge (Figures 3-1 and 3-3). The mean annual discharge is not high water. It is the average of all high and low discharges over the period of the gage record[9].
- Using the scour line as the OHWM. Below the scour line, non-emergent vegetation does not grow. This line is below the OHWM on most shorelines. Exceptions include high-energy environments or shorelines with steep channel gradient (Figure 3-2, Photograph 3). In such cases, the scour line and OHWM may be the same.
- Assuming a change in bed materials, for example from cobble to sand, represents the OHWM. Since the OHWM is related to geomorphic features such as banks, which are adjacent but not part of the channel bed, changes to substrate within the bed are not an appropriate indicator for determining the OHWM (Figure 3-1).

[9] For example, equating the mean annual discharge to ordinary high water is like equating an average return on investments to a high return on investments.

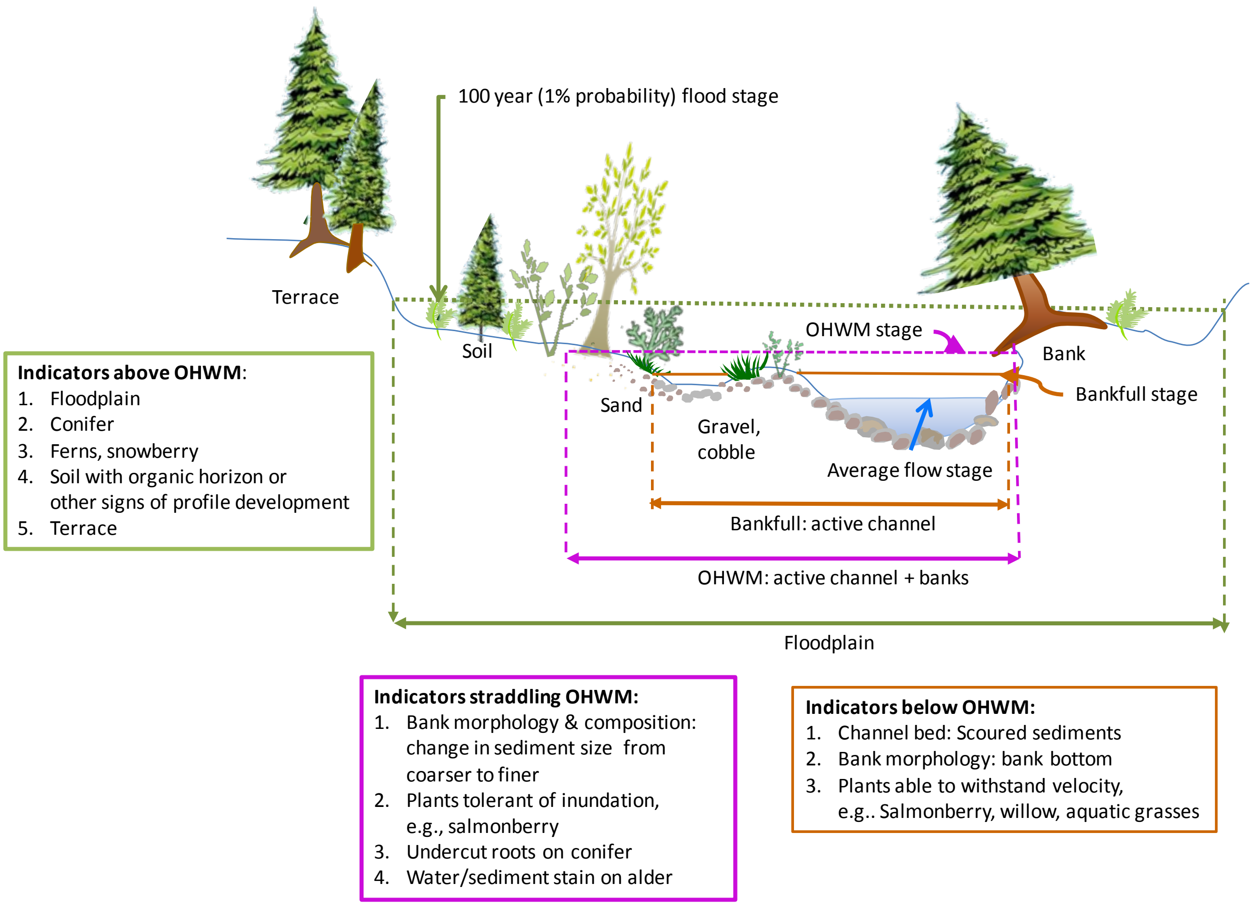


Figure 3-1: Cross-section of a typical stream, showing OHWM in relation to average discharge stage, bankfull stage, and the 1% flood stage.

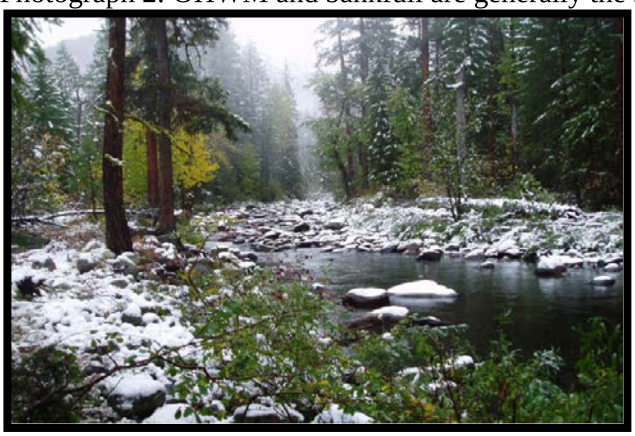
Photograph 1: OHWM higher than bankfull

The OHWM location is generally landward of bankfull location where there are:

- Multiple channels.
- Depositional features such as bars.
- Sand to cobble sediment size.
- Channel gradient < 1%.
- Unconfined.

The bankfull flow recurrence interval may be close to the 1 to 1.5 year flood.

Photograph 2: OHWM and bankfull are generally the same



The OHWM and bankfull locations are generally equivalent where channel characteristics are:

- Straight, slightly incised.
- Moderately confined.
- Cobble to boulder sized sediment.
- Plane bed morphology.

Larger sediment size requires a higher bankfull discharge to initiate bedload transport. The bankfull recurrence interval may range between the 1.5 and 2-year flood.

Photograph 3: OHWM lower than bankfull

The OHWM is waterward of the bankfull location where channel characteristics are:

- Incised and straight.
- Large sediment size (boulders).
- Steeper gradient (>2%).

Smaller bed sediment is transported out of incised reaches leaving only the large material. Transport of large material takes higher bankfull or effective discharge. The steeper channel slope does not compensate for the large sediment size. In these cases, the bankfull discharge recurrence interval is often greater than the two-year flood recurrence interval.

Figure 3-2: The photographs and stream descriptions illustrate the channel characteristics that influence the location OHWM in relation to bankfull location. Bedload sediment size is an important determinant of bankfull location and associated flow recurrence interval.

- Ignoring side channels in multiple channel systems. Secondary channels may be within the OHWM (Figure 3-3, 3-4).
- Using the waterward edge or beginning of the vegetation as the OHWM. Vegetation below or at the OHWM should be considered "distinct from that of the abutting upland"[10], not the abutting riparian plant community (Figures 3-1 and 3-4).
- Assuming that ordinary high water is equivalent to overbank floods. The OHWM never includes the 100-year or one percent probability floodplain (Figure 3-1 and 3-3). The two-year peak flow, or 50 percent probability flood, is more frequently cited as the upper limit of OHWM[11].
- Assuming the entire riparian corridor is at or below the OHWM. Hill et al (1990) suggest that stream riparian vegetation relies on high flows that occur with a 1.5 to 10-year frequency. Chapin et al (2002) found that the high flow frequency varied from 3.1-7.6 years with an average peak flow frequency of 4.6 years. The OHWM is generally not above the elevation of the two-year high flow. The riparian areas maintained by peak flows higher than the two-year peak flow are normally *above* the OHWM.
- Not including contiguous or associated wetlands within the stream OHWM (Figure 3-3).
- Assuming that vegetation supported by lateral saturated subsurface flow is below the OHWM. Riparian and groundwater supported vegetation may be similar, but location in respect to fluvial features may be different. For example, at the base of hillslopes and older terraces higher than the floodplain, groundwater may discharge providing support for vegetation similar to riparian vegetation. Generally, these are areas of lateral subsurface water discharge and are not associated with the OHWM. Soil may be used as another discriminator between vegetation supported primarily by groundwater processes versus vegetation associated with the OHWM. Soils in groundwater-dominated "wetlands" more often have morphological features, such as gleyed or depleted features, caused by chemical changes such as reduction, which occur under anoxic conditions because of long duration soil saturation. In contrast, the "mark upon the soil" indicators for OHWM on streams are dominantly physically derived—where flowing water removes surface organic matter and deposits fresh sediment. Both processes limit soil development into distinct horizons. While groundwater seepage often occurs below the OHWM or long duration flooding may create temporarily reduced conditions, the physical alterations by flowing water will dominate soil characteristics.

---

[10] RCW 90.58.030(2)(b) and WAC 173-22-030(6).

[11] see for example discussion on Federal Highway Administration NEPA site: http://nepa.fhwa.dot.gov/ReNEPA/ReNepa.nsf/discussionDisplay?Open&id=025B88C63E14808285257276005C3DE9&Group=Natural%20Environment&tab=DISCUSSION

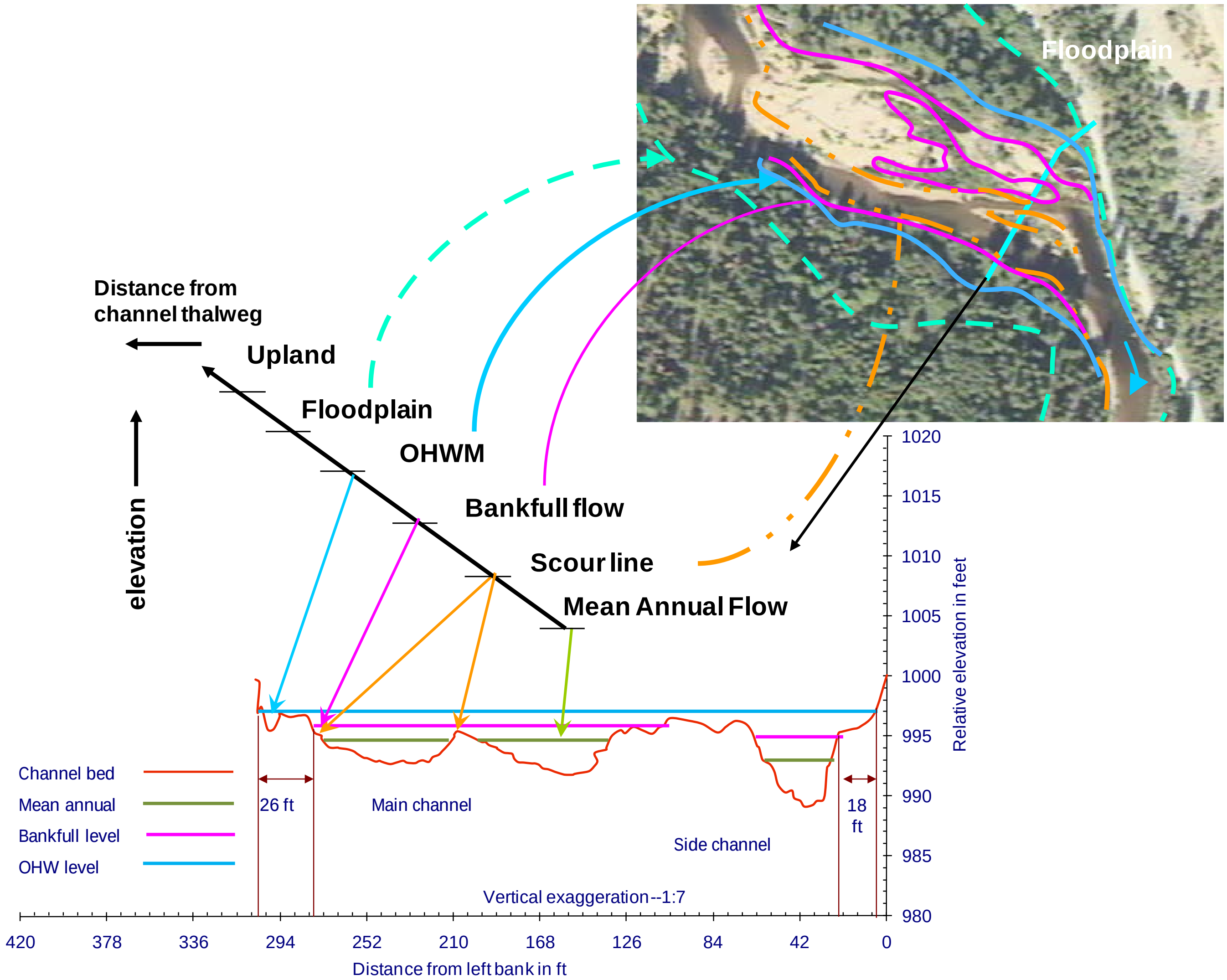


Figure 3-3: Cross-section from a multi-channel stream reach illustrates the relationship between OHWM location and floodplain, bankfull flow, and scour line locations.

3.2.3 Special circumstances

The WAC shoreline definitions provide clarifying language on the OHWM location on streams with braided channels, river deltas, and where streams enter tidal waters. Determining the OHWM in these settings will require a little extra effort to ensure consistency with the WAC definitions. On river deltas and tidally influenced streams, the determination will require evaluating a combination of stream and lake or tidal OHWM indicators. Figures 3-3 and 3-6 illustrate these situations.

> *Braided streams* – "… the OHWM is found on the banks forming the outer limits of the depression within which the braiding occurs" (WAC 173-22-030(5)(c)). The outer limit is usually interpreted to mean the outermost channel that has been active within the last ten years. Also, note that there may be "islands" of land not subject to inundation within these outer limits and having their own OHWM.

River deltas – "…those lands formed as an aggradation feature by stratified clay, silt, sand and gravel deposited at the mouths of streams where they enter a quieter body of water. The upstream extent of a river delta is that limit where it no longer forms distributary channels" [WAC 173-22-030(6)]. Excluded are lands that can reasonably be protected by governmental flood control devices [WAC 173-22-040(3)(d)].

Tidal water – "…Where a stream enters the tidal water, the tidal water is bounded by the extension of the elevation of the marine ordinary high water mark within the stream;" (WAC 173-22-030(9)).

Deltas will also form where streams enter reservoirs. Depending on how much fluctuation there is in reservoir water levels, the pool OHWM may extend up into the stream channel or multiple deltas may develop at the stream mouth. Often reservoirs have distinct lines indicating the mean high pool elevations (Figures 3-4 and 3-5). If indicators are not obvious, many reservoirs have stage gages, or information on mean high pool elevation is available from the dam/reservoir operators. Where streams enter a lake or reservoir, the OHWM includes the extension of the elevation of the lake's OHWM within the stream [WAC 173-22-030(4)]. Once you have determined the lake/reservoir OHWM elevation, use field indicators to identify the comparable elevation within the stream system.

Figure 3-4: Shoreline of Rufus Wood Lake on the Columbia River, May 10, 2007.

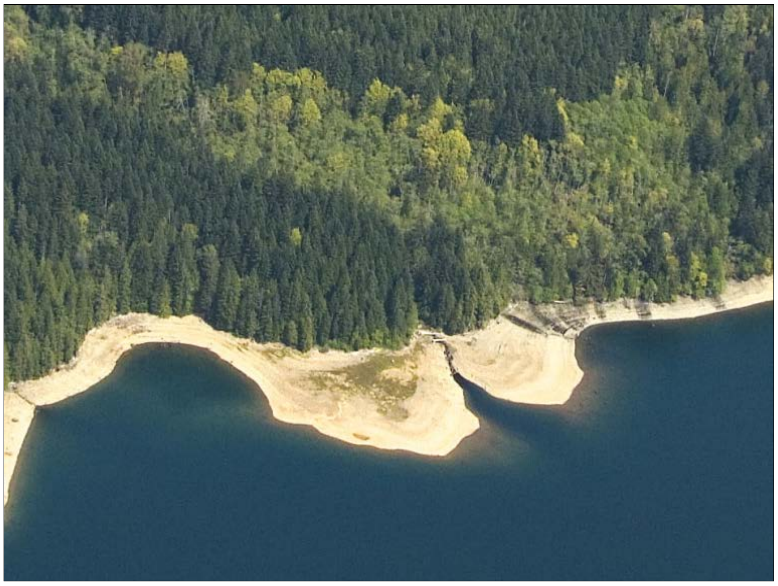


Figure 3-5: Shoreline of Lake Cushman, Mason County, April 30, 2007. Note stream inlet at center of photo. OHWM within the stream at full pool elevation may extend into the forested portion of the channel.

Figure 3-6 illustrates a case where marine OHWM indicators are used in the intertidal zone. Both stream and low energy tidal OHWM indicators are used at the upstream limit of tidal influence, which typically includes a zone of freshwater tidal inundation. Above the upstream extent of tidal influence, stream OHWM indicators are used. In the Figure 3-6 case there is a contiguous wetland at this cross-section. The wetland is included in the OHWM since it is inundated at the stream stage related to the stream OHWM. Determining the OHWM at this location may require identifying the landward wetland edge. Refer to Chapter 4 for a more detailed discussion of OHWM determinations on tidal waters.

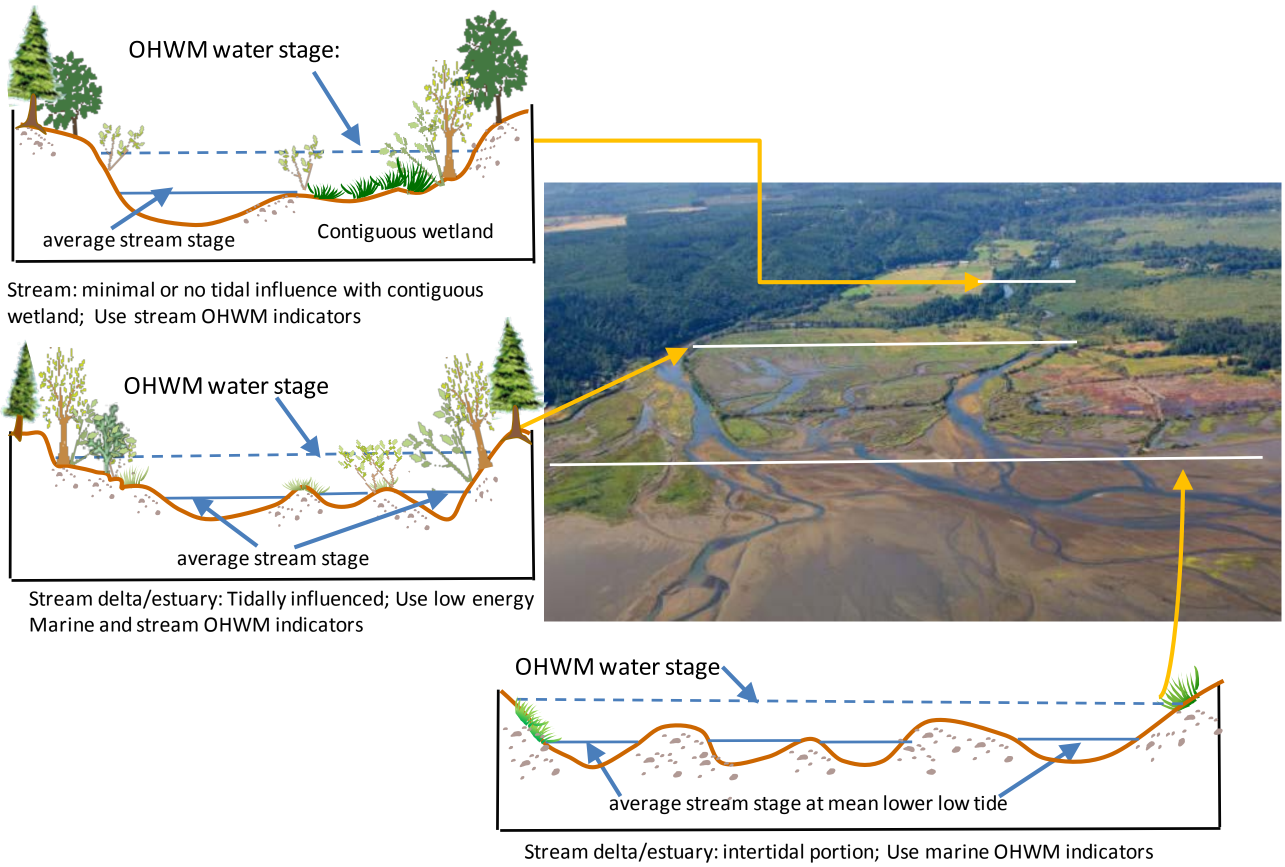


Figure 3-6: Schematic of hypothetical cross-section profiles from the intertidal zone to upstream of tidal influence illustrates the OWHM location. Marine and stream OHWM indicators are used in the intertidal zone of the river delta. A combination of low-energy marine and stream indicators are used upstream of intertidal zone. Profiles are not to scale.

3.3 Office Assessment

Before conducting the field survey, develop an understanding of site conditions and history. *This basic office assessment provides information to help:*

- Identify key features to evaluate in the field.
- Identify approximate OHWM location to evaluate when in the field.
- Avoid some of the common errors listed in Chapter 2.
- Determine site and reach channel complexity and if additional hydrologic analysis is necessary.
- Obtain information to be summarized in an OHWM determination report (National Oceanic and Atmospheric Administration [NOAA] tidal data).

Step 1: Assess landscape and geomorphic features
Collect and review aerial photographs, topographic maps, Light Detection and Ranging (LiDAR), Shaded Relief Digital Elevation Models (DEM), or other relevant and available information (Appendix C). Use available information to describe the landscape and geomorphic characteristics of the site in the report. It is often useful to assess a much older set of aerial photographs or maps to provide some context of the changes occurring at the site or watershed.

The following are suggested features to consider. By considering each question, a preliminary understanding of the stream system will emerge. This is not an inclusive list. There may be other aspects of the landscape and geomorphology that will be important to describe at a specific site.

Landscape features may include:

- Where is the project located in relation to the watershed? (that is, upper steeper reaches, mid-valley floor, or lower end)
- How developed is the watershed and what is the level of development near the project?
- Has development changed rapidly over time?
- Are there flow control devices such as dams, weirs, or diversions upstream that may influence OHW events?
- Is the project site within the area of tidal influence, including backwater effects?
- Are there steep banks or a floodplain at or near the site?
- Is bank armoring visible on aerial photos? Has armoring changed over time?
- Which side of the Cascades is the site on? What does that tell you about expected precipitation and flow conditions? Are high flows rain dominated, snow dominated, or rain-on-snow dominated?[12]

[12] This information indicates the likely time of year that ordinary high water levels may be observed. Where substantial rainfall occurs in a particular season each year, or where the annual flood is derived principally from snowmelt, the ordinary high water flow that makes the mark on soil and vegetation may occur yearly in spring and early summer. In rain-dominated regions, the ordinary high water flow that makes the mark on soil and vegetation usually occurs in the season of highest precipitation but may not occur every year. Where most floods are the result of combined rainfall and snowmelt, the ordinary high water flow that makes the mark on soil in respect to vegetation can occur in winter due to rain-on-snow storms and in spring during snowmelt.

Geomorphic characteristics to consider include:

- Is the channel confined or constrained? (See sidebar.) Are there levees, bank armoring or riprap, bedrock, or bordering roadways that constrain channel movement?
- Describe the channel pattern. Is it single, braided, or meandering? Are there gravel bars or secondary channels? Are there distinctive oxbows or cutoffs? (See Appendix D.)
- Is there bank erosion or channel movement upstream or downstream of the site that might be further evidence of migrating?[13] (See sidebar and Appendix D.) Evaluate historic and current aerial photographs for comparison. Look up- and downstream of the site for evidence of channel movement or erosion (indicator examples in Appendix D).
- What is the channel gradient; how steep is the channel?

Channel confinement is defined as the ratio of bankfull channel width to modern floodplain width. Modern floodplain is the flood-prone area and may correspond to the 100-year floodplain. Typically, channel confinement is an indicator of how much a channel can move within its valley before a hill slope, terrace, or other hard point stops it.

Confined: valley width (vw) to bankfull channel width (bcw) <2.
- Confinement restricts channel movement
- OHWM likely stable unless banks are eroding

Moderate confinement: vw/bcw ≥2 and <4.
- Channel movement can occur
- OHWM may change over time

Unconfined: vw/bcw ≥4.
- Channel can move rapidly
- OHWM changes in space and time

Channel migration indicators:
- Meandering pattern
- Gravel bars
- Multiple bar forms
- Young disturbance tolerant vegetation
- Wood jams
- Multiple channels
- Secondary channels

Channel gradient influences channel form, migration, and bank erosion:

<2%--lower gradient	→ Migration, flooding
2-4%--moderate gradient	→ Limited migration & flooding, bank erosion
>4%--high gradient	→ Bank erosion, slope failure

- Are there adjacent floodplains or large wetlands to consider? Floodplain maps should be consulted to determine flood magnitudes, frequencies, horizontal floodplain boundaries, and elevations of the floodplain. The floodplain maps provide information on location and magnitude of floods larger than the ordinary high peak flow that creates the mark on the soil in respect to vegetation.
- Is it likely that site soils and vegetation have been changed through adjacent land use practices?

[13] Channel migration mapping is required as part of Shoreline Master Program (SMP) updates. Specific SMA regulations apply to development within channel migration areas.

- Are channel processes, such as deposition and erosion, likely to have been altered? (These might suggest that an OHWM determination might be more easily made up- or downstream of the site.)

Please note that geomorphic conditions such as channel migration, aggradation, and bank erosion influence the location of the OHWM in space and time. Channel changes can affect location of the OHWM in regards to future development. Channel changes, such as bank erosion and avulsions, can occur overnight or between the time when the OHWM was determined and the project is constructed. Development in areas of channel migration and bank erosion may lead to artificial modifications to the stream to prevent further erosion, affecting aquatic organisms and nearby property or infrastructure.

If bank erosion, aggradation, or other channel changes are occurring, the potential effect to structures should be assessed. Channel migration or bank erosion is an important risk factor for developed areas. In areas where the channel is clearly migrating or aggrading/degrading, the existing OHWM is not necessarily relevant to protecting adjacent property, resources, or infrastructure. Migrations can result in flooding and property damage. Evidence of changing channel conditions and the potential for an altered OHWM in the near future should be assessed in the field and considered during permitting and design of projects. In these areas, identifying a more conservative OHWM is strongly recommended. Getting bank stabilization permits for future structures in areas of channel migration or bank erosion may be difficult or not possible (WAC 173-26-221(3)(b)).

Step 2: Choose potential locations for field survey

During early review of photos and maps it may become clear that certain locations might provide more accurate OHWM determinations even though they may not be precisely at the site in question. Where the site soils and vegetation are highly altered or channel processes such as deposition and erosion are altered, an alternative site or sites should be considered. An alternative site might be appropriate where channel conditions change from confined or constrained to unconfined or not constrained. Under this condition, survey techniques can be used (Figure 3-7). The vegetation and soil indicators still apply to alternative sites.

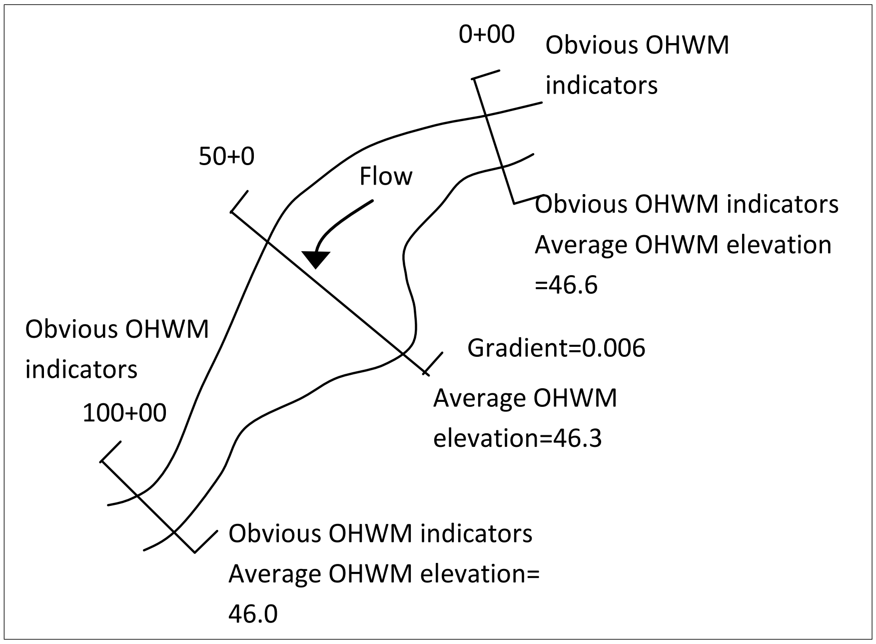


Figure 3-7: Making determinations where channel confinement changes or indicators are not available on site.

Channel patterns often dictate where the OHWM will be found and where to look when making field determinations. These relationships are summarized in Table 3-1 below and should be considered before completing the field survey.

Table 3-1: Location of OHWM in relation to channel pattern

(Supporting figures are in Appendix E.)

Channel pattern	OHWM location
Straight—single channeled, sinuosity < 1.5, alternating bars.	• The OHWM is along main channel based on high water stage, soil, and vegetation.
Meandering—single channeled.	• OHWM is at top of bank on outside meander bend. • OHWM extends across point bar & active floodplain as determined by soil and plant indicators.
Meandering—oxbows, secondary channels.	• Secondary channels may have flow in them below the OHWM and/or form associated wetlands. • The OHWM is measured on the outside of the secondary channels that have flow during OHW events.
Multiple channels not vegetated—braided.	• On the banks forming the outer limits of the depression within which the braiding occurs
Multiple channels, vegetated—island braided	• As above • OHWM changes over time and space. • Some islands maybe above OHWM and require their own OHWM.
Wandering—multiple channels; may be migrating and avulsing. Often include meandering, braided, and island-braided patterns within a reach.	• Secondary channels, associated wetlands, islands may be within the OHWM. • OHWM can rapidly change during floods.

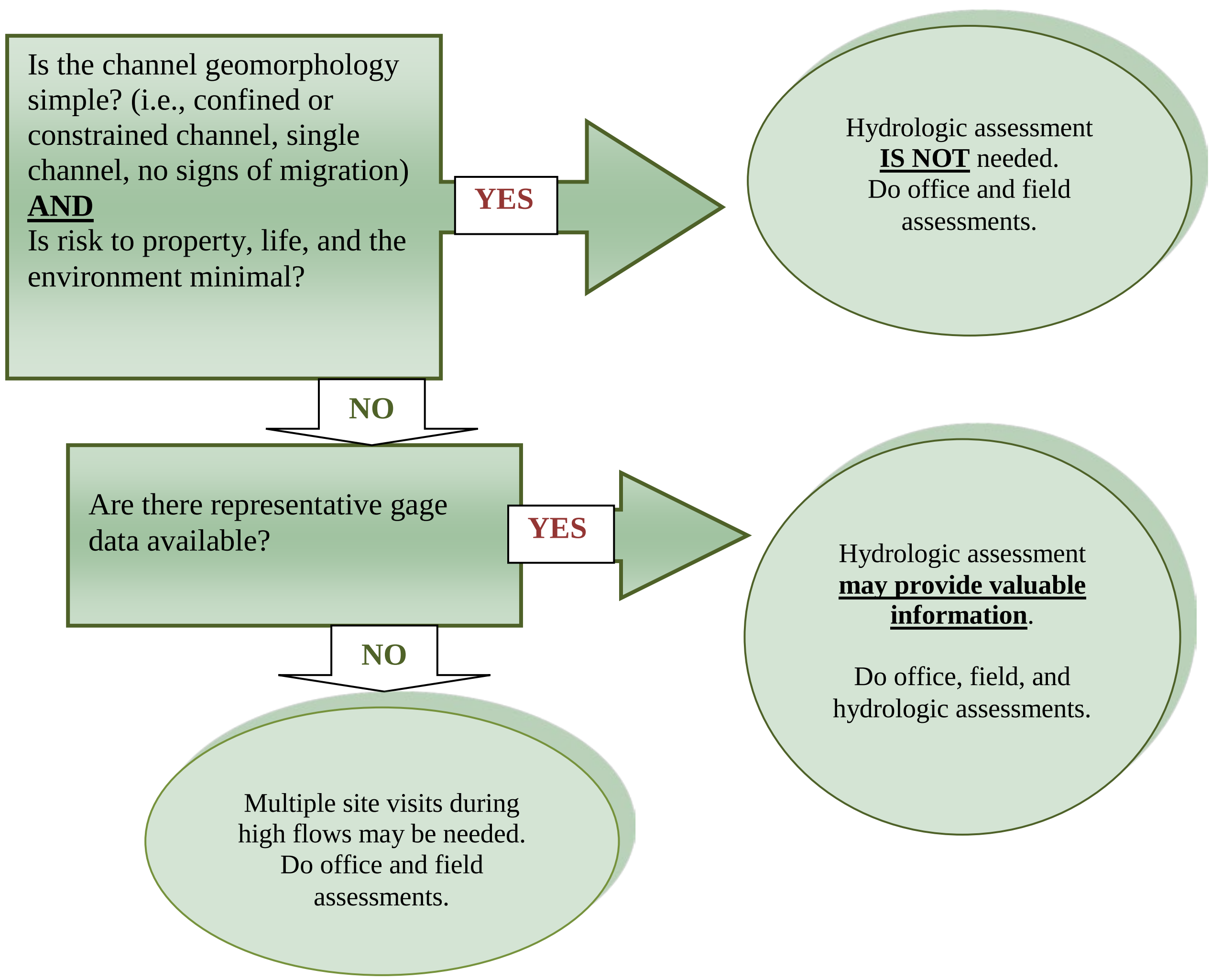
A thorough office assessment can greatly benefit the effectiveness of the field survey, both for choosing potential locations for survey work and improving interpretation of site conditions.

Reporting recommendations from the office assessment:
- Site description, project proposal, land ownership.
- Summary of landscape and geomorphologic conditions.
- Floodplains, flood history, wetlands, and soil survey.
- Copies of photos and maps used (including vicinity map).
- Data sources.
- Any observed special conditions.

Importance of hydrologic assessment

Assessing hydrologic characteristics in relation to the OHWM is not required, but we recommend it. Ecology, in most cases, uses hydrologic assessment methods to help determine the stream OHWM. Using available hydrologic data is similar to evaluating lake water levels or marine tidal datums for those shoreline water body OHWM determinations. The method Ecology uses is described in Chapter 5. Where appropriate hydrologic data are available, they can provide information on recent high-water events with water stages greater than the OHWM water stage, possibly obscuring field indicators. Additionally, hydrologic information also indicates where the OHWM might be in relation to the water stage on your site visit day. For example, if the stage is above the expected OHWM elevation, you should reschedule your site visit for a lower water level when indicators are more likely to be visible. In combination with the water gage stage data, it provides a rough estimate of how much higher or lower in elevation you should be looking for OHWM indicators.

However, not all sites have suitable hydrologic data. In addition, hydrologic assessments do not add value at some sites because of simple geomorphic characteristics and lack of hazards. The chart below guides the user in deciding when a hydrologic assessment is useful. Questions based on geomorphic conditions, hydrologic data availability, and potential hazard to resources, environment, and infrastructure, provide the decision points. Sometimes, where sites are complex or controversial or if proper gage data are not available, multiple site visits, including visits during high flows, may be useful.



Conducting a hydrologic assessment

Although the SMA definition of OHWM requires the use of field indicators, an assessment of hydrologic data can be quite useful when determining the OHWM. In its most practical application, hydrologic data can provide additional context to the occurrence of peak flows above and below those that create the OHWM. In addition, analysis of recent flows could reveal that high-flow events may have obscured OHWM indicators, resulting in incorrect delineations or that an OHWM may be inundated on the day of a planned visit. Hydrologic information can also be used to schedule field efforts for a period near the time of year when a flow that creates the mark on the soil in respect to vegetation may occur. *Instead of repeating the last phrase, we will use the terms ordinary high water (OHW) event, flow, or stage to simplify the phrase: "the presence and action of water that creates the mark on the soil in respect to vegetation."* The ordinary high flow or stage is .-8the stream flow associated with the OHWM for the stream.

Similarly, the data can be used beforehand to determine how the flow observed on the field day relates to flow events that may create the OHWM. This in turn can guide where to look on the bank for field indicators. If discharge (or flow) data have corresponding stage data, then they can be used to estimate the expected elevation of the OHWM relative to that day's water level. For example, the data may suggest the OHWM is roughly four feet above the water stage on the field day.

Hydrologic analysis can be used to crosscheck results obtained using other indicators when soil and vegetation indicators have been obscured by development and landscaping. When there are no clear indicators on the ground then the RCW requires using the line of the mean high water. The gage discharge and stage data provide information to determine the mean high water line. In addition, in complex cases or cases where there may be extra scrutiny of the determination the hydrologic data can provide corroborating information that supports results from field indicators.

The following methods describe the use of gage data to approximate the range of potential OHW flow and associated stages. The methods can be applied even in circumstances where the gage data are not from the specific reach or stream the project site is on. This is because the primary objective is to understand how recent peak flow events relate to OHWM and to use that knowledge to either schedule the field survey or relate field survey results to those high-flow events that create the OHW stage. The methods generally require 10 years of gage data for the subject stream or a nearby, reasonably analogous stream. Real-time gage data are preferred for this method. Important: these methods cannot be used to establish accurate water surface elevations at the site unless the gage is in close proximity and elevations can be tied to the elevations at the gage; however, these methods can generally inform where to look on the streambank for OHWM indicators relative to current water levels.

Please note that precipitation information typically will not be a fitting surrogate for evaluating occurrence of OHW events. The precipitation event recurrence interval often does not correspond to high-flow event recurrence intervals because of other variables that influence storm runoff, such as soil moisture content, snow water equivalent, and land cover.

Initial questions to consider when evaluating gage data include:

1. Are there gage data available for the stream?

a. Is the gage in the same reach as the project?

b. Are there up- or downstream regulating devices (dams, diversions, etc.) that may be impacting or controlling water levels?

c. Are there tributaries that will confound the gage data?

d. Does it have at least a 10-year period of record?

2. If there are no gage data for the stream, where is the closest or most comparable gage site with at least 10 years of data[14]? Comparable refers to a gage that is proximal and located in a hydrologically similar reach or watershed. Also, when assessing suitability of an off-stream gage, consider factors that may cause spatial and temporal variability within a watershed and a stream's response to precipitation:

   a. See "b, c, and d" above.

   b. Slope and aspect of the drainage: steeper drainages may respond differently to storms than lower gradient streams; storm precipitation that occurs on one aspect may not occur on another aspect.

   c. Drainage basin size: streams with smaller watersheds may respond more often with relatively greater magnitudes to storm events than streams with much larger watersheds to the same storm event.

   d. Dominant source of peak flow: rain-dominated streams will respond differently to storms than streams located within the transitional snow zone (rain-on-snow), or snow zones.

   e. Watershed development and existing vegetation: Urban streams will respond more often and quickly to storm runoff than rural or forested streams.

Hydrologic Assessment Step 1: Use gage data to approximate upper and lower extremes for OHW flows

Flood recurrence and daily flow statistics can be used to predict a wide but reasonable range of discharges that should encompass the OHWM flow. Once determined, the minimum and maximum values of this range are used to inform on-site OHWM delineations. These "bookends" can be generated with variable levels of effort and accuracy.

Simple

In Washington, the two-year peak flow recurrence interval (or the peak flow that has a 50 percent probability of occurring in any given year; also called median peak flow or 50 percent probability peak flow) provides a reliable upper limit of the OHW flow range, while the 1.01-

[14] If there are gages with records longer than 10 years, use them if they are comparable.

year recurrence interval peak flow (i.e. 99 percent probability of occurring in any given year or a peak flow that is exceeded 99 years out of 100) provides a lower-flow limit for the range.[15]

- Retrieve the maximum annual peak flow data (called "Peak Streamflow") for the most proximal on-stream gage. Data can typically be accessed at the U.S. Geological Survey (USGS) water data website. (See Appendix C for web links to gage data.) The entire period of record should be assessed for this analysis.

- Generate the upper bookend by estimating the two-year peak flow (or peak discharge) for the dataset. This can be accomplished either by graphing or calculating the flow directly from downloaded data.

    - Figure 3-8 shows an example graph of the peak annual discharge data as downloaded from USGS. Count the total number of points on the graph (i.e., number of years in the period of record), divide the sum by two, and place a line at the quotient value, which will equally divide the points. In Figure 3-8 there are 60 points; therefore, a line that marks the 50 percent probability will have 30 points at or below and 30 points at or above the line. The solid line at approximately 3,900 cfs shows this. This can also be done more simply but less accurately by visually estimating the placement of the line.

  Alternatively:

    - The two-year peak flow can be calculated by downloading the peak-flow data into a spreadsheet and using the "median" function for all the peak discharge values in the dataset. The calculated median is 3,870 cfs.

  Alternatively:

    - The already calculated two-year peak flow can be accessed for many stream gages in Washington using the USGS StreamStats for Washington's interactive map. The interactive map can be used to aid in finding a useful stream gage and can be used to access stream gage statistics. In the map, click "Zoom to," "Streamgage" and enter the desired stream gage. Use the "identification" tool and click on the zoomed stream gage. Click on the "Site Number" link and the "Data-Collection Station Report" will pop up, which gives a number of hydrologic statistics (the "NWIS URL" link will also bring up all available data for the selected stream gage). The two-year peak flood flow found in StreamStats is 3,810 cfs. (The difference is due to StreamStats using a bit older data.)

[15] In most Ecology-determined stream OHWM cases, the discharge or stage associated with the OHWM is greater than the 1.01-year peak flow. The 1.25-year peak flow/stage has generally been found to be closer to the lower OHWM boundary. We use the 1.01-year to allow for variation.

- Generate the lower bookend by determining a value that is near the 1.01-year peak flow. Again, this can be accomplished either graphically or by calculating from downloaded data.
    - Using the peak annual discharge plot created for the upper bookend, find the lowest peak flow in the record. This will typically be a higher value than the actual 1.01-year peak flow, but is often a reasonable alternative to calculating the 1.01-year peak flow. See Figure 3-8 visually showing a minimum peak flow of about 800 cfs.

Alternatively:

- Using the spreadsheet from the upper bookend calculation, utilize the "min" function for all the peak discharge values. This returns a value of 766 cfs. Again, the value will likely be higher than the actual 1.01-year peak flow.

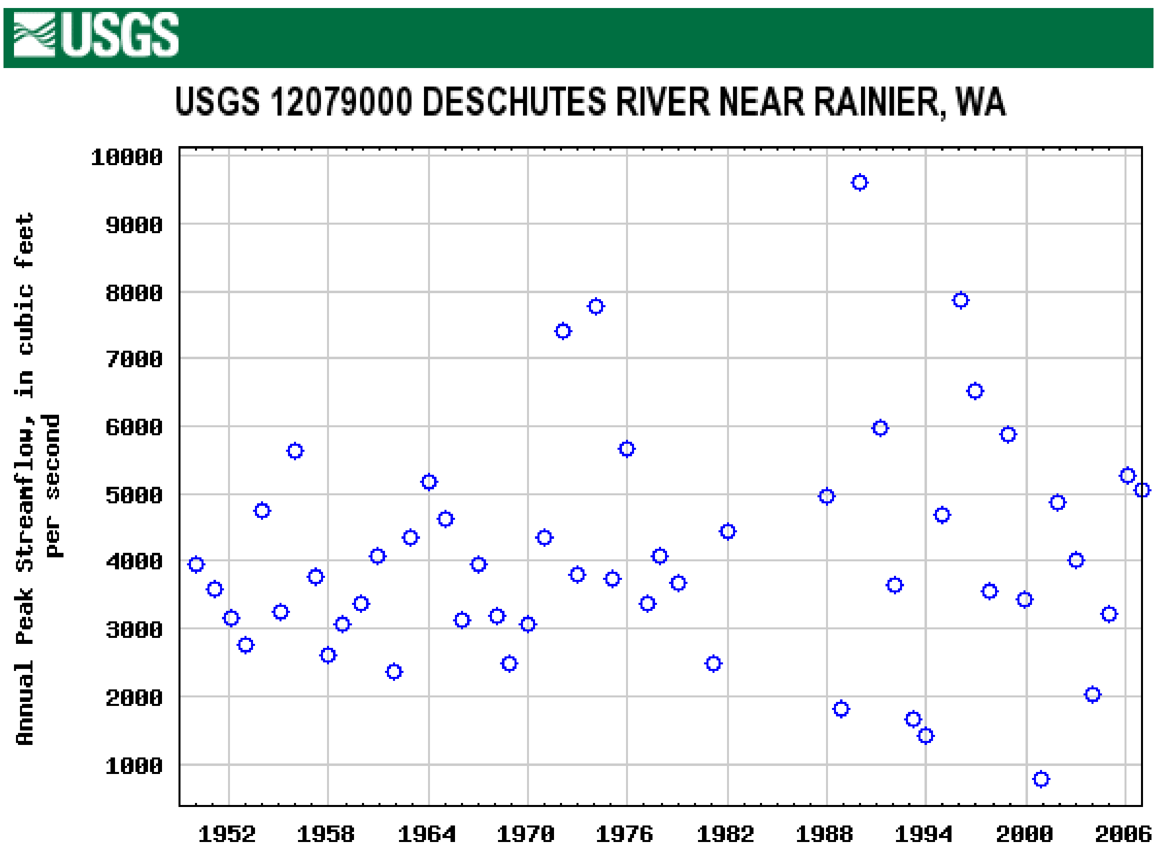


Figure 3-8: Hydrograph of the maximum peak annual discharge data for the Deschutes River illustrates the relation of the 2-year and 1.01-year peak flows to all peak flows.

Refinements
While the above-generated bookends are valid and helpful, there is often a large difference between the simple lower and upper bookends, such as shown in Figure 3-8. This wide range results in a large area of concern (vertical range) on the bank during the actual site visit. The difference between the bookends (and the size of the area of concern on the ground) can often be reduced by considering daily mean discharges in addition to the annual peak flows.

The refinements selected below should be chosen/pursued based on the user's level of expertise and abilities to comfortably/competently perform the techniques offered.

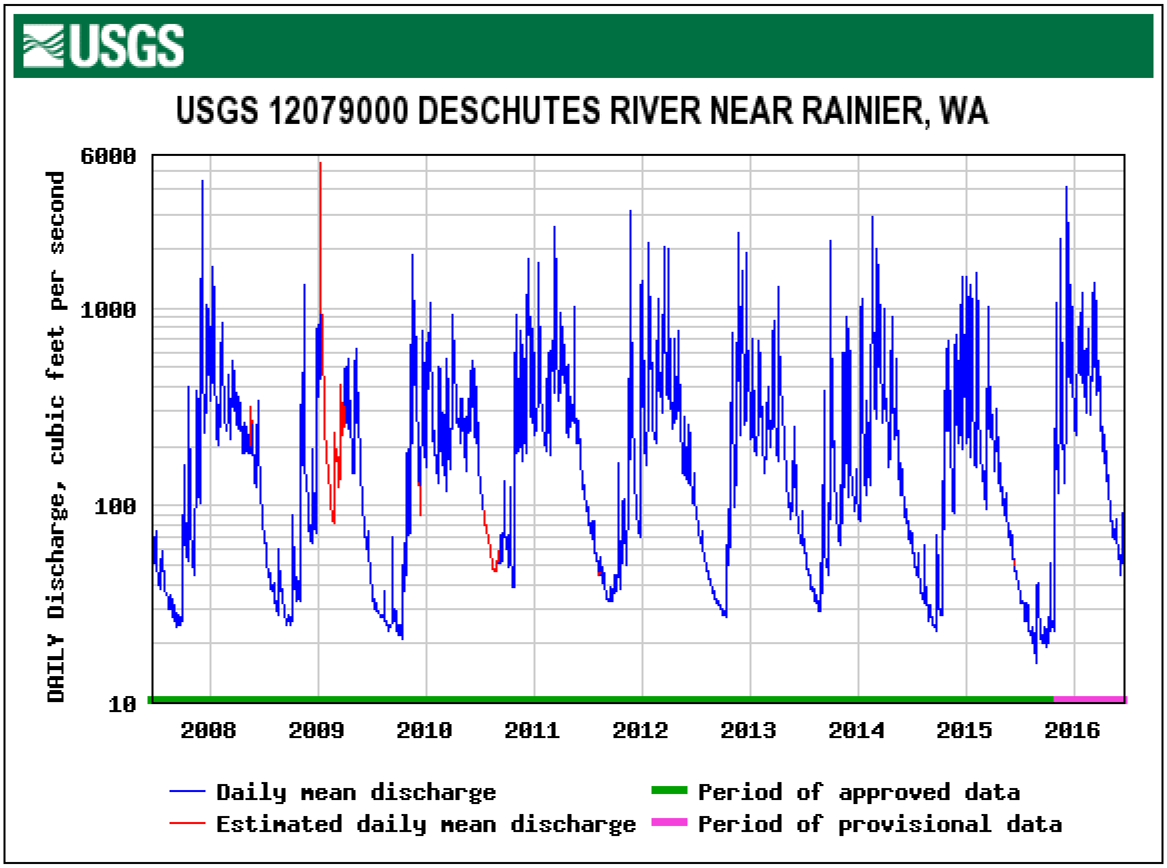


Figure 3-9: Example of graphed 2-year (purple line) and 1.01-year (green line) peak flows superimposed on the daily discharge hydrograph for the Deschutes River. The graph indicates that the 2-year peak flow does not occur in at least 60% of the years and should be adjusted downward to the new value (purple line). The 1.01-year peak flow value visually falls where longer-duration events occur, suggesting reasonable placement.

As can be seen in Figure 3-9, comparison of the peak-flow generated bookends above to daily mean flows typically will reveal that the upper bookend (two-year peak flow) is relatively high and that the lower bookend is often (but not always) too low.

To be refined but safely above the mark on the soil with respect to vegetation, the upper bookend flow is reduced to a flow value that is exceeded at least once each year in 60 percent of years (i.e., the flow should be equaled or exceeded in six out of 10 years). Conversely, the lower bookend can be safely adjusted upward or downward to a value that is exceeded by longer-duration (approximately seven consecutive days) events occurring in 60 percent of years. The reasoning here is that a high flow occurring in one-day events in six years out of 10 likely will not make a mark on the soil, and lower high flows that occur in most years for durations exceeding seven days would be considered common and below the expected location of the OHWM (i.e., the bank location associated with these flows would be commonly inundated). Additionally, they should have a continuous duration sufficient to create a mark on the soil with respect to vegetation. In Washington this duration ranges from three to seven consecutive days. High flows that occur for durations less than 3 days likely will not leave a mark.

- The upper bookend can be refined (typically lowered) by recognizing that the OHWM will be created by high flows that occur regularly.

    - From the same gage as used above, generate a plot of daily mean discharge data for the past 10 years (longer periods are preferred if there are no increasing or decreasing trends in the data; however, an acceptable mix of low and high years is usually represented within a decade of data). On the graph of daily data, place a line at the value for the two-year annual peak flow value generated above. If the placed line is not exceeded in six out of the 10 years, then it should be visually lowered until reaching a high-flow value that is exceeded in six out of the 10 years (or 60 percent of the total years graphed). The discharge that corresponds with the newly placed line will represent the new, refined upper bookend. Note in Figure 3-9 that the revised upper bookend has been visually lowered to a value (about 2,500 cfs) that is exceed in six out of 10 years.

Alternatively:

    - The upper bookend refinement may also be calculated. From the same gage as used above, download daily discharge data for the past 10 (or more) years into a spreadsheet. Determine the highest discharge value that is exceeded in at least six of the 10-year dataset. This can be accomplished by separating the data for each year in the record and determining the highest flow that is exceeded in 60 percent of the years. An iterative process may be necessary to refine a value that is exceeded at least once (but no more than a few times) a year in 60 percent of the years selected. The calculated value for the same dataset used in Figure 3-9 was found to be 2,400 cfs.

- Refinement of the lower bookend is not always necessary. Often the lowest high flow in the record is a viable lower boundary. However, if it is noted that this lower bookend is exceeded in nearly every year by long-duration (>seven-day) events or if it is rarely exceeded by seven-day events, the lower bookend can be adjusted (raised or lowered) to a value where it is exceeded in most years (six out of 10) by events with approximately seven-day duration.

    - The lower bookend should be visually adjusted, either lower or higher, to a flow value that is exceeded by longer-duration events in at least six out of 10 years. In Figure 3-9, the lowest peak flow of 766 cfs (the green line approximating the 1.01-year peak flow) appears to be exceeded by longer-duration events in most, but not all, years (appears to be out eight out of 10). This suggests that the lower bookend is reasonably well placed and no adjustments are necessary.

Alternatively:

- The lower bookend placement (seven-day duration occurring in six out of 10 years) can be calculated; however, the methodology is a bit more complicated and is covered in "Further Refinements" section below. The calculated value for the lower bookend in Figure 3-9 is 740 cfs, confirming that the 1.01-year flow with visual validation is adequate.

Further Refinement
Based upon the knowledge and experience of the person performing the hydrologic analysis, there are additional methods and calculations that can be performed to substantiate the bookends generated above or to further refine the range between the bookends.

- To refine the upper bookend, it should be recognized that a two-day duration event occurring six out of 10 years, like one-day event, likely will not have the regularity and/or duration to create an OHWM, thus this event's value can be used as the upper bookend. This value is more difficult to estimate visually, thus calculation of the value is preferred.

  - Download mean daily flows from the same gage into a spreadsheet. The data should be separated by year. "If" statements can be used to test the number of times in each year that a flow value was exceeded and to find the number of times in a year that the same flow value was exceeded for two consecutive days. Through an iterative process, the flow value can be adjusted until results show that it was exceeded for two consecutive days at least once a year, but not more than a few times in a year, in exactly (if possible) six years out of the 10-year record.

- To further refine the lower bookend, it should be recognized that, as stated above, a flow value that is exceeded for seven consecutive days in most years is likely too low to create a transitional mark on the soil. It is expected that inundation at this regularity and duration would result in morphology typically found well below the OHWM. Thus, this value is a trustworthy lower bookend. Again, this flow value is difficult to estimate visually, and calculation is the preferred method.

  - Download mean daily flows from the same gage into a spreadsheet. The data should be separated by year. "If" statements can be used to test the number of times in each year that a flow value was exceeded and to find the number of times in a year that the same flow value was exceeded for seven consecutive days. Through an iterative process, the flow value can be adjusted until results show that it was exceeded for seven consecutive days at least once a year, but not more than a few times a year, in exactly (if possible) six years out of the 1-year record.

- Another approach to set the initial bookends is to use calculated hydrologic statistics, such as the three-day and seven-day, 10-year maximum discharge rates, and to plot these against the daily discharge record. (This can be done instead of, or in addition to, the comparison to two-year and 1.01-year peak flows described above.) Then, follow the same process of considering each of these hydrologic statistics with whether it occurs in 60 percent of years to find a flow that best fits this recommendation for estimating the upper and lower bookends (Figure 3-9).

Additional Methods/Calculations

There are a number of acceptable methods that can be used to generate bookends. The goal is to determine a reasonable range/area on the ground to inform the more important field assessment.

Other calculations may be beneficial in assessing streamflow characteristics. A relatively quick and easy peak flow calculation is the recurrence interval.

The recurrence interval (in years) for any flow within the dataset can be calculated using the peak flow data and the equation RI = n+1/m, where n is the number of years of peak flow data and m is the flood rank, based on magnitude of flow, from highest to lowest (e.g., the largest peak flow will have an m = 1). To determine the two-year peak flow (or 50 percent probability peak flow), the equation m = n+1/2 should be used to determine the value of m. The flow value corresponding to the calculated flood rank (m) is the two-year flow. Note that if m is not a whole number, then the flow from the flood ranks immediately above and below the m value should be averaged to determine the two-year peak flow. In Figure 3-8 there are 60 points, thus n=60. Using the equation above, m=60+1/2 = 61/2 = 30.5. Since 30.5 is not a whole number, the flow values corresponding to m = 30 and m = 31 should be averaged to derive the two-year flow, which for this dataset is 3,870 cfs. If desired, the entire set of peak annual flows can be subjected to the equation above to see the recurrence interval for all peak flow. The probability of each flow can be determined using the reciprocal of the recurrence interval (e.g., Probability = 1/RI x 100%, or the equation P = m/(n+1) x 100%). Please refer to appropriate references to learn more about calculating median and other statistical flow analyses.[16]

Hydrologic Assessment Step 2: Convert discharge to stage

Stream "stage" is defined by the USGS (http://water.usgs.gov/edu/qa-measure-streamstage.html) as "the water level above some arbitrary point, usually with the zero height being near the river bed, in the river and is commonly measured in feet." The purpose of converting discharge to stage is to give an idea of where to look on the ground for OHWM indicators relative to the water surface; to narrow the area of focus on the ground. Stage data provide information to improve focus on the ground. A very useful aspect is that it can be used to estimate how much higher in elevation the bookends (thus the OHWM) should be than the water level during the site visit. This method is most reliable when the site is close to the gage used for generating bookends and has similar channel geometry to the gaged section. However, it can still provide a coarse screening tool at more distant and off-stream sites allowing the site reviewer to look in more focused areas for OHWM indicators.

- Discharge data may be correlated to stage data by various methods.

---

[16] The equation suggested works for evaluation return frequency or probability of occurrence for frequent, small magnitude peak flows. Other methods are recommended for less frequent, higher magnitude floods, such as the 1% probability flood, especially when extrapolating data to these floods.

- The stage associated with the bookend flow values can be determined visually. Generate a graph (either within the USGS website or in a spreadsheet) for the same discharge data from the same gage and same date range as utilized earlier. Again, this should be at least the most recent 10-year period. Generate a graph of corresponding daily stage data. Place the stage hydrograph directly below the daily discharge hydrograph, where the dates are lined up as closely as possible (see Figure 3-10). Locate peak flow points on the daily discharge hydrograph that equate to the chosen upper and lower bookends. From prior work, the one-day maximum flow occurring in 60 percent of years is approximately 2,500 cfs. Figure 3-10 shows the corresponding stage would be visually estimated to be approximately nine feet. The lower bookend from above (the 1.01-year flow) is approximately 766 cfs. Note that there is not an obvious peak in the daily discharge graph that is at 766 cfs, therefore an peak near (preferably below) 766 cfs should be selected. There are two peaks at 700 cfs, which are correlated to a stage of about 5.3 feet in the stage graph below. It should be noted that the USGS ceased collecting stage data in 2009, thus the data range selected for this exercise was adjusted to capture the 10 years prior to the final stage reading. In addition, please note that these are estimates only, designed only to inform the site visit, and that unusual circumstances such as this will often be encountered. One should only expect a reasonable level of accuracy.

Alternatively:

- Daily stage data may be downloaded and aligned by date in the same spreadsheet as utilized above. The stage (in feet) corresponding to the nearest bookend discharge values (in cfs) can be found.

- An additional method is to download the daily discharge and stage data and produce a stage-discharge curve and equation. Then, the discharge for the upper and lower bookends can be calculated from the regression equation.

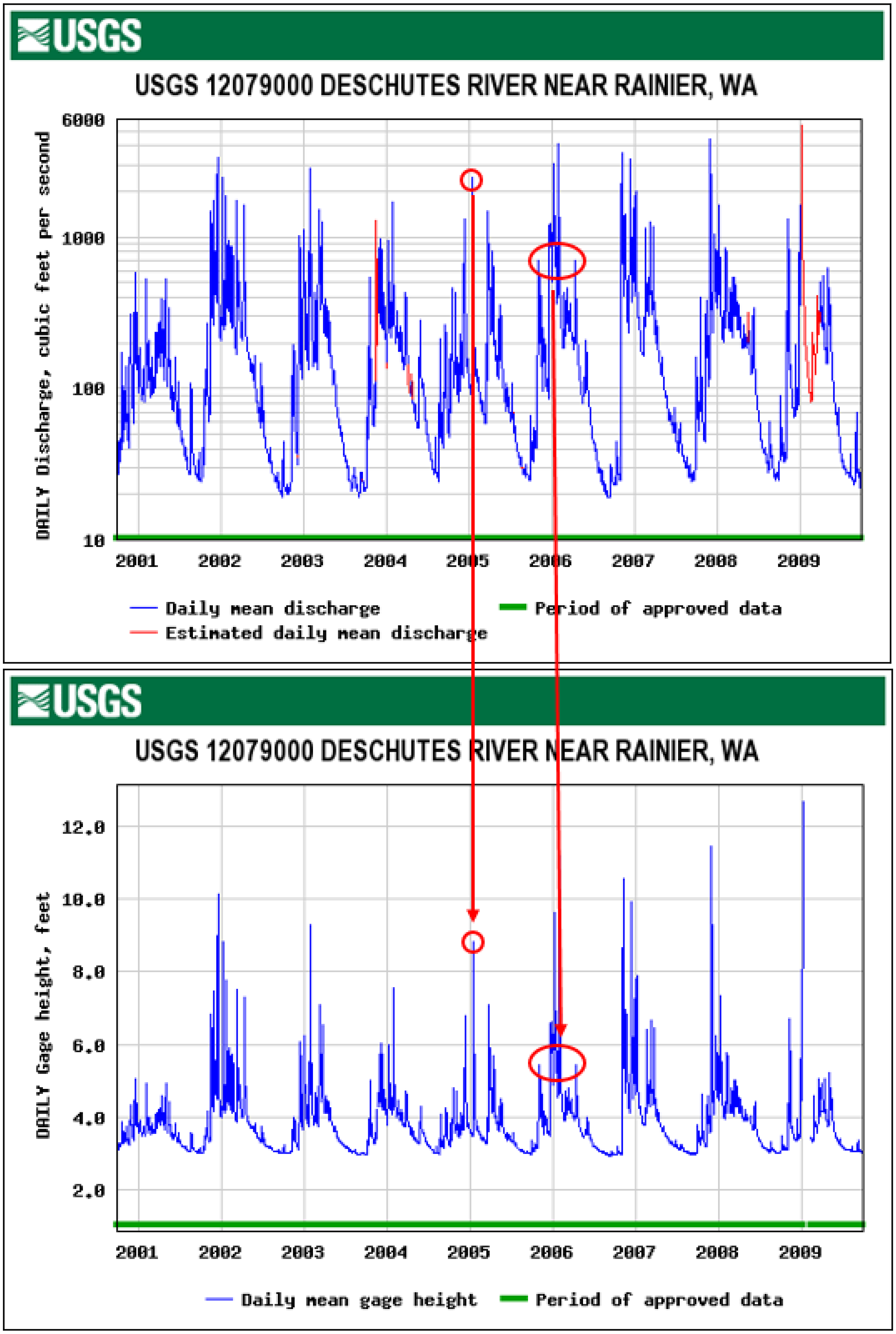


Figure 3-10: Stage for the previously determined flow "bookends" is visually estimated by aligning the stage (gage height) graph with the discharge graph.

- For sites with proximal on-stream gages, the estimated bookend stages can be used to guide site assessment to a range within which the OHWM will usually be found.

    - Understanding that the stage is typically measured from a point near the riverbed, during the site visit the reviewer should focus on the bank between the estimated stage heights (vertically above the streambed). For the example above it would be expected to find the OHWM between about 5.5 and 9 feet above the streambed.

    - Often times the location (elevation) of the streambed is obscured by the water in the stream. This can be overcome by review of real-time gage/stage data prior to visiting the site. If the stage for the example above was found to be three feet immediately prior to the site visit, then the bookend range would be between about 2.5 and 6 feet above the stream's water level when on site.

- For sites that are distant from a gage or are on an ungaged stream, the discharge and stage bookends can still be useful. Recognizing the inexactness of bookend locations for gaged reaches, it should be understood that for ungaged reaches the bookends will be less reliable. However, with some minimal calculations, useful generalities about flow and stage at the subject site might be formulated.

    - Select a surrogate stream gage. The most important factors in selecting a surrogate gage are proximity, gage drainage area relative to site drainage area (site drainage area can be determined in the USGS StreamStats program – the ratio between the site and the selected gage should be between 0.33 and 3), geology (should be similar), and whether one or both are regulated or are near a tributary that might affect the data.

    - Determine the bookend flows for the surrogate gage. It is acceptable to proceed to Step 3 below and assume that findings for the surrogate gage will apply to the subject site.

    - Additional information may be gathered by performing a drainage area ration calculation between the site and surrogate gage. Calculate the discharge bookends for the selected surrogate gage. Multiply the gage bookends by the drainage area ratio between the site and gate to approximate bookend flows at the ungaged site. Considering that channel morphology between the subject site and gage may be drastically different, a conversion of discharge to stage at the gage may be of little worth. However, simply knowing the difference in height from the streambed to the two bookends at the gage may provide some general awareness of where to look for OHWM indicators at the site. This may be of particular benefit when considering flows and stage on the day of the site visit (see Step 3 below).

Hydrologic Assessment Step 3: Compare recent events to OHWM bookends
The last step is to evaluate flows and stage estimated in Steps 1 and 2 against recent gage data and determine whether an OHWM-related discharge has occurred recently, which may have left fresh indicators on the land.

Graph daily gage data from the previous 12 months (either within USGS website or downloaded to a spreadsheet). Note whether the OHWM discharge bookends have been met or exceeded. OHWM discharge bookends might not have occurred within the previous 12 months. In this case, use the 10-year daily data to identify the last time they did occur. Factor this into evaluating field indicators.

Reporting recommendations:

- Gage location information and relationship to project site.
- Gage data, its period of record, and the portion of the record used for the analysis.
- Graphs and calculations.
- Relationship of flows observed during the field day(s) and the estimated OHW.

Also, note all events that exceeded the OHWM upper bookend. Consider what this means in terms of field indicators and whether field indicators from the most recent peak flows might be close to the OHWM. Peak flows significantly higher than the OHWM upper bookend may have masked field indicators of the OHWM. In both cases, the stage data may provide more information than discharge data.

On the field day, check real-time flow and stage data for the previous 30 days. Again, use this information to guide the field survey and develop an understanding of whether field indicators from the most recent peak flows might be close to the OHWM or might mask the OHWM. This method will work for most single-channel streams. Additionally, if the flow/stage on the day of the site visit exceeds the bookends or is very high within the bookend range, then it might be good to cancel the site visit, as the OHWM indicators might be submerged.

Keep in mind, the method may not work for more complex sites or situations, such as for streams that are actively migrating, aggrading, or degrading. In these cases, multiple field surveys may be needed and should, if possible, be scheduled during periods when flows are at or near the OHWM bookends. Sites that are more complex may also require mapping cross-sections of the floodplain and hydraulic modeling. These methods are not included in this guidance but will be addressed in future guidance.

3.4 Field Assessment

After establishing a basic understanding of site conditions from photos and maps, a field survey can be scheduled. The following chapter provides guidance on general site observations and the use of soil, vegetation, and other indicators to determine OHWM. The basic intent of the field assessment is to develop and follow an orderly approach to making an OHWM determination. The method described below relies on development of site transect or profile information as a means of establishing a defensible OHWM delineation. In easier cases with a few strong indicators that support one another the field component may be simple, and the detailed process outlined below may not be necessary.

As stated previously, the method followed should be driven by site needs. More rigorous methodology and documentation may be needed for sites where the determination is difficult and the site is complex or the project is controversial. Several field visits (at different times of the year, and optimally after a high flow) may be necessary. Additionally, collection of transect information is recommended for difficult sites. Use of hydrologic data are recommended and may be required for sites that are more complex.

An assessment of hydrologic data can also make the field assessment more effective since these data can be used to develop an understanding of the timing and elevation of flows that create the OHW stage and recent higher flow events. This information can provide clues to on-site indicators. For example, it can be used to decide whether an OHW event or a peak flow of higher magnitude occurred recently or whether a prolonged drought may be influencing deposition or vegetation patterns. The information can be used to schedule the field survey during—or recently after—high flow events occurred.

General observations

Record preliminary observations of the site on the field survey form (Appendix A). Photo documentation of relevant features is strongly recommended.
Some questions to consider include:

- Have there been any recent disturbances in the project area (for example, flooding, channel movement, bank erosion, fire, over browsing, or grazing)?
- Are there any visible diversions or channel control structures upstream that may not have been identified on aerial photos?
- Are there bridges, railroads, road embankments, or other features that constrain the channel? Are the constraints permanent and publicly maintained?
- Is there tidal backwater that influences stream elevations?
- Are there livestock or domestic animals in the riparian zone?
- Is there any riprap or other bank armoring upstream or downstream?
- Are beavers active in the area?

Identify lower and upper boundaries of OHWM using transect(s):

- Set up transect(s) from the water's edge to the upland.
- Identify vegetation and soil indicators along transect starting at water's edge.

For difficult or contentious sites it may be useful to set up one or more transects on the site to evaluate, map, and organize observations to identify indicators that can be used to set the upper and lower bounds (or bookends) of the OHWM.

Keep in mind, the definition of OHWM should be interpreted with the "abutting upland," not the abutting riparian community, which can include wetland areas.

Vegetation and soil may be absent or highly altered, especially during certain times of the year, making it more difficult to find and interpret these indicators. However, where vegetation does provide adequate indicators, the following transect method can be used. Otherwise, search for other indicators. As additional indicators are identified, the upper and lower boundaries (bookends) defining the changes in the vegetation community can be moved closer. Remember, the OHWM is not necessarily a tight line but rather a band that can be many feet wide.

The level of effort should be commensurate with the complexity of the site and the ecological significance of the determination. This step outlines a general approach to reviewing the study area. Please scale your effort accordingly. A complex site may suggest a detailed tape-measured transect; a simple site may merit a hand-drawn map with approximate measurements and photo documentation.

If the OHWM indicators are obvious, like clear vegetation changes or repeated depositional wrack lines, and they are continuous across the landscape at a specific elevation, then transects between upland and the OHWM are probably not necessary. If, on the other hand, there are various contradictory indicators and the line appears to jump up and down the bank, then transects are a good way to collect data that can be used to determine a consistent OHWM on your site.

Field verification of preliminary OHWM determination[17]

1. Starting at the water's edge, walk the scoured channel and floodplain within the study area to get a general impression of the vegetation communities, soil, and geomorphic features (e.g., breaks in slope, sediment texture) present at the site. It may be helpful to have an aerial photo in hand to orient yourself. Refer to the end of this chapter for narrative descriptions of indicators to consider. Note any potential anthropogenic influences that may affect indicators, such as clearing, filling, upstream diversions, etc.

> When using vegetation as an indicator, use vegetation **communities** not the occurrence of individual plants.

2. Locate the scoured channel (lowest part of the channel). There may be more than one, separated by islands or bars. Note plant species by strata and note size, growth form, and height or thickness of stems or trunks.

3. As you move through the site, draw a rough cross-sectional profile of the reach, noting the scour line, bank, side channels, multiple channels, islands, bars, depressions, terraces, benches, and other floodplain features, as follows:

[17] This field assessment section is adapted in large part from the field procedures outlined in Lichvar & McColley 2008.

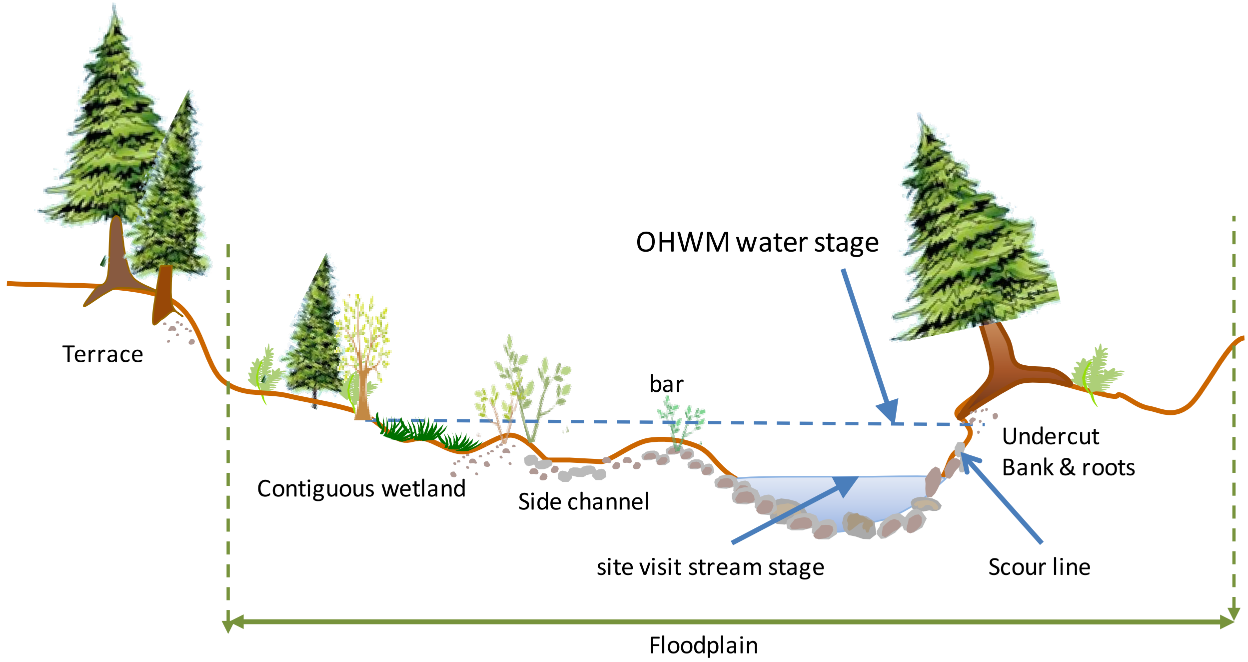


Figure 3-11: An example cross-sectional profile illustrating some channel and floodplain features.

4. Stand at the wetted channel edge and walk away along a cross-section perpendicular to the channel. Identify the transition area between the channel and the active floodplain. Look for a change in vegetation age class or growth form and/or species composition, as well as a change in sediment texture and a break in slope. Look for changes in percent cover of vegetation and previously deposited organic debris. Note changes in sediment deposits (grain size, color) at obvious locations along transect.

5. Describe the general characteristics of the active floodplain, including the percent cover of vegetation, species composition, and the approximate stand age (early successional to mature).

6. Continue walking the cross-section away from the channel. Record indicators of the active floodplain/low terrace boundary. Walk the active floodplain/low terrace boundary both upstream and downstream of the cross-section to verify that the indicators used to identify the transition are consistent in both directions.

Upland vegetation (or other clear indicators of upland edge) should dominate the upper edge of the riparian zone. The end of this chapter contains a list of potential indicators to set the upper edge of this zone.

7. Document plant communities and relative elevations at various locations along the transect with photos, sketches, and notes. Identify dominant and subdominant plants and percent vegetation changes from the water's edge to the clear upland areas. Document the vegetation strata (forbs, grasses, shrubs, and trees), age, vigor and height. Vigor and age are often overlooked as helpful indicators. Look for changes such as stressed plants or recently germinated plants in areas where hydrologic conditions have changed.

8. Note landward limit of flood or overbank deposits, water stains or marks, flood debris and wrack deposits, drainage patterns, flattened vegetation, and other indicators.

9. Determine the bookends for the site's OHWM based on your observations and noted indicators.

Narrow the bookends

After developing the transect information, focus on portions of transects where the indicators are most confusing or where there is less confidence on whether the location is above or below the OHWM. Choose a location where the indicators are strongest. If this is a narrow band and it is reasonable to set the OHWM at the upper edge of this band, choose this point and document the determination. This is consistent with the liberal construction policy of the SMA.

When the band is wide, it may be necessary to do more investigative work. This may involve doing additional transects up, down, and across the stream from the site and/or returning to the site during higher flow events. If there are gage data available from a nearby site, they can be used to further support the OHWM determination.

Once you have documented the indicators and narrowed the upper and lower bookends, you can mark the approximate locations of the OHWM. Make sure you describe the confidence you have in your determination in terms of the reliability of the indicators you used to make your determination. If a survey is needed, hire a licensed surveyor to survey your marked locations.

Reporting recommendations:

- Draw a sketch of the stream's cross-sectional profile.
- Mark the locations of your transects on an aerial photo.
- Document **in the field** the rationale (hydrologic, soils, vegetation, other) used for your OHWM determination. You may not remember it when you get back to the office.
- Include photo documentation of indicators observed.

Summary of Key Field Indicators with Descriptions

Indicator	Description	Landscape Position			Relation to OHWM		
		channel	bank	flood-plain	below	straddle	above
Sediment bars	Sediment deposition forms bars in stream channel.	✓	✓		♦		
Scour line	The landward evidence of frequent sediment transport indicated by the upper line in a streambed swept clean by a frequent swift current.	✓			♦		
Clean cobbles/boulders	Indication of a channel process that prevents accumulation of coarse sediment.	✓			♦		
Bank erosion/channel scour	Signs of erosion by water on bank or edge; often represented by the line between perennial vegetation and non-vegetated channel or annual vegetation.	✓	✓		♦		
Exposed roots/root scour	Exposure of tree and shrub roots from erosive flows.		✓	✓	♦		
Stratified sediment deposits	Channel processes that sort and wash large cobble, rubble and gravel, and/or floodplain overbank deposits created by vertical and horizontal accretion during floods.			✓	♦	♦	
Flood or overbank deposits	Material deposited during flood event.		✓	✓	♦	♦	♦
Top of bank	The intersection between the bank and the more level valley surface or higher magnitude floodplain.		✓				♦
Water stains/marks	Discolorations or stains on tree bark, rocks, bridge pillars, other fixed objects.	✓	✓	✓		♦	♦
Sediment lines/flood lines	Silts, sand or small gravel that mark the edge of recent high water events; an indication of ponded conditions.		✓	✓	♦	♦	♦

Summary of Key Field Indicators with Descriptions							
Indicator	**Description**	**Landscape Position**			**Relation to OHWM**		
		channel	**bank**	**flood-plain**	**below**	**straddle**	**above**
Flood debris and wrack accumulation	Debris (trash, leaves, grass, etc.) left on the ground or caught on trees and shrubs from past high water events.		✓	✓		♦	♦
Drainage patterns, flattened vegetation	Flow patterns visible on the soil surface or eroded into the soil; absence of leaf litter.		✓	✓	♦		
Toe of lowest terrace	The toe is the break in gradient between the lowest terrace face and floodplain.			✓		♦	
Hillslope toe	The break in gradient between valley wall and valley floor. Frequent flooding can be what forms/maintains this edge.			✓	♦	♦	♦
Organic soil accumulation	Accumulation of organic matter and duff on alluvial surface.			✓			♦
Juvenile salmonids in floodplain depressions	Juvenile salmonids stranded in floodplain depressions after high flows.			✓	♦	♦	

Chapter 4 – Tidal Waters

4.1 Introduction

All tidal waters in Washington, encompassing over 2,500 miles of shoreline, are regulated by the SMA (RCW 90.58.030). Washington's tidal waters (marine and estuarine) are a critical ecological and societal asset. Waters of the outer coast and Salish Sea provide critical livelihoods, shipping, commercial and military facilities, in addition to recreational opportunities and aesthetic values. Ecological services include sustaining commercially important finfish and shellfish stocks, habitat for waterfowl and shorebirds, and critical habitat for state and federally listed species, such as orca (*Orcinus orca*) and Chinook salmon (*Oncorhynchus tshawytscha*).

The OHWM on tidal waters represents the mark (biologic and geomorphic) subject to tidal inundation several times per year. Water reaches the OHWM via tidal currents, wave run-up, or wind-driven splash. There are many reasons why it is important to be accurate in determining the OHWM on tidal waters; from a human health and safety perspective, homes built below or too close to the OHWM are at risk of incurring damage during OHW tides or extreme high water events, or homeowners themselves may be injured by wave-driven logs or water (Figure 4-1).

Biologically, even the upper intertidal zone (portion of the beach just below the OHWM) is an important ecological component of the marine ecosystem. For example, surf smelt and sand lance, which are prey for salmon, spawn in many upper intertidal beaches in Puget Sound (Penttila 2007); the nearshore up to the extreme high tide line has been federally designated as habitat critical for the recovery of Chinook salmon (Federal Register, Vol. 70:170, 52630-52858). In addition, development too close to the shoreline may introduce pollution onto marine beaches, such as that from fertilized lawns, septic systems, or oily driveways and parking areas.

In many cases, when homes are built at or below the OHWM, bulkheads become necessary to protect the home and property, and then additional bulkheading becomes the desired standard for that stretch of beach. Bulkheads have a very negative effect on the biological and physical processes of the intertidal zone, possibly for miles up and down the beach. These shore stabilization structures often result in a reduced beach width. Coarse gravels, left behind after the fine sediments wash away from unnatural wave deflection, result in reduced habitat for Pacific sand lance and surf smelt. Beach erosion is also a result of bulkheads cutting off the sediment source of eroding bluffs (Johannessen and MacLennan 2007). By 2005 more than 50 percent of the coastal emergent wetlands and tidal flats in the major deltas of Puget Sound had been lost to diking and in-filling, and between 22 to 37 percent of the shoreline of the main Puget Sound basin had been altered by bulkheads, seawalls, piers, docks, jetties, and other structures (Finlayson 2006).

Determining the OHWM on tidal waters follows the same steps described in the introduction of this manual: conduct an office assessment, hydrologic assessment when appropriate, and visit the site for the field assessment. Tidal data provides important information on historic and predicted water levels; tidal predictions are available for over 150 sites. Tidal observations are recorded at

13 active stations in Washington (http://tidesandcurrents.noaa.gov/). Using tidal data for the OHWM determination is discussed in section 4.2, below.

Figure 4-1: Threats to health and safety by building too close or below OHWM on exposed shorelines. Photo courtesy of Hugh Shipman.

4.2 Defining the Ordinary High Water Mark

As described in previous chapters, the SMA defines the OHWM as a physical and ecological feature on the landscape, a feature that is often a transition zone between the aquatic and terrestrial environments and not always a distinct line. Tidal waters within Washington encompass a wide variety of shoreline conditions, from high-energy rocky headlands exposed to the full Pacific surf to quiet backwaters, estuaries, and salt marshes that only rarely are exposed to high-energy waves. This environmental variability is recognized in the SMA implementing rules through separate OHWM WAC definitions for high-energy and low-energy environments in tidal waters [WAC 173-22-030(5)(a)]. While the OHWM is to be identified based on field indicators, the mean higher high water (MHHW) tidal datum is referenced in the high- and low-energy environment definitions. Since the MHHW datum is not identified through any particular field indicators, as is the OHWM, it can be difficult to discern in the field without the assistance of a surveyor.

According to WAC 173-22-030(9) tidal waters include marine and estuarine waters bounded by the ordinary high water mark. Marine waters are large bodies of salt water with salinities of at least 30 parts per thousand (ppt). High-energy marine environments occur where the action of waves or currents is sufficient to prevent vegetation establishment below mean higher high tide, while low-energy environments are those where the action of waves and currents is not sufficient to prevent vegetation establishment below mean higher high tide. Estuaries occur where fresh water from streams, rivers, or groundwater seeps flow into and mix with marine waters yielding salinities between 0.5-28 ppt.

The tidal waters definition includes the following relative to OHWM in estuaries: “Where a stream enters the tidal water, the tidal water is bounded by the extension of the elevation of the marine ordinary high water mark within the stream” (WAC 173-22-030(9)). The hydraulics in an estuary are influenced upstream of the zone of salt water influence because of the surge effect, or incoming tidal waters that back up outflowing fresh waters, creating a surge plain. As freshwater from a stream flows into marine waters, it tends to lie on top of the heavier salt water creating a brackish mixture that extends the elevation of the marine OHWM (Figure 4-2). During low tide, the salt wedge will be out into the bay, and it can be more difficult to determine where the marine OHWM indicators should be used versus the stream OHWM indicators (Figure 4-3) as discussed in Chapter 3.

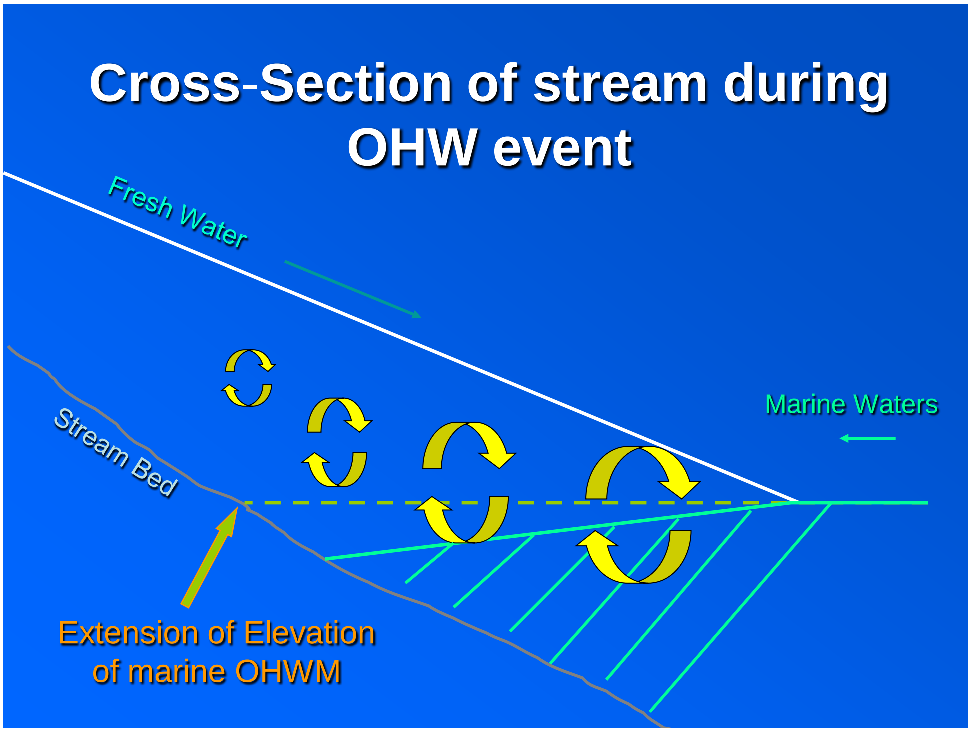


Figure 4-2. Mixing of marine and fresh water where stream enters tidal waters. Denser marine water will stay in the lower water column (salt wedge) and will raise the elevation of the fresh water on an incoming tide, extending tidal influence upstream.

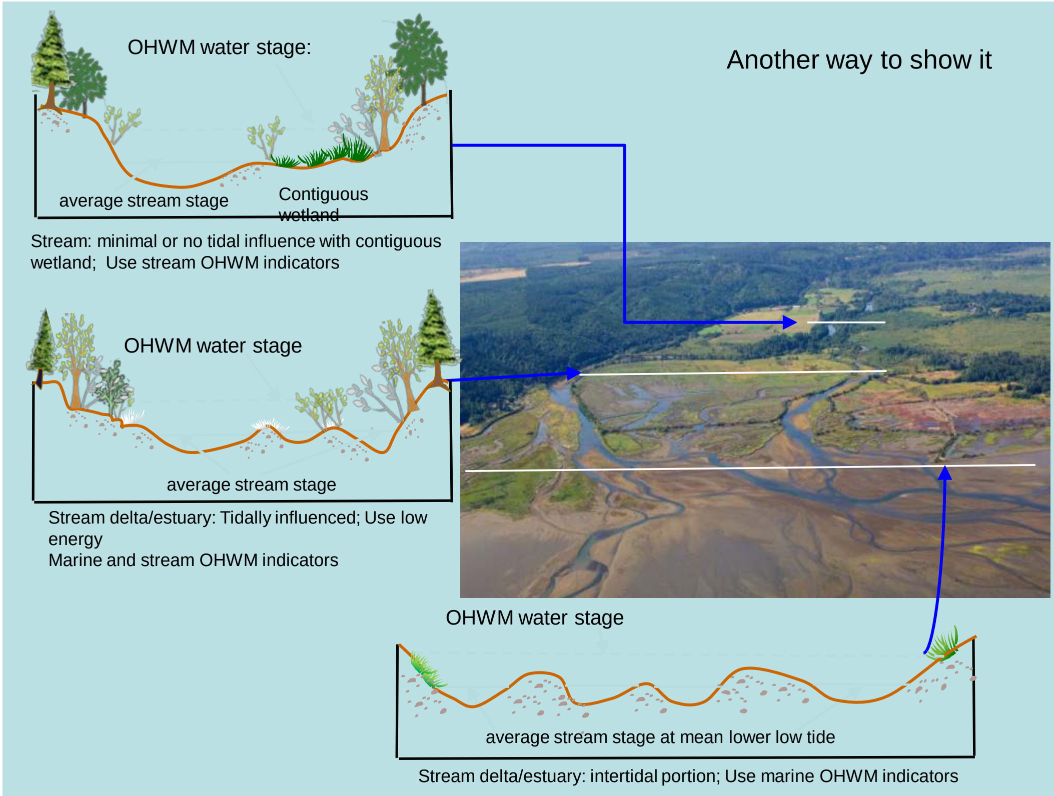


Figure 4-3: Marine OHWM indicators vs. Stream OHWM indicators

As there are different definitions in WAC 173-22-030 for high-energy and low-energy tidal waters, there are also separate criteria, which may require using different indicators while on a site. When making an OHWM determination in the marine environment it is important to focus on the presence of field indicators rather than tidal data alone. Tidal data should be used to support the indicators seen on site.

In cases where the OHWM cannot be found along marine shorelines, the SMA allows use of the MHHW as the OHWM default (RCW 90.58.030(2)(c)). There are rare circumstances when field indicators are not evident (e.g., a new jetty) at any time of year, and tidal data (MHHW) may be the only option for establishing the OHWM before defaulting to the MHHW.

Please note that the apparent absence of field indicators or inability of the investigator to find indicators at certain times of year or on a specific parcel does not mean that the OHWM cannot be found. It may require more in-depth investigations, including looking at other sites within the same shoreline reach, to ascertain the location of the OHWM.

<u>OHWM and Tidal Data</u>

Washington’s tidal waters have a diurnal to semi-diurnal tidal cycle. This means that there are roughly two high tides, two low tides each day, usually consisting of a lower low, a higher low tide, and a lower high and higher high tide (Figure 4-4). When looking at tide tables it may help to be able to identify these different tides so that indicators of their presence may be observed at a site. This will be explained in detail in section 4.3.

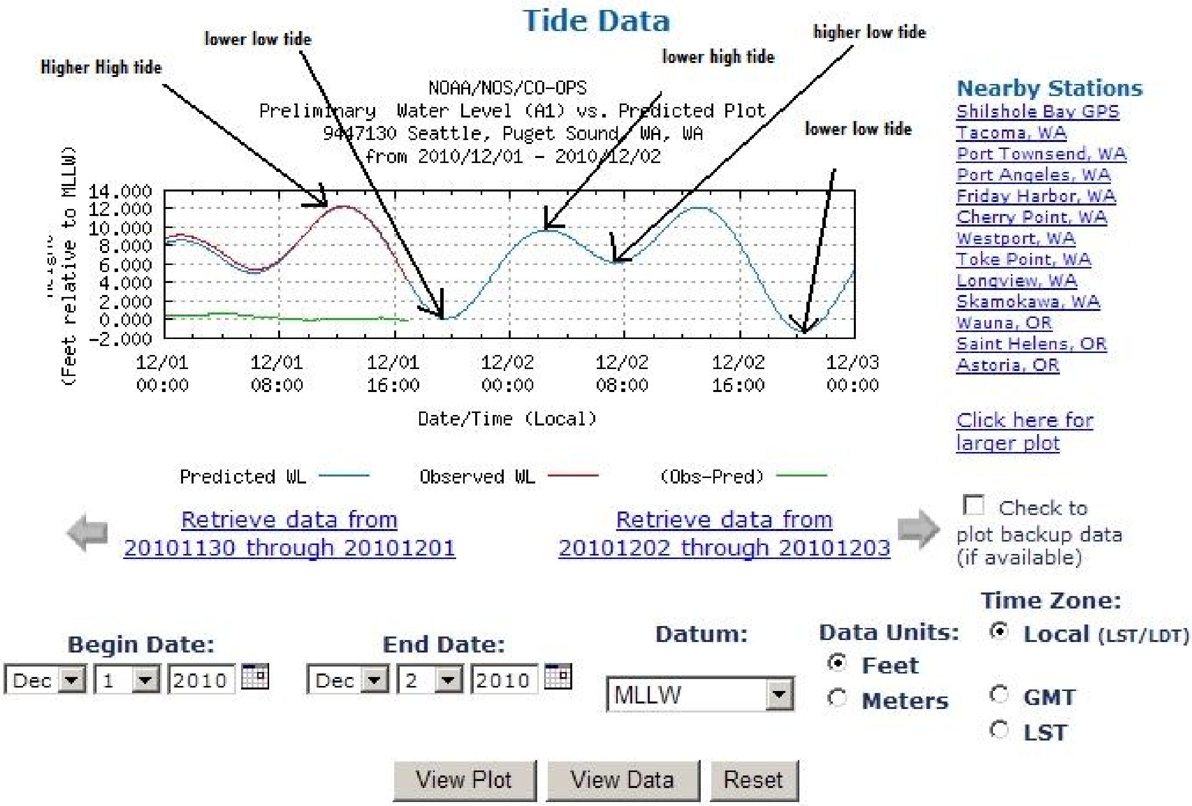


Figure 4-4: Example of diurnal tidal cycle on NOAA's website.

When reviewing tide charts the elevation datum[18] referenced is generally Mean Lower Low Water (MLLW). Upland elevations on lands outside of the intertidal zone usually reference NAVD88 or NGVD29 datums, and there are conversions for these datums to MLLW on the NOAA website. However, to be consistent with NOAA tidal data, it is best to use MLLW as the datum. MLLW is defined as the average of all lower low tides in an epoch. An epoch is an approximately 19-year time period that forms the basis for the current MLLW datums used to predict tidal elevations. MLLW is usually represented as the 0-foot elevation on most nautical charts. Figure 4-5 shows the vertical association of the various data in relation to the OHWM.

[18] A base elevation used as a reference from which to reckon heights or depths; MLLW = 0. (www.tidesandcurrents.noaa.gov)

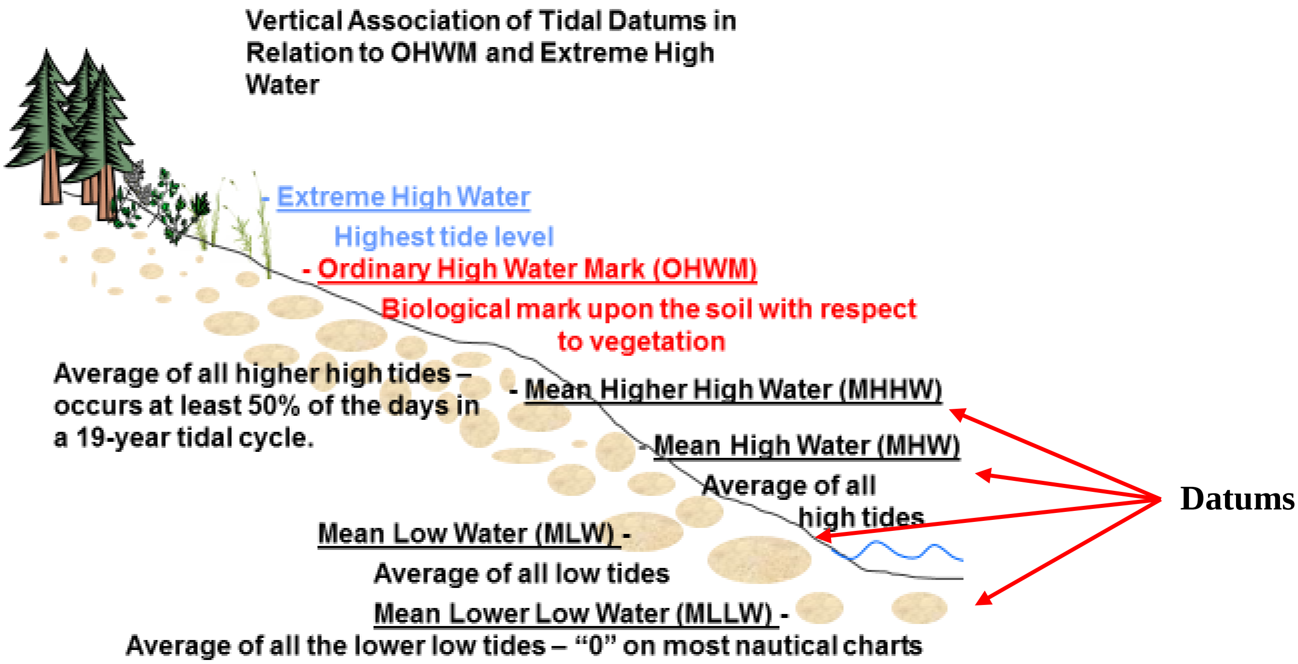


Figure 4-5: Vertical association of tidal data and OHWM along a typical undisturbed marine shoreline.

Mean Low Water (MLW) is the average of all low tides, both higher lows and lower lows, and it occurs more often than MLLW. Mean High Water (MHW) is the average of all high tides, both higher high and lower high. It is reached more often than MHHW.

MHHW is the average of all higher high tides and is reached at least 50 percent of the days of an epoch, or 19-year cycle. This means that MHHW occurs at least once every two days in a diurnal to semi-diurnal tidal cycle.

Although OHWM is not a datum, it has its position on the intertidal landscape. OHWM is a mark on the soil (geomorphic) with respect to vegetation (biologic) and is always found above MHHW. OHWM, highest astronomical tide (HAT), and extreme high water are not synonymous, because these water levels do not occur regularly enough (ordinary) to leave a persistent mark upon the soil with respect to vegetation. The HAT is the highest predicted tide for a given tidal epoch and is typically higher than the elevation of OHWM field indicators. Extreme high water events are usually associated with large storms and occur much less frequently and higher on the shore than OHW events (Figure 4-6).

Extreme high water events may only happen every few years when very high tides occur in conjunction with a windstorm or atmospheric low-pressure system. One unfortunate thing about these extreme events, besides the obvious destruction to properties, is that they tend to eliminate some or all of the indicators of the OHWM for some time, so it can be much more difficult to locate the OHWM on a beach recently subjected to an extreme event (Figure 4-7). In addition, these infrequent strong storms can be very important in driving beach morphodynamics (Finlayson 2006). In other words, these strong storms can change the location of the OHWM by changing the gradient or profile of beaches. For example, if a beach erodes and the profile becomes flatter, tidal water may be able to run up further onto the beach more easily and more often. Conversely, if a beach becomes steeper because of a storm event, the OHWM may move waterward. Beaches are highly dynamic environments and, although the OHWM may change frequently, the local jurisdiction may need to take human health and safety into consideration when evaluating setbacks, similar to a channel migration zone in the riparian environment.

Figure 4-6: Aftermath of an extreme high water event; OHWM located at the waterward face of the bulkhead. Double Bluff Park, Whidbey Island – February 4, 2006. Photo courtesy of Hugh Shipman.

Figure 4-7: Extreme high water event in action. Double Bluff Park, Whidbey Island – February 4, 2006. Photo courtesy of Hugh Shipman.

OHW events generally occur several times a year (generally in the range of eight to 12), usually during winter months, the solstices (June and December), and to a lesser extent the equinoxes (spring and fall). Storm events characterized by low-pressure systems contribute to many annual OHW events on Washington's coastal waters. Finlayson (2006) has found that a change in atmospheric pressure of only 1millibar can alter sea level by approximately one inch in the Salish Sea. Climate patterns also govern tides in any given year, which can be quite variable. This is why the use of the 19-year epoch, instead of interpreting tidal information from one or two years of data, is important when analyzing tidal elevations. For example, "during El Niño years, mean air pressure drops throughout the region, resulting in a 4-8 inch rise in winter sea levels over predicted tide levels" (Finlayson 2006). In the winter of 2010 the Seattle station experienced 13 tides nearly a foot above what would be considered the OHWM due to a strong El Niño pattern.

Since we know that OHWM is always above the MHHW, it is important to understand what MHHW means in terms of determining the location of OHWM. MHHW is the highest datum elevation provided by tidal stations (and not a mark discernible on the ground), which is available to the public. It may be helpful to know the elevation of MHHW before visiting a site so that one may be able to approximate its location relative to visible indicators on the shoreline. MHHW varies according to where the station is located along the coastline. It is important to choose the station nearest to the shoreline being studied, without major landmasses or areas of heavy current between the site and the station.

Within the Salish Sea, the tidal range generally increases with distance from the Pacific Ocean, approximately doubling between the Strait of Juan de Fuca and the bays of the south Sound (Mojfeld 2002, Finlayson 2006). Figures 4-8 and 4-9 illustrate the variations in tidal range within the Salish Sea. Tidal range is a significant factor in controlling the formation and behavior of estuaries and may influence long-term erosion rates (Rosen 1977).

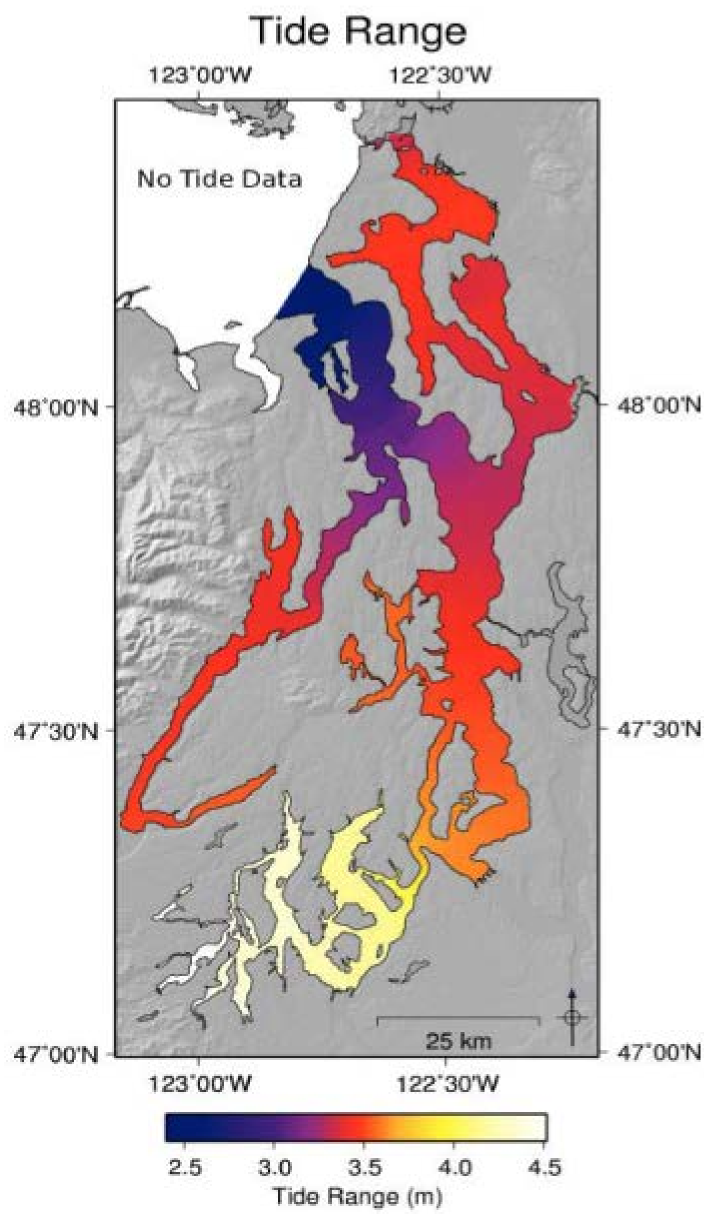
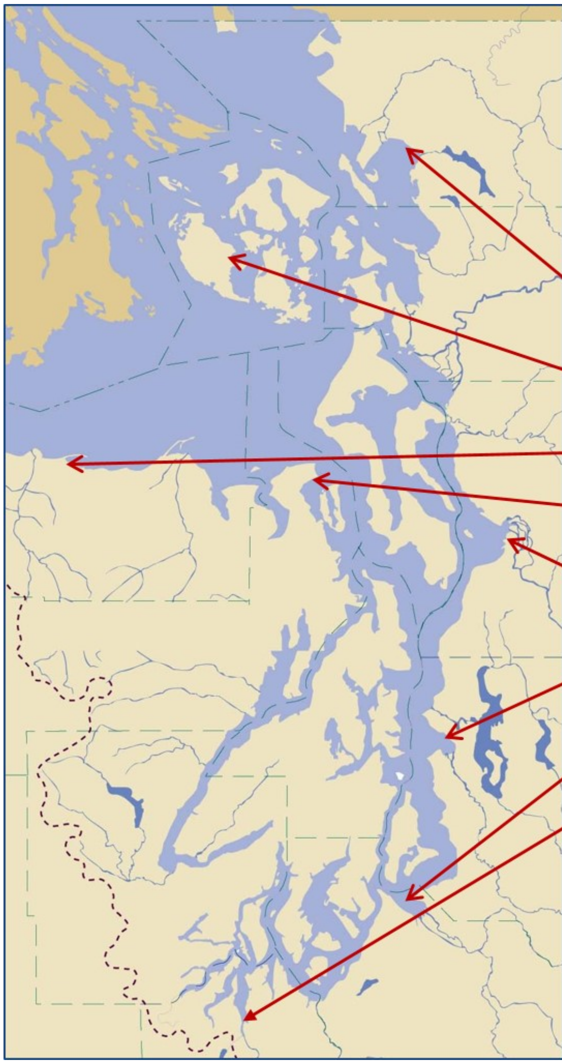


Figure 4-8: Tide Ranges in the central and southern Salish Sea (Finlayson 2006).



Puget Sound Tidal Datums

Tide Station	MHHW*	Highest Observed Tide*
Bellingham	8.46	10.5
Friday Harbor	7.72	11.26
Port Angeles	7.03	10.27
Port Townsend	8.45	11.77
Everett	11.11	14.35
Seattle	13.35	14.65
Tacoma	11.84	14.98
Olympia	14.56	18.19

*Elevation in feet above MLLW

U.S. Army Corps of Engineers
http://www.nws.usace.army.mil/About/Offices/Engineering/HydraulicsandHydrology/HistoricalDatumRegions.aspx

Figure 4-9: Observed MHHW and extreme tidal elevations within the eastern Salish Sea.

Since the 1980s, Ecology staff have been studying tidal elevations relative to OHWM indicators. Recently these investigations have included noting tidal heights in the field, mapping beach profiles at sites in the Seattle area, and analyzing tidal records for six recording tide stations on Washington's inland waters (east of and including Port Angeles). Between 1996 and 2010 recorded tides for each of these stations show that tides 1.5 feet above MHHW occur regularly (on average 12 times per year) and correspond to OHWM field indicators (Figure 4-10). Staff are currently working to compile data on several sites using the indicators described below to determine the OHWM and, when possible, relating observed indicators to elevations above MHHW.

Sea level rise

Recent sea level rise is a well-documented phenomenon throughout much of the world and most coastal areas in Washington (http://oceanservice.noaa.gov/facts/sealevel.html, Mote et al. 2008, COSLRCOW 2012). The 100-year tide record at Seattle shows that sea level is rising at a rate of about 2 mm/year and at Friday Harbor, about 1 mm/year. At Neah Bay, sea level is decreasing by about 1.6 mm/year and this is likely due to the tectonic forces from the subduction of the Juan de Fuca plate beneath the North American plate (Finlayson 2006).

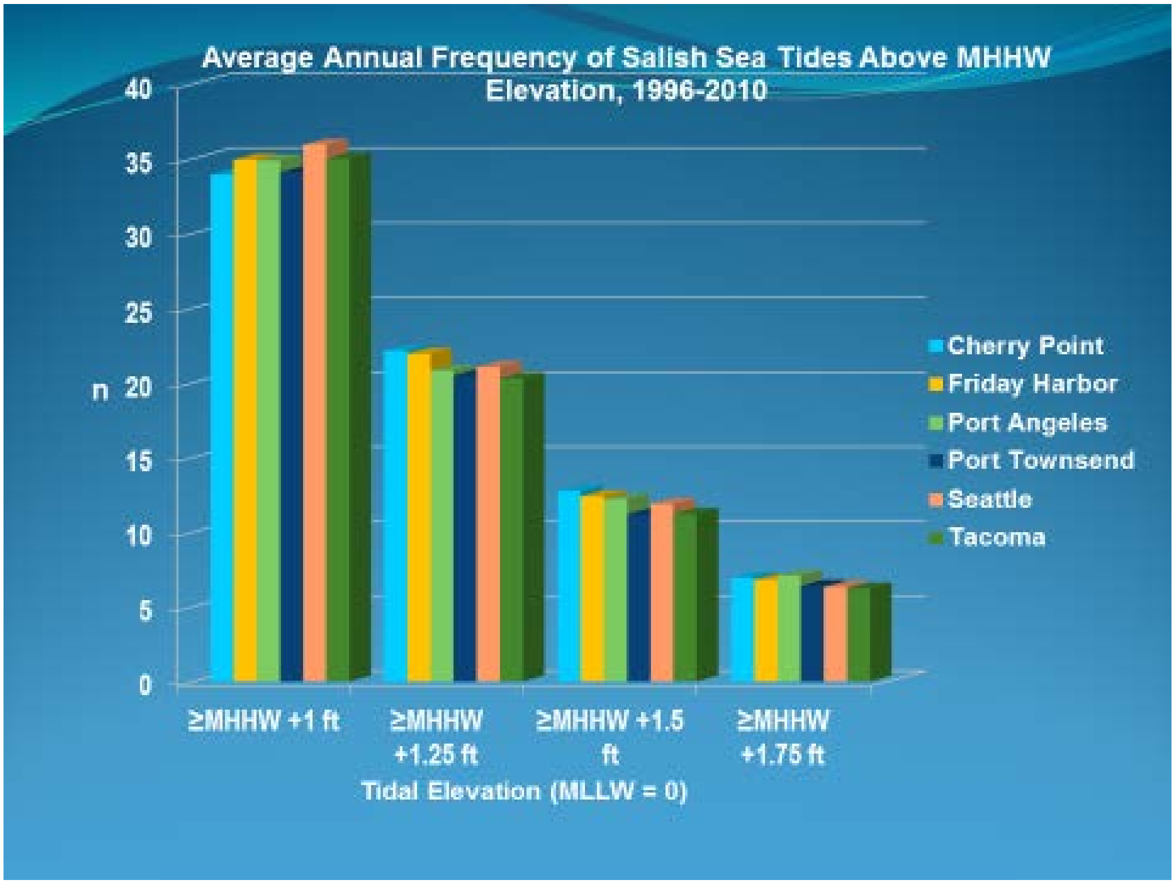


Figure 4-10: Frequency of tides at and above MHHW.

4.2.1 Field indicators descriptions

Field indicators for high-energy tidal systems

As defined in the WAC (173-22-030(5)(a)(i)), in "…*high energy environments, where the action of waves or currents is sufficient to prevent vegetation establishment below mean higher high tide, the ordinary high water mark is coincident with the line of vegetation. Where there is no vegetative cover for less than one hundred feet parallel to the shoreline, the ordinary high water mark is the average tidal elevation of the adjacent lines of vegetation. Where the ordinary high water mark cannot be found, it is the elevation of mean higher high tide.*"

Line of Vegetation

Description: The line of vegetation must be comprised of a *community* of *persistent* (perennial) vegetation (Figure 4-11). Do not use isolated tufts or sparse plant cover to determine the line of persistent vegetation. These are considered outliers, which may be indicative of the formation of a future plant community or of seasonal colonizers that may not persist through the next winter season. It is not appropriate to make a determination based on what is suspected to happen in the future. The OHWM determination must be based on the current conditions. However, keep in mind that beaches can build up berms during years of a low-energy interval, which are unsustainable under higher energy conditions (Finlayson 2006). These berms with outliers of plants can be wiped out in one high-energy winter storm event.

The OHWM should also *not* be based on annual species. Saltbush (*Atriplex patula*), for example, is a common annual plant species that readily colonizes Salish Sea beaches in the late spring and summer only to die off in the fall and be removed by waves in the late fall and winter. Figure 4-14 is a photo of saltbush and its very small root system that cannot withstand the harsh winter beach environment. It illustrates how these annual plant species can rapidly form a temporary line of vegetation on the beach during the late spring and summer months.

Relation to the OHWM: The statutory definitions focus on the biological indicators pertaining to vegetation. The intent of the "line of vegetation" is reflective of the area on the beach where the mechanical forces of waves and the high salinity of marine water occur often enough to preclude the establishment of a persistent vegetation community below that mark.

Figure 4-11: Line of a community of dunegrass and, therefore, the OHWM on a High Energy Marine system.

Figure 4-12: Line of persistent vegetation on the outer coast.

Figure 4-13: Sparse patches of annual vegetation, American searocket (*Cakile edentula*), waterward of OHWM.

Figure 4-14: Saltbush root system and the temporary line of vegetation it has formed during the late spring.

Some common plant species that tend to form persistent plant communities include the following:

Yarrow (*Achillea millifolium*) perennial

Left: Gumweed (*Grindellia integrefolia)* perennial
Right: Beach pea (*Lathyrus japonicas*) perennial

Ambrosia (*Ambrosia cammisonis*) perennial

European beach grass (*Ammophila arenaria*) perennial

Recalling the definition of high-energy marine environments, the WAC says, *"…Where there is no vegetative cover for less than one hundred feet parallel to the shoreline, the ordinary high water mark is the average tidal elevation of the adjacent lines of vegetation."* This means that if there is a parcel or site without vegetation, but there is a line of vegetation on adjacent parcels, the OHWM can be extrapolated from those adjacent lines of vegetation (Figure 4-15). Generally, this scenario is not common and usually occurs when a landowner has eliminated the vegetation on his or her property, or there is such intense use of the beach that the vegetation community cannot persist. In some cases, such as public parks, heavy foot traffic or children playing on the beach may be enough disturbance to preclude the establishment and survival of a vegetation community.

Figure 4-15: Heavy use of the beach has inhibited vegetation growth.

Drift Logs

Description: Drift logs are often tossed on shore by extreme storm events and may remain there until other extreme high waters pull them back out. Careful evaluation of accretion features, tidal channels, shoreline processes, and the logs themselves is needed. Look up and down the shoreline for indications that the beach may have changed due to coastal processes. Also, check to see if there is evidence that the logs have floated recently by examining the logs and the spaces between them. If there is discoloration or bleaching of logs (may be easier to see from a distance) or if there is vegetation growing in the cracks and crevices of or between the logs, then they are likely firmly in place and do not float or get inundated by waves often enough to prevent these indicators. Be sure to check the ground/wrack between the logs and within tidal channels for signs of recent inundation.

Relation to OHWM: If no vegetation occurs at a site with drift logs, the OHWM tends to be at the landward edge of the drift pile. If there is persistent vegetation growing in amongst logs or if the logs are uniformly colored, look for the OHWM within the log pile by observing color differences or vegetation (Figure 4-16). Conversely, if there is smaller drift material or flotsam in between the logs, sand or beach gravels deposited on the logs, or other evidence that the logs shift due to flotation or are inundated, then the OHWM is probably at the landward edge of the drift pile (Figure 4-17).

Figure 4-16: OHWM within the drift pile on Hat Island.

Figure 4-17: Drift logs meet line of persistent vegetation, which equals the OHWM.

Erosional or Depositional Features

<u>Description</u>: On non-vegetated beaches where a high or low bank/bluff is present, the OHWM is usually at the toe of the bank/bluff (Figure 4-18). These bank/bluffs are generally eroding, and they "feed" sediments to other stretches of beach through drift cell movement. Where there is a well-established spit or barrier beach, the OHWM is generally at the face or on top of the second berm, which is generally the storm berm (Figures 4-19 and 4-20). The differences between a seasonal berm and a more permanent storm berm can be subtle, but in less disturbed settings,

there will likely be other indicators to observe such as drift logs or a line of persistent vegetation. Wetlands or low-energy marine systems often occur behind these spits.

Relation to OHWM: In high-energy environments, the lack of persistent vegetation waterward of the bank/bluff indicates the beach is inundated regularly, and the OHWM is located at the toe of the bank/bluff.

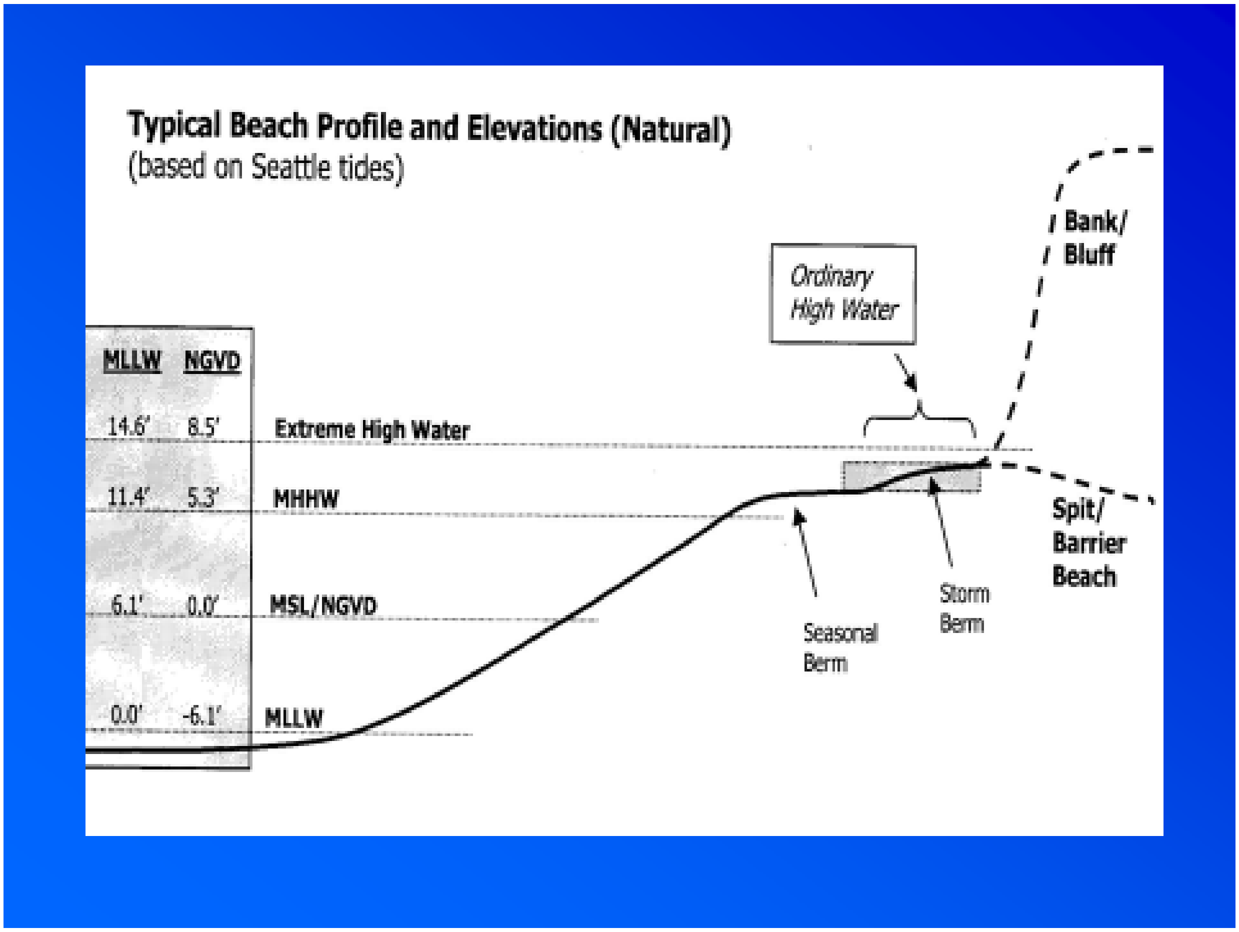


Figure 4-18: Drawing credit – Hugh Shipman.

Figure 4-19: Eroding bluff. OHWM (red line) is at the toe of the bluff. MHHW elevation (blue line) is the drift line below the OHWM.

Figure 4-20: Storm berm and OHWM in relation to seasonal berm on a typical Salish Sea beach.

Bulkheads

Description: Bulkheads are shore-parallel vertical structures designed to prevent flooding, overtopping, or erosion of the shoreline by the action of waves. They are typically constructed of wood pilings, concrete, or rock riprap. Currently, approximately 800 miles of bulkheads line the Salish Sea, and the islands within have many more miles of bulkhead-lined beaches, as cited in Johannessen and MacLennan (2007).

Relation to OHWM: On beaches with bulkheads, the OHWM is usually at the face of the bulkhead since many were constructed below the OHWM and even below MHHW. On occasion, the beach in front of the bulkhead may be accreting. In these cases, there should be an established persistent vegetation community in front of the bulkhead to indicate the OHWM (Figure 4-21). If there is not a line of vegetation in front of the bulkhead, it is assumed that the OHWM is at the face of the bulkhead.

Figure 4-21.

Conversely, beaches often erode in front of bulkheads and other structures if up-current feeder bluffs are not replenishing them or if adjacent structures cause wave deflection (Figure 4-22).

Figure 4-22. Collapsed walkway undermined by waves, Port Gardner Bay. Note coarser substrate on the water side of walkway as wave deflection has eroded fines and gravel.

Over many years, if left unmaintained, bulkheads can deteriorate and become dysfunctional. Eroding beaches can accelerate the deterioration. Spaces between log pilings or collapsed concrete can allow tidal water to flow through the former bulkhead, and the OHWM would then revert to its former location behind the bulkhead. In those cases there are usually indicators of water flow or drift lines landward of the failing bulkhead to help in locating the new OHWM (Figure 4-23).

In addition, land subsidence or increasing sea levels may cause bulkheads to become overtopped with greater frequency. OHWM may occur landward of a bulkhead in this circumstance, too.

Figure 4-23: Breach in bulkhead resulting in relocation of OHWM.

Field indicators for low-energy tidal systems

Low-energy tidal systems may include coastal lagoons, pocket estuaries, river deltas or mouths, or dendritic channels or sloughs that fluctuate and overflow with tidal waters. WAC 173-22-030(11)(a)(ii) states, "*In low energy environments where the action of waves and currents **is not** sufficient to prevent vegetation establishment below mean higher high tide, the ordinary high water mark is coincident with the **landward limit of salt tolerant vegetation***." In low-energy environments, as in high-energy environments, the primary OHWM indicator is the biological mark upon the soil with respect to vegetation. In low-energy systems the vegetation is influenced more by the inundation of salt water than by the mechanical and forceful removal of vegetation by waves, as in a high-energy system (Figure 4-24).

Low-energy systems are often characterized by brackish water with low salinities, which can make the vegetation transition from salt-tolerant to salt-sensitive species subtle. MHHW is typically not associated with visible field indicators, and rarely do you have the benefit of a surveyed MHHW on a site to be able to determine whether vegetation is present below MHHW. Generally, plants found at and below MHHW are able to withstand regular saltwater inundation and typically have a wetland indicator status (WIS) of Facultative Wetland (FACW) or Obligate (OBL) (see Table B-2, Appendix B for WIS definitions). Determining the WIS of the dominant plants on the shoreline can be a good indicator of vegetation established below MHHW. Common species found below MHHW in this region include pickleweed (*Salicornia depressa*) and saltgrass (*Distichlis spicata*), OBL and FACW, respectively.

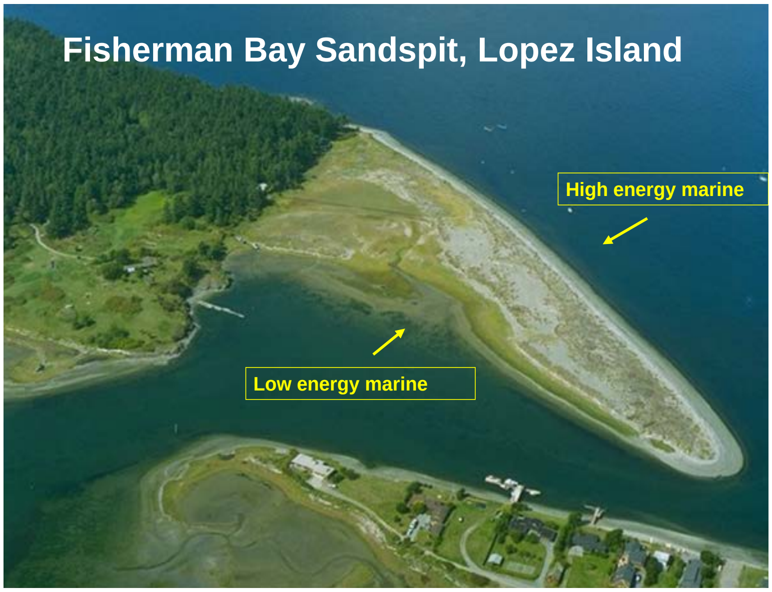


Figure 4-24: Use the line of persistent vegetation on the high-energy side of the spit and the landward limit of salt-tolerant vegetation on the low-energy side.

Salt-Tolerant Vegetation

Description: Salt-tolerant vegetation is defined as vegetation which is tolerant of interstitial soil salinities greater than or equal to 0.5 ppt (WAC 173-22-030(11)(a)(ii)). Salt-tolerant plants often look succulent or appear to be covered with salt crystals because they handle the stress of living in a saline environment by storing reserves of fresh water (like desert plants, therefore succulent) to maintain turgor, and they excrete salt. Some common plants that are very tolerant of salt include pickleweed, saltgrass, fleshy jaumea (*Jaumea carnosa*), seaside plantain (*Plantago maritima*), and Lyngby sedge (*Carex lyngbei*).

Many plant species have varying degrees of salt tolerance under different conditions. Dr. Ian Hutchinson conducted a study in 1988 where 116 selected plants were researched for their level of salt tolerance. The study consisted of a literature search after which each species was grouped into categories ranging from very salt tolerant (salinity >20 ppt) to very salt sensitive (salinity 0-0.5ppt) (Hutchinson 1988). Technically, all species in the sensitive (0.5-5ppt) to very tolerant categories qualify as salt tolerant under the WAC definition. However, some of the species listed as sensitive by Hutchinson were not well represented in the literature, so when species in this category are dominant in an area, other field indicators should be observed to help support the OHWM determination.

Relation to OHWM: In low-energy tidal environments, the OHWM is defined as the landward limit of salt-tolerant vegetation (WAC 173-22-030(11)(a)(ii). The landward limit of salt-tolerant vegetation and the seaward limit of salt-sensitive vegetation may not always correspond in a neat, distinct line. Often there will be a band of salt-sensitive and salt-tolerant vegetation (Figure 4-25). This band may move landward or waterward depending on years of varying weather patterns, such as El Niño years or years of lower tides. The OHWM should be determined where one plant community type dominates over the other. In addition, there may be drift lines or other tidal or geomorphic indicators to help support the observation of biological indicators.

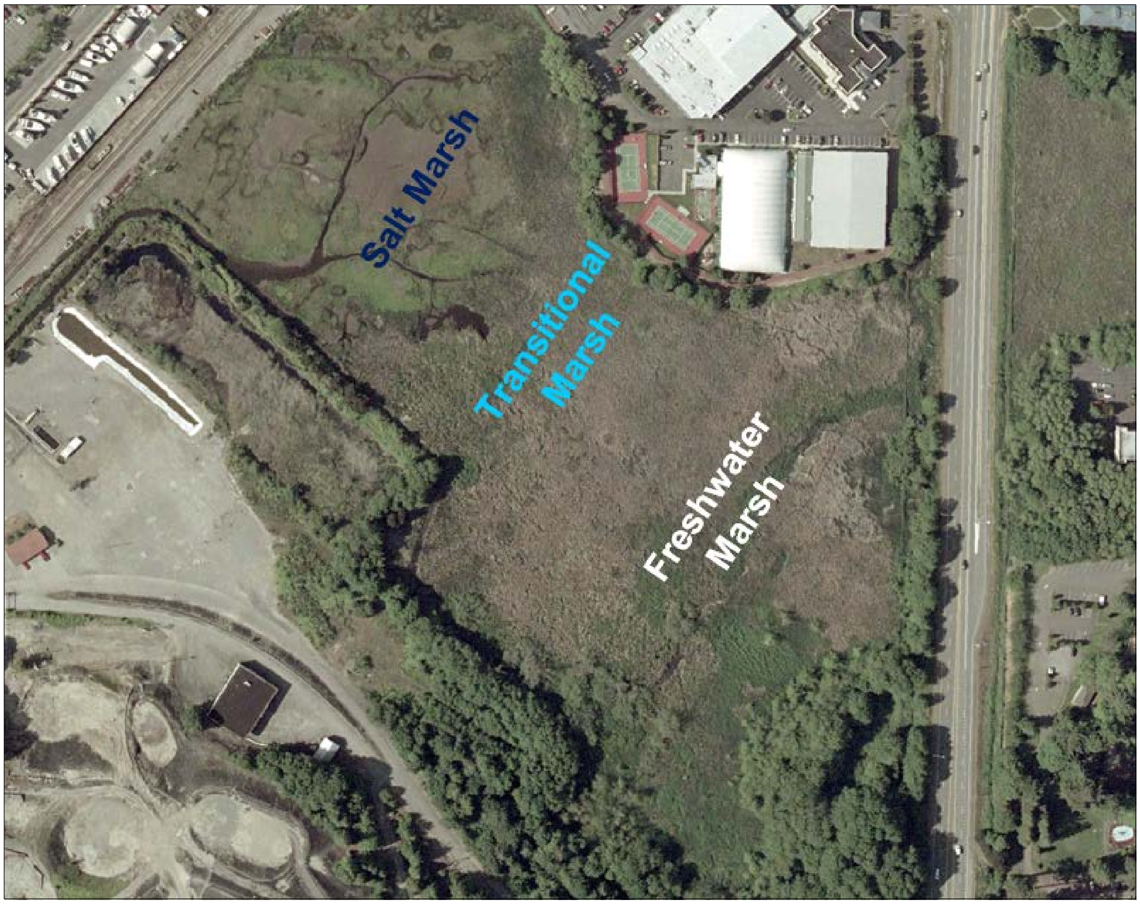


Figure 4-25: Aerial photograph of Edmonds Marsh showing salt marsh with tidal channels and mudflats (connected to marine waters via culvert), transitional marsh between salt-tolerant and salt-sensitive wetland communities, and freshwater emergent marsh dominated by salt-sensitive species.

Growth of Overhanging Vegetation

Description: Another biological indicator of the OHWM in low-energy marine environments is the lower limit of overhanging vegetation along well-vegetated shorelines. These shorelines are usually characterized by woody, salt-sensitive species such as salal (*Gaultheria shallon*), snowberry (*Symphoricarpos albus*), red alder (*Alnus rubra*), and western red cedar (*Thuja plicata*). It is often easier to see this indicator from a distance (Figure 4-26).

Relation to OHWM: The inundation of the salt water, which rises several times a year on average, is enough to prevent growth of these very salt-sensitive plants below the OHWM. Figure 4-27 shows the OHWM using two different indicators.

Figure 4-26: Very salt-sensitive species cannot survive below the marine OHWM.

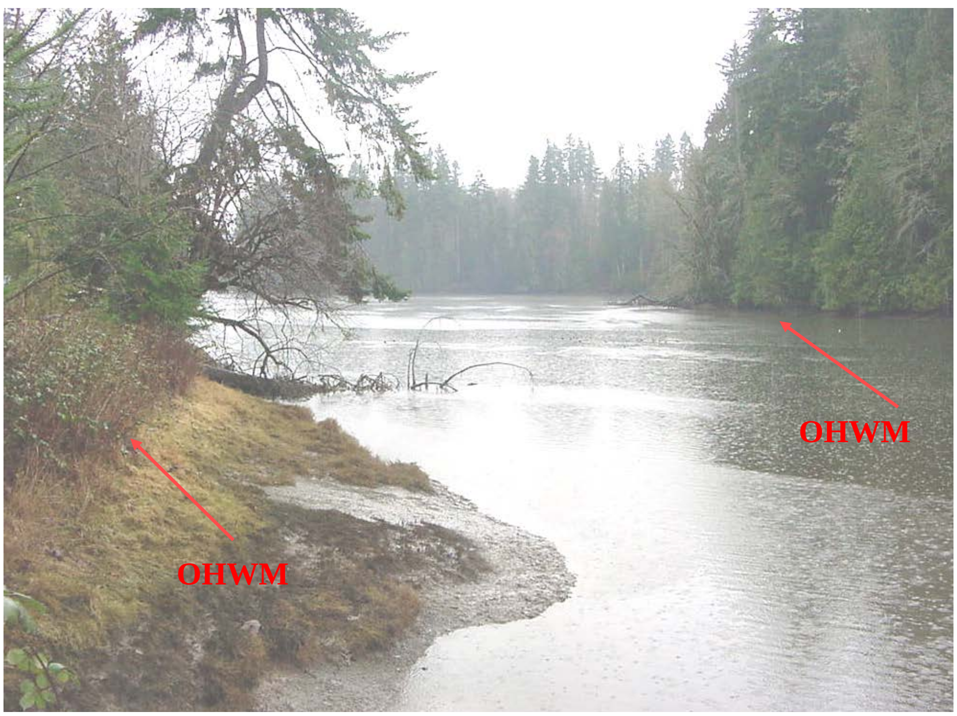


Figure 4-27: The lower limit of overhanging vegetation on the right side and the landward limit of salt-tolerant vegetation on the left, which correspond if one elevation is extrapolated to the other.

Blind Tidal Channels

Description: A geomorphic indicator specific to low-energy marine environments is the occurrence of blind tidal channels. These tidally influenced channels, which generally lie in the lower mouths of rivers, along sloughs, and in tidal floodplains (Figure 4-28), are closed at the upstream end. Erosional forces from the outgoing tides headcutting form them either over time or by depositional processes from the streams flowing from above. Hood (2006) describes the depositional processes occurring in the Skagit River Delta as islands in the delta that were once separated by distributaries of the Skagit River becoming larger islands due to sedimentation with the distributaries being cut off by large woody debris and then backfilled with sediment.

When these tidal channels flood due to an OHWM tide, fresh water from the stream tends to back up, flooding the surrounding lands. Since fresh water is less dense than salt water, it tends to ride on top of salt water from the marine shoreline. Therefore, salt-sensitive plant species may dominate outside of the tidal channels even though the area floods regularly from the marine shoreline and is, thus, below the OHWM.

Those tidal channels at the low end of smaller stream systems may not receive and back up as much fresh water as some of the larger river systems. Therefore, these channels are often characterized by salt-tolerant vegetation on top of and within the banks.

Relation to OHWM: Blind tidal channels tend to overtop during higher high tides. There may be higher islands between the channels that may be above OHWM, but where there are blind tidal channels the OHWM is usually at or near the upstream end of them. If salt-tolerant vegetation extends beyond the end of the blind tidal channels, then OHWM is likely to be at the landward limit of the salt-tolerant vegetation as long as it can be demonstrated that tidal water reaches that area.

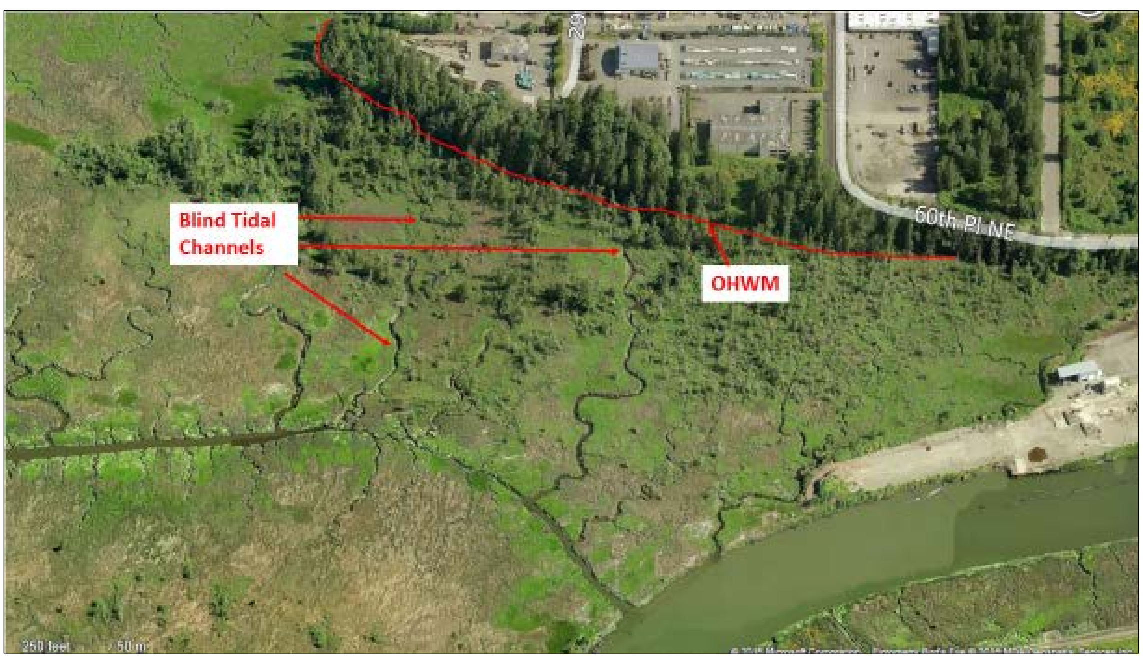


Figure 4-28: Blind tidal channels off Ebey Slough extend into the conifer stands and all the way to the toe of the slope. Therefore, the edge of the wetland and the extent of the OHWM are synonymous here.

Figure 4-29: Ebey Slough area at an OHWM tide where the flooded vegetation is salt sensitive. The OHWM extends to the toe of the slope.

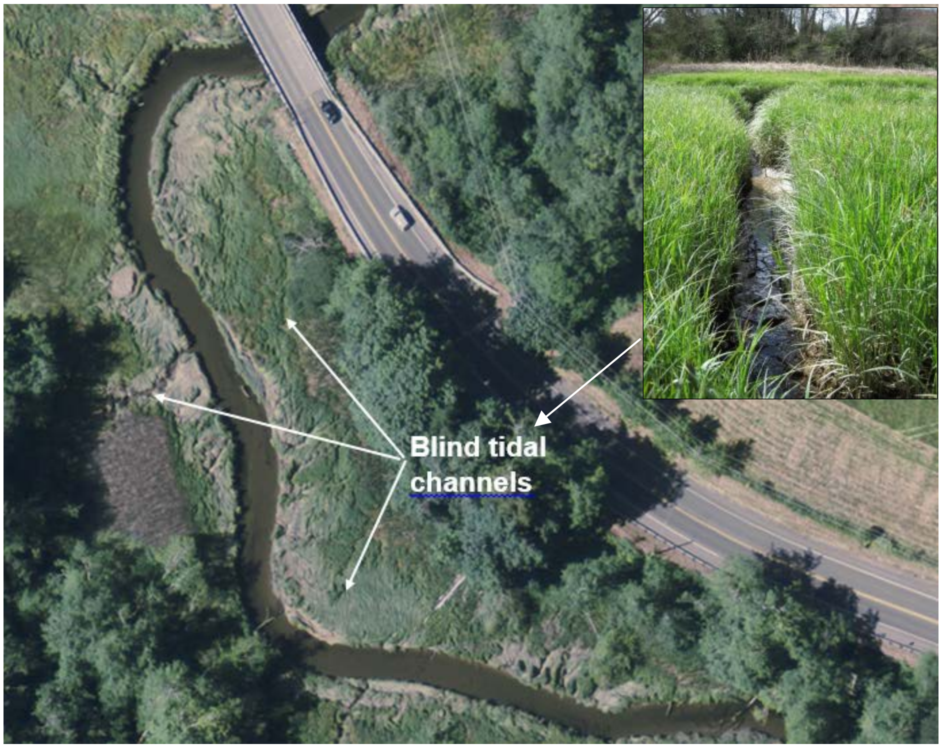


Figure 4-30: Blind tidal channels on lower Woodland Creek with salt-tolerant vegetation (*Carex lyngbei*) on top of the banks.

Algal Mats

Description: Algal mats are most often found in the low-energy marine environment. Algal mats are layers or deposits of filamentous algae that have attached to low vegetation or dried out on the surface of salt marshes or mud flats. The algae are formed in a shallow water column with sufficient light and then settle to the bottom when the tide recedes. Often the algal desiccation is cyclical; once the tide rises, the algae resumes production and then dries as the tide falls, forming thick mats interwoven with deposited mud (Figure 4-28).

Relation to OHWM: Algal mats are found below the OHWM since they reflect inundation sufficient for algal growth and development.

Figure 4-31: Algal mat in Big Beef Estuary salt marsh, Kitsap County.

Green Algae Smears

Description: Green algae smears on bridges and other concrete structures are most often seen in the low-energy marine environment (Figure 4-32).

Relation to OHWM: All marine algae species are considered aquatic and occur below the OHWM. The OHWM is usually found just above the upper limit of the algal smear line. There may be a water stain at the OHWM.

Figure 4-32: Algal smears on a concrete bridge in the lower Snohomish estuary.

Field indicators for both high- and low-energy tidal environments

If vegetative, geomorphic, and structural indicators are not readily observed on a site, other biological indicators such as barnacles and lichens may be present on rocky or wood substrates such as pilings, bulkheads, or rocky cliff faces. Generally, these biological features are considered secondary indicators since they can be difficult to identify or their presence or absence may be more indicative of predation rather than tidal inundation. In addition, staining by minerals in the water may mask or cause a mistaken identification of lichen, especially on rock faces. These indicators should be used with other indicators, tidal data, or both.

Intertidal zonation is a horizontal banding of marine organisms living on rocky coastlines, pilings, or bulkheads. The organisms occur in bands from the lowest tidal elevation upwards to the splash zone as they compete for space and food in the harsh environment of a tidal regime. There are many physical and biological factors affecting marine organisms, including predation, thrashing waves, and temperature stress from exposure. On the majority of rocky marine shorelines in Washington, intertidal zonation is comprised of lichens in the supratidal to the upper part of the intertidal zone, then barnacles to rockweed and mussels down into the subtidal zone (Figure 4-33). Some organisms, such as limpets and snails, are not stationary and may move around between zones feeding on the anchored organisms, such as barnacles and lichen.

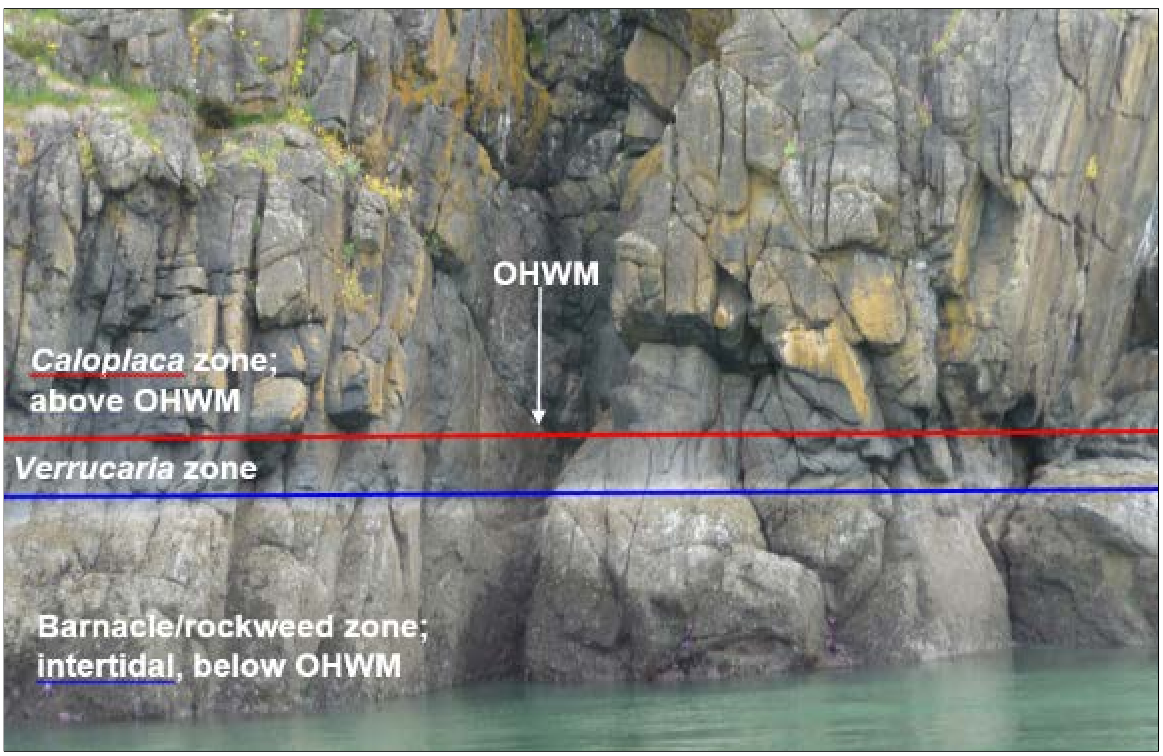


Figure 4-33: Illustration of intertidal zonation on a rocky shoreline on Saddlebag Island, WA.

Barnacles

Description: Barnacles are filter feeders and can only feed when they are under water, so they are not found much above MHHW (remembering that a MHHW tide occurs approximately once every two days). There are two common genera of barnacles that colonize along shorelines in

Washington: *Balanus spp*., and *Cthamalus spp* (Figure 4-34). Balanus are larger than Cthamalus and tend to outcompete them in the more frequently inundated lower intertidal zone, which is a more preferable habitat for both. Cthamalus can tolerate the upper intertidal zone, so they often are found above the Balanus zone near or at MHHW. However, snails and sea stars more readily prey upon Cthamalus than the larger Balanus, so there may be Balanus in the lower intertidal zone and no barnacles at all in the upper intertidal.

Relation to OHWM: The intertidal zone of live barnacles is always found below OHWM (individual rocks or substrate with barnacles attached may be displaced). If barnacles are present on a substrate, the OHWM will be well above that zone. Do not look for the OHWM in the barnacle zone (Figure 4-35).

Figure 4-34: Cthamalus spp. among the much larger Balanus spp. barnacles.

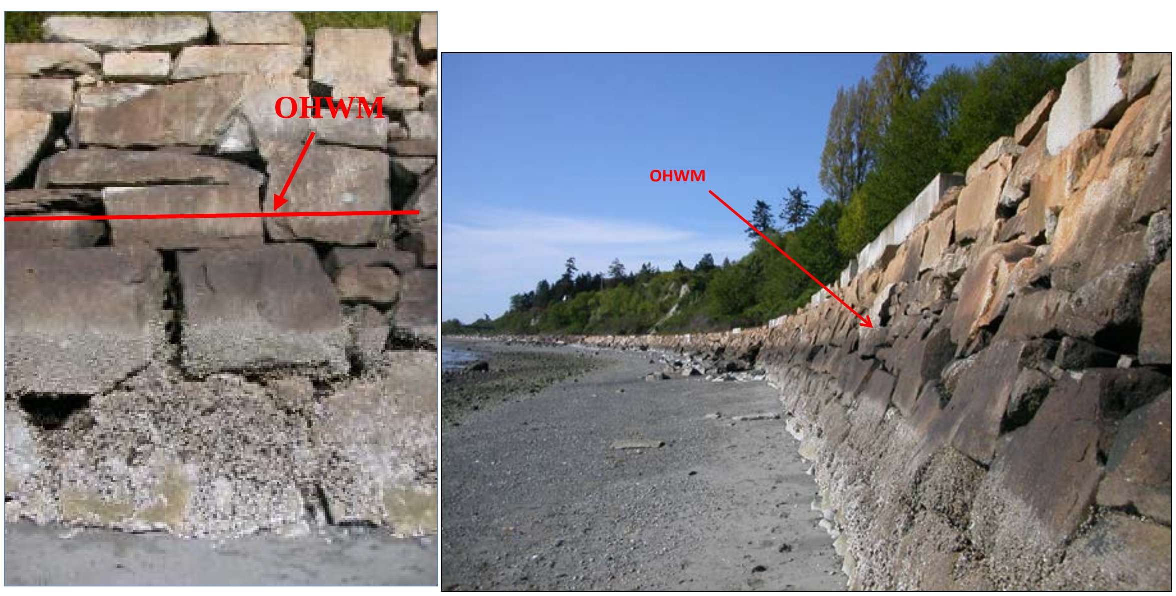


Figure 4-35: Barnacles in the intertidal zone below OHWM.

Lichens

Description: Two common Lichen genera occur in the zonal vicinity of the OHWM in Washington that can be helpful in locating the OHWM. They are Hydropunctaria and Caloplaca, both with a crustose growth form. The black lichen *Hydropunctaria maura* (syn. *Verrucaria maura*), also known as tar lichen, appears as a black band of paint on silicious rocky surfaces (Figure 4-36). Under magnification, one can see numerous small cracks and bumps. Lichens rarely occur on rocks comprised of basalt with its smoother structure, which is often the type of rock chosen for riprap bulkheads or stabilization walls.

Figure 4-36: Black lichen *Hydropunctaria maura* (syn. *Verrucaria maura*). Courtesy of www.a-p-h-o-t-o.com.

Caloplaca spp. are mostly orange in color and often resemble weathered orange or yellow paint, especially from a distance (Figure 4-37). The genus Caloplaca is notorious for its variation both within and between species. *Caloplaca marina* is likely the most common orange lichen that we see on rocks in coastal areas of Washington, but it can be easily confused with other Caloplaca species (Arup 1995).

Relation to OHWM: *H. maura* occurs below the splash zone in areas that are periodically inundated by high tides, but above the zone of barnacles. *Caloplaca marina* is a supralittoral species, meaning that it occurs above the area of tidal inundation, but can be within the splash zone above the OHWM. Generally, if the black and orange lichen are present on a site, the OHWM will be at the upper edge of the black lichen and the lower edge of the orange lichen due to their habitat requirements in the intertidal zone.

If the black lichen is not present at a site but orange lichen is, unless you are qualified to properly identify lichens to species, you cannot assume that the orange lichen is Caloplaca marina and, therefore, above the OHWM. This indicator is only reliable when both the black and orange lichen are found together and even then they should only be used to support other indicators of the OHWM.

Figure 4-37: ***Caloplaca marina***

Water Marks

Description: Water marks can be in the form of water stains, which can occur from mineralization of concrete or rock faces along the marine shoreline (Figure 4-38) or from bleaching or deterioration of wooden pilings or bulkheads (Figure 4-39).


Figure 4-38: Water stains on a concrete wall in an estuary on Whidbey Island. Note how the upper end of the stained area coincides with the eroded shoreline to the left.


Figure 4-39: Staining and deterioration of wood support pilings under a cabin on the beach.

Relation to OHWM: Water marks can occur both above and below the OHWM due to various factors. There are times when the water marks can provide good supporting evidence for other indicators, however, such as in Figure 4-39 above. Generally, when this indicator is present, it is best to look for other indicators to ensure the mark you are seeing is due to tidal water.

Wrack and debris

Description: Lines of small debris that can be seen on the ground or within vegetation can provide valuable information as to where a recent tide has reached. Generally, the higher high tides are the ones to look for in the tide charts since they tend to wipe out drift lines from lower tides. If it is possible to find out what the actual tidal elevation was for the station you are using, it can be compared to the predicted tide and the MHHW elevation for that area. Some drift lines are comprised of eelgrass that has been brought up onto the beach from past tides. If the eelgrass is still green, moist, and fresh, it is likely that its presence can be correlated to a recent past tide, and an elevation can be determined. Sometimes the driftlines are subtle, as in Figure 4-41 below, and they may be a result of a receding tide where the highest wave extent was obscured by other features.

Relation to OHWM: If the drift line is above the MHHW elevation, it may be close to the OHWM. If the drift line is at or below the MHHW elevation, then you know to look higher up on the shoreline for the OHWM (Figure 4-40).

Figure 4-40: Browse the web to find out what the last high tide was before your site visit and you may be able to determine the elevation of this snowline. Photo courtesy of Hugh Shipman.

Figure 4-41: Subtle eelgrass drift line on the beach.

4.2.2 Common misunderstandings

- Stream OHWM indicators are not necessarily the same as marine OHWM indicators. The OHWM indicators for streams (section 3.2.1 above) should be used well upstream of an estuary when fresh water is present. As a stream flows into an estuary and the water becomes brackish (salinity greater than 0.5 ppt), the marine OHWM indicators should be used. There may be a zone where both indicators are relevant, but that will be a judgment call (Figure 4-42.)

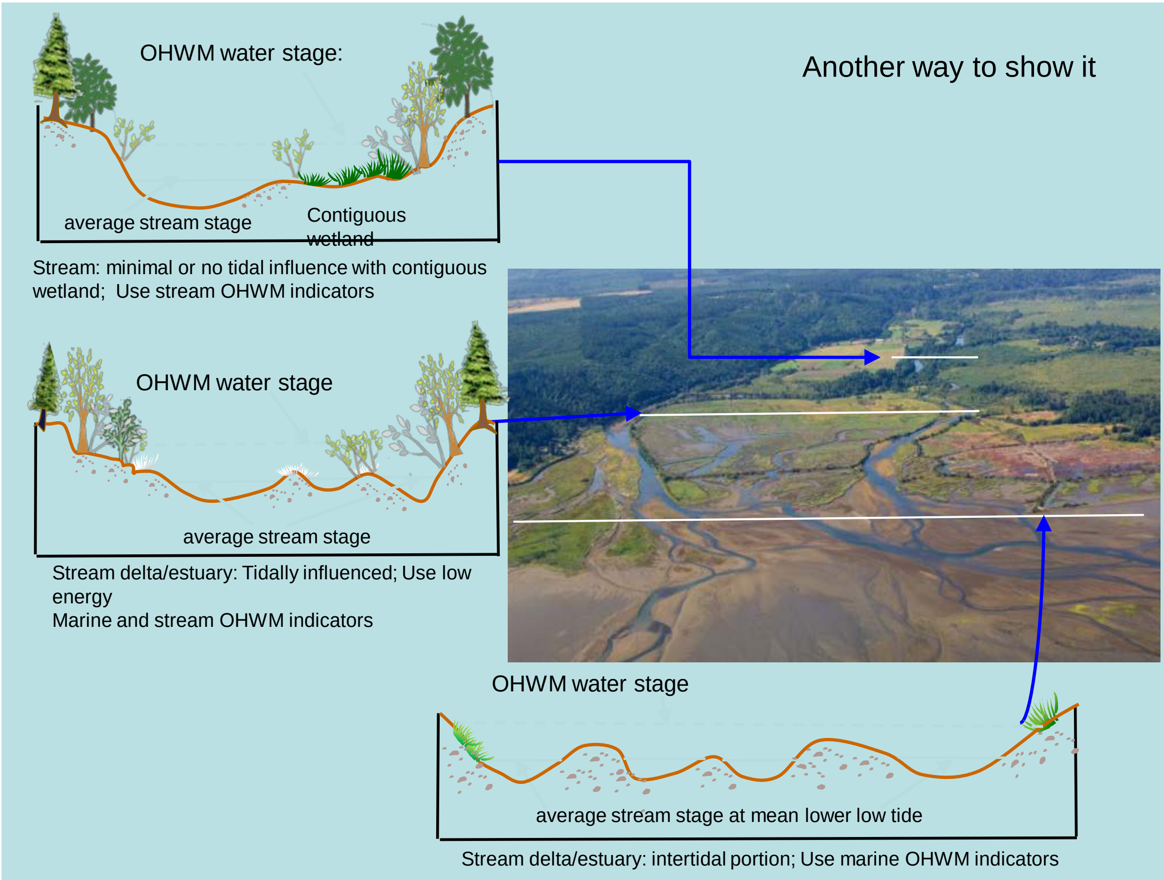


Figure 4-42: Marine OHWM indicators vs. Stream OHWM indicators.

- OHWM is not a datum but a biological mark upon the soil with respect to vegetation. You will not be able to find the OHWM elevation for an area on any website. Although tidal data can help bookmark the approximate location of OHWM, it should not be used exclusively for making an OHWM determination.
- OHWM elevation is not synonymous with MHHW or extreme high water. MHHW tides occur at least once every two days in all tidal areas of Washington. Extreme high water events generally occur in winter months when low-pressure systems are coupled with tides at or above OHWM tides, resulting in wind-driven waves or extremely high wave run-up.
- Salt-tolerant vegetation may not be the only indicator to look for in low-energy systems. Fresh water often rides on top of salt water (salt water is denser and heavier than fresh water) in an estuary during an incoming tide, so if there is continuous and contiguous water from the shoreline via blind tidal channels or intermittent flooding by higher high tides, the OHWM will be at the extent of the flooding or blind tidal channels. The freshwater riding on top of the salt water may not support a salt-tolerant plant community.
- The occurrence of lichen on rocks, logs, or concrete can be misleading. Sometimes black staining can be mistaken for black lichen, and orange lichen is often improperly identified. It is important that you only use the lichen indicator if other indicators can support it and then, only if the black lichen is found below the orange lichen.
- The marine OHWM is dynamic and may change locations on a beach because of large storms, updrift shoreline manipulations such as jetties or groins, or changing weather

patterns such as El Niños or La Niñas. It is important to make the OHWM determination based on current conditions and not try to speculate what might happen in the future.

4.3 Office Assessment

Becoming familiar with a site before conducting a field visit can provide valuable background information, help focus field activities, reduce the amount of time spent on the site and aid in a more defensible OHWM determination. There are three key pieces of information that should be obtained prior to a site visit: good aerial photos, tidal data for the period immediately before the scheduled site visit, and tidal data regarding the highest 8-12 tides for the year. Looking back three to five years for these data is advisable. The elevation of the Highest Astronomical Tide (http://tidesandcurrents.noaa.gov/datum_options.html) can also be useful.

Ecology's online Coastal Atlas (https://fortress.wa.gov/ecy/coastalatlas/tools/map.aspx) can provide information on shoreline drift cell movement and coastal biology, such as seagrass presence, which can indicate the type and degree of expected wrack build-up on the beach. Drift cell movement may indicate whether the beach is in an area of accretion or subject to erosion. When available, LiDAR and buoy (National Data Buoy Center, http://www.ndbc.noaa.gov/) data can also be valuable tools for the office assessment. LiDAR data can be used to assess topography at a site and generate relatively precise (1-foot contours) elevations for a site. Data from the National Data Buoy Center can be used to assess wind speed, direction, and wave height for a number of open water sites.

Reviewing available resources, including tidal data, prior to a site visit is recommended and will help focus the field assessment. Reviewing tidal data during or following a site visit will corroborate findings and greatly aid in determining the bookends (higher and lower possible elevations) for a given site within which the OHWM can be found. Use of tidal data is not required for an OHWM determination, but its proper use and interpretation can be extremely helpful and is especially recommended for difficult sites or for those where litigation is anticipated.

Hydrologic Assessment

Finding good aerial photos on the internet is relatively easy. Finding tidal data that is accurate and useful for a specific site can be difficult. Tidal data can be useful to support field observations of OHWM indicators. Referring back to Section 1. Introduction, the OHWM is based on observable field indicators and is always above MHHW. If you know the elevation of MHHW for the station nearest your site and the approximate elevation of the last higher high tide from tide charts, and you can find evidence of it on the beach (wrack, debris, watermarks, etc.) you may have a known elevation at a known location on the beach.

Tidal information can support observed field indicators, but in most cases should not be the sole basis for an OHWM determination. Tidal data can help you focus on the area to look for indicators of OHWM. Also, be sure to check the observed tidal data (actual confirmed tidal elevations) to verify whether the predicted tide was accurate. If it varied due to climatic or other factors, consider those. Tidal predictions do not include variables such as low-pressure systems, or wind and wave run-up on a given day.

Figure 4-43: If you know the approximate elevation of this drift line on the beach in relation to the MHHW, you may be able to bookend where to look for the OHWM or support the indicators observed at the OHWM.

While a hydrologic assessment is not required for OHWM determinations, it can be quite useful. NOAA tide predictions are available for 162 sites in Washington on the Columbia River, outer coast, and Salish Sea. The preferred website for tidal predictions is tidesandcurrents.noaa.gov because tidal data, as well as observed tides, are available for 15 stations on this website, and all predictions and observed tides are based on NOAA stations that are monitored and calibrated (these are known as harmonic stations).

Gathering relevant, important information for your planned site visit may follow the steps outlined below:

Step 1. Locate the subject site(s) on a map and get driving directions (bingmaps.com, googlemaps.com).

Step 2. Download an aerial photo using satellite imagery (bingmaps.com, googlemaps.com, or googleearth.com) or oblique imagery and print the clearest or most relevant photos. Review of aerial photos may give an initial determination of whether the site is a high-energy or low-energy system.

Look at the Washington State Coastal Atlas (https://fortress.wa.gov/ecy/coastalatlas/) to determine drift cell movement, possible seagrass presence (dislodged seagrasses can form visible wrack lines on the beach), location of feeder bluffs, and sea level rise data. The Coastal Atlas also provides historic aerial photos dating back to the 1970s or in some cases the 1940s, historic estuaries, SMA jurisdiction, and coastal landforms.

Make an initial determination as to whether the site is high or low energy and whether it may be accreting or eroding.

Step 3. Login to www.tidesandcurrents.noaa.gov or another website with reliable tidal data. We have found that this website evolves over time due to regular updates, so the instructions below may not be precisely accurate.

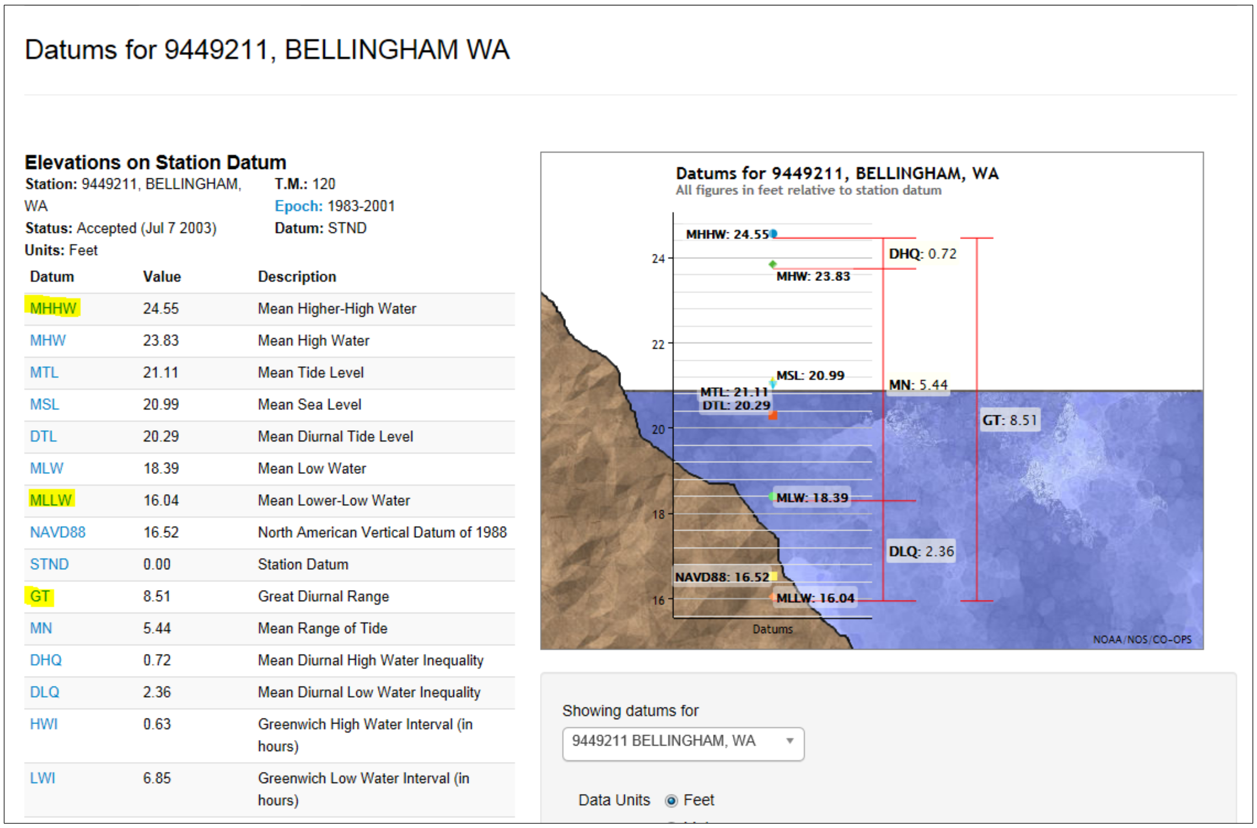
- Locate the most appropriate station that corresponds to your site.

  From the NOAA website home page, click on the "Products" tab, then "Datums" in the dropdown box. Select Washington from the column on the left. If you do not know the name of the specific station you wish to use, use the map feature to locate an appropriate station near the subject site. Ideally, choose a "Harmonic" station with a met or meteorological station attached because these stations can provide observed tidal data. If a subordinate station is preferred due to location, you will have to extrapolate observed tidal elevations from a harmonic station later.

  Choose a station that is close and in the same relative water body as the subject site. Try to ensure that there are no large areas of land or areas with exceptional currents between your site and the station. For example, if your site were on the east side of Camano Island, you would not want to choose a station on the west side of Puget Sound, such as Port Townsend. You could choose the Seattle station and extrapolate the tidal data from that station to your site or choose a closer subordinate one, such as Stanwood. On the outer coast, there are fewer stations, but La Push, Toke Point, and Westport are all Harmonic stations with associated met stations.

- Find the MHHW elevation for your chosen station.

  From the station selection map click on the "Datums" tab in the dropdown menu, or if you are on the Washington list of stations page, click on the station name. You will see a table of sorts with several datums and elevations. You will be interested in the difference between the MLLW elevation and the MHHW elevation. Although, generally, MLLW represents "0", each station is different based on where the tidal gauge is located or measured. For Bellingham, for example, the MLLW elevation is measured from 16.04 feet. Since the MHHW measured at that station reads 24.56, the difference between the two is the actual MHHW elevation of 8.51 feet, representing the tidal range in the diurnal cycle. A quick way to find the actual MHHW elevation is to find the "Great Diurnal Range" (shown as GT on the table), which represents the difference between the two datums (Figure 4-44). Therefore, the MHHW elevation for the Bellingham station is 8.51 feet. In addition, be sure the Units are in feet and you are in the present epoch.



Datums for 9449211, BELLINGHAM WA

Elevations on Station Datum

Station: 9449211, BELLINGHAM, WA
T.M.: 120
Epoch: 1983-2001
Status: Accepted (Jul 7 2003)
Datum: STND
Units: Feet

Datum	Value	Description
MHHW	24.55	Mean Higher-High Water
MHW	23.83	Mean High Water
MTL	21.11	Mean Tide Level
MSL	20.99	Mean Sea Level
DTL	20.29	Mean Diurnal Tide Level
MLW	18.39	Mean Low Water
MLLW	16.04	Mean Lower-Low Water
NAVD88	16.52	North American Vertical Datum of 1988
STND	0.00	Station Datum
GT	8.51	Great Diurnal Range
MN	5.44	Mean Range of Tide
DHQ	0.72	Mean Diurnal High Water Inequality
DLQ	2.36	Mean Diurnal Low Water Inequality
HWI	0.63	Greenwich High Water Interval (in hours)
LWI	6.85	Greenwich Low Water Interval (in hours)

Figure 4-44: Datum page for the Bellingham station. Note that the MLLW elevation subtracted from the MHHW elevation equals the actual MHHW or the Great Diurnal range- GT.

- Obtain predicted tidal information for the chosen station.

Go back to the "Products" tab at the top of the page and click on "NOAA tide predictions" from the dropdown menu. Choose the station you selected earlier from the list on the page or use the map feature again to locate the station. Click on the station name if you are on the page with the list or on "tide predictions" if you are using the map feature.

Make sure that the datum is MLLW, the time is Local Standard Time (LST)/Local Daylight Time (LDT), and the units are in feet. Recent updates to the NOAA website seem to have defaulted to these units, but it is wise to check. On the tide predictions page, you can choose the days you would like to have displayed. The most relevant period for an

OHWM determination is about a day or two before the site visit and the day of the site visit. The result will be a graph of the tidal cycle for those chosen times and a table on the right with specific elevations.

With this information you can plan your site visit for a time when the tide is either very high. This way, you can observe where that tide reaches on the beach, or you can choose to go after a higher high tide event with the hope that you might be able to see a wrack line or other remnant of it on the beach. If you are able to observe the location of the last higher high tide and you know the elevation of it relative to the MHHW (remember MHHW is always below OHWM), you will be able to better focus your investigation. However, you will need to go back to the NOAA website to determine whether the predicted tide was consistent with what was observed as the actual tide.

- Obtain observed tidal information for chosen station.

If you find that tidal data may play a role in your OHWM determination, it will be important to find out the observed tidal elevations for your station and the subject site. Atmospheric pressure, wind speed and direction, and varying climatic patterns all play a role in tidal elevations. Tidal predictions can vary by up to two feet from the observed tides depending on these weather patterns (Finlayson 2006). Morton and Speed (1998) found that tide gauge records consistently underestimated the actual elevation and horizontal positions that water reaches on the beach as a result of wave run up [see also O'Connell 2005, Ruggiero et al. 2003].

Observed tidal data can be obtained just before the site visit if the tide you are interested in has already occurred, or it can be checked after the site visit. Having the NOAA website bookmarked on your smartphone can be a handy way to get the observed data soon after the tidal occurrence. If you choose to use an app or other website from your phone, make sure that the data is referenced from NOAA tidal stations and outputs.

If using a subordinate station, note the harmonic station it is referenced to. The information should be right below the station name and number. For example, the Bellingham station is referenced to the Port Townsend harmonic station. There is also information regarding the time offset and the height offset, which you should record. This will help you compute the actual tidal heights for a subordinate station after the tidal occurrence.

To get the observed tidal data go back to the "Products" tab and from the dropdown box click on "water levels". Click on Washington, and the 15 harmonic stations will be listed. Click on the station for which the subordinate station is referenced. A plot will appear which shows you whether the observed tide was higher, lower, or as predicted. Make sure that the time zone is LST/LDT, as the default here is currently Greenwich Mean Time (GMT).

To get a more precise understanding of the observed tides, click on the "Data Only" tab near the bottom of the page. There will be a list of tidal heights for predicted and preliminary observed, and, possibly, verified if enough time has passed since the tidal event. Here are the steps for approximating the observed high tide elevation for a given site and time:

1. Calculate the residual between the predicted and observed tidal elevation for the appropriate observation station, location “A” (Observed "A" – Predicted "A" = Residual "A");
2. Calculate the high tide prediction for the subordinate station you chose for the subject site, location “B”, based on the high tide correction factor provided by NOAA (Predicted "A" * correction factor = Predicted "B"); then
3. Add or subtract the residual from “A” to the tide prediction for “B” to estimate the water level for a given time at your site (Predicted "B" +/- Residual "A" = approximation of Observed "B").

Step 4. Gather field equipment.

The type of field equipment necessary to help assess and document the OHWM depends on the site and is determined by several factors such as whether the site is:

- High energy or low energy.
- Has been disturbed by natural occurrences of extreme high tides or use of the shoreline by residents.
- Has been disturbed illegally by property owners.
- Is bulkheaded.
- Has biological features present such as shoreline vegetation, drift logs, seagrasses (which often form a wrack line), or lichen.

Nonetheless, some standard equipment for your site visit is:

- Camera.
- Pin flags or stakes and flagging.
- Plant identification books.
- 50 or 100-foot tape measure.
- Measuring stick.
- Aerial photos and tidal data.
- Field indicator printouts from this guidance document.
- Hand lens for lichen or plant id.

3.4 Field Assessment

Once on site, be methodical in your approach to making and documenting an OHWM determination. The following steps should ensure a thorough site investigation.

Step 1. Walk along the shoreline and look for signs that the site is either high energy or low energy.

Step 2. Look for OHWM indicators on the site such as a line of vegetation, wrack lines, drift logs, salt-tolerant vegetation, black and orange lichen, etc. Compare the current conditions to the aerial photo of the site and note any changes. Look up and down the beach and note if it is a relatively undisturbed stretch of shoreline or if there are bulkheads or groins/jetties, as these may affect drift cell movement and, thus, beach accretion or erosion features. Also, note if there are feeder bluffs nearby and whether they are still functioning as such. If there are drift logs, look for signs that waves may run under them or crash over them. Record all observations.

Step 3. Consult the tidal data and see if there are any wet or moist drift lines or wrack on the beach from the most recent higher high tide. Seagrass wrack should still be green and identifiable for it to have been deposited by the most recent higher high tide. If a drift line is present, note the predicted elevation and whether it is above, below, or at MHHW. If possible, access it from a smart phone, log on to NOAA's Tides and Currents website (http://tidesandcurrents.noaa.gov/) and look up the observed water level for the station's reference station. Calculate the approximate observed tidal elevation of the last higher high tide; this should provide an elevation of that drift line. This information should help focus on where to look for OHWM indicators. If onsite web access is unavailable, take photos and notes regarding the location of the drift line.

Step 4. Note and photograph all biological indicators of the OHWM on the beach, both on the site being investigated and up and down the beach if necessary. Try to correlate the elevation of the various indicators. If they do not align with a single elevation, then you may be misinterpreting one or more of them. For example, observations of an orange lichen without the black lichen below may be misleading. It may be that the orange lichen is not *Caloplaca marina* but another species without relevance to saltwater tolerance.

If visiting the site during a high tide that is at or above the OHWM elevation, field indicators may be underwater or obscured; to document the location of the OHWM relative to the MHHW elevation, it may be necessary to return to the site when the water level is below the MHHW elevation. However, it can be valuable to observe the location of an OHWM tide.

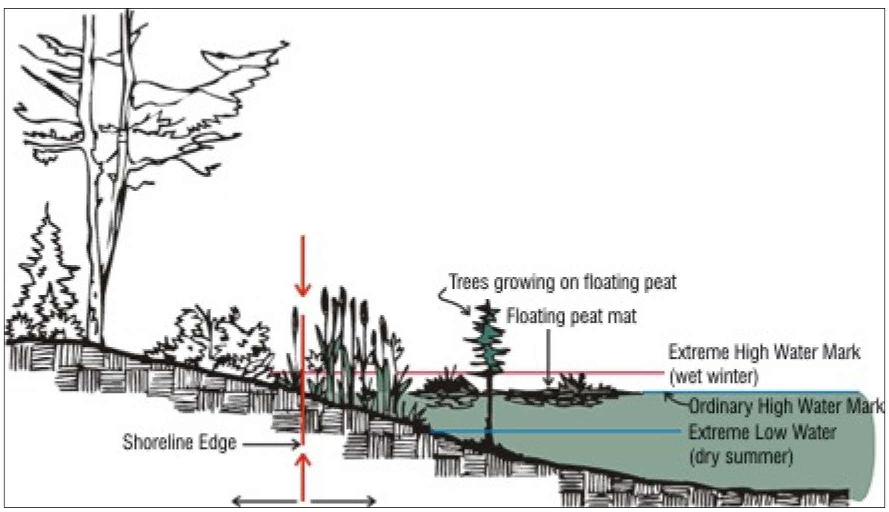
Step 5. For high-energy environments - Once you have corroborated all of the OHWM indicators, install pin flags or hang flagging on woody vegetation, if available, and take several photographs looking up and down the beach. Be sure to remove the flags before leaving the site to ensure they do not end up in the nearshore environment, unless they will be surveyed or GPS points taken later. Survey or GPS data is useful when developing site plans for future development, especially when determining setbacks from the OHWM for local shoreline permitting.

For low-energy environments – If there is not a distinct line of salt-tolerant vegetation, establish a transect perpendicular to the shoreline that crosses what you think to be the OHWM. Locate two to four vegetation plots along the transect at least a square meter in size (for emergent vegetation) and larger for woody vegetation. Make a list of all plant species in each plot. Using the Hutchinson (1988) salt tolerance list as a guide, determine where the salt-tolerant vegetation dominates the plant community and the salt-intolerant vegetation drops out or vice versa. Install pin flags or hang flagging tape along the OHWM and take several photos looking up and down the beach to visually document your findings. Leave flagging in place if a survey or GPS points will be taken later. Otherwise, remove the flagging prior to leaving the site so that it does not end up in the nearshore environment. Survey or GPS data is useful when developing site plans for future development, especially when determining setbacks from the OHWM for local shoreline permitting.

Step 6. Once back in the office, collect all information that was gathered on the site visit. Write a letter or short report (no need to be longer than a couple of pages) describing the data collected in the office and in the field and make sure to adequately document how you came to determine the location of the OHWM on the site. Be sure to attach all relevant photos, notes, and plant species lists and data sheets.

Chapter 5 – Lakes

> *"On Lake Sammamish, as on other water bodies, the ordinary high water mark (OHWM) is a moving line, changing over time as natural forces operate on the lakeshore."*
>
> Howe v. King County. Shoreline Hearings Board Decision 86-48.



5.1 Introduction

For purposes of the SMA, lakes include bodies of freshwater (including reservoirs) greater than 20 acres in area. This area (continuous and contiguous water surface) can include vegetated areas along the shoreline inundated by a continuous OHWM, and is not limited to just the open water areas. Services provided by lakes include: popular locations for residential and recreational development; important fish and wildlife habitat; essential commercial services such as domestic water supply, port and shipping facilities; commercial development including resorts and restaurants; and recreational opportunities (e.g., camping, boating, or fishing).

The steps in determining an OHWM on lakes are the same as described in the introduction of this manual: conduct an office assessment, hydrologic assessment in many cases (when gage data is available), and visit the site for the field assessment. Gage data provides important information on lake levels and should be used whenever it is available.

5.1.1 Origin and patterns of lakes

The approximately 8,888 lakes in Washington differ widely by type and geographic distribution among the counties. While fundamentally a basin with an accumulation of water, lakes originate in a variety of ways which dictate their geographic distribution (Dion 1978).

Figure 5-3: Transition zone between the Sammamish Slough and Lake Washington in Kenmore, WA

Most lakes in Washington resulted from glacial and stream action. In the Puget Sound lowlands and areas of northeastern Washington many lakes occupy depressions in the carpet of glacial drift material (gravel, sand, silt and clay) laid down by continental glaciers during the ice age 10,000 to 20,000 years ago. Their shapes are, generally, either long troughs cut into drift plains by the passing ice sheet, or circular **kettles** left by the melting of huge blocks of glacial ice (Dion 1978). Glacial **drift plain lakes** (such as Lake Washington, Figure 5-1, and Lake Sammamish) are generally aligned in the direction of ice movement.

Cirques are deep lakes formed by glacial erosion in the side of a mountain. Lake Chelan is the state's largest and longest natural lake and is a spectacular example of this. **Oxbow lakes** are formed by stream processes when a river meander is cut off and isolated, as a result of a change in the watercourse. They exhibit distinctive sinuous or curved shapes in river floodplains. **Coulees** in the semiarid Columbia Basin were cut by the gigantic Missoula floods, which resulted from breakage of ice dams on glacial lakes.

The geographic location of a lake, influenced by its form of origin, will dictate factors that affect the location of its OHWM. For most Washington lakes the general pattern of water level fluctuation is a rising stage in spring and early summer followed by a decline in the fall and winter (Dion 1978). The water rise is driven by rainfall and snowmelt. After an early summer peak the stage declines gradually to a winter low.

Puget Sound lowland lakes follow a different pattern, in which lake stages begin to rise in the fall in response to greater rainfall and lower evaporation. These lakes peak in mid to late winter, and gradually draw down to a late summer low due to a decrease in rainfall and increase in evaporation.

Groundwater-fed lakes in the Puget Sound lowland follow a distinct pattern when compared to surface-water-fed lakes. Generally speaking, they peak several months later in the water year and can exhibit an inter-annual variability on a decadal cycle. (More on this under "special circumstances and considerations" later in this chapter.)

In semi-arid regions of the state where evaporation usually exceeds precipitation, many "closed lakes" lack outlets and are typically saline.

5.2 Defining the OHWM

Remembering that the SMA defines the OHWM as a physical and ecological feature on the landscape (see RCW 90.58.030(2)(c)), the OHWM is often a transition zone between the aquatic and terrestrial environments and not a distinct line. The aquatic environment includes the riparian environment that thrives on or withstands inundation by ordinary high water. In some places the transition zone occurs in a narrow band and can be easily identified. In other places it can be a broad and gradual change that can be difficult to determine without a detailed review. For those rare instances when the OHWM cannot be found at a site, the SMA allows the OHWM to be placed at the line of mean high water on fresh waters.

5.2.1 Definition of lakes in the SMA

There is no commonly accepted definition of what constitutes a lake in terms of minimum size and depth. Generally speaking, lakes are more than an acre in size. In his "Lakes of Washington" report series, Wolcott (1973) used Webster's definition for inventorying lakes:

> *"A considerable inland body of standing water; also an expanded part of a river. When a body of water is so shallow that aquatic plants grow in most of it, it is usually called a pond; when a pond is mostly filled with vegetation, it becomes a marsh."*

Wolcott (1973) describes his approach in surveying the lakes in Washington: "*I decided to tabulate all bodies of water which conform to Webster's definition of a lake and which are one acre or more in area, regardless of depth. In addition, all named lakes, even though less than an acre, are included."* Wolcott also stipulated the following:*"In general, the marsh which contains some open water the year around, even though quite shallow, is classed as a lake."*

Lakes are defined in the Shoreline Management Act as follows:

> *"Lake" means a body of standing water in a depression of land or expanded part of a river, including reservoirs, of twenty acres or greater in total area. A lake is bounded by the ordinary high water mark or, where a stream enters a lake, the*

extension of the elevation of the lake's ordinary high water mark within the stream. WAC 173-22-030(4).

Under the SMA definition lakes are bodies of standing water of at least twenty acres in area and can consist of a combination of deeper open water and shallower marshy areas. Wetland areas within the ordinary high water mark of a lake are part of the lake; the associated wetland is the portion of a wetland that extends beyond a lake's OHWM. **(Please refer to Chapter 6 for guidance on how to determine the boundary of "associated wetlands.")**

What is the minimum amount of "open water" that is required to classify an area as a SMA lake? Although the SMA does not specify, we suggest that a minimum of two acres of open water be discernible within the minimum 20 acres of standing water. This represents 10 percent of the smallest potential SMA lake (20 acres). The open water should be a discrete and contiguous area and not consist of a collection of smaller spaces scattered throughout the vegetated matrix of the water body (Figure 5-2). There is no minimum depth. The open water polygon can include aquatic bed vegetation but not include emergent, scrub-shrub, or forested vegetation classes. The standing water in the lake must be a "continuous and contiguous" body of water. It may be easier to evaluate this at the beginning of the growing season, when the water is higher and the aquatic bed vegetation has not begun to grow.

Figure 5-2: Thorndyke Lake, Jefferson County, is twenty-three acres of standing water; four acres are open water. Lake is currently not designated a shoreline.

Where slope wetlands abut lake-fringe (lacustrine) wetlands, the OHWM is often found at the slope break where there is a bi-directional flow from the lake through the lake-fringe wetland (Figure 5-3). A distinguishing feature of lake-fringe wetlands is that the lake is the primary source of hydrology and water is free to move to or from the lake and wetland. The table below (Gwin et al. 1999) summarizes the geomorphic setting and hydrology for slope and lake-fringe wetlands.

HGM Class	Geomorphic Setting	Water Source	Hydrodynamics
Slope	Occur on sloping land where there is a discharge of groundwater to the land surface	Dominant water is groundwater, interflow from uplands and precipitation	Unidirectional flow downslope
Lacustrine Fringe	Adjacent to lakes where the water elevation of the lake maintains the water table and water surface level within the wetland	Lake water is dominant source; additional sources include groundwater discharge and precipitation	Bi-directional water flow controlled by water level fluctuations in adjoining lake

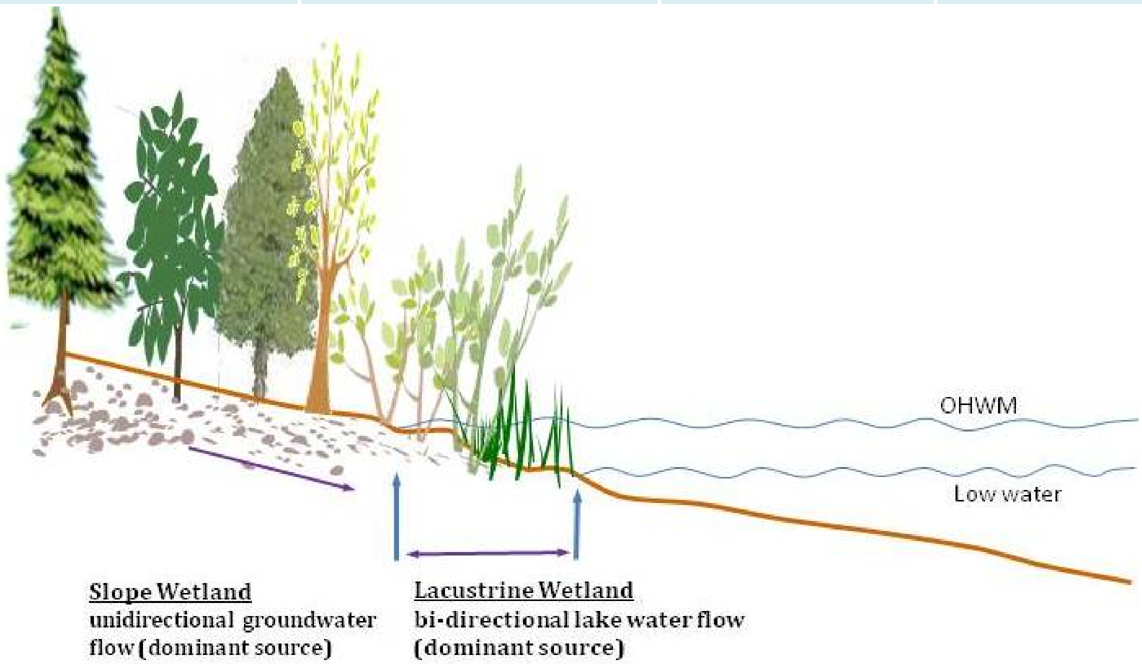


Figure 5-3: Idealized cross section of lake, showing intersection of lacustrine with slope wetland on shoreline.

5.2.2 Field indicator descriptions

The following table lists the key field indicators that you can expect to see on a lake shoreline. A more detailed description of each indicator, as well as its relation to the OHWM, follows the table. The field determination of the OHWM should be based on the clearly documented preponderance of evidence that supports it. Be sure to substantiate your determination by including all indicators seen and their strength (absent, weak, moderate, strong) in establishing the OHWM. The time of year may influence the expected strength of the indicators. A lack of obvious field indicators during drier times of the year does not mean the OHWM is the edge of water during your site visit. Adjacent areas within the shoreline reach may provide indicators applicable to your site of interest.

Summary Descriptions of Key Field Indicators for Lake OHWM				
Lake Indicators	**Description**	**Below**	**Straddling**	**Above**
Vegetation changes at lake-upland transition	Community transition from lacustrine fringe to UPL community at lake-upland transition	✓	✓	
Eroded/exposed roots	Wave and water action on lakes with sufficient fetch can expose roots of trees and shrubs growing on the shoreline.	✓	✓	
Morphological adaptations	Buttressed tree trunks, adventitious roots, multi-stemmed trunks, plants on hummocks. Some OBL emergent species such as *Carex obnupta*, which tolerate prolonged inundation, grow on elevated hummocks in the zone between OHWM and low pool elevation.	✓	✓	
Plants on hummocks	Some OBL emergent species, tolerant of prolonged inundation, may grow on elevated hummocks in the zone between OHWM and low pool elevation. FACU or UPL species growing on hummocks would be above OHWM.	✓	✓	✓
Topographic break	Erosional or depositional features.	✓		
Substrate changes	Changes in soil color, texture, and organic content resulting from wind-driven wave action on the lake shoreline that sorts and washes the substrate.	✓	✓	
Filamentous algal growth/crust	Algal growth is an indicator of prolonged inundation. Colonies of green algae that grow into hair-like mats on rocks, plants, woody stems, and other substrates. Desiccate into an algal crust on substrate at low water. Filamentous algae are more prevalent on developed lakes with nutrient inputs.	✓	✓	
Live and dead remains of animals	Presence of aquatic invertebrates and vertebrates (e.g., fish) shows that area is subject to at least periodic recent inundation and is at or below OHWM.	✓	✓	
Amphibian egg masses	Note: seasonal indicator; not apparent at low water	✓	✓	
Water marks and stains	Discolorations or stains on bark of woody vegetation, bulkheads, rocks, bridge supports, building, fences, or other fixed objects as a result of inundation. May include lines on lichen growth that are stunted or killed by standing water. On alkali lakes with high concentrations of dissolved salts, and in areas with high evaporation, shoreline rocks can be coated with salt deposits, typically in bands.	✓	✓	
Sediment deposits	Thin layers or coatings of fine-grained material (e.g., silt or clay) or organic matter (e.g., pollen), sometimes mixed with other detritus, remaining on tree bark, plant stems or leaves, rocks, and other objects after surface water recedes.	✓	✓	
Water stained leaves	Fallen or recumbent leaves that have turned grayish or blackish in color due to inundation for long periods.		✓	
Wrack accumulation	Debris (trash, leaves, grass, etc.) left on the ground or caught on drift logs, structures or vegetation from past high water events.		✓	✓
Organic soil accumulation	Accumulation of organic matter and duff.			✓

Summary Descriptions of Key Field Indicators for Lake OHWM				
Lake Indicators	**Description**	**Below**	**Straddling**	**Above**
Continuous and contiguous pool of water	At high pool elevations determine the extent of the "continuous and contiguous" water surface elevation from the adjoining lake to establish the outer boundary between lake fringe and slope wetlands or upland.	✓	✓	

Considerations:

Low-water masking of indicators. Consider late-season drawdown and growth of annuals. Wrack builds up towards the water. Accumulation is a function of supply.

High-water masking of indicators. During extreme high water events indicators will be inundated or may be obscured once water recedes.

Vegetation changes at lake-upland transition
Description: Changes in the wetland indicator status of plant species and shoreline plant community as you move landward from the water's edge. The wetland indicator status reflects a plant's ability to withstand at least periodic inundation or saturated soils. The transition from a plant community composed predominantly of wet species to upland species is often associated with a rise in elevation (or the wetland transitions from lake-fringe to slope) or topographic break.

Relation to the OHWM: Plants tolerant of wet soils (periodic or prolonged saturation or inundation) are often found at or below the OHWM, while intolerant species are found landward of the OHWM.

Caution: Be sure to use the current wetland plant list for the applicable region, available at: http://rsgisias.crrel.usace.army.mil/NWPL.

Wetland Indicator Status
Five indicator statuses or ratings are used to designate a plant species' ability to persist in wetland (i.e., waterlogged) or upland soils. The indicator status is based on an index of wetland fidelity that considers the frequency and abundance in wetlands versus uplands (Lichvar and Minkin 2008).

Wetland Indicator Status	Description[19]	Examples
Obligate (OBL)	almost always a hydrophyte, rarely in uplands	**skunk cabbage, cattail, water lily**
Fac Wet (FACW)	usually a hydrophyte, occasionally found in uplands	**Oregon ash, buttercup, reed canarygrass, willows**
Facultative (FAC)	commonly occur as either a hydrophyte or non-hydrophyte	**red alder, salmonberry, Sitka spruce, white clover, red fescue, lady fern**
Fac Up (FACU)	occasionally a hydrophyte, usually occur in uplands	**western hemlock, snowberry, Douglas fir**
Upland (UPL)	rarely a hydrophyte, almost always in uplands	**Oregon oak, hairy manzanita**

Hydrophytes are plants that are adapted to life in water or in saturated soils. Prolonged saturation creates an oxygen deficiency in the soil in just a few days. Since all plants require oxygen for growth and survival, only plants with special adaptations or colonization strategies can survive in these conditions. Approximately one-third of vascular plants that grow in the United States (7,000 of the 20,000) can tolerate the wet conditions of a wetland. Of those that grow in wetlands, 26 percent are obligate (found only in wetlands) (Tiner 2006).

Due to their ability to withstand periodic if not prolonged inundation, OBL and FACW wetland plants are the most reliable indicators of the OHWM. There are 24 species of FACW trees and 8 species of OBL trees in Washington state (National Wetland Plant List http://rsgisias.crrel.usace.army.mil/NWPL/).

[19] Descriptions conform to the new definitions of the Wetland Indicator Status in Lichvar and Minkin 2008, *Concepts and Procedures for Updating the National Wetland Plant List*. Full citation in bibliography.

Eroded/exposed roots

Description: Wave and water action on lakes can expose roots of trees and shrubs growing on the shoreline (Figures 5-4 and 5-5). Adventitious roots or "water roots" occur immediately above the soil surface in response to inundation or soil saturation.

Relation to the OHWM: On the shoreline exposed roots are an indication of the presence and action of water and are typically found at or below the OHWM.

Caution: On steep slopes, tree roots may be exposed due to topography and not necessarily due to the presence and action of water.

Figure 5-4: Exposed adventitious and buttressed roots on cottonwood trees on shoreline of Hicks Lake, Thurston County.

Figure 5-5: Exposed roots and abrupt transition to upland plant community on shoreline of Hicks Lake, Thurston County.

Morphological adaptations

Description: Morphological adaptations are easily recognized physical characteristics developed by plants for survival in prolonged inundation or saturation in the root zone. In the Western Mountains and Valleys region common morphological adaptations include adventitious roots, multi-stemmed trunks, tussocks (hummocks), and buttressing in tree species.

Relation to the OHWM: These adaptations develop in response to prolonged inundation or saturation in the root zone. You will need to determine whether the prolonged wetness is due to inundation (contiguous and continuous water surface), which would be waterward of the OHWM, or only saturation, which would be at or landward of OHWM.

Caution: Because some morphological adaptations may be due to solely to saturated soil conditions and not inundation, it is important to carefully document other site characteristics such as topographic (e.g., drainage channels) and substrate changes to support the OHWM determination.

Plants on hummocks

Description: Some OBL emergent species such as *Carex obnupta* and *Glyceria spp*., which tolerate prolonged inundation, grow on elevated hummocks in the zone between OHWM and low pool elevation. The hummocks are slightly elevated above the ground.

Relation to the OHWM: Plants with FACW and OBL wetland indicator status (see p. 8 above and Appendix B) are typically found at and below OHWM, while species with FACU and UPL status are found above OHWM. Distressed or dead shrubs and trees may indicate that a site has recently become wetter.

Caution: Plants, particularly trees and shrubs, may not accurately indicate recent changes in water levels. Be sure to review multiple years of aerial photographs and gage data, when available, to help determine if the plant community is reflective of current conditions.

Topographic break (erosional or depositional feature)
Description: One or more topographic breaks can be observed at the shoreline of a lake, depending on the fetch and wave exposure on the shoreline.

Relation to the OHWM: OHWM usually found at or below topographic break. When vegetated, dominant plant species waterward of the topographic break can help refine the OHWM location. The OHWM can be correlated with gage data when available.

Caution: Topographic breaks should be due to contemporary, ordinary events. Strong storms may push water levels to higher than OHWM elevations, contributing to erosion or deposition, and you should use care to ensure that topographic changes are the result of ordinary water levels.

Figure 5-6: Erosional topographic break and substrate change on the shoreline of Big Lake, Skagit County.

Substrate changes

Changes in substrate color, texture, and organic content result from wind-driven wave action on the lake shoreline that sorts and washes the substrate.

The presence and action of water will sort fines (fine sand, silt, and clay) from coarser materials, often removing them, as well as organics, to deeper water.

Description: Noticeable change in substrate color, texture, and organic content along shoreline from lake to upland/wetland. Lake shore substrates typically are coarser, such as sorted sands, gravels, or cobbles and are devoid of organics, in contrast to upland soils with organics and sometimes a duff layer (Figure 5-6).

Relation to the OHWM: Sorted sands, gravels, and cobbles with little or no duff (decomposed organics) are typically found below OHWM. Soils with a well-developed duff layer or with noticeable organics in the upper layer are above OHWM.

Caution: It is important to confirm that observed substrate changes are due to the presence and actions of water and not the result of human actions such as filling or grading.

Figure 5-7: Change in substrate texture and color along lakeshore. Darker and finer textured soils (higher organics) are taken from the landward side of OHWM at water's edge.

Filamentous algal growth/crust

Description: Filamentous algae are colonies of green algae that join together to form long strands and develop dense hair-like mats. They attach to rocks, aquatic plants, woody stems, and other substrates (Figures 5-8 and 5-9). As the lake elevation draws down the algal growth begins to decay and desiccate. When dry it can form a thin layer of crust on the substrate it was growing on but may be masked by plants growing above the dried algal mat after the water has receded (Figures 5-10 and 5-11). Filamentous algae is more prevalent on developed lakes. When present it is a reliable indicator of prolonged inundation.

Relation to the OHWM: The presence of algal matting indicates prolonged inundation sufficient to support the growth of algae and is typically found at or below OHWM.

Caution: This indicator may be seasonal and may not be readily apparent at low water, especially in summer if other plants have grown in where water levels have receded.

Figure 5-8: Dried algal crust on rocky shoreline of West Medical Lake, Spokane County. Note also stain line on rocks.

Figure 5-9: Green filamentous algae growing on stems of aquatic plants, thin branches, and rocks.

Figure 5-10: Same area shown in photo above. Emergent plants are masking indicators of recent inundation, including algal mats.

Figure 5-11: Dried crust of filamentous algae growing on moss at base of snag shown in photos above and close up of algal crust.

Live and dead remains of aquatic vertebrates and invertebrates

Description: The presence of numerous live individuals or dead remains of aquatic vertebrates (fish or amphibians) or invertebrates (clams, aquatic snails, aquatic insects, ostracods, shrimp) on the soil surface or clinging to plants or other emergent objects are a primary indicator of recent inundation in wetlands (Figure 5-12; US Army Corps of Engineers 2010). When present, they serve as a reliable indicator of recent inundation.

Relation to the OHWM: Occur below and at OHWM.

Caution: Verify that invertebrate remains have not been transported by high winds or unusually high water.

Figure 5-12: Dead aquatic snails and stickleback fish on dried mud pan of lacustrine wetland.

Amphibian egg masses

Description: Pond-breeding amphibians in the Pacific Northwest.

Relation to the OHWM: Egg masses laid in pools of standing or gently flowing water at or below OHWM (Figure 5-13). In a dry year egg masses laid in water may strand above water after the water recedes.

Caution: Egg masses can only be used as positive indicators. Their absence is not evidence. Amphibians do not lay their eggs in areas exposed to wave chop. They require protected areas with shrubs dangling or growing in the water or in shallow areas with emergent vegetation. The following species of amphibians have been documented as breeding in ponds and lakes in Washington (Leonard et al. 1993).

Tiger salamander (*Ambystoma tigrinum*) – breeds April and May.

Northwestern salamander (*A. gracile*) – breeds February through July. Easiest egg masses to see.

Long-toed salamander (*A. macrodactylum*) – breeds mid-December through June.

Cope's giant salamander (*Dicamptodon copei*) – breeds spring into fall.

Pacific giant salamander (*D. tenebrosus*) – breeds spring into fall.

Rough skinned newt (*Taricha granulosa*) – breeds February to July. Eggs very difficult to find.

Great basin spadefoot (*Scaphiopus intermontanus*) – breeds spring and summer.

Western toad (*Bufo boreas*) – breeds February to July.

Woodhouse's toad (*B. woodhousii*) – breeds April to July.

Pacific Tree Frog (*Pseudacris regilla*) – breeds February through July.

Red-legged frog (*Rana aurora*) – breeds January or February – likely too sensitive to breed in Lake Sammamish.

Cascades frog (*R. cascadae*) – breeds March to July.

Columbia spotted frog(*R. luteiventris*) – breeds February to June.

Northern leopard frog (*R. pipiens*) – breeds in early spring.

Bullfrog (*R. catesbeiana*) – breeds in summer. Large visible egg masses.

Green frog (*R. clamitans*) – breeds in late spring or early summer.

Figure 5-13: Northwestern salamander egg mass in standing water, Cowlitz County, March 2010. Photo courtesy of Rebecca Rothwell.

Water marks

<u>Description</u>: Discolorations or stains on bark of woody vegetation, bulkheads, rocks, bridge supports, building, fences, or other fixed objects as a result of inundation (Figures 4-14 through 4-17). Marks may include lines of lichen growth that are stunted or killed by standing water. On alkali lakes with high concentrations of dissolved salts, water lines may be formed by salts.

<u>Relation to the OHWM</u>: Lines are typically due to prolonged inundation and are found at or below OHWM.

Figure 5-14: Glacial erratic rock on Beaver Lake, King County, September 2006. Note several water marks on rock. Photo courtesy of Maren Van Nostrand.

Figure 5-15: Chapman Lake, Spokane County. Photo courtesy of Doug Pineo.

Figure 5-16: Salt deposits on rocks on Medical Lake shoreline, Spokane County.

Figure 5-17: Water mark on sign at WDFW boat launch, Clear Lake, Skagit County 12-1-2010.

Sediment deposits

Description: Thin layers or coatings of fine-grained material (e.g., silt or clay) or organic matter (e.g. pollen), sometimes mixed with other detritus, remaining on tree bark, plant stems or leaves, rocks, and other objects after surface water recedes (Figure 5-18).

Relation to the OHWM: Tend to be at or below OHWM.

Caution: Sediment or pollen stains are a reliable indicator of recent standing water. Be sure to account for extreme high water conditions.

Figure 5-4: Sediment stains on *Carex obnupta* leaves indicate recent inundation. Photo courtesy of Dave Parks, WA DNR.

Water-stained leaves

Description: Water-stained leaves are fallen or recumbent dead leaves that have turned grayish or blackish in color due to inundation for long periods. Staining occurs in leaves that are in contact with the soil surface while inundated for long periods (US Army Corps of Engineers 2010). They maintain their blackish or grayish colors when dry. They should contrast strongly with fallen leaves in nearby non-lake/wetland landscape positions (Figure 5-19).

Relation to the OHWM: Occur at and below OHWM.

Caution: Water-stained leaves are not as common in arid areas of the state. In the wetter areas of the state be sure to correlate water-stained leaves with inundation from the lake and support with other indicators.

Figure 5-19. Water-stained leaves. Notice darker staining on right third of photo, and lighter color of leaves on left side. Photo taken at OHWM of Phantom Lake, King County.

Wrack accumulation

Description: Accumulation and deposition of water-borne debris at water's edge (Figure 5-20). Floating material, such as plant stems and Styrofoam® or plastic, is pushed ashore by wind and waves and then deposited as the water recedes.

Relation to the OHWM: Lines of wrack are typically found at and below OHWM, especially when found in conjunction with other indicators.

Caution: Large storms may deposit material above OHWM.

Figure 5-20. Wrack lines left on shore by receding water levels. Flags mark OHWM 6/15/10 and 4/4/12.

Organic soil accumulation

Description: Organic soils (mucks and peats) typically form where there is a steady supply of organic material and a constant or nearly constant source of anaerobic water. These soils form in ponded depressional areas, wet low-lying areas in low energy sections of floodplains, closed depressions, forested wetlands, estuaries, and shallow water lakes. Organic soils will not form along shallow lake shorelines where the action of waves and water prevent the accumulation of organic matter.

Relation to the OHWM: Organic soil accumulates below the OHWM.

Caution: This indicator is particularly helpful when a sharp transition is found along the upland-wetland gradient that changes from an upland mineral soil to a hydric organic soil in standing water.

Continuous and contiguous water surface

Description: The landward extent of "continuous and contiguous" water surface elevation during ordinary high water (Figures 5-21 to 5-23). This elevation establishes the outer boundary between lake-fringe and slope wetlands or upland. Be sure to identify small channels or bare/sparsely vegetated areas associated with this pool elevation (within the OHWM).

Relation to the OHWM: Continuous and contiguous water surface establishes the OHWM.

Caution: The OHWM is not limited to only the open water and may extend into shoreline wetlands for a considerable distance. Be sure to investigate lake shore wetlands to determine the landward extent of OHWM. If you are onsite during an extreme high water event it may be difficult to determine the OHWM elevation, and corroborating indicators may be obscured.

During the initial Shoreline Master Program (SMP) development lakes were identified from aerial photographs, and those lakes with at least 20 acres of open water were included within the SMP. Subsequent research has shown that this method does not accurately identify the high water lake extent and that shoreline wetlands need to be included in the analysis when determining if a lake should be designated as a shoreline within the SMP. In a 2006 study Bahls et al. concluded that a significant proportion of lakes, which should have been designated as shoreline waters, were overlooked because shoreline wetlands within the continuous and contiguous water surface elevation were not included in the acreage calculation. From Bahls et al 2006:

> "Lakes that are 20 acres or larger in size meet the criteria for designation and protection under the jurisdiction of Washington's Shoreline Management Act. However, since the original list of designated lakes was established in 1972, biologists have found some lakes that meet the size criteria but were erroneously not designated as shorelines; probably because mapping methods were generally limited to coarse measurements of open water areas or did not include the area of wetlands within the ordinary high water mark (OHWM) of the lake.
>
> The objectives of this project were to estimate the error rate in current lake designation in the state and develop a reliable and cost-effective method that could be used by local governments to identify lakes that meet the shoreline criteria. We used GIS data in Phase I of the assessment to classify 8,888 lakes in Washington based on their size and potential to meet shoreline criteria. Lake size included two components – acres of open water and acres of adjoining wetland. In Phase II we measured lake size using aerial photo interpretation for a random stratified sample of 108 lakes in western Washington. In Phase III, we field verified a random sub-sample of 12 of these lakes.
>
> We found that, the accuracy of the GIS analysis in identifying lakes that meet shoreline criteria varied among lake classes, partly because the portion of mapped wetlands that was actually within the OHWM was highly variable. Ninety percent of the lakes with mapped open water areas of 20 acres or greater appeared to meet shoreline criteria upon further investigation, while only about 30 percent of lakes with an open water area between 10 and 19 acres and adjacent wetlands (for a total combined size of 20 acres or more) were found to meet shoreline criteria. Lakes with smaller open water areas or limited wetlands were even less likely to meet shoreline criteria. In summary, we estimate that in addition to the 765 lakes currently designated as shorelines in Washington, approximately 253 lakes meet shoreline criteria but are not designated. In other words, an estimated 25 percent of the lakes that meet shoreline criteria in Washington State are not designated or protected under the Shoreline Management Act."

Figure 5-21: Clear Lake, Skagit County. High water pool elevation extends ~240 feet into the shoreline wetland from open water of lake. Photo taken December 1, 2010.

Figure 5-22: Approximate location of high water mark on Clear Lake. Note that water level on this lake recedes into the wetland and away from the OHWM during the summer.

Figure 5-23: OHWM training class, following the "contiguous and continuous" extension of water from lake into lacustrine wetland.

5.2.3 Common misunderstandings of lake OHWM

- Assuming the OHWM on a lake is the same as "mean high water" (MHW). The SMA definition of OHWM directs the use of MHW only in rare cases when you cannot find an OHWM in the field. Determining the MHW on a lake is problematic for most lakes since the USGS provides gage data on only 37 lakes in Washington[20]. Local jurisdictions may also have gage data available for lakes in their area.
- Assuming that the lake OHWM is found along the edge of open water. In lakes with low-relief shorelines and associated wetlands, OHWM often extends into the shoreline vegetated shallows or wetlands. To determine the OHWM you need to find the landward extent of the contiguous and continuous water surface, including small drainage channels and inundated areas.
- Assuming that high water occurs during the same season for all lakes. High water in groundwater-fed lakes in western Washington may lag several months, and in some cases, years, behind the seasonal rainfall. Reservoirs are another special case where high water may not always occur during the rainy season. When conducting OHWM determinations on these two types of lakes, gather as much background information as possible relative to seasonal water levels (e.g., gage data) in support of your determination.
- Assuming OHWM on reservoirs is equivalent to the controlled surface water elevation.
- Assuming that trees or shrubs do not grow below the OHWM on a lake. Several deciduous trees (Oregon ash, black cottonwood, willows) and shrubs in Washington may be found

[20] http://waterdata.usgs.gov/wa/nwis

growing below OHWM. Trees and shrubs with a Facultative Wetland (FACW) or shrubs with an Obligate (OBL) wetland indicator status can tolerate periodic inundation, especially during the winter when the trees are dormant. Also, the OHWM may extend landward in channels or low spots within a forest or shrub canopy, and trees and shrubs may be growing on hummocks or higher ground above (but not necessarily landward of) the OHWM.

5.2.4 Special circumstances and considerations

There are several situations that merit consideration when making an OHWM determination:

- Where stream begins and lakes ends.
- Changes in land use.
- OHWM on peatlands.
- Beaver activity.
- Wide amplitude of water levels in groundwater-fed lakes.

Streams entering a lake

In low gradient settings the lake OHWM often extends upstream within the stream channel where the stream enters a lake. In such a case, you should look for the upstream limit of lake OHWM indicators, the result of a continuous and contiguous water surface, and where the OHWM transitions to stream indicators. Shoreline jurisdiction would extend upstream to the point where the stream mean annual flow is greater than twenty cubic feet per second and would include any associated wetlands or river deltas.

Land use changes

Changes in land use (e.g., cessation of agricultural drainage practices) and beaver activity can affect the location of OHWM. Shoreline activities permitted by the local government or Ecology (e.g., bulkheads or levees) may also change the location of the OHWM, with one notable exception. Shoreline habitat restoration projects within urban growth areas may use the pre-project OHWM if the project would cause a landward shift in OHWM that would impose new regulatory requirements on lands previously not subject to those requirements (see RCW 90.58.580).

OHWM on peatlands

Peat wetlands, particularly those dominated by *Sphagnum* mosses, offer a unique situation in determining the OHWM because the peat mat may be floating on the water's surface (Figure 5-24). Raised bogs typically are formed by a *Sphagnum* mat that, as it grows, rises above the surrounding surface. The raised portion of the bog is often surrounded by a moat (lag) of open water and may include open water (eye) near the center. Just as in other lakes, you should look for the landward limit of the ordinary high water surface elevation to establish the OHWM. If a lag or evidence of the high water surface elevation is not apparent, you may need to use aerial photographs to determine if the eye is at least two acres of open water (see Figure 5-2, Figure 5-24).

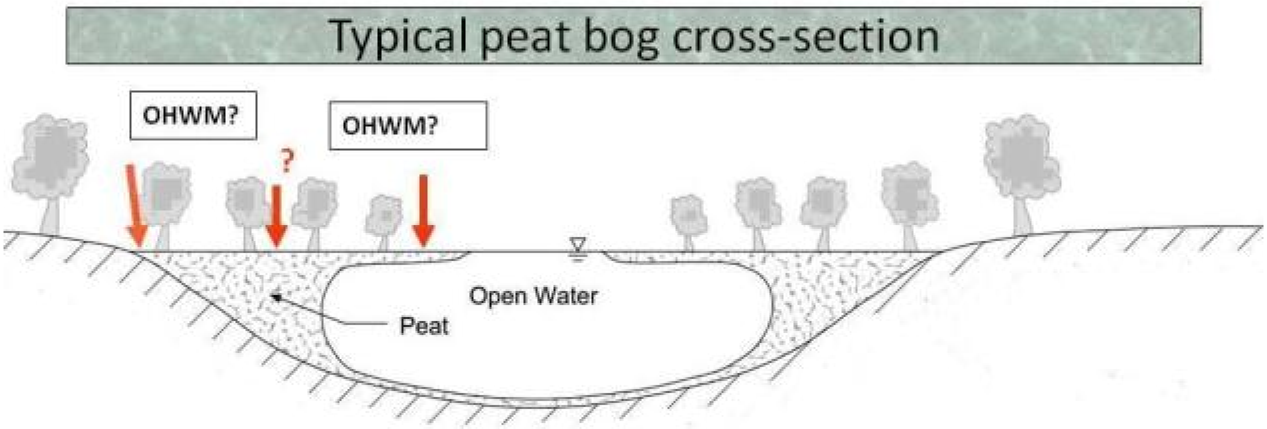


Figure 5-24: From Kulzer et al. 2001.

Crystal Lake in Snohomish County includes areas of open water (Crystal Lake and Little Lake) with an extensive area of peat at the north end of the system. A field investigation determined that the OHWM for the lake system extends to the north end of the peat mat (Figure 5-25).

> *" This is a large deposit of sphagnum moss – probably the largest in the state."*

Source: Rigg, G. 1958. **Peat Resources of Washington**. Page 178.

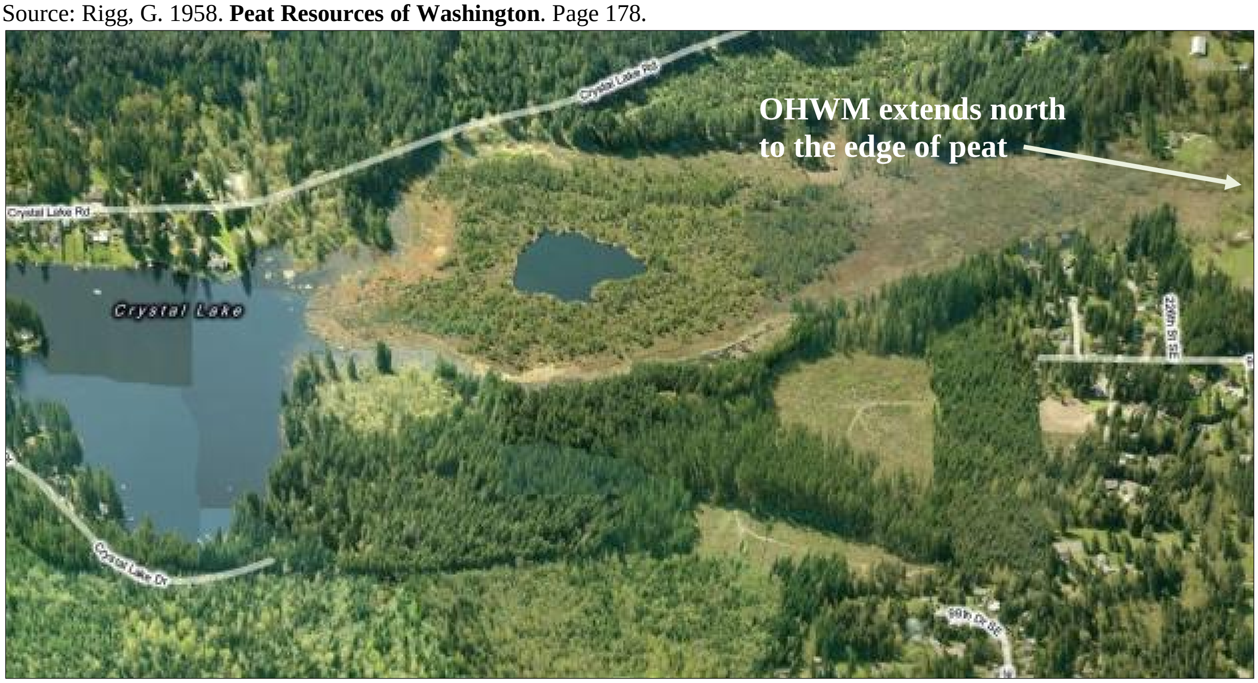


Figure 5-25: Aerial photograph of Crystal Lake, Snohomish County showing areas of open water and peat mat bordering north edge of lake. OHWM, based on continuous and contiguous water surface extends to landward edge of peat mat.

Beaver Activity

Beaver activity can and does influence the location and nature of many lakes in Washington. Their dam-building activities have formed an abundance of small lakes and marshes across the landscape. Some lakes remain as permanent features while others shrink or go away as dams are washed out or removed by human activity (such as dam removal and beaver trapping). This in turn changes the location of the OHWM and, therefore, SMA jurisdiction (Figure 5-26).

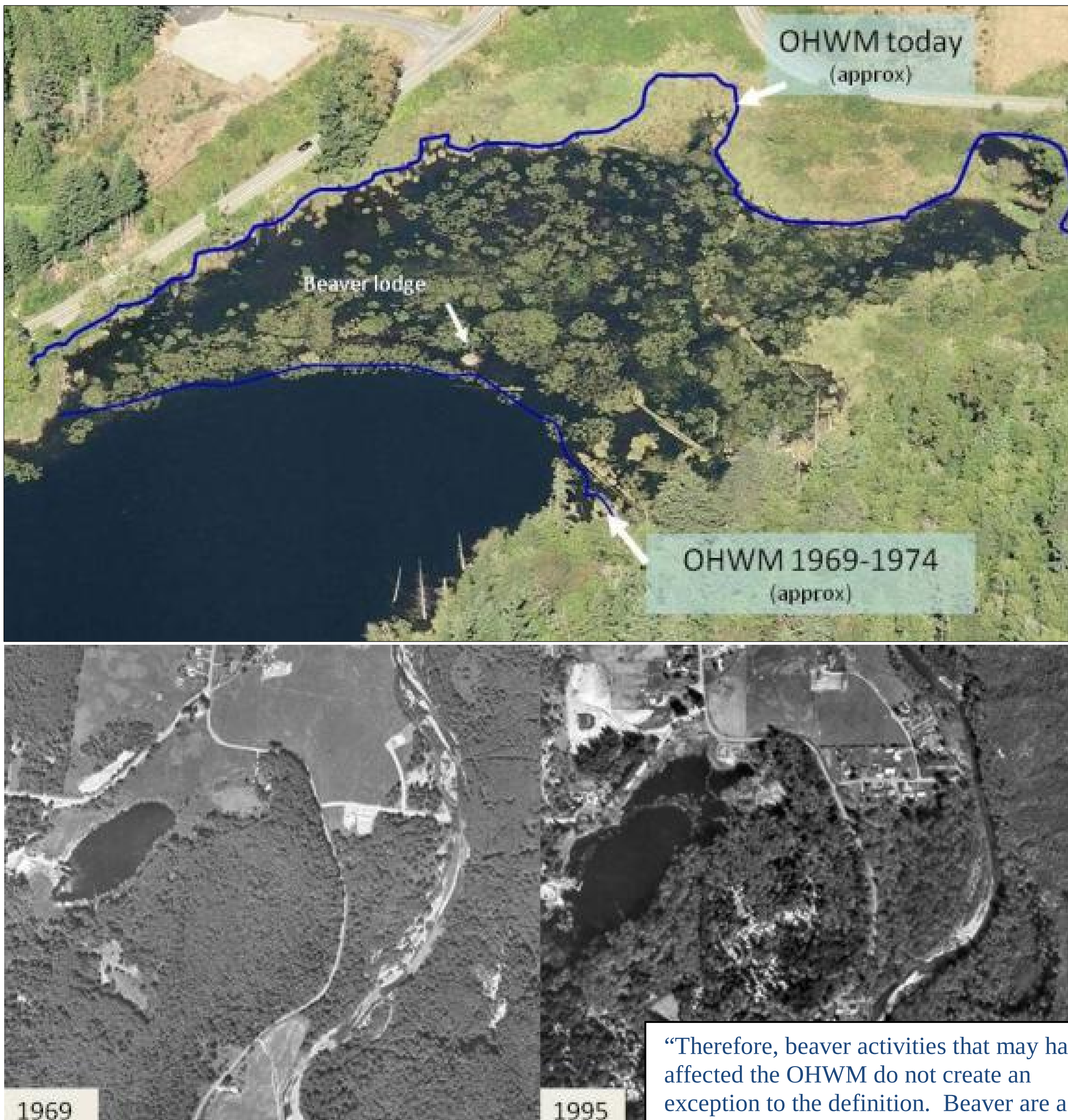


Figure 5-26: Aerial photographs of Conner Lake, Snohomish County for several years showing changes in the OHWM location due to beaver activity.

> "Therefore, beaver activities that may have affected the OHWM do not create an exception to the definition. Beaver are a part of the environment and their activities are encompassed by the phrase in SMP 7.08.150 "or as may naturally change thereafter.""
>
> SHB 88-37, Osborne v. Mason County (re: unpermitted fill on Spencer Lake)

Groundwater-fed lakes

Water level fluctuations in lakes are affected by rainfall patterns that can vary year to year and decade to decade. The degree of water level fluctuation in lakes ranges from barely noticeable to rather dramatic year to year depending on the lake. Groundwater-fed lakes can exhibit water level fluctuation patterns on a decadal cycle.

These lakes have a different hydrograph than surface-water-driven lakes. Use caution when making an OHWM determination on these types of lakes during low rainfall years.

When making OHWM determination on groundwater-fed lakes, “timing is everything.” The timing is not only important in terms of considering that high water is later in the water year than on a similarly situated surface-water-fed lake; it is also important to consider where the lake is with respect to the amount of rainfall that has fallen in the last few years relative to the average rainfall. A comparison of rainfall data and lake levels for Gravelly Lake, Pierce County between 1970 and 1995 shows how lake levels fluctuate due to changes in rainfall (Figure 5-27). There may be a delay of several weeks or even months in the water level of a groundwater-fed lake and rainfall patterns. Conducting an OHWM site visit during the rainiest time of year may not correlate when the lake is at a high water stage.

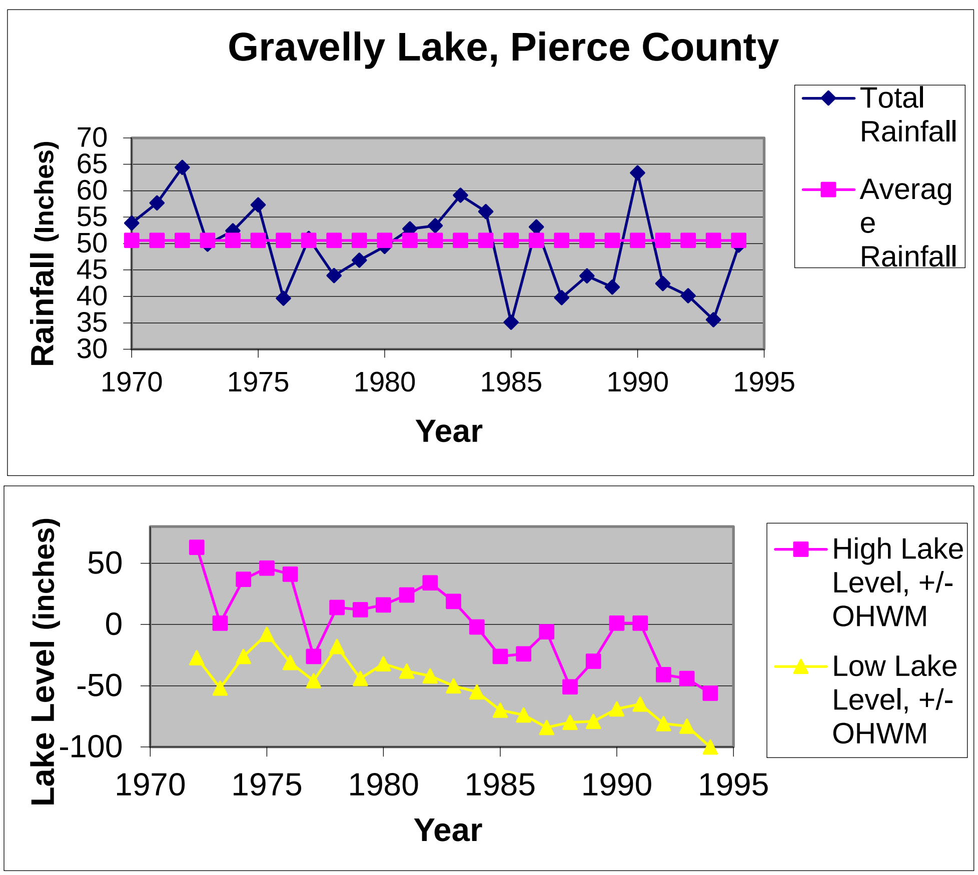


Figure 5-27: Rainfall and lake stage data for Gravelly Lake, Pierce County. Note below average rainfall, 1991-1993 and falling lake levels, 1992-1994.

Figure 5-28 shows Gravelly Lake during ordinary high water and a shoreline property where a bulkhead was proposed during the low water period in the early 1990s.

Figure 5-28: Approximate location of proposed bulkhead on Gravelly Lake beach, Pierce County. Location based on below normal lake levels, 1992-1994.

5.3 Office Assessment

The office assessment is an important first step in familiarizing yourself with the site of interest and its landscape setting. For many sites, the office assessment can give you an approximation of where you would expect to see OHWM indicators in the field, help point out data/information gaps, and help identify areas for more detailed investigation in the field. Before heading out to the site a review of available resources can help focus your field inquiry, saving time and effort. As with other shoreline environments, quite a bit of information can be gathered on a particular lake by searching the internet. Governmental agencies are custodians of a great deal of limnological and water quality information on lakes that may be helpful, including maps (bathymetry, soils, geology, wetlands and land use), hydrologic data, and aerial photos. Many counties provide internet-accessible GIS information that can help you evaluate a lake in preparation for a site visit. Search the county's website for information on lakes. For example, Snohomish County provides aerial photos, bathymetry, water quality watershed maps, and other lake-related information for 38 of the 460 lakes in the County.[21] This will help you identify public access points, whether

[21] Snohomish County provides detailed information on 38 of the 460 lakes in the county at http://www1.co.snohomish.wa.us/Departments/Public_Works/Divisions/SWM/L/Individual_Lake_Resources.htm.

there may be gage data for the lake, as well as other data collected through a citizen monitoring program.

Flood maps are another resource that may be helpful in the office assessment. These maps are often available on the internet or as hard-copy maps. Have any areas along the lake shore been mapped as flood hazard zones by the local jurisdiction or the Federal Emergency Management Administration (FEMA)?

Aerial photographs, especially when photographs from several years are available for a site, can give you an idea of how the lake and shoreline have changed through time and at different seasons. Has the size and shape of the lake changed appreciably over the years? Have there been land cover changes (e.g., plant cover or development) along the shoreline or contributing basin?

When available, gage data can be a valuable resource in evaluating current and historic lake water levels. Real-time data is available via the internet for some lake gages. Evaluating gage data can give you a good idea of expected water surface elevations, seasonality of high water, and how lake levels change through time. Reviewing gage data along with rainfall data[22] can give you a sense as to how your lake responds to seasonal precipitation, and which high water levels are due to periods of above normal precipitation or extreme events.

5.4 Field Assessment

Once you have completed your office assessment and identified areas to investigate during your field assessment, one of the first questions you need to answer is what the water level relative to OHWM is at the time of your site visit. This will determine how and where to look for OHWM indicators.

5.4.1 General observations

Use the field survey form (Appendix A) to record preliminary observations of the site. Field sketches and profiles as well as documenting site conditions with photographs are strongly recommended.

Some questions to consider include:

- Are you present during an ordinary high water stage? If so, follow and demarcate the limits of “continuous and contiguous” water.
- Are you present during or immediately after an unusually high water stage (extraordinary)? If so, you may need to return once the water has receded. Unusually high water levels due to extreme events may erase or obscure indicators, making OHWM determinations immediately afterward more challenging.

Spokane County provides brief descriptions and contour maps for 17 lakes in the county at http://www.spokanecounty.org/sheriff/content.aspx?c=2071.

[22] Western Regional Climate Center, available at: http://www.wrcc.dri.edu/.

- Are you present during the right time of year for an ordinary high water stage? Depending on which region of the state you are in, and particularly with groundwater-fed lakes, a lake's high water stage may not necessarily occur during the wettest time of year. Also, finding OHWM indicators may be easier in the winter and early spring when the vegetation has died back and the leaves are off of deciduous plants.

Once in the field begin looking for indicators, which can be generally grouped as changes in topography, vegetation, substrate, or wrack. Depending on the site and relief, these changes may be rather abrupt and confined to a narrow zone or more subtle and gradual with the most obvious soils/substrate OHWM indicator being an abrupt change in substrate texture (e.g., gravel to loam) along the shoreline. Organic content of the soil can also be a good indicator of the OHWM transition zone with more organics preset on the landward edge. Dig a series of consecutive soil pits perpendicular to the water's edge. Look for transition zones for soil texture and color. For example, note transition from water-deposited silts and sands to more loamy texture soils.
Be cautious to note entisols (young soils) along stream deltas or signs of recent disturbance or fill.

5.4.2 Identify lower and upper boundaries of OHWM using transect(s):

- Set up transect(s) from the water's edge to the upland.
- Identify vegetation and soil indicators along transect starting at water's edge.

For difficult or contentious sites it may be useful to set up one or more transects on the site to evaluate, map, and organize observations to identify indicators that can be used to set the upper and lower bounds of the OHWM. On sites where the transition from aquatic to upland habitat is abrupt (bulkheads, rocky shoreline, or high bank), transects may not be necessary.

Keep in mind the definition of OHWM should be interpreted with the "abutting upland," not the abutting riparian community, which can include wetland areas. Mark your preliminary OHWM determination with pin flags, survey stakes, tape flagging, or other suitable means.

5.4.3 Field verification of preliminary OHWM determination

Once you have made a preliminary determination of the upper and lower limits of the OHWM you should begin a systematic investigation of the field indicators to refine and support your preliminary determination.

1. To begin your site investigation it may be helpful to walk along the water's edge making note of the general site characteristics, such as the plant community(ies), soil, and geomorphic features (e.g., breaks in slope, sediment texture). Carry aerial photos and site plans (when available) during the initial walk through to orient yourself. Be sure to note any recent human alterations to the site or immediate sub-basin (e.g., clearing, filling or bulkheads) that may influence indicators.

> When using vegetation as an indicator, use vegetation **communities**, not the occurrence of individual plants.

2. Locate the water's edge and record the dominant plant community (or lack of vegetation), substrate/soil, topography, and any other indicators present such as wrack. If you use transects to establish the OHWM, follow the same steps (and documentation) for each subsequent transect.

3. Begin moving landward from the water's edge making note of any changes in the dominant plant community, substrate/soil, and topography. Be sure to draw profiles that show these features.

4. When you reach a discernible transition to an upland plant community, focus your investigation on changes to the other principal indicators (substrate and topography) to refine the OHWM zone or boundary.

5. Flag the boundary at a comparable elevation based on the field indicators that you have documented, and take photographs of the flagged OHWM.

6. Finish filling out the field form and any additional field notes, including general site sketches and profiles while still on site.

Chapter 6 – Associated Wetlands and River Deltas

6.1 Introduction

Wetlands are waters of the state regulated under the SMA as well as the Growth Management Act (RCW 36.70A) and Water Pollution Control Act (RCW 90.48). A variety of wetland types are found throughout Washington State in a wide diversity of landscape settings (Granger et al. 2005). Many wetlands found along or near shoreline waters (in proximity) are considered to be associated and are also regulated as shorelines. At the landscape scale, wetlands typically provide at least three functions (ecological services): habitat for fish and wildlife, water quality improvement, and hydrologic attenuation (Hruby 2004). Given their landscape position, associated wetlands can be critically important in supporting and sustaining shoreline ecological function, including providing habitat for listed species, limiting shoreline erosion and flooding, and improving water quality. Accurate identification of the OHWM and shoreline jurisdiction in associated wetlands is an important preliminary step in ensuring that these resources, and the shoreline, are protected. In some cases, depending on the development proposal, a wetland delineation will also be required as part of the permitting submittal. The SMA implementing rules establish standards for wetland delineations (see WAC 173-22-035), and we strongly recommend that delineations be performed by qualified professionals consistent with those standards.

Associated wetlands and river deltas are shoreland areas listed in statute (see RCW 90.58.030(2)(d)) that may require additional effort and consideration in establishing the OHWM and shoreline jurisdiction. The WAC (WAC 173-22-040) designates shoreland areas to include:

- **Tidal waters**: Wetlands that are in proximity to and either influence or are influenced by tidal water. This influence includes but is not limited to one or more of the following: periodic tidal inundation, hydraulic continuity, formation by tidally influenced geohydraulic processes or a surface connection through a culvert or tide gate.

- **Lakes**: Wetlands that are in proximity to and either influence or are influenced by lakes. This influence includes but is not limited to one or more of the following: periodic inundation or hydraulic continuity.
- **Streams**: Wetlands that are in proximity to and either influence or are influenced by streams. This influence includes but is not limited to one or more of the following: periodic inundation, location within a flood plain, or hydraulic continuity.
- **River deltas**: Those lands within a river delta flood plain except for those lands that can reasonably be expected to be protected from floodwaters by flood control devices maintained by or maintained under license from the federal government, the state, or a political subdivision of the state.

Figure 6-5: Clear Lake, Skagit County. Associated wetlands on slope gently grade to wetlands within the OHWM of lake.

The WAC defines associated wetlands as those wetlands which are in **proximity to** and either **influence or are influenced** by tidal waters or a lake or stream subject to the Shoreline Management Act (WAC 173-22-030(1)). To be considered a shoreline-associated wetland, a wetland must be in proximity to and either influence or be influenced by a shoreline stream, tidal water, or lake. The entire wetland is associated if any part of it lies within the 200-foot jurisdictional zone ("in proximity"), as measured from the ordinary high water mark. Associated wetlands may also include those wetlands beyond the 200-foot jurisdictional zone that influence or may be influenced by a shoreline water (Figure 6-2).

River deltas adjoining shorelines of the state are also considered associated, except for those lands protected from floodwaters by authorized flood control devices. Deltas, often dynamic areas with multiple shifting channels and islands, are created at the mouth of a river where it enters a larger water body (Figure 6-3). For SMA purposes deltas extend upstream to the limit of distributary channels (WAC 173-22-030(6)0), and determining the OHWM within these systems can require use of methods for each of the associated shoreline types (tidal and stream or lake and stream).

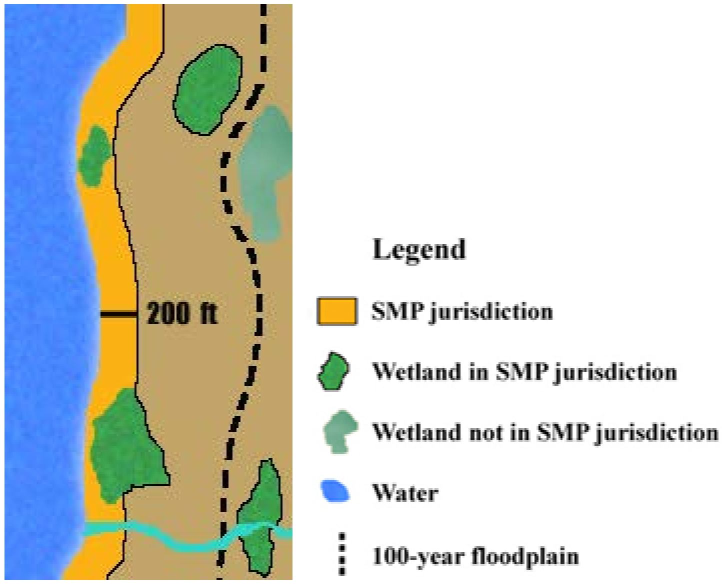


Figure 6-2: Associated wetlands in shoreline jurisdiction either are fully or partially within 200 feet of the OHWM, within the floodplain, or associated through hydraulic continuity (from SMP Handbook, Ecology 2010, http://www.ecy.wa.gov/programs/sea/shorelines/smp/handbook/index.html).

Figure 6-3: Cle Elum River delta, Cle Elum Lake. Shoreline jurisdiction encompasses the entire delta within the floodplain.

"In proximity" means that a wetland is close enough to the shoreline to affect or be affected by that shoreline. Proximity is not limited to horizontal distance but can also include consideration of vertical distance. Proximate wetlands can include such situations as:

- A 100-acre wetland in the floodplain that is two miles away from a shoreline water body, intercepts flood runoff, and dampens the flood surge that eventually enters that water body.

- A wetland in an overflow-channel adjacent to a stream, which acts as a flood storage area for the stream.
- Interdunal wetlands on the outer coast of Washington were determined to be under shoreline jurisdiction due to surface and sub-surface drainage to the ocean (see Ecology v City of Westport et al., Shoreline Hearings Board No. 93-73).
- A wetland behind a dike or levee connected to a shoreline water through ditches or culverts.

The entire wetland or river delta is associated if any part of it lies within the area 200 feet from either the OHWM or floodway. This also includes wetlands that extend above or upstream of the 20 cubic feet per second (cfs) point. This ensures that a wetland is managed as an ecological unit.

Factors used to determine whether wetlands meet the *"proximity and influence"* test include but are not limited to one or more of the following:

- Periodic **inundation.**
- **Hydraulic continuity.**
- On tidal waters: formation by tidally influenced geohydraulic processes or a surface connection through a culvert or tide gate.
- On streams: if any part is located **within the 100-year floodplain** of a shoreline.

One needs to **consider all factors together** when determining association of a wetland or a river delta. The less proximate, the more one needs to document clear influence. If the influence is great enough, it can be farther away.

It is the relationship between the two, and needs to be determined on a case-by-case basis.

A wetland's hydrology does not have to be in a defined channel to be considered associated. Hydraulic continuity clues include saturated hydric soils continuous with the water body, inundated or bare areas due to prolonged inundation within the estimated OHWM elevation, presence of algal mats or OBLIGATE wetland plants contiguous with the shoreline water, and sheet flow from the site during or following precipitation events.

In some cases wetlands *outside* the 100-year floodplain *may* be associated if they are hydraulically connected with shoreline waters through surface or subsurface flows.

A road, dike, or other barrier between the shoreline and the wetland does not necessarily preclude hydraulic continuity. If there is an *obvious topographic break* from the elevation of the water body (excluding natural or man-made berms) and no discernible surface or shallow groundwater connection, the wetland is probably *not* associated.

Interdunal Wetlands

In coastal systems, all wetlands in the interdunal area are associated with the Pacific Ocean. Interdunal wetlands occur in the sandy depressional swales and deflation plains, primarily between the primary and secondary dunes on the Pacific Coast (Grays Harbor and Pacific counties). The deflation plain behind the primary dune is formed by wind that erodes the sand down to the wet sand at the water table. Winter precipitation elevates the water table to a depth of approximately three feet with fresh or brackish water. When the sand is wet, it is more resistant to wind erosion and allows the formation of interdunal wetlands. The wetlands are typically vegetated with salt spray-tolerant emergent and scrub-shrub vegetation such as slough sedge (*Carex obnupta*), Pacific silverweed (*Argentina egedii*), salt rush (*Juncus lesueurii*), and Hooker's willow (*Salix hookeriana*). Older systems can become scrub-shrub or forested and include Sikta willow (*S. sitchensis*), shore pine (*Pinus contorta*), Sitka spruce (*Picea sitchensis*), or western red cedar (*Thuja plicata*). Some interdunal wetlands near lakes and ponds have developed peat and represent North Pacific Bog and Fen ecological systems (Natural Heritage Program 2011). Although they are not tidal, interdunal wetlands are in hydraulic continuity with the Pacific, and thus are associated wetlands of the Pacific. They provide important groundwater recharge and unique wildlife habitat functions.

Figure 6-4: Homes built in Dunes Estates, north of Ocean Shores, on edge and within interdunal wetlands. The interdunal wetlands are the matrix of darker green.

Figure 6-5: First home built in Dunes Estates, north of Ocean Shores, WA. Note seasonal high water table.

The question of whether interdunal wetlands are associated was the subject of the Westport-by-the-Sea case before the Shoreline Hearings Board in 1993. The Board found:

> "*We conclude that the freshwater wetlands in the interdunal area overlaying the aquifer, because they discharge through the aquifer into the Pacific Ocean, are in hydraulic continuity with the Pacific, and so they are associated wetlands of the Pacific, and thus subject to Shoreline Management Act jurisdiction*." Ecology v. City of Westport et al., Shoreline Hearings Board No. 93-73.

Figure 6-6a: *Salix hookeriana* (Hooker's willow)/*Carex obnupta* (slough sedge) association interdunal wetland, Leadbetter Point, Long Beach, WA. Photo by Joe Rocchio. Figure 6-6b: *Pinus contorta* (shore pine)/*Carex obnupta* (slough sedge) interdunal wetland, Leadbetter Point, Long Beach, WA. Photo by Joe Rocchio.

Salt Marshes (Low Energy Tidal Wetlands)

Salt marshes represent a special instance where determining the OHWM and shoreline jurisdiction requires additional investigation, particularly where there is a surface water connection to tidal waters. In these cases, there are two elements that need to be considered to establish the OHWM: the landward limit of tidal exchange and the landward limit of salt-tolerant vegetation. Because the OHWM for low energy tidal waters is based on the landward limit of salt-tolerant vegetation (see WAC 173-22-030(5)(a)(ii)), it is important to determine the transition from the salt-tolerant to salt-intolerant plant communities. Use of a salinity meter and the listed salinity tolerances for wetland plants are essential tools in making that determination. Once the landward limit of salt-tolerant vegetation has been determined (which establishes the OHWM and abutting 200-foot shoreland area), document any tidal channels or ditches within the wetland. Ditches draining to tidal waters through a culvert with a tide gate need to be considered, as tide gates typically limit but do not completely exclude tidal exchange.

The Elger Bay wetland on Camano Island (Figure 6-7) is an example of both a low-energy marine system with open tidal exchange and a salt marsh where the landward edge of the marsh (salt-tolerant vegetation) is also the OHWM. Numerous tidal channels extend to the marsh edge and are regularly inundated at high tide. Rather than being an associated wetland, this marsh is waterward (below) of the OHWM.

Figure 6-7: Elger Bay wetland, Camano Island. Green line marks estimated edge of wetland, much of which is salt marsh. Tidal channels extend throughout the salt marsh, both of which would demarcate the OHWM. Wetland plant communities intolerant of salinity and landward of tidal channels OHWM would be associated wetland.

Not all wetlands in close proximity to the shoreline of tidal waters have a salt marsh community. Salinities greater than 0.05 parts per thousand (ppt) may be limited to the tidal channels or ditches that drain to the sea. The Ship Harbor wetland, just east of the Anacortes ferry terminal, is a freshwater emergent and scrub-shrub wetland landward of the beach that does not have any appreciable salt-tolerant community (Figures 6-8 and 6-9). Careful documentation of the dominant plant communities, presence of tidal channels and ditches, and salinity measurements in these coastal wetlands is important in substantiating your OHWM determination.

Figure 6-8: Ship Harbor wetland, an emergent/scrub-shrub freshwater wetland along the Guemes Channel shoreline, Anacortes. Once the site of a cannery, it has now regained much of its natural character.

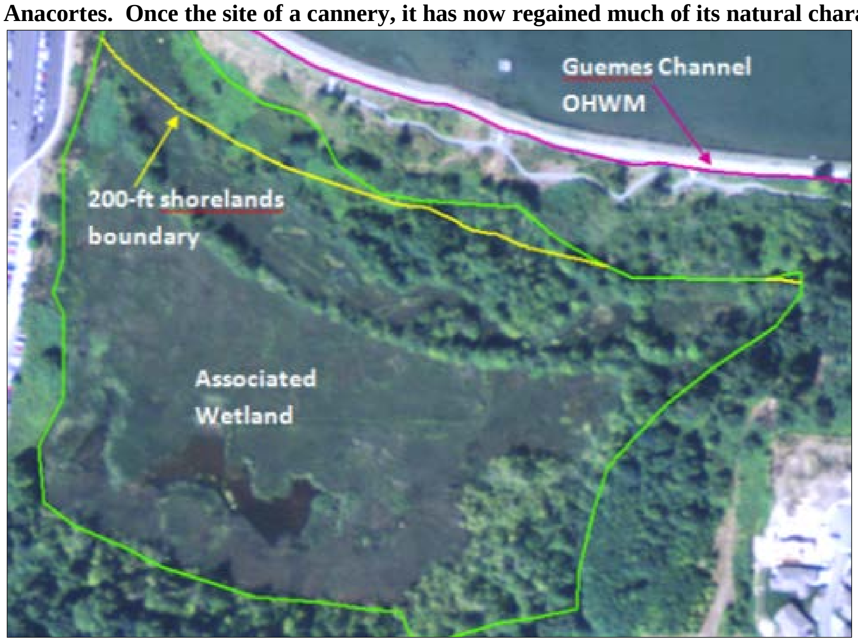


Figure 6-9: Aerial view of Ship Harbor wetland showing approximate Guemes Channel OHWM, 200-foot shorelands boundary offset from OHWM, and estimated wetland boundary. All of the wetland is within shoreline jurisdiction.

Edmonds Marsh is a good example of an associated wetland that includes a low-energy tidal system, a salt marsh (both below OHWM), and an adjoining freshwater wetland all within shoreline jurisdiction (Figure 6-10). Willow and Shellabarger Creeks, as well as the marsh itself, drain to the Salish Sea via culverts (Figure 6-11). Tidal channels, mudflats and salinities up to 5.1 ppt (December 2010) within the salt marsh show the effects of regular tidal exchange.

Figure 6-10: Edmonds Marsh. Pink polygon is the approximate landward extent of salt-tolerant vegetation and OHWM. The marsh to the east of the pink line (and the highway) is associated wetland in shoreline jurisdiction. Note tidal channels and mudflats in the salt marsh.

Figure 6-11: Culverts under BNSF rail line in Edmonds. Salish Sea tidal influence extends under the BNSF line into Edmonds Marsh.

6.2 Office Assessment

The office assessment can provide valuable background information that may help focus your efforts during the site investigation. The level of effort required for both the office and field assessments will depend, in part, on the proposed project and potential impacts to shoreline resources. As with other shoreline types, a variety of resources are typically available (e.g., aerial photographs, maps, and reports) and should be reviewed before conducting the field survey. **This basic office assessment provides information to help:**

- Identify key features to evaluate in the field.
- Identify approximate OHWM locations and plant communities to evaluate when in the field.
- Avoid some of the common errors listed in Chapter 3.
- Determine site and shoreline reach complexity and if additional hydrologic analysis is necessary. Establish an initial wetland extent to determine if the wetland extends offsite.
- Obtain information to be summarized in an OHWM determination report.

6.2.1 Step 1: Assess landscape and geomorphic features

Collect and review aerial photographs; topographic, soils, and wetland maps; LiDAR and DEM data; and wetland inventories or delineation reports when available, or other relevant and available information. Use available information to describe the landscape and geomorphic characteristics of the site in the report. Reviewing older aerial photographs, maps, and reports can also be helpful in evaluating changes at the site or shoreline reach. For large or complex sites where transects will be used during the field assessment, it may be helpful to mark the transect locations on the aerial photographs and site plans for use in the field. You can also mark any distributary channels that you should investigate once onsite.

Two valuable online resources that should be reviewed as part of the wetland office assessment include the Web Soil Survey administered by the Natural Resources Conservation Service (NRCS) (http://websoilsurvey.nrcs.usda.gov/app/) and the U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) (http://www.fws.gov/wetlands/data/Mapper.html). Both resources provide relatively current landscape-scale maps overlain on aerial photographs. Although neither are accurate enough for site-specific delineations, they provide a generalized characterization of wetlands and soil units that can help in understanding your site and shoreline reach. The NRCS has classified hydric (wetland) soils for the U.S. and Web Soil Survey to be used to show mapped hydric soils for a given site or area. Mapped hydric soils adjoining streams and water bodies show where, at least historically, soils were subject to prolonged inundation or saturation. They may show additional areas to be included in the OHWM field investigation. The following are suggested features to include in the initial assessment. By considering each question, a preliminary understanding of the shoreline system will emerge. This is not an inclusive list. There may be other aspects of the landscape and geomorphology to describe at a specific site.

Landscape features may include:

- Where is the project located in relation to the watershed? (that is, upper steeper reaches, mid-valley floor, or lower end)

- How developed is the watershed and what is the level of development near the project?
- Has a watershed assessment been done for project area?
- Are there mapped hydric soils on or near the site or shoreline reach?
- Have wetlands been inventoried within the watershed or the project vicinity?
- Are standing water and changes in the plant communities visible on aerial photographs?
- Are stream deltas present at or near the project?
- Is the project in or near a mapped flood zone?

6.2.2 Step 2: Choose potential locations for field survey

During early review of photos and maps it may become clear that certain locations within the shoreline reach might provide more accurate OHWM determinations, even though they may not be precisely at the site in question. Where the site soils and vegetation are highly altered, an alternative site or sites within a similar landscape setting should be considered, particularly sites located on publicly owned lands where permission to access the property may be easier to obtain. The vegetation (and hydrology indicators for wetlands) and soil indicators still apply to alternative sites.

For associated wetlands and river deltas, aerial photos and topographic data can help identify distributary channels and define the lateral limits of the site investigation. Distributary channels need to be considered in determining the OHWM; are they located within the floodplain, and do they convey flow (or tidal exchange) during OHW events?

6.3 Field Assessment

6.3.1 Conducting the field assessment

Prior to heading out to the field, it is a good idea to be familiar with available background information for the site and its vicinity. The office assessment will provide a basic understanding of the site and shoreline reach conditions from photos and maps. More details on conducting the office assessment are provided in section 6.2. This section lists some of the most common field indicators and provides guidance on general site observations and the use of soil, vegetation, and other indicators to establish the OHWM and determine association. The basic intent of the field assessment is to develop and follow an orderly approach to making an OHWM determination. The method described below relies on development of site transect or profile information as a means of establishing a defensible OHWM delineation. In easier cases, with a few strong indicators that support one another, the field component may be simple and the detailed process outlined below may not be necessary.

As stated previously, the method followed should be driven by site needs. A more rigorous methodology and documentation may be needed for sites where the determination is difficult and the site is complex or the project is controversial. Collection of transect information is recommended for difficult sites. Use of hydrologic data (gage and tidal data) is also advised and may be required for sites that are more complex. A wetland delineation by a qualified professional may also be needed to establish the wetland boundary and shoreline jurisdiction. If the project will require in-water or wetland work, the wetland boundaries and OHWM should be verified by the agencies and required authorizations issued before work begins.

Essential tools for the field assessment include a field notebook and field data forms (OHWM and wetland), aerial photographs and maps/site plans, plant lists for wetland indicator status and salinity tolerance, shovel, Munsell® soil color chart, camera, flagging, measuring tape, clinometer or Abney level and clinometer. In wetlands adjoining tidal waters, a salinity meter may also be important.

It may be best to begin your field assessment along the shoreline of the water body to get a sense of how high on the shoreline the OHWM indicators occur. This also gives you an opportunity to look for distributary channels, ditches, and water control structures along the shoreline. Once you begin investigating conditions within the wetland, be sure to follow any channels to their landward extent on the site and determine if flow within these channels is unidirectional or bidirectional. If adjacent to tidal waters, measure the salinity in these channels and within the wetland plant communities to aid in establishing the landward limit of salt tolerant vegetation (i.e., the OHWM). To determine the wetland boundary it will be necessary to examine the soils as well as the plants and indicators of wetland hydrology.

Be sure to document in your field notes the indicators used to establish the OHWM or wetland boundary and any other pertinent comments. Sketch the area investigated and any associated boundaries (OHWM, wetland, and if needed, plant communities) and test plots on an aerial photograph or site plan to document your findings while in the field. Sketched profiles of topographic changes or channels will also support your findings. Use of a global positioning system (GPS) in the field can greatly improve the mapping accuracy of important features and boundaries.

6.3.2 Description and rationale for field indicators

The following descriptions of key field indicators include the rationale for their interpretation in relation to the OHWM and wetland boundary. These determinations should be based on the preponderance of evidence that supports it. This could mean the number of indicators present and/or the strength (absent, weak, moderate, strong) of key indicators. Consider, also, the time of year and seasonal impacts on the expected strength of the indicators. Remember that a lack of obvious field indicators during drier times of the year (or abnormally dry periods) does not mean the OHWM is the edge of water during the site visit. In addition, wetland hydrology indicators are used to establish that water is present for long enough (14 consecutive days) during the growing season to meet the hydrology criterion; water does not have to be present to meet a wetland hydrology indicator[23].

The regulatory standard for associated wetlands is "proximity and influence." While it is possible to make a preliminary assessment for both elements in the office, it is conditions in the field that ultimately determine whether you are in a wetland and whether it is an associated wetland subject to shoreline jurisdiction. Proximity has been determined to be any wetlands or portions of wetlands found within 200 feet of the OWHM (i.e., within shorelands). While the statutory definitions of influence focus on hydrologic continuity, those definitions clarify that "… influence includes but is not limited to: …periodic inundation…or hydraulic continuity…" (WAC 173-22-040(1)(b), (2)(b) and (3)(b)). Field indicators of that influence may include changes in topography, substrate or biota on the shoreline or within the wetland.

6.3.3 Proximity indicators

Proximity

Description: Wetland edge (hydric soils, wetland hydrology, and dominance of wetland vegetation) is within 200 feet of a shoreline water OHWM or floodway. If any portion of the wetland is within shorelands, then the entire wetland is within shoreline jurisdiction.

Relation to the OHWM: Statutory definition of shorelands (associated wetland) (WAC 173-22-030).

Inundation

Description: Direct observation of surface water (inundation) or indicators of inundation from an adjoining shoreline water within the wetland; water flow is bidirectional. Inundation indicators include drift and sediment deposits, algal mats, drainage channels, and sparsely vegetated concave areas.

Relation to the OHWM: Contiguous and continuous water surface with shoreline water establishes the OHWM, and indicators are due to periodic inundation.

6.3.4 Influence indicators

Hydraulic continuity

Description: Surface or subsurface flow or contiguous saturated soils between the wetland and shoreline water. On tidal shorelines, dominance of salt-tolerant vegetation (interstitial salinities greater than 0.5 ppt).

Relation to the OHWM: Hydraulic continuity with a shoreline water is in the associated wetland statutory definitions (WAC 173-22-040). Dominance of salt-tolerant vegetation in tidal settings shows periodic inundation or soil saturation from tidal waters.

---

[23] For a detailed discussion and descriptions of wetland hydrology indicators see the applicable Corps regional supplement to the 1987 wetland delineation manual available at: http://www.usace.army.mil/Missions/CivilWorks/RegulatoryProgramandPermits/reg_supp.aspx

Abiotic indicators of influence

Description: Changes in topography (e.g., drainage channels or swales), substrate or substrate moisture content (e.g., a subsurface or groundwater discharge zone), stormwater or flood storage or water quality/chemistry (e.g., salinity or iron staining) because of periodic or continual hydrologic connectivity between the shoreline water and the wetland.

Relation to the OHWM: Field indicators are objective evidence of hydrologic connectivity between the shoreline water and the wetland.

Biotic indicators of influence

Description: Observable or measurable changes in plant or animal communities because of periodic or continual hydrologic connectivity between the shoreline water and the wetland. Examples would include changes in the plant community composition or density/vigor of plants.

Relation to the OHWM: Floristic field indicators ("with respect to vegetation") are objective evidence of hydrologic connectivity between the shoreline water and the wetland.

Appendices

		page
Appendix A:	Field Data Form	156
Appendix B:	Plant Species Distribution Across OHWM Gradient	160
Appendix C:	Internet Links	177
Appendix D:	Geomorphic Examples and Indicators	182
Appendix E:	Example Report Outline	198
Appendix F:	Glossary	199
Appendix G:	Comparison of Different OHWM Definitions in Various Statutes and Rules	215
Appendix H:	References and Suggested Reading	216

Appendix A: Field data form

General Information

Site/Project Name/Owner: ________________

Location: ________________

Description: ________________

____

The following field form is for use in the field to help in making ordinary high water mark delineations on streams. The form should be used as a guide. A team consisting of a hydrologist/ geomorphologist and a biologist may be needed to accurately determine the ordinary high water mark.

General Observations: Day of Site Visit

Date of site visit:			
Time of site visit:			
Weather conditions:			
Watershed development:	Highly developed ❍	Mod. Developed ❍	Undeveloped ❍
Reach development:	Highly developed ❍	Mod. Developed ❍	Undeveloped ❍
Recent site disturbance?	No ❍	Yes ❍	Describe:
Upstream flow control devices?	No ❍	Yes ❍	Describe:
Bank armoring at the site?	No ❍	Yes ❍	Describe:
Bank armoring up or downstream?	No ❍	Yes ❍	Describe:
Observable tidal backwater?	No ❍	Yes ❍	
In-water structures? (i.e. bridge pilings, railroad embankments)	No ❍	Yes ❍	Describe:
Animals grazing in riparian zone?	No ❍	Yes ❍	Describe:
Observable beaver activity?	No ❍	Yes ❍	Describe:

Complete Vegetation Transects

- Use guidelines in Chapter 4 to complete vegetation transects.
- Determine upper and lower bounds of the OHWM from vegetation transects.
- After completing vegetation transects, look for more field indicators near the upper and lower bounds of the OHWM. Use the checklist as guidance.

Sketch

If a simple site, sketch a cross-sectional diagram of the site below. Include location of the waterway and upper and lower bounds of the OHWM defined by the vegetation communities or other OHWM indicators. Page 3 of the data form can be used for more complex sketches

Additional Indicators

Check the indicators that are observable at the site that provide rationale for establishing the OHWM at this location. The rationale should be described in detail in the report and should be supported with photographs taken during the site visit.

	Soil and geomorphic indicators [24]	Vegetative indicators [25]	Other indicators
Below OHWM	o Sediment bars o Scour line o Clean cobbles/boulders. o Bank erosion/scour o Lack of soil horizons	Vegetation tolerant of inundation or high flow disturbances such as: o Willows o Black cottonwood o Japanese knotweed o Skunk cabbage o Aquatic plants	o Exposed roots/root scour o Drainage patterns, as shown by flattened vegetation o Aquatic animals o Algal mats o Iron staining

[24] Refer to Chapter 4 for a more complete description of indicators.

[25] Species are provided as examples. Refer to Appendix B for a more complete listing of plant species and their distribution across the OHWM gradient. Some species occur in more than one category depending on site conditions. For example Indian plum and red alder may straddle the OHWM where soil drainage is high. They may occur above OHWM were soil drainage is low to moderate.

	Soil and geomorphic indicators [24]	Vegetative indicators [25]	Other indicators
At or straddling OHWM	o Top of bank o Toe of lowest terrace (if terrace has developed horizons which may include a duff layer and A and B horizons versus freshly deposited alluvium) o Benches	o Willows o Western red cedar o Vine maple (streams) o Black cottonwood o Red alder o Salmonberry o Nootka rose o Maidenhair and lady fern o Blackberries o Dunegrasses	o Sediment lines on vegetation or other fixed objects o Change from channel deposits to older alluvium. o Darker stain lines on fixed objects o Exposed roots/root scour. o Drainage patterns, as evidenced by flattened vegetation o Weathered and buried driftwood
Above OHWM	o Hillslope toe o Terraces or alluvium with an organic horizon or other developed soil horizons o Relic floodplain surface o Well developed soil A andB horizons/duff layer	o Indian plum o Red alder o Western red cedar o Douglas fir o Western hemlock o Ponderosa pine o Oregon white oak o Coast pine o Quaking aspen o Vine maple (lakes) o Blackberries	o Lighter or no staining on fixed objects o Overbank deposits

Notes

Elevation →												
		← Cross Section → Note approximate distance between grid marks										

Plant Distribution Across OHWM Gradient					
Above OHWM		**At/Straddling OHWM**		**Above OHWM**	

Appendix B: Plant species distribution across OHWM gradient

Note: most aquatic plants that occur waterward of OHWM are not included in this list. These include submerged, floating and rooted aquatics that grow either underwater, are free floating, or grow in standing water. This list is a work in progress.

Table B-1. Plant species list

Note: most aquatic plants that occur waterward of OHWM are not included in this list. These include submerged, floating and rooted aquatics that grow either underwater, are free floating, or grow in standing water.

Species Name	Common Name	Western Mountain WIS[26]	Arid West WIS	Below OHWM	At/ Straddle OHWM	Above OHWM	Habitat, Notes S = streams; L = lakes; B = *Sphagnum* bogs; C= coastal; E = estuarine
TREES							
Acer macrophyllum	BIG-LEAF MAPLE	FACU	FAC			✓	Dry to moist sites, low to middle elevations.
Alnus rubra	RED ALDER	FAC	FACW		✓	✓	Moist woods, streambanks, flood plains, low elevations. Ubiquitous along coastal range, colonizes disturbed sites.
Alnus incana	MOUNTAIN ALDER (gray alder)	FACW	FACW	✓S	✓	✓	Occurs on a wide variety of fluvial surfaces ranging from well-aerated, well-drained streams to very poorly aerated wet soils in shrub wetlands.
Arbutus menziesii	PACIFIC MADRONE	UPL	—			✓	Dry, sunny, rocky, sites with coarse-textured soils, low to middle elevations, esp. coastal areas.
Betula papyrifera	PAPER BIRCH	FAC	FAC		✓S	✓	Moist, open to dense woods, low to moderate elevations. Often planted south of Whatcom Co.
Frangula purshiana (formerly *Rhamnus P).*	CASCARA BUCKHORN	FAC	FACU			✓	Grows in moist, acidic soils in the shady side of clearings or in the forest understory margins, near the edges of mixed deciduous-coniferous forests.
Fraxinus latifolia	OREGON ASH	FACW	FACW	✓	✓	✓	Moist to wet organic-rich silt soils at low elevations, streambanks and flood plains. King Co. and south.
Picea sitchensis	SITKA SPRUCE	FAC	FAC		✓	✓	Alluvial flood plains, marine terraces, low to middle elevations. Forms adventitious roots in areas subject to flooding.
Pinus contorta var. contorta	SHORE PINE	FAC	FAC	✓B	✓C	✓C	Highly adaptable; dunes, bogs, rocky slopes, exposed coastal shorelines. Forms adventitious roots in areas subject to flooding. Below OHWM in *Sphagnum* bogs.
Pinus contorta var. latifolia	LODGEPOLE PINE	FAC	FAC			✓	Dry mountain slopes occasionally to timberline.
Populus balsamifera spp trichocarpa	BLACK COTTONWOOD	FAC	FAC	✓	✓	✓	Low to middle elevations, moist to wet sites, flood plains, river banks, and disturbed upland sites.
Populus tremuloides	QUAKING ASPEN	FACU	FACU		✓S	✓	Clonal stands, pioneering species, mixed soil types, streambanks, mountain drainages.

[26] WIS = wetland indicator status; current as of May 2016 update to National Wetland Plant List.

Species Name	Common Name	Western Mountain WIS[26]	Arid West WIS	Below OHWM	At/ Straddle OHWM	Above OHWM	Habitat, Notes S = streams; L = lakes; B = *Sphagnum* bogs; C= coastal; E = estuarine
Prunus emarginata	BITTER CHERRY	FACU	FACU		✓S	✓	Moist disturbed sandy gravelly areas along riparian corridors.
Pseudotsuga menziesii	DOUGLAS-FIR	FACU	FACU			✓	Dry to moist sites. Gravelly sandy soils.
Quercus garryana	OREGON WHITE OAK	FACU	UPL		✓	✓	Dry, rocky, well-drained sites; can straddle OHWM on well drained soils. In OR, straddles OHWM in riparian areas in Tualatin and Beaverton valleys (Cooke, 2010, pers. com). Has been observed below OHWM in seasonally ponded wetlands in Mason Co.
Salix lasiandra	PACIFIC WILLOW	FACW	FACW	✓	✓	✓	Common throughout WA in all wet adapted habitats.
Thuja plicata	WESTERN REDCEDAR	FAC	FAC	✓S	✓	✓	Moist to wet soils, shade, seeps, alluvial soils, bogs, low to middle elevations; occurs as a riparian dominant on toe-slope seepages, moist benches, and wet bottoms adjacent to streams.
Tsuga heterophylla	WESTERN HEMLOCK	FACU	FACU			✓	Dry to well-drained wet sites, shade tolerant, organic and mineral soils, low to middle elevations. Forms adventitious roots in areas subject to recent (post germination) flooding.
SHRUBS							
Acer circinatum	VINE MAPLE	FAC	FAC		✓	✓	Typically found as understory shrub or small tree in moist forests. Common along streambanks and alluvial terraces, coastal plains, in forest openings, talus slopes. Indicator of well-drained but moist soils.
Amelanchier alnifolia	SERVICEBERRY	FACU	FACU			✓	Common in the transition zone between upland and wetlands and streams; from sea level to subalpine.
Andromeda polifolia	BOG ROSEMARY	OBL	OBL	✓C, B	✓C, B		Bog communities.
Arctostaphylos uva-ursi	KINNIKINNICK, RED BEARBERRY	FACU	FACU		✓	✓	Open slopes on drier, often rocky sites from low to middle elevations. Tolerates inundation in low energy coastal dunal wetlands.
Betula glandulosa	BOG BIRCH	OBL	OBL	✓	✓		Margins of bogs, streams, and lakes.
Cornus alba	REDSTEM DOGWOOD	FACW	FACW	✓S, L	✓	✓	Common; margins of lakes, ponds, and streams.
Corylus cornuta	BEAKED HAZEL-NUT	FACU	FACU		✓S, L	✓	Occurs occasionally straddling OHWM on lakes and streams.
Crataegus douglasii	BLACK HAWTHORN	FAC	FAC		✓S	✓	Common in riparian areas in eastern Washington.
Cytisus scoparius	SCOT'S BROOM	NI	NI		✓S	✓	Withstands winter high flows if growing on well-drained gravel substrate.
Gaultheria shallon	SALAL	FACU	FACU			✓	Woods, from sea level to moderate elevation in the mountains. Can be found on logs and hummocks within and below OHWM.
Holodiscus discolor	OCEANSPRAY	FACU	FACU			✓	Dry to moist, open sites.

Species Name	Common Name	Western Mountain WIS[26]	Arid West WIS	Below OHWM	At/ Straddle OHWM	Above OHWM	Habitat, Notes S = streams; L = lakes; B = *Sphagnum* bogs; C= coastal; E = estuarine
Kalmia microphylla	BOG LAUREL	OBL	OBL	✓B	✓B		Occurs in acidic bogs and fens, lowlands to mid-elevations.
Lonicera involucrata	BLACK TWINBERRY	FAC	FAC		✓	✓	Moist woods to wet forest, common along the edges of lakes and streams.
Mahonia aquifolium	TALL OREGON GRAPE	FACU	UPL			✓	Open slopes and forests on drier, often rocky sites from low to middle elevations.
Malus fusca	PACIFIC CRABAPPLE	FACW	FAC	✓L ,S	✓	✓	Margins and within the saturated edges of streams and lakes.
Morella californica	PACIFIC WAX-MYRTLE	FACW	FACW		✓C	✓C	Occurs in coastal areas (Long Beach to Quinault River), and northern OR on moist but well-drained sand.
Myrica gale	SWEETGALE	OBL	—	✓L ✓E	✓B, L	✓C	Occurs in bogs, fens, swamps, upper fringes of salt marshes, and lake margins; mostly at low elevations.
Oemleria cerasiformis	INDIAN PLUM	FACU	FACU		✓S	✓	Streambanks and moist to dry woods; low elevations; straddles OHWM on hummocky areas.
Oplopanax horridus	DEVIL'S CLUB	FAC	FAC		✓S	✓	Moist woods at mid-elevations, especially along streams. Most commonly found in seeps on sandy slopes.
Physocarpus capitatus	PACIFIC NINEBARK	FACW	FACW		✓	✓	Streambanks, swamps, moist woods, and occasionally on drier shrubby sites.
Rhododendron columbianum (formerly *Ledum glandulosum/ L. groenlandicum*)	LABRADOR TEA	OBL	FACW	✓B	✓B		Occurs in acidic bogs and fens, lowlands to mid-elevations.
Ribes bracteosum	STINK CURRANT	FAC	FAC		✓	✓	Moist woods and streambanks usually in the transition zone between wetlands and uplands near seeps.
Ribes divaricatum	WAX CURRANT	FAC	FAC		✓S	✓	Moist woods and streambanks commonly in the transition zone between wetlands and uplands above streams.
Ribes lacustre	SWAMP GOOSEBERRY	FAC	FACW			✓	Moist woods and streambanks to drier forest slopes and subalpine ridges.
Rosa gymnocarpa	BALDHIP ROSE	FACU	FACU			✓	Moist to dry woods in open sites.
Rosa nutkana	NOOTKA ROSE	FAC	FACU	✓S, L	✓	✓	Varieties from N to S of range. Occurs below OHWM in northern WA (Skagit, Whatcom counties). Generally found in dry habitats south of Skagit. Found in meadows, thickets, streamside areas, roadsides, clearings; low to middle elevations.
Rosa pisocarpa	CLUSTERED ROSE	FAC	FAC	✓	✓		A coastal rose generally found on moist soils. Found below OHWM on streams, lakes, and coastal freshwater wetlands.
Rubus armeniacus (formerly R. discolor)	HIMALAYAN BLACKBERRY	FAC	FAC		✓	✓	Thrives and may form impenetrable thickets in wastelands, pastures, roadsides, creek gullies, river flats, riparian areas, fence lines and right-of-way corridors. Often found in wetlands in western WA.
Rubus laciniatus	EVERGREEN BLACKBERRY	FACU	FACU			✓	Thrives and may form impenetrable thickets in pastures, roadsides, upland riparian areas, fence lines and right-of-way corridors.
Rubus parviflorus	THIMBLEBERRY	FACU	FAC		✓S	✓L	Open, moist to dry slopes in areas of bright sun; streambanks, road edges, logged slopes.

Species Name	Common Name	Western Mountain WIS[26]	Arid West WIS	Below OHWM	At/ Straddle OHWM	Above OHWM	**Habitat, Notes** S = streams; L = lakes; B = *Sphagnum* bogs; C= coastal; E = estuarine
Rubus spectabilis	SALMONBERRY	FAC	FAC	✓	✓	✓	Moist to wet places from streambanks to wooded areas from low to subalpine. Broad representation in riparian zones; dominant on terraces and transition slopes; lower cover on boulders, debris flows, gravel bars and seeps.
Rubus ursinus	PACIFIC DEWBERRY (creeping blackberry)	FACU	FACU			✓	Common and often abundant on disturbed sites, thickets and dry, open forest at low to middle elevations.
Salix alba	WHITE OR GOLDEN WILLOW	FACW	FACW	✓	✓		When naturalized in mud flats on floodplains. When cultivated can tolerate well-drained conditions.
Salix geyeriana	GEYER WILLOW	FACW	OBL	✓	✓		Prefers inundated banks of slow-moving streams, and along shores of small ponds and in wet meadows.
Salix hookeriana	HOOKER WILLOW	FACW	FACW	✓	✓	✓C	Wet places, often on the edge of standing water, sometimes on sandy beaches or dunes; low to mid elevations. Typically above OHWM in low energy marine environments. Most salt tolerant of willows.
Salix melanopsis[27]	DUSKY WILLOW	OBL	OBL	✓	✓		Common along sandy banks and gravel bars of the Columbia River; rapidly colonizes disturbed alluvium via suckering.
Salix prolixa	HEARTLEAF WILLOW, Mackdenzie's willow	OBL	OBL	✓	✓	✓	Multi-stemmed shrub found along shores, low terraces, and roadsides.
Salix scouleriana	SCOULER's WILLOW	FAC	FAC	✓	✓	✓	Shrub (below OHWM) or tall tree (uplands), common. Can occur in any freshwater wet habitat, may dominate early seral vegetation on gravel bars; moderate elevation.
Salix sessilifolia	SOFT-LEAVED WILLOW	FACW	—	✓	✓		Common along sandy banks and gravel bars of the Columbia River.
Salix sitchensis	SITKA WILLOW	FACW	FACW	✓	✓	✓	Moist woods and streambanks, lowlands to moderate elevations in the mountains. Often confused with Scouler's Willow.
Sambucus nigra	BLUE ELDERBERRY	FACU	FAC		✓	✓	Valley bottoms, along streams and open slopes where not too dry, from low to moderate elevations in the mountains.
Sambucus racemosa var. racemosa	RED ELDERBERRY	FACU	FACU		✓	✓	Wide variety of areas, typically in forests, fields, and wet areas.
Sorbus scopulina	WESTERN MT. ASH	FACU	FACU			✓	Upland woods.
Spiraea douglasii	DOUGLAS SPIREA	FACW	FACW	✓	✓	✓	Can grow in 2 feet of water as well as outside of wetlands; tolerates disturbance.
Symphoricarpos albus	SNOWBERRY	FACU	FACU	✓ S	✓	✓	Inhabits slopes and valley bottoms of the foothills of the Coast Ranges; found along streambanks, in swampy thickets, moist clearings and open forests at sea level to middle elevations. Grows well in sun or shade. Occurs below OHWM in Whatcom and Skagit county lakes and streams.

[27] *S. melaopsis* has combined both of the previously named *S. exigua* and *S. fluviatilis*

Species Name	Common Name	Western Mountain WIS[26]	Arid West WIS	Below OHWM	At/ Straddle OHWM	Above OHWM	Habitat, Notes S = streams; L = lakes; B = *Sphagnum* bogs; C= coastal; E = estuarine
	HERBS, FORBS, FERNS, & HORSETAILS						
Achillea millefolium	COMMON YARROW	FACU	FACU		✓C	✓	Common in open, dry to somewhat moist areas
Adiantum aleuticum	ALEUTIAN MAIDENHAIR FERN	FAC	FAC		✓S	✓	Widespread throughout the PNW; moist woods and streambanks, lowlands to mid-elevations in the mountains.
Alisma trivale	NORTHERN WATER PLANTAIN	OBL	OBL	✓	✓		Found in shallow marshes, ponds, sloughs, ditches, and at the margin of lakes.
Ambrosia chammissonis	AMBROSIA	UPL	—		✓	✓	Maritime shoreline from BC to CA; common on sandy beaches above high tide.
Argentina anserina (formerly *Potentilla anserina*)	PACIFIC SILVERWEED	OBL	OBL	✓C	✓		Coastal dunes to marsh edges; sandy bluffs. Typically occurs in high tidal marshes, at or above the mean high water, often assoc. with tufted hairgrass and Lyngbye's sedge. Also found in non-tidal freshwater meadows.
Athyrium filix-femina ssp. cyclosorum	LADY FERN	FAC	FAC	✓S	✓	✓	Found in shallow inundation to saturated soils in all freshwater wet habitats. Occurs below OHWM on well drained alluvial soils.
Atriplex patula	FATHEN SALTBUSH	FACW	FACW	✓C	✓		Succulent, annual, salt marsh herb. Coastal and inland, saline or alkaline soil; below OHWM.
Bidens cernua	NODDING BEGGAR-TICKS	OBL	OBL	✓	✓	✓	Ditches, shallow ponds and lakeshores.
Bidens frondosa	COMMON BEGGAR-TICKS	FACW	FACW	✓	✓	✓	Ditches, shallow ponds and lakeshores.
Blechnum spicant	DEER FERN	FAC	FAC		✓	✓	Moist coniferous woods and swamps.
Cakile edentula var edentula	AMERICAN SEAROCKET	FACU	FACU	✓C	✓	✓	Sandy areas along coastline, on sand dunes, highest reaches of salt marshes with sandy substrates.
Caltha palustris	YELLOW MARSHMARIGOLD	OBL	OBL	✓	✓		Coastal bogs and marshes.
Chamerion angustifolium (formerly *Epilobium a.)*	FIREWEED	FACU	FACU		✓	✓	From wet soils to dry meadows.
Cicuta douglasii	WESTERN WATER-HEMLOCK	OBL	OBL	✓	✓		Marshes, ditches, along streams and in disturbed areas; lowlands to mid-montane.
Circaea alpina	ENCHANTER'S-NIGHTSHADE	FAC	FAC			✓	Cool, moist forest, along streams, from valley bottoms to middle elevations.
Cirsium arvense	CANADA THISTLE	FAC	FACU			✓	Fields, pastures, meadows, clearings, and roadsides. Class C noxious weed.
Claytonia cordifolia	HEART-LEAF SPRINGBEAUTY	FAC	FAC		✓	✓	On wet soil, usually along streams, moderate to mid-elevations in the mountains.
Claytonia sibirica	SIBERIAN SPRINGBEAUTY	FAC	FAC			✓	Moist, shady forests, upper beaches, streambanks, low to middle elevations.
Comarum palustre	PURPLE MARSHLOCKS	OBL	OBL	✓	✓		Along lake edges, bogs, wet meadows, and streambanks.

Species Name	Common Name	Western Mountain WIS[26]	Arid West WIS	Below OHWM	At/ Straddle OHWM	Above OHWM	**Habitat, Notes** S = streams; L = lakes; B = *Sphagnum* bogs; C= coastal; E = estuarine
(formerly *Potentilla palustris*)							
Cotula coronopifolia	BRASSBUTTONS	OBL	OBL	✓C			Estuarine salt marshes on tidal mudflats rarely inland in emergent wetlands; below OHWM.
Cuscuta salina	SALT MARSH DOTTER	NI	—	✓	✓		Slender annual parasitic vine; extends yellowish thread stems to wrap around other plants in coastal salt marsh habitats.
Epilobium ciliatum	FRINGED WILLOWHERB	FACW	FACW	✓	✓		Moist open areas from wet meadows to scrub-shrub wetlands and streams.
Equisetum arvense	FIELD HORSETAIL	FAC	FAC	✓	✓	✓	Common to disturbed areas, shady coniferous forests, swamps, bog edges and clearings, moist ground and along streams.
Equisetum fluviatile	WATER HORSETAIL	OBL	OBL	✓	✓		Commonly grows in dense colonies along shorelines or in shallow water.
Equisetum hyemale var. affine	SCOURINGRUSH HORSETAIL	FACW	FACW	✓	✓		Common on moist to wet sites, often along major streams and rivers, on open sand bars as well as in shaded alluvial forests.
Equisetum telmateia	GIANT HORSETAIL	FACW	FACW		✓	✓	Disturbed areas, moist forest to wet meadows, ditch margins and streambanks.
Fallopia japonica (formerly *Polygonum cuspidatum*)	JAPANESE KNOTWEED	FACU	FACU	✓	✓	✓	Rapid colonizer of fresh alluvial deposits; strongly rhizomatous; common and very aggressive. Class B noxious weed.
Fallopia sachalinensis (formerly *Polygonum sachalinense*)	GIANT KNOTWEED	FACU		✓	✓	✓	Rapid colonizer of fresh alluvial deposits; strongly rhizomatous; common and very aggressive. Class B noxious weed.
Gentiana sceptrum	KING GENTIAN	OBL	OBL	✓			Open lakes and streambanks, bogs, wet meadows, moist sandy flats behind sand dunes; most often near the coast.
Glaux maritima	SEA-MILKWORT	OBL	FACW	✓C			In emergent tidal salt marshes; below OHWM.
Grindelia integrifolia	PUGET SOUND GUMWEED	FACW	FACW		✓C	✓C	Coastal habitats on beaches, rock outcrops, coastal headlands, and emergent saline wetlands.
Heracleum maximum (formerly H. lanatum)	COMMON COW-PARSNIP	FAC	FACW		✓	✓	Moist areas, low to mid-elevations.
Honckenya peploides	SEASIDE SANDWORT	FACU	—		✓C	✓C	Forms mats on sandy and gravelly beaches near or just above high tide.
Hypericum formosum	WESTERN ST. JOHN'S WORT	FACW	FACW		✓	✓	Moist open sites and along streambanks.
Impatiens noli-tangere	WESTERN TOUCH-ME-NOT	FACW	—	✓S	✓	✓	Common along stream and lake boundaries.
Iris pseudacorus	YELLOW IRIS	OBL	OBL	✓	✓		Limited to areas with permanent shallow water, along the shores of lakes, ponds, and streams also ditches and swales.
Jaumea carnosa	FLESHY JAUMEA	OBL	OBL	✓C	✓C		This is an estuarine species occurring in salt marshes and tidal flats.
Lilaeopsis occidentalis	WESTERN GRASSWORT	OBL	OBL	✓	✓		Marine, salt flat, muddy or sandy beaches and shores along and near the coast.
Lotus corniculatus	BIRDS-FOOT TREFOIL	FAC	FAC			✓	Found in wet to moist, open disturbed areas.

Species Name	Common Name	Western Mountain WIS[26]	Arid West WIS	Below OHWM	At/ Straddle OHWM	Above OHWM	Habitat, Notes S = streams; L = lakes; B = *Sphagnum* bogs; C= coastal; E = estuarine
Ludwigia palustris	WATER-PURSLANE	OBL	OBL	✓			Found in drainage swales, margins of ponds and lakes and shallow streams.
Lycopus americanus	BUGLEWEED	OBL	OBL	✓			Found in marshes and low wet ground, margins of lakes and slow moving streams.
Lycopus uniflorus	NORTHERN BUGLEWEED	OBL	OBL	✓			Found in marshes and low wet ground, margins of lakes and slow moving streams and *Sphagnum* bogs.
Lysichiton americanus	SKUNK CABBAGE	OBL	OBL	✓	✓	✓	Wet woods, streams and bogs, seepage areas.
Lysimachia thyrsiflora	TUFTED LOOSESTRIFE	OBL	OBL	✓	✓		An invasive weed in swamps, lakes and ditches.
Lysimachia vulgaris	GARDEN YELLOW LOOSESTRIFE	FACW	FACW	✓	✓		An invasive weed in swamps, lakes and ditches.
Lythrum salicaria	PURPLE LOOSESTRIFE	OBL	OBL	✓	✓		Can tolerate salinity up to 8 ppt (Hutchinson 1988). Class B noxious weed.
Maianthemum dilatatum	FALSE LILY-OF-THE-VALLEY	FAC	FAC		✓	✓	Shady, moist areas, open to dense woods; sea level to moderate elevations in the mountains.
Maianthemum racemosum	FEATHERY FALSE SOLOMON'S-SEAL	FAC	FAC			✓	Moist woods and open forests; sea level to mid-elevations in the mountains.
Mentha arvensis	FIELD MINT	FACW	FACW	✓	✓	✓	Streambanks, wet meadows, seepage areas, lakeshores, beaver ponds.
Mentha spicata	SPEARMINT	FACW	OBL	✓	✓		Streambanks, wet meadows, seepage areas, lakeshores and beaver ponds.
Mimulus guttatus	MONKEY-FLOWER	OBL	OBL	✓	✓		Common in wet meadows but also found along streams, ditches and seeps.
Myosotis laxa	SMALL WATER FORGET-ME-NOT	OBL	OBL	✓			Common in freshwater marshes, ditches, slow-moving water, and shallow pools.
Oenanthe sarmentosa	WATER-PARSLEY	OBL	OBL	✓			Usually grows in shallowly inundated areas.
Orthocarpus bracteosus	ROSY OWL-CLOVER	FACW	FAC	✓	✓		Found in high salt marshes and coastal estuaries in firm sandy substrate.
Parentucellia viscosa	YELLOW GLANDWEED	FAC	FAC		✓	✓	Pastures and other disturbed sites that are wet during the early growing season and dry out in summer.
Persicaria spp.	various smartweeds	FACW - OBL	FACW - OBL	✓			Many smartweeds are found along the edges of lakes and slow-moving streams, including *P. amphibia, hydropiper, hydropiperiodes, lapathifolia.*
Persicaria maculosa	SPOTTED LADY'S-THUMB	FACW	FACW	✓			Typically on moist, disturbed soils.
Petasites frigidus	ARCTIC SWEET COLTSFOOT	FACW	FACW		✓ S	✓	Moist disturbed areas (roadside ditches, road cuts), streambanks, fens, swamps, moist forest soils.
Plantago lanceolata	ENGLISH PLANTAIN	FACU	FAC		✓	✓	Weedy plant of disturbed moist areas; common at edges of disturbed emergent wetlands.
Plantago major	COMMON PLANTAIN	FAC	FAC			✓	Common in the upland buffer of disturbed wetlands.
Plantago maritima	SEASIDE PLANTAIN	FACW	FACW	✓	✓		Occurs below the OHWM of coastal marshes.

Species Name	Common Name	Western Mountain WIS[26]	Arid West WIS	Below OHWM	At/ Straddle OHWM	Above OHWM	Habitat, Notes S = streams; L = lakes; B = *Sphagnum* bogs; C= coastal; E = estuarine
Polypodium glycyrrhiza	LICORICE FERN	NI	NI			✓	Wet mossy ground, logs and rocks; commonly epiphytic, often on big-leaf maples at low elevations.
Polystichum munitum	SWORD FERN	FACU	FACU		✓	✓	Found in forest transition zones, often on hummocks, downed logs. Never rooted in wet soil.
Prunella vulgaris	COMMON SELF-HEAL	FACU	FACU			✓	Found in moist areas, sea level to moderate elevations.
Pteridium aquilinum	BRACKEN FERN	FACU	FACU		✓	✓	All habitats from moist to dry woods, along roadsides.
Ranunculus acris	TALL BUTTERCUP	FAC	FACW	✓	✓	✓	Moist meadows, pastures, and forest clearings. Invades disturbed wet pastures.
Ranunculus repens	CREEPING BUTTERCUP	FAC	FAC	✓	✓	✓	Moist areas, lawns and gardens, disturbed areas.
Ranunculus sceleratus	CELERY-LEAVED BUTTERCUP	OBL	OBL	✓			Moist meadows, muddy shorelines, lake margins, and streambanks, often where water is brackish.
Rumex crispus	CURLY DOCK	FAC	FAC		✓	✓	Disturbed and waste places, wet meadows, and wet pastures.
Rumex obtusifolius	BITTER DOCK	FAC	FAC		✓	✓	Disturbed and waste places, wet meadows, and wet pastures.
Rumex occidentalis	WESTERN DOCK	FACW	FACW	✓	✓		Disturbed and wet waste places, wet meadows, and wet pastures.
Sagittaria latifolia	WAPATO	OBL	OBL	✓			Found in shallow marshes, ponds, sloughs, ditches and at the margin of lakes.
Salicornia depressa (formerly *S. virginica*)	PICKLEWEED	OBL	OBL	✓			Common in salt marshes throughout Puget Sound and coastal estuaries that receive regular tidal inundation; below OHWM, often below MHHW.
Sanguisorba officinalis	GARDEN BURNET	FACW	FACW	✓	✓		Found in *Sphagnum*-dominated bogs, usually coastal.
Scutellaria lateriflora	MAD-DOG SKULLCAP	FACW	FACW	✓	✓		Freshwater tidal marshes, wet meados, and along streambanks and lakeshores.
Sidalcea hendersonii	HENDERSON'S CHECKER-MALLOW	FACW	—	✓	✓		Wet meadows, estuaries and tidal flats in the lowland zone.
Sisyrinchium californicum	GOLDEN-EYED GRASS	FACW	FACW	✓	✓		Coastal species: low sand dunes to coastal bogs or fens to roadside ditches, prefers sandy or nutrient-poor systems.
Sium suave	HEMLOCK WATER-PARSNIP	OBL	OBL	✓			Found at edges of ponds and lakes, or muddy or sandy streambanks.
Solanum dulcamara	NIGHTSHADE	FAC	FAC		✓	✓	Disturbed areas: moist open woods, waterways, lakeshores and ditches.
Sparganium angustifolium (formerly *S. emersum*)	NARROW-LEAF BUR-REED	OBL	OBL	✓			Shallow standing water up to 3-feet deep; lake margins, pond edges, and sloughs with slightly acidic muds and silts.
Sparganium eurycarpum	GIANT BUR-REED	OBL	OBL	✓			Shallow standing water up to 3-feet deep; lake margins, pond edges, and sloughs with slightly basic clay-rich mineral soils.
Spiranthes romanzoffiana	HOODED LADIE'S TRESSES	FACW	FACW	✓	✓		Wet meadows and along streams.

Species Name	Common Name	Western Mountain WIS[26]	Arid West WIS	Below OHWM	At/ Straddle OHWM	Above OHWM	Habitat, Notes S = streams; L = lakes; B = *Sphagnum* bogs; C= coastal; E = estuarine
Stachys chamissonis var. cooleyae	COOLEY HEDGENETTLE	FACW	OBL	✓	✓		Found in moist to saturated depressions in partial shade. Prefers mineral soils.
Streptopus amplexifolius var. amplexifolius	CLASP-LEAF TWISTED-STALK	FAC	FAC		✓	✓	Open to dense moist forests at low to mid-elevations.
Symphyotrichum subspicatus var. subspicatus	DOUGLAS ASTER	FACW	FACW	✓	✓	✓	Mostly in coastal areas, along seashore, streambanks, emergent wetlands and uplands.
Tiarella trifoliata	THREE-LEAF FOAMFLOWER	FAC	FAC		✓	✓	Damp woods, especially along streambanks and forested roads.
Tolmiea menziesii	YOUTH-ON-AGE	FAC	FACW		✓	✓	Moist woods and streambanks, lowlands and low elevations in the mountains.
Trientalis europaea	ARCTIC STARFLOWER	FAC	FAC	✓	✓		Bogs, emergent and forested wetlands**.**
Trifolium pratense	RED CLOVER	FACU	FACU			✓	Fields, pastures, along roadsides and in disturbed areas. It thrives in soils that are well-drained but frequently watered and does not tolerate prolonged inundation.
Trifolium repens	WHITE COLVER	FAC	FACU		✓	✓	Moist disturbed areas in all sun regimes.
Trifolium wormskjoldii	MARSH CLOVER, COW CLOVER	FACW	FACW	✓	✓		Wet and periodically inundated areas: high salt and brackish marshes, coastal dunes, wet meadows and steambanks.
Triglochin maritima	SEASIDE ARROW-GRASS	OBL	OBL	✓	✓		Low salt or brackish tidal marshes, occasionally in high marsh. A mudflat colonizer.
Typha angustifolia	NARROWLEAF CATTAIL	OBL	OBL	✓	✓		Shallow, quiet to slow-moving fresh to brackish waters in marshes, bays and lagoons.
Typha latifolia	BROAD-LEAF CATTAIL	OBL	OBL	✓	✓		Widespread in freshwater wetlands, ditches, swales, bays and sloughs.
Urtica dioica	STINGING NETTLE	FAC	FAC		✓	✓	Moist, nitrogen-rich habitats.
Veronica americana	AMERICAN SPEEDWELL	OBL	OBL	✓			Grows in shallowly inundated freshwater wetlands, ditches, slow-moving streams and shallow pools or lake margins.
Veronica anagallis-aquatica	WATER SPEEDWELL	OBL	OBL	✓			Grows in shallowly inundated freshwater wetlands, ditches, slow-moving streams and shallow pools or lake margins.
Veronica scutellata	MARSH SPEEDWELL	OBL	OBL	✓			Grows in shallowly inundated freshwater wetlands, ditches, slow-moving streams and shallow pools or lake margins.
Viola glabella	STREAM VIOLET	FACW	FAC	✓	✓		Moist forests, in clearings, and along streams
Viola palustris	MARSH VIOLET	OBL	OBL	✓			Common in *Sphagnum* wetlands and also in moist meadows, along streams
GRASSES, SEDGES, RUSHES							
Agrostis capillaris (formerly *A. tenuis)*	COLONIAL BENTGRASS	FAC	FAC		✓	✓	Common in wet meadows, along streams and wet ditches along roads; non-native.

Species Name	Common Name	Western Mountain WIS[26]	Arid West WIS	Below OHWM	At/ Straddle OHWM	Above OHWM	**Habitat, Notes** S = streams; L = lakes; B = *Sphagnum* bogs; C= coastal; E = estuarine
Agrostis exarata	SPIKE BENTGRASS	FACW	FACW	✓	✓		Coastal salt marshes and inland in alkali areas.
Agrostis gigantea (formerly *A. alba)*	REDTOP	FAC	FACW		✓	✓	Common in full sun on streambanks, wet pastures, slow-moving streams, and disturbed areas; non-native.
Agrostis stolinifera	SPREADING BENTGRASS	FAC	FACW		✓	✓	Streambanks, wet pastures, and areas in or near ditches to slow-moving water.
Alopecurus aequalis	SHORT-AWN FOXTAIL	OBL	OBL	✓			In or near slow-moving water: ditches, streambanks and wet pastures. Found mostly in sunny sites.
Alopecurus geniculatus	WATER FOXTAIL	OBL	OBL	✓			In or near slow-moving water: ditches, streambanks and wet pastures. Found mostly in sunny sites.
Alopecurus pratensis	MEADOW FOXTAIL	FAC	FACW	✓	✓		An introduced pasture grass that grows in seeded pastures. Invades emergent wetlands.
Ammophila arenaria	EUROPEAN BEACHGRASS	FACU	FACU		✓C	✓C	Dominant in coastal dunes as a sand stabilizer. Non-native.
Anthoxanthum odoratum	SWEET VERNAL GRASS	FACU	FAC		✓	✓	Moist pastures and drier fringes of wetlands.
Bromus carinatus	CALIFORNIA BROME	NI	NI		✓	✓	Grasslands, meadows, and forest openings, transition between wetland and upland.
Calamagrostis canadensis	BLUEJOINT REEDGRASS	FACW	FACW	✓	✓		Wet meadows, bogs, streambanks, lake margins, and ditches. Will survive if planted in uplands but does not thrive.
Calamagrostis nutkaensis	PACIFIC REEDGRASS	FACW	FACW	✓C	✓C		Coastal on sand dunes, coastal bluffs and headlands; sites commonly exposed to sea winds.
Carex amplifolia	BIGLEAF SEDGE	OBL	OBL	✓			Emergent wetlands and bogs.
Carex aquatilis var. dives (formerly *C. sitchensis)*	WATER SEDGE	OBL	OBL	✓			Shallow permanent water often at the margins of pools or lakes.
Carex arcta	NORTHERN CLUSTERED SEDGE	OBL	OBL	✓			Shallow permanent water often at the margins of pools or lakes; occasionally found in bogs.
Carex athrostachya	SLENDERBEAK SEDGE	FACW	FACW	✓	✓		Seasonally wet meadows that may be dry in summer.
Carex comosa	BEARDED SEDGE	OBL	OBL	✓			Freshwater marshes, along lake margins and wet meadows.
Carex deweyana	DEWEY SEDGE	FAC	FACU			✓	Mostly upland species found on hummocks, along streambanks and in moist woods.
Carex echinata	STAR SEDGE	OBL	OBL	✓			Swamps, bogs and other wet places, lowlands to moderate elevations in the mountains.
Carex exsiccata	WESTERN INFLATED SEDGE	OBL	OBL	✓			Lake margins, slow-moving streams or backwater areas with permanent shallow inundation.
Carex hendersonii	HENDERSON'S SEDGE	FAC	FAC		✓	✓	Boggy areas and wet woods, low to mid-elevations in the mountains.
Carex interrupta	GREEN-FRUITED SEDGE	OBL	OBL	✓			Rocky banks and streambeds, and other low, wet places.
Carex laeviculmus	SMOOTHSTEM SEDGE	FACW	FACW	✓	✓		Forested wetlands.

Species Name	Common Name	Western Mountain WIS[26]	Arid West WIS	Below OHWM	At/ Straddle OHWM	Above OHWM	**Habitat, Notes** S = streams; L = lakes; B = *Sphagnum* bogs; C= coastal; E = estuarine
Carex lasiocarpa	WOOLLYFRUIT SEDGE	OBL	OBL	✓			Sedge mats and in shallow water and pH neutral bogs.
Carex lenticularis	LAKESHORE SEDGE	OBL	OBL	✓			Wet meadows, streambanks and lake margins.
Carex leptalea	BRISTLYSTALKED SEDGE	OBL	OBL	✓			Wet meadows along lake margins.
Carex limosa	MUD SEDGE	OBL	OBL	✓			Lake margins and wet meadows with permanent inundation.
Carex lyngbyei	LYNGBYE'S SEDGE	OBL	OBL	✓C, S			Salt tolerant; typically found in tidal channel margins and low energy marine environments below OHWM.
Carex macrocephala	LARGEHEAD SEDGE	FACU	—		✓C	✓C	Sandy beaches and sand dunes along the coast.
Carex obnupta	SLOUGH SEDGE	OBL	OBL	✓	✓	✓	Can occur in mesic floodplain forested wetlands that go dry in the summer.
Carex ovalis (formerly *C. leoprina*)	HAREFOOT SEDGE	FACW	FACW		✓		Wet meadows.
Carex stipata	SAWBEAK SEDGE	OBL	OBL		✓		Wet meadows and ditches, soil often dries by summer.
Carex unilateralis	LATERAL SEDGE	FACW	FACW	✓	✓		Moist to wet meadows, lake margins and along streams.
Carex utriculata	INFLATED SEDGE	OBL	OBL	✓	✓		Acidic wetlands (bogs and fens) with permanent standing water, along the margins of lakes and ponds.
Carex viridula ssp. viridula	LITTLE GREEN SEDGE	OBL	OBL	✓	✓		Wet meadows at lake margins.
Carex vulpinoidea	FOX SEDGE	OBL	OBL	✓	✓		Wet meadows and emergent marshes.
Cinna latifolia	SLENDER WOODREED	FACW	FACW	✓	✓		Moist woods and meadows.
Dactylis glomerata	ORCHARD GRASS	FACU	FACU		✓	✓	Adapted to moderate to well-drained basic to acidic soils; will not tolerate soils that are saturated for extended periods of time.
Deschampsia cespitosa	TUFTED HAIRGRASS	FACW	FACW	✓	✓		Coastal brackish marshes, some freshwater meadows, gravelly river bars, lakeshores.
Deschampsia elongata	SLENDER-HAIRGRASS	FACW	FACW	✓	✓		Wet silts and gravels along streams and ponds.
Dichanthelium acuminatum	TAPERED ROSETTE GRASS	FAC	FAC		✓	✓	Saturated soils at pond, lake and stream margins.
Distichlis spicata	SALTGRASS	FACW	FAC	✓	✓		Saltmarshes and other moist saline sites in E WA.
Dulichium arundinaceum	DULICHIUM	OBL	OBL	✓	✓		Acidic bogs and fens; often along the margins of streams and ponds. Occasionally in the lowlands (esp. in King Co.), mostly at mid elevations.
Echinochloa crusgalli	LARGE BARNYARD GRASS	FAC	FACW	✓	✓		Moist, open, disturbed areas such as cultivated fields, drainage ditches and gravel deposits.

Species Name	Common Name	Western Mountain WIS[26]	Arid West WIS	Below OHWM	At/ Straddle OHWM	Above OHWM	**Habitat, Notes** S = streams; L = lakes; B = *Sphagnum* bogs; C= coastal; E = estuarine
Eleocharis acicularis	NEEDLE SPIKERUSH	OBL	OBL	✓			Marshes, muddy shores and other wet places.
Eleocharis obtusa	BLUNT SPIKERUSH	OBL	OBL	✓			Wet meadows with permanent shallow inundation, lake margins and freshwater tidal wetlands.
Eleocharis ovata	OVOID SPIKERUSH	OBL	OBL	✓			Shallow water in wet meadows that often dries out in summer.
Eleocharis palustris	CREEPING SPIKERUSH	OBL	OBL	✓	✓		Shallow water in wet meadows that often dries out in summer; tolerant of alkaline conditions.
Eleocharis parvula	DWARF SPIKERUSH	OBL	OBL	✓			Wet saline or alkaline soils; common in Snohomish estuary.
Elymus repens	QUACKGRASS	FAC	FAC		✓		Common in non-native weedy-disturbed pastures, lawns and meadows.
Eriophorum chamissonis	RUSSET COTTONGRASS	OBL	OBL	✓			Emergent wet meadows, especially near the coast.
Festuca arundinacea	TALL FESCUE	FAC	FACU		✓	✓	Pastures, ditchbanks, and roadsides; tolerant of poorly drained acidic soils, alkaline soils, and saline soils. Drought tolerant.
Festuca pratensis	MEADOW FESCUE	FACU	FACU			✓	Found in the upland portion of pastures, ditch-banks, and roadsides; very drought tolerant.
Festuca rubra	RED FESCUE	FAC	FAC		✓	✓	Sandy and gravelly soils in coastal marshes and sand dunes; tolerates acidic soils.
Glyceria borealis	NORTHERN MANNAGRASS	OBL	OBL	✓			Aquatic, growing in wet meadows, along streams and lakes.
Glyceria grandis	AMERICAN MANNAGRASS	OBL	OBL	✓	✓		Occurs along sloughs, wet meadows and lake margins; tolerates drier and shadier habitats.
Glyceria striata	TALL OR FOWL MANAGRASS	OBL	OBL	✓	✓		Open areas, along stream, ditch and lake margins.
Holcus lanatus	VELVET GRASS	FAC	FAC		✓	✓	Invades planted meadows, along roadsides and other disturbed areas that are moist.
Hordeum jubatum	FOX-TAIL BARLEY	FAC	FAC		✓	✓	Wet rocky, gravelly or sandy depressions.
Isolepis cernua	TUFTED CLUBRUSH	OBL	OBL	✓	✓		Brackish to saline water of marshes, beaches and shores.
Juncus acuminatus	TAPERTIP RUSH	OBL	OBL	✓			Ditches, lake margins and wet meadows that are permanently inundated.
Juncus arcticus (formerly *Juncus balticus*)	ARCTIC RUSH	FACW	FACW	✓	✓		Soils that remain moist to saturated all year, often where there are saline or alkaline conditions, just inland of mudflats along the coast.
Juncus articulatus	JOINTED RUSH	OBL	OBL	✓	✓		Wet sites near the coast; brackish marshes, saturated soils in sand dune depressions, lake margins and stream edges
Juncus bolanderi	BOLANDER'S RUSH	OBL	OBL	✓	✓		Marshes and river bottoms from tidelands to lower montane west of the Cascade Mountains.
Juncus bufonius	TOAD RUSH	FACW	FACW	✓	✓		Disturbed moist sites on open ground, in gravel fill, on the edges of vernal pools and stream margins.

Species Name	Common Name	Western Mountain WIS[26]	Arid West WIS	Below OHWM	At/ Straddle OHWM	Above OHWM	**Habitat, Notes** S = streams; L = lakes; B = *Sphagnum* bogs; C= coastal; E = estuarine
Juncus bulbosus	SPREADING RUSH	OBL	—	✓	✓		Sandy or peaty shores of streams and pools.
Juncus effusus	SOFT RUSH	FACW	FACW		✓	✓	Wet low pastures, freshwater or coastal saltwater tidelands; tolerates periods of drought and total inundation.
Juncus ensifolius	DAGGERLEAF RUSH	FACW	FACW	✓	✓		Moist open sites with winter inundation only.
Juncus falcatus	SICKLE-LEAF RUSH	FACW	FACW	✓	✓		Coastal swamps, tideflats and back into the sand dune depressions.
Juncus gerardii	MUD RUSH	FACW	FACW	✓	✓		Coastal freshwater marshes, occ. in marine-influenced coastal saltwater marshes.
Juncus mertensianus	MERTEN'S RUSH	OBL	OBL	✓			Meadows along seeps, streambanks and pond edges; also drainage ditches with permanent water.
Juncus nevadensis	SIERRA RUSH	FACW	FACW	✓	✓		Margins of streams and lakes.
Juncus oxymeris	POINTED RUSH	FACW	FACW	✓	✓		Wet meadows and lakeshores.
Juncus supiniformis	SPREADING RUSH	OBL	OBL	✓	✓		Frequently found in wet places including shorelines of lakes, ponds, and streams. One of the few *Juncus* that grows into deeper water.
Juncus tenuis	SLENDER RUSH	FAC	FACW	✓	✓		Freshwater sites with saturated soils during the spring and dry conditions during the summer; disturbed sites with seeps and springs: ditches, pastures and road cuts.
Leersia oryzoides	RICE CUTGRASS	OBL	OBL	✓			Sun and shade, shallow permanent water; lake, pond, stream and ditch margins; mudflats.
Leymus mollis (formerly *Elymus mollis*	AMERICAN DUNEGRASS	FACU	FACU		✓ C	✓	Coastal dunes and on the edges of gravel beaches; our native dunegrass. In some coastal areas this grass and/or *Ammophila* sets the OHWM.
Luzula multiflora ssp. multiflora	COMMON WOODRUSH	FACU	FACU			✓	Fields, meadows, open woods and clearings.
Luzula parviflora	SMALL-FLOWERED WOODRUSH	FAC	FAC		✓	✓	Moist shady forests on hummocks.
Phalaris arundinancea	REED CANARYGRASS	FACW	FACW	✓	✓	✓	Areas that are open and irregularly inundated and disturbed.
Phleum pratense	COMMON TIMOTHY	FAC	FACU			✓	Pastures and waste sites that are wet to moderately dry.
Phragmites australis	COMMON REED	FACW	FACW	✓	✓		Ponds, springs, lakes and rivers on both fresh and alkali/saline habitats in E WA. Occ. found in salt marshes and intertudal areas in W WA.
Pleuropogon refractus	NODDING SEMAPHOREGRASS	OBL	OBL	✓			Forested lake and stream margins and wet meadows; prefers peat soils but can grow in gravels.
Poa annua	ANNUAL BLUEGRASS	FAC	FACU		✓	✓	Common in lawns, meadows, gardens and disturbed places (roadsides, abandoned lots). Does well in poor soils.

Species Name	Common Name	Western Mountain WIS[26]	Arid West WIS	Below OHWM	At/ Straddle OHWM	Above OHWM	Habitat, Notes S = streams; L = lakes; B = *Sphagnum* bogs; C= coastal; E = estuarine
Poa palustris	FOWL BLUEGRASS	FAC	FAC		✓	✓	Meadows, woods, ditches and streambanks.
Poa pratensis	KENTUCKY BLUEGRASS	FAC	FAC		✓	✓	Open areas: meadows, pastures and lawns; found adjacent to wet meadows.
Poa trivialis	ROUGH BLUEGRASS	FACW	FAC	✓	✓		Disturbed moist sites: meadows, woods and streambanks.
Polypogon monspeliensis	ANNUAL RABBIT'S-FOOT GRASS	FACW	FACW	✓	✓	✓	Coastal in vernal pools to sandy beaches above OHWM.
Rhynchospora alba	BEAKRUSH	OBL	OBL	✓B			*Sphagnum* bogs and other acidic wetlands.
Schoenoplectus acutus (formerly *Scirpus a.)*	HARDSTEM BULRUSH	OBL	OBL	✓			Lakeshores and emergent marshes; tolerates saline and alkaline conditions.
Schoenoplectus maritimus [28] *(formerly Scirpus m.)*	SALTMARSH BULRUSH	OBL	OBL	✓			Lakeshores and emergent marshes; tolerates saline and alkaline conditions.
Schoenoplectus pungens [29]	THREE-SQUARE BULRUSH	OBL	OBL	✓			Lakeshores and emergent marshes; tolerates saline and alkaline conditions.
Schoenoplectus tabernaemontanii (formerly Scirpus t.)	SOFTSTEM BULRUSH	OBL	OBL	✓			Similar to hardstem bulrush but smaller, seldom forms extensive colonies; prefers coastal areas. Stem not as tough as hardstem and easily crushed.
Scirpus cyperinus	WOOLGRASS	OBL	OBL	✓	✓		Shallow acidic marshes, especially in less disturbed areas; planted extensively so no longer rare.
Scirpus microcarpus	SMALL-FRUITED BULRUSH	OBL	OBL	✓	✓		Full sun, wet to inundated nitrogen-rich soils. Grows well in disturbed sites and has been extensively planted.
Spartina alterniflora	SALTMARSH CORDGRASS	OBL	OBL	✓C			Marine and estuarine environments.
Trichophorum cespitosum	TUFTED BULRUSH	OBL	OBL	✓	✓	✓	Bogs, fens, peat and gravel shores.
Trisetum cernuum	TALL OATGRASS	FACU	FACU			✓	Moist forest, streambanks and upper beaches.
ALGAE[30], LICHEN							
Hydropunctaria maura (formerly *Verrucaria maura*)	TAR LICHEN	N/A			✓		Forms a black stain on rocks at or above OHWM; height related to energy of shore zone; lower energy environments allow *Hydropunctaria* to exist at OHWM.
Caloplaca spp.	ORANGE SEASHORE LICHEN	N/A				✓	Supralittoral; in spray zone above OHWM.

[28] Listed as *Bolboschoenus maritimus ssp. paludosus* by Jepson.
[29] Misapplied by Hitchcock to *Scirpus americanus.*
[30] Marine algae species occur below OHWM.

Use of the Wetland Indicator Status as a Deductive Tool

The wetland indicator status (WIS) reflects the range of estimated likelihood of a species occurring in wetlands versus non-wetland across the entire (or regional) distribution of the species (Lichvar and Gillrich 2011).

Table B-2. Wetland indicator status categories

Indicator Code	Status Type	Comment
OBL	Obligate	Occurs almost always under natural wetland conditions, rarely in uplands.
FACW	Facultative Wetland	Usually occurs in wetlands, but occasionally found in uplands.
FAC	Facultative	Equally likely to occur in wetlands or uplands.
FACU	Facultative Upland	Usually occurs in uplands, but occasionally found on wetlands.
UPL	Upland	Rarely found in wetlands, almost always in uplands. If a species does not occur in wetlands in any region, it is not on the National Wetlands Plant List.
NI	No indicator	Insufficient information was available to determine an indicator status.
—	No occurrence	The species does not occur in that region.

Plant species are not precise indicators of certain levels of environmental factors. A species presence at a site depends on complex factors, incuding climatic, edaphic and biotic. And, the effect of a single factor, e.g. wetness, is impossible to isolate. Also, while an indicator status is assigned to a species as a whole, the *plants* we actually observe of that species may be ecotypes adapted to relatively wetter or drier conditions than average. These ecotypes may or may not be distinguished morphologically.

The application of wetland indicator status for any species still requires caution. The wetland indicator categories should not be equated to degrees of wetness. Many obligate wetland species occur in permanently or semi-permanently flooded wetlands. A number of obligates also occur in, and some are restricted to, wetlands which are only temporarily or seasonally flooded. Slough sedge is a good example. The facultative upland species include a diverse collection of plants, which range from weedy species adapted to existing in a number of environmentally stressful or disturbed sites (including wetland and riparian areas), to species in which a portion of the gene pool (an ecotype) always occurs in wetlands. Both weedy and ecotype representatives of the facultative upland category occur in seasonally and semi-permanently flooded wetlands.

Practicioners making OHWM determinations should use the wetland indicator status to inform their decision, not to rely on the indicator to make their decision.

Practitioners are cautioned to use the indicator status as a deductive tool rather than a precise indicator for determining the extent of ordinary high water.

Appendix B Useful References

Burke Museum Plants and Lichens of Washington Image Collection http://biology.burke.washington.edu/herbarium/imagecollection.php. [11]

Cooke, S.S. (Ed.). 1997. A Field Guide to the Common Wetland Plants of Western Washington & Northwestern Oregon. Seattle Audubon Society. [1]

Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: http://www.fs.fed.us/database/feis. [1]

Flora of North America. Available on-line at www.efloras.org. [11]

Guard, B.J. 1995. Wetlands plants of Oregon and Washington. Lone Pine publishing. [1]

Hamel, K. (editor). 2001. An aquatic plant identification manual for Washington's freshwater plants. Washington State Department of Ecology, publication 01-10-032. Available on-line at http://www.ecy.wa.gov/programs/wq/plants/plantid2/index.html. [2]

Hutchinson, I. 1988. Salinity tolerance of plants of estuarine wetlands and associated uplands. Report to the Washington State Department of Ecology, in fulfillment of contract No. C0088137. [3]

Karrenberg, S., et al. 2002. The life history of Salicaceae living in the active zone of floodplains. Freshwater Biology 47:733-748. [1]

Klinkenberg, B. (Editor) 2007. E-Flora BC: Electronic Atlas of the Plants of British Columbia [www.eflora.bc.ca]. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver. [11]

Kovalchik 2004. Classification and management of aquatic, riparian, and wetlands sites on the national forests of eastern Washington: series description. [1]

Lichvar, R.W. and J.J. Gillrich. 2011. Final Protocol for Assigning Wetland Indicator Status Ratings during National Wetland Plant List Update. ERDC/CRREL TN-11-1. US Army Corps of Engineers Cold Regions Research and Engineering Laboratory, US Army Engineer Research and Development Center, Hanover, NH. [4]

Pabst, R. J. and T. A. Spies. 1998. Distribution of herbs and shrubs in relation to landform and canopy cover in riparian forests of coastal Oregon. Canadian Journal of Botany 76:298-315. [1]

Steiger, J., et al. 2005. Hydrogeomorphic processes affecting riparian habitat within alluvial channel–floodplain river systems: a review for the temperate zone. River Research and Applications 21:719-737. [1]

Tiner, R. 1991. The concept of a hydrophyte for wetland identification. Bioscience 41(4):236-246. [1]

U.S. Army Corps of Engineers. 2014. Natonal Wetland Plant List. Available on-line at: http://rsgisias.crrel.usace.army.mil/NWPL/

USDA NRCS Plants Database (last accessed 7-18-07) http://plants.usda.gov/index.html. See http://plants.usda.gov/java/factSheet for detailed fact sheets on 749 plants species. [11]

Washington Native Plant Society. Available on-line at: http://www.wnps.org/photogallery1.html. [1]

Appendix C: Useful internet links for making OHWM determinations[31]

Streams

Geomorphic assessment data sources:

Salmonscape interactive mapping: http://wdfw.wa.gov/mapping/salmonscape/

USGS 7 ½' quadrangle topographic maps – Information regarding channel gradient (change in elevation/distance)
Elevation data for observation and measurement of gradient and other information.
http://www.csc.noaa.gov/inventory/#; http://nationalmap.gov/viewer.html

Current and historic aerial photographs, with at least 10 years between photo sets.
Sequential photographs allow observation of change through time.
Google Earth®: time sequence georeferenced aerial imagery; http://earthexplorer.usgs.gov/; http://nationalmap.gov/viewer.html;
http://metadata.gis.washington.edu/geoportal/catalog/main/home.page
NASA WorldWind: http://worldwind.arc.nasa.gov/
Coastal Atlas: https://fortress.wa.gov/ecy/coastalatlas/
Other sources: County, city, library, U.S. Army Corps of Engineers

10-meter DEM - Channel gradient can be measured from DEM. Channel pattern and movement is difficult to measure because it is challenging to identify shallow side channels due to resolution and error.
USGS: http://nationalmap.gov/viewer.html

LiDAR - shows secondary channels and other geomorphic features. Elevation from LiDAR can be used to draw cross-section profiles. Coordinates can also be measured from LiDAR data.
Puget Sound LiDAR Consortium: http://pugetsoundlidar.ess.washington.edu/ (includes some coverage in eastern Washington, lower Columbia River, and northwest Oregon).
USGS- The National Map http://nationalmap.gov/viewer.html

3-D views – useful for identifying floodplain features; allows 3-D look at topography, useful for visually determining confinement.
NASA WorldWind: http://worldwind.arc.nasa.gov/; Bing® and Google Earth imagery

Hydrologic assessment related data sources:

USGS Stream Flow Data for Washington: Includes real time data (within the last 31 days), recent data (within the last 548 days), and historical data (within the period of record):

[31] Please note that Internet links change frequently and some of these may no longer work after the date of this publication.

http://waterdata.usgs.gov/wa/nwis/rt. (interactive map) and Real time, daily, monthly, and annual data: http://waterdata.usgs.gov/wa/nwis/sw

Washington Department of Ecology also has realtime and historical stream discharge data: http://www.ecy.wa.gov/programs/eap/flow/shu_main.html

Stream Statistics for Washington: http://water.usgs.gov/osw/streamstats/Washington.html

Washington State Department of Ecology River and Stream Water Quality Monitoring Data: http://www.ecy.wa.gov/programs/eap/fw_riv/index.html

U.S. Army Corps of Engineers River Data organized by basin: http://www.nwd-wc.usace.army.mil/nws/hh/www/index.html

US Department of the Interior Stream Discharge Data: http://www.usbr.gov/pn/hydromet/

USGS Water Resource Investigations Reports 96-4208, 98-4160, 03-4042: Determining upstream boundary points on Washington streams and rivers under the requirements of the Shoreline Management Act. Available through the Washington Department of Ecology Shorelands program
http://www.ecy.wa.gov/programs/sea/SMA/st_guide/jurisdiction/USGS_studies.html

Some counties and public utility districts maintain continuous stream gages additional to USGS and Ecology gages.

- King County: http://green2.kingcounty.gov/hydrology/
- Snohomish County: http://test.snoco.org/app2/SPW/SPW_SWHydro/hydrology-find-site.asp
- Thurston County: http://www.co.thurston.wa.us/monitoring/flow/flow-home.html
- Clark County: http://www.clark.wa.gov/environment/stormwater/streamhealth/flow.html

Check with relevant community or PUD for more stream discharge data.

Tidal Waters

NOAA National Ocean Services. Includes information on predicted and observed tides and educational information: http://tidesandcurrents.noaa.gov

- The NOAA website also directs you to their “Tides Online” at: http://tidesonline.nos.noaa.gov/geographic.html

- NOAA National Ocean Service’s benchmark website has tidal benchmark station locations: http://tidesandcurrents.noaa.gov/stations.html?type=Bench+Mark+Data+Sheets

Lakes

USGS real-time data for 25 lakes and reservoirs:
http://waterdata.usgs.gov/wa/nwis/current?type=lake&group_key=basin_cd&search_site_no_station_nm

Washington State Department of Ecology Lake Data:
https://fortress.wa.gov/ecy/coastalatlas/tools/LakeDetail.aspx

Lakes of Washington. Water Supply Bulletin 14 (1973). Western Washington (Volume 1) and Eastern Washington (Volume 2). http://www.ecy.wa.gov/programs/eap/wsb/wsb_Lakes.html

Thurston County Lake Elevation Monitoring Data. Volunteers submit lake level data on the following lakes in Thurston County: Black, Chambers, Deep, Hewitt, Hicks, Lawrence, Long, McIntosh, Offutt, Pattison, Scott, Smith and Ward. Approx ten years of data, ending in 2006-07 are available at http://www.co.thurston.wa.us/waterresources/lakes/lakes-monitoring.html

Wetlands

Washington State Department of Ecology's Wetland Rating System and other technical reports provide additional guidance on determining appropriate hydrologic boundaries on wetlands: http://www.ecy.wa.gov/programs/sea/wetlands/ratingsystems/index.html

Wetland indicator status information: http://rsgisias.crrel.usace.army.mil/NWPL/#

National Wetlands Plant List: http://rsgisias.crrel.usace.army.mil/NWPL/#

Soil

NRCS Web Soils Survey: http://websoilsurvey.nrcs.usda.gov/app/

Washington Soil Survey Reports: http://www.nrcs.usda.gov/wps/portal/nrcs/main/wa/soils/

Plants

Burke Museum Plants and Lichens of Washington Image Collection:
http://biology.burke.washington.edu/herbarium/imagecollection.php

Electronic Atlas of the Plants of British Columbia: www.eflora.bc.ca

Flora of North America: www.efloras.org.

Hamel, Kathy (editor). 2001. An aquatic plant identification manual for Washington's freshwater plants. Washington State Department of Ecology, publication 01-10-032: http://www.ecy.wa.gov/programs/wq/plants/plantid2/index.html.

Integrated Taxonomic Information System (ITIS): http://www.itis.gov

USDA Plants Database: http://plants.usda.gov/

USDA Fire Effects Information System: http://feis-crs.org/feis/

Includes species specific information, and information on regeneration processes, site characteristics, successional status, seasonal development, and fire ecology. Also has a comprehensive list of references.

- Tree http://www.fs.fed.us/database/feis/plants/tree/index.html
- Bryophyte http://www.fs.fed.us/database/feis/plants/bryophyte/index.html

- Cactus http://www.fs.fed.us/database/feis/plants/cactus/index.html
- Fern or fern ally http://www.fs.fed.us/database/feis/plants/fern/index.html
- Forb http://www.fs.fed.us/database/feis/plants/forb/index.html
- Graminoid http://www.fs.fed.us/database/feis/plants/graminoid/index.html
- Lichen http://www.fs.fed.us/database/feis/lichens/index.html
- Shrub http://www.fs.fed.us/database/feis/plants/shrub/index.html
- Vine or liana http://www.fs.fed.us/database/feis/plants/vine/index.html

Washington Native Plant Society: http://www.wnps.org/photogallery1.html.

Aerial Photographs and Interactive Mapping

Google Earth, aerial photographs: http://www.google.com/earth/

National Geographic Topographic Maps: http://maps.nationalgeographic.com/maps

Aerial photos and topographic maps: www.terraserver.com

USGS- The National Map http://nationalmap.gov/viewer.html

Search for maps and photos showing channel migration, channel pattern, and site conditions:
Google Earth, aerial photographs: http://www.google.com/earth/

NASA WorldWind. Includes 3-D views of topography useful for identifying floodplain features: http://worldwind.arc.nasa.gov/

Department of Ecology Shoreline Aerial Photos: https://fortress.wa.gov/ecy/coastalatlas/tools/ShorePhotos.aspx

Puget Sound Historic Air photos: http://riverhistory.ess.washington.edu/photo.php

Department of Ecology Digital Coastal Atlas: https://fortress.wa.gov/ecy/coastalatlas/

Puget Sound LiDAR showing secondary channels and other geomorphic features. Elevation from LiDAR can be used to draw cross-section profiles: http://pugetsoundlidar.ess.washington.edu/lidardata/index.html

SalmonScape. Data for 20 WRIAs and topographic maps: http://wdfw.wa.gov/mapping/salmonscape/index.html

Interactive mapping available for the following counties and cities:

- Statewide: USGS- The National Map http://nationalmap.gov/viewer.html

- City of Bainbridge Island: http://www.ci.bainbridge-isl.wa.us/196/GIS-Mapping-Map-Gallery

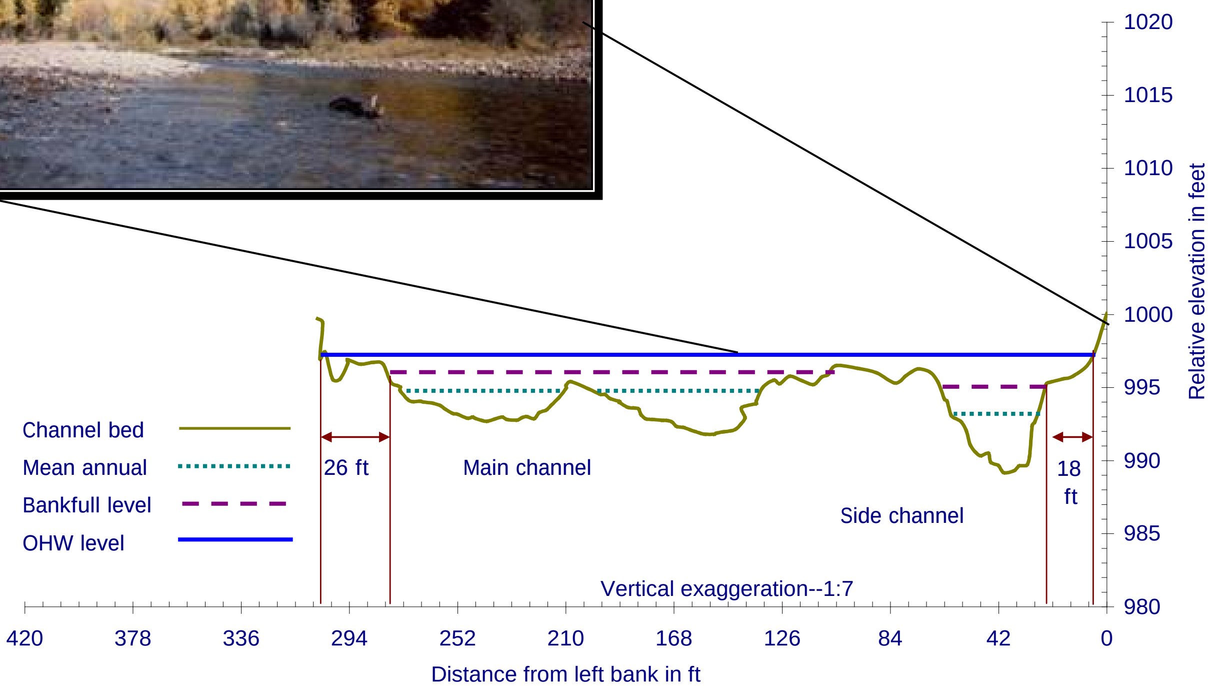
- City of Bellevue: http://www.ci.bellevue.wa.us/mapping_center.htm
- Chelan County: http://www.co.chelan.wa.us/assessor/pages/gis-mapping?parent=Maps
- Clallam County: http://www.clallam.net/Maps/
- Douglas County: http://www.douglascountywa.net/departments/tls/gis/Refmaps.asp
- Clark County http://gis.clark.wa.gov/applications/gishome/index.cfm
- Grays Harbor County: http://www.ghcog.org/gis.html
- Island County: http://www.islandcounty.net/publicworks/digitalphotos/mainmap.htm
- Jefferson County: http://maps.co.jefferson.wa.us/
- King County: http://www.kingcounty.gov/operations/GIS/Maps/iMAP.aspx
- Kitsap County: http://www.kitsapgov.com/gis/
- Lewis County: http://maps.lewiscountywa.gov/topic/interactive-maps/
- Mason County http://mapmason.co.mason.wa.us/website/mason/viewer.htm
- Okanogan County: http://okanoganwa.mapsifter.com/Mapsifter/disclaimer.aspx
- Pierce County: http://www.co.pierce.wa.us/index.aspx?NID=491
- San Juan County: http://sjcgis.org/PolarisJS/
- Skagit County: http://www.skagitcounty.net/Maps/iMap/
  Skagit County topographic atlas (84 pages of 11"x17" downloadable maps): http://www.skagitcounty.net/Departments/GIS/atlas.htm
- Snohomish County http://gis.snoco.org/maps/permits/viewer.htm
- Spokane County: http://www.spokanecounty.org/pubpadal/
- Thurston County: http://www.geodata.org/online.htm
- Whatcom County: http://apps2.whatcomcounty.us/pds/gis/gismaps/gismaps.jsp

Appendix D: Geomorphic examples and indicators

When OHWM is higher than the mark created by bankfull discharge

The OHW discharge and width are generally greater than bankfull discharge and width where there are:

- Multiple channels
- Depositional features such as bars
- Sand to cobble sediment size
- Channel gradient < 1%
- Unconfined

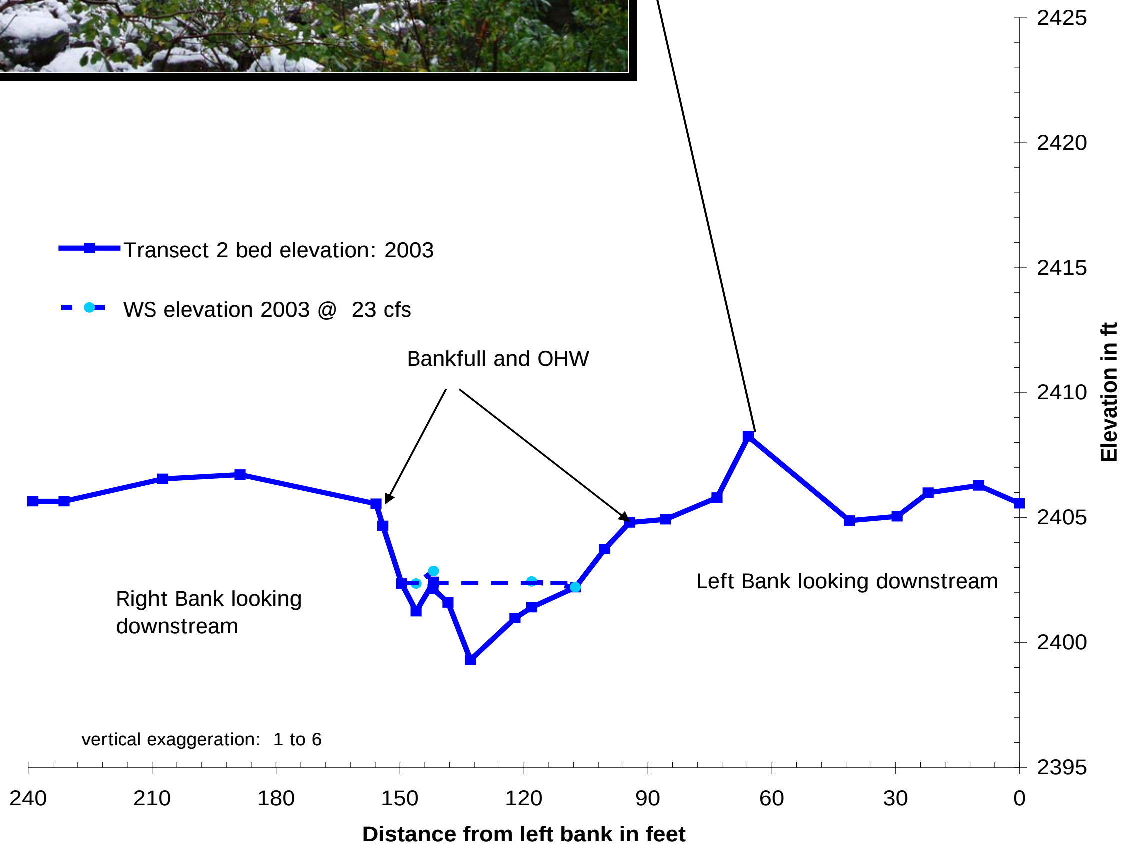


A cross-section profile from the reach in the photograph illustrates the difference between mean annual, bankfull and OHW water levels. OHWM is generally higher than bankfull mark in reaches that are unconfined, with lower gradient, multiple channels or sediment deposition. These reaches have smaller sediment size than reaches that are confined or with steeper gradient as illustrated in the next two examples. For this document, bankfull discharge is defined as the effective discharge, which is the minimum discharge required to transport bedload (sediment). A stream's ability to transport sediment is a function of sediment size, channel gradient and water depth relative to sediment size. Given two streams with similar channel gradient, bankfull discharge will occur at a lower flow recurrence interval for the stream with the smaller sediment size. The bankfull flow recurrence interval may be close to the 1 to 1.5-year flood.

When OHWM is equal to the mark created at bankfull discharge

The OHW discharge and width and bankfull discharge and width are generally equivalent where channel characteristics are:

- Straight, slightly incised
- Moderately confined
- Cobble to boulder sized sediment
- Plane bed morphology

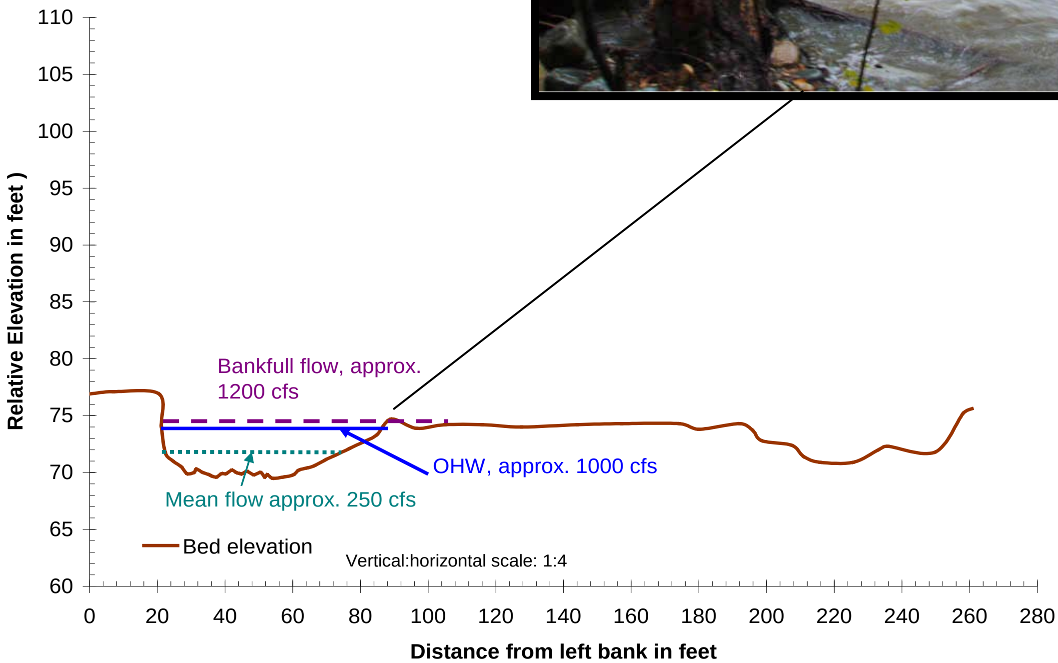


Larger sediment size requires a higher bankfull discharge to have bedload transport. The bankfull recurrence interval may range between the 1.5 and 2.0-year flood.

When OHWM is lower than the mark created at bankfull discharge

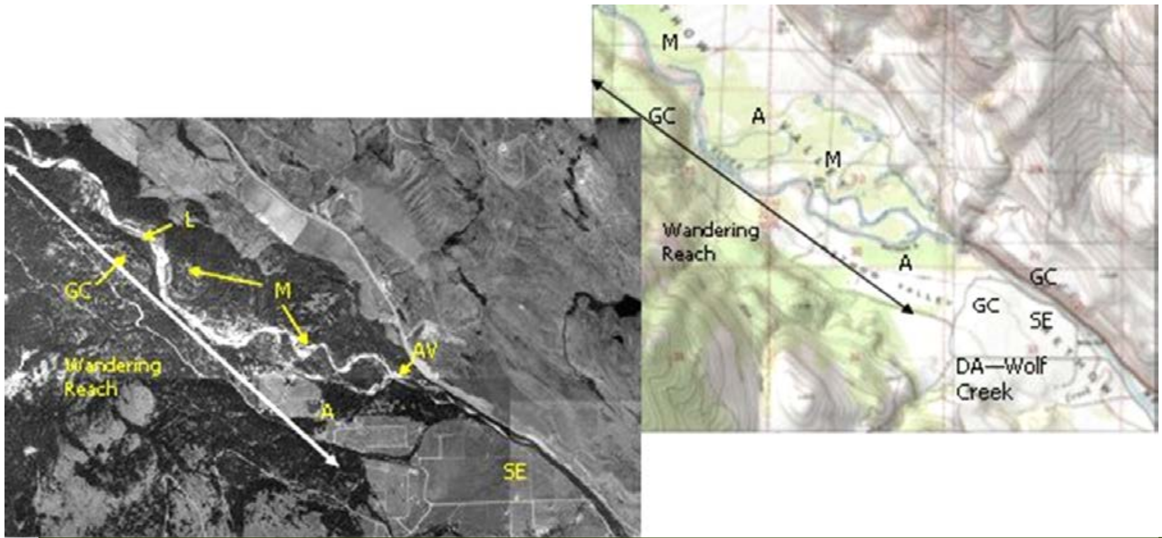
The OHW discharge and width is less than bankfull discharge and width where channel characteristics are:

- Incised and straight
- Large sediment size (boulders)
- Steeper gradient (>2%)



Much of the smaller sediment is transported out of incised reaches leaving only the large material. Transport of large material takes higher bankfull or effective discharge to transport. The steeper slope does not compensate for the large sediment size. In these cases, the bankfull discharge recurrence interval is often greater than the two-year flood recurrence interval.

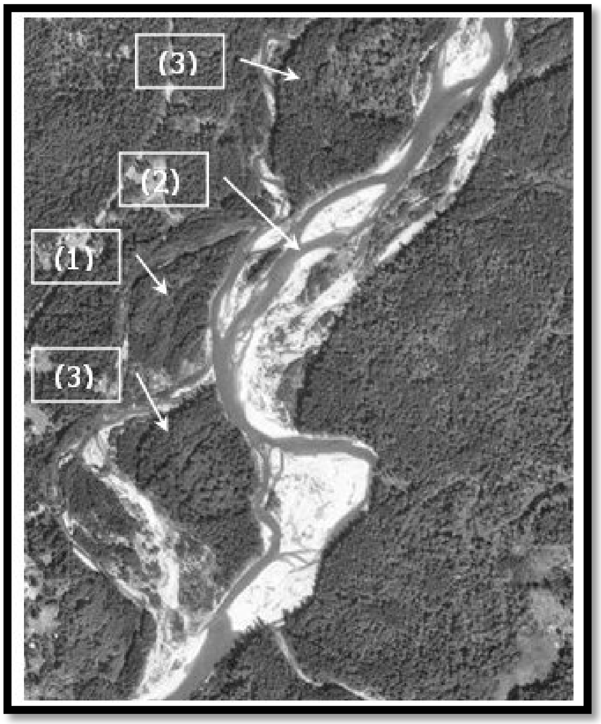
Channel Patterns



Pattern (Code)	**OHWM variability (space & time)**
Meandered (M)	Low to moderate
Braided (B)	Low to moderate
Anabranching (A)	High
Wandering (W)	High
Delta or alluvial fan (DA)	High
Straight and entrenched (SE)	Low
Straight and narrow (SN)	Low
Geologic control (bedrock or other erosion resistant material) (GC)	Low
Avulsion (AV)	High

OHWM identification in areas with a moderate to high OHWM variability rating requires more information and rigorous methods. The topographic map is from 1976, and the USGS orthophoto is from 1998. Both the map and air photo show that the downstream reach (lower right of each) is straight and possibly entrenched while the upstream reach is wandering with island braided and meandering patterns. Lateral erosion and avulsions appear to be the dominant migration process. An avulsion (AV) appears to have occurred between 1978 and 1998. The main channel appears to have moved from river right to river left.

Wandering: Wandering gravel bed streams are a special category and occur in areas where high coarse sediment loads are natural. Streams downstream of glaciers and those that cut through glacial outwash deposits provide examples. The wandering stream pattern consists of multiple patterns occurring within one reach. Rapid channel migration and avulsion characterize this pattern. The timing of these events is not predictable.

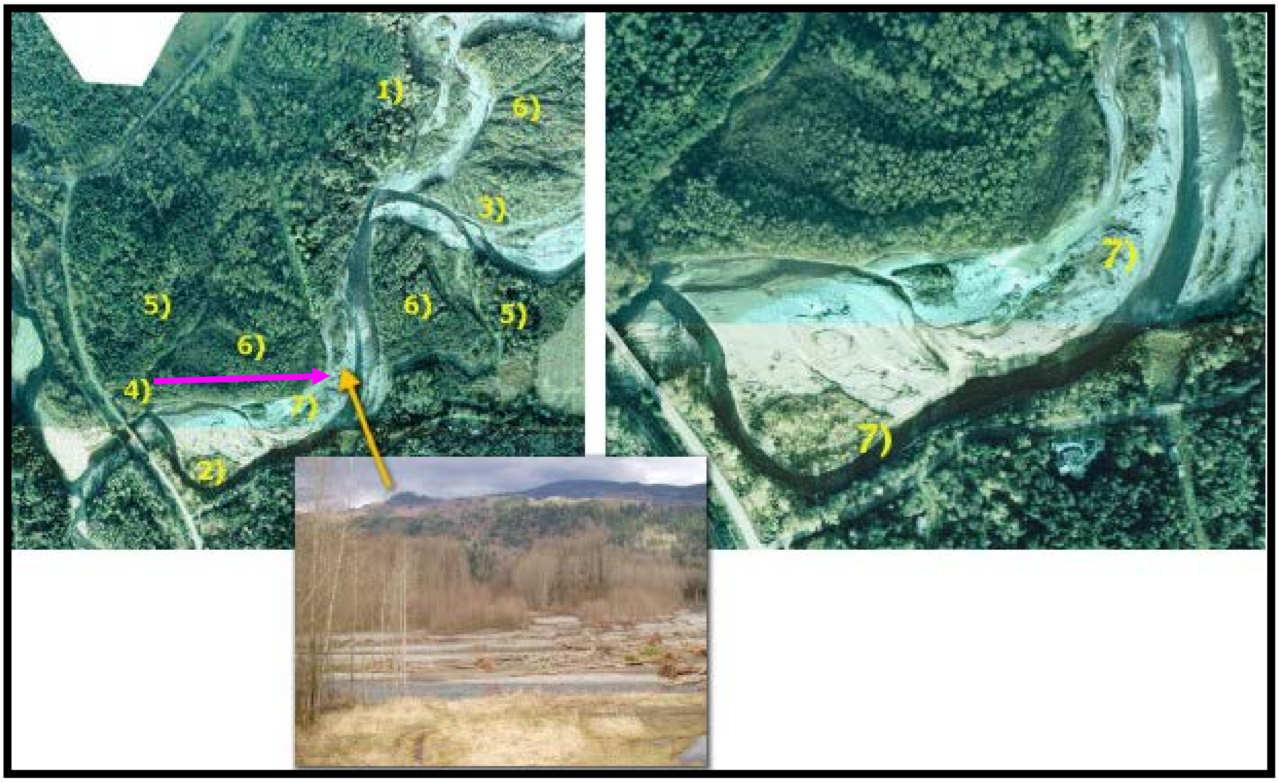


The photo illustrates a wandering stream with three channel patterns within a single reach: (1) meandering with scroll bars; (2) braiding with multiple low flow channels; and, (3) island braided with forested floodplain islands (anabranching).

Channel Migration

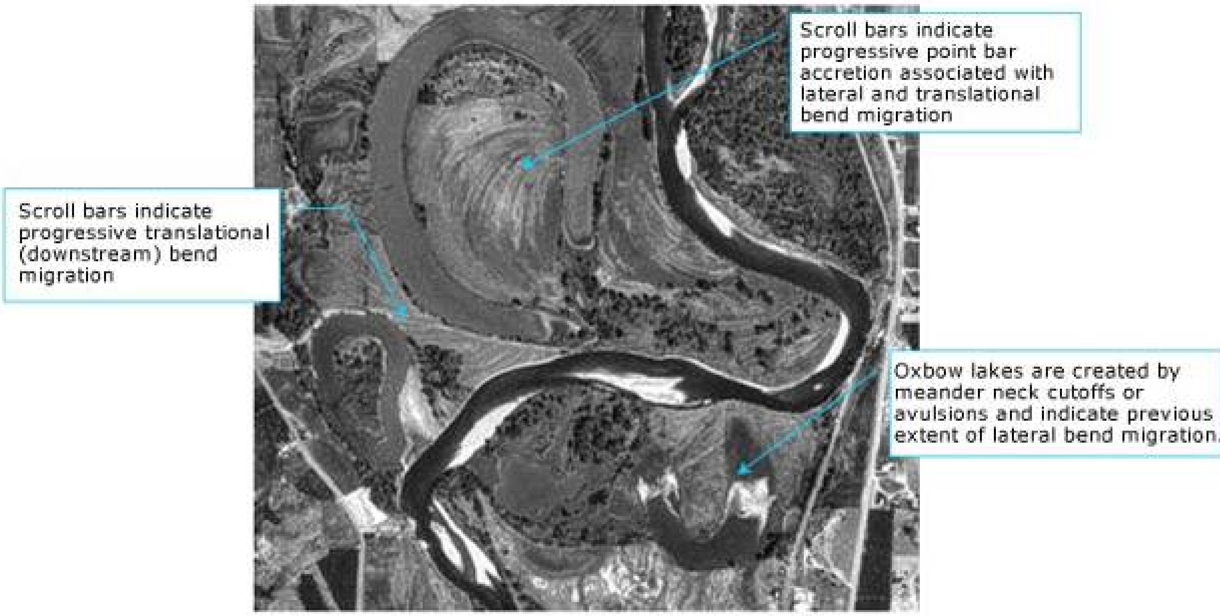
The geomorphic office assessment requires identifying channel and floodplain features from maps and aerial photographs including channel movement and pattern. Channel and floodplain features that indicate channel migration are illustrated as follows:

1. obvious channel movement
2. eroding banks
3. secondary channels
4. braiding
5. anabranching (multiple channels around vegetated islands)
6. young disturbance vegetation
7. sediment deposition (bars)



Other Indicators of Channel Movement

Scroll bars: The Okanogan River (below) illustrates meandering patterns and migration associated with a meandering stream. Scroll bars and oxbow lakes indicate lateral and translational movement.



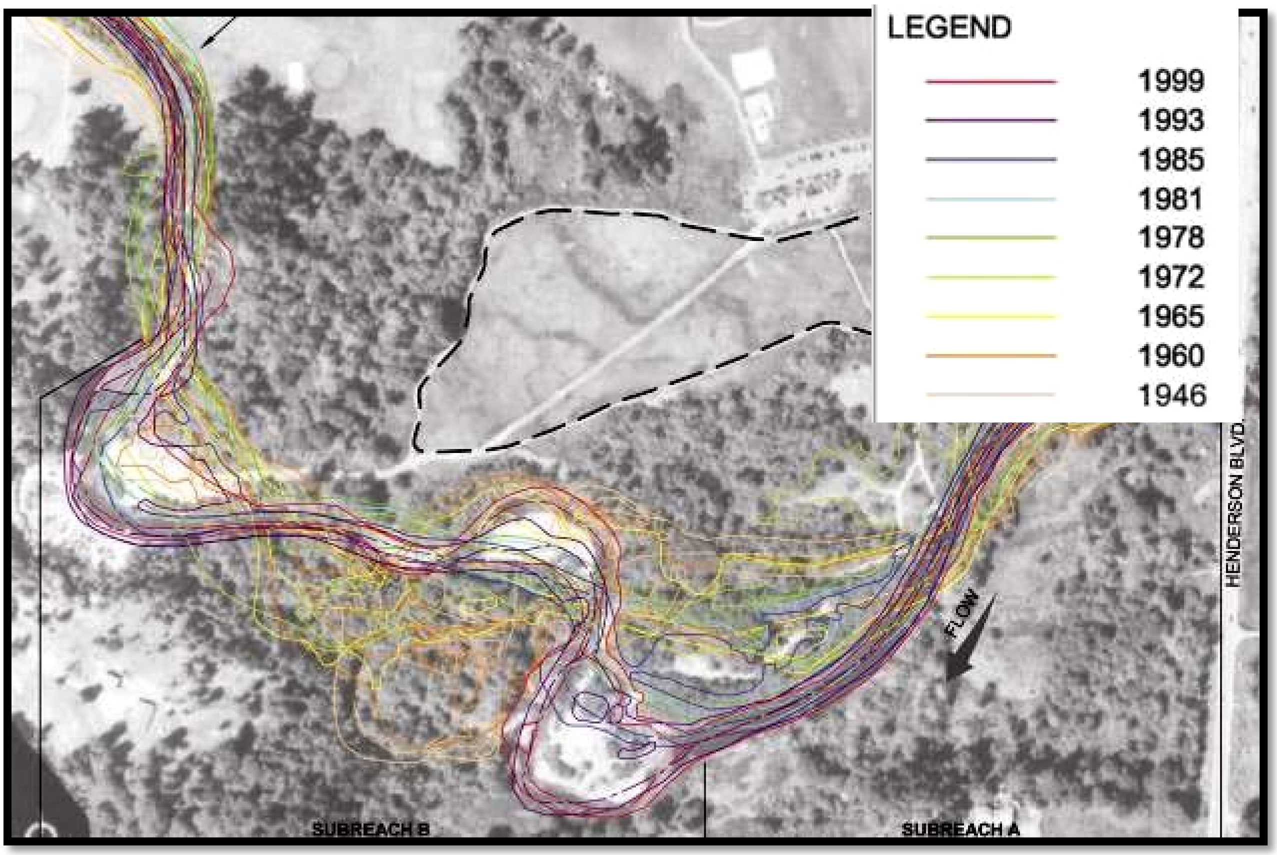
Sinuosity:

When sinuosity (valley length/channel length) is < 1.5, channels are categorized as straight. A higher sinuosity implies a meandering pattern. Channels with higher sinuosity will be more likely to migrate than those that have a sinuosity <1.5. However, low sinuosity channels will migrate if bank material can erode.

Sinuosity <1.5

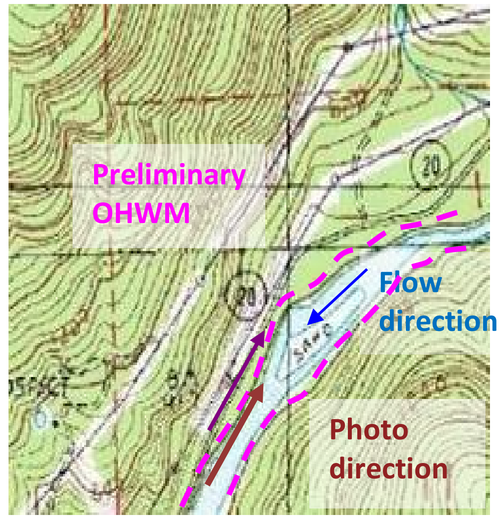
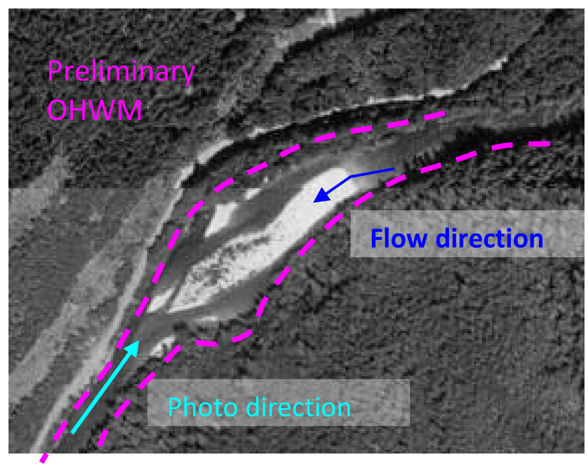
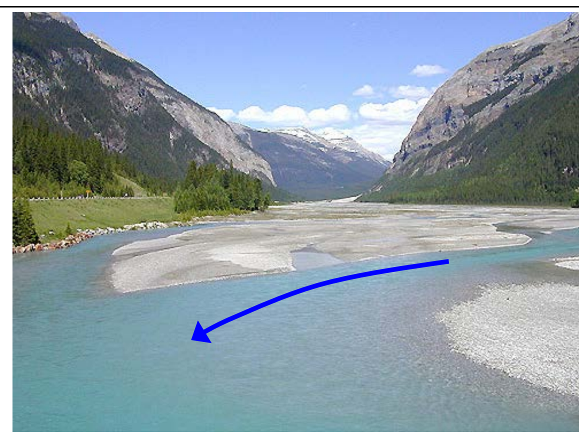
Channel Migration:
Channel migration analyses have been done for some communities. Channel migration maps for sites can be obtained or viewed on county internet sites for these counties: Jefferson, King, Lewis, Mason, Okanogan, Pierce, Snohomish, Thurston, Yakima, Whatcom. The US Bureau of Reclamation has completed channel migration maps for the Hoh River and Quinault River.

Below is a channel migration map for the Deschutes River, Thurston County.



Examples of Channel Characteristics and Influences on OHWM
Descriptions, aerial photographs, topographic maps, and photographs provide examples of mapping the preliminary OHWM based on channel characteristics such as confinement and pattern.

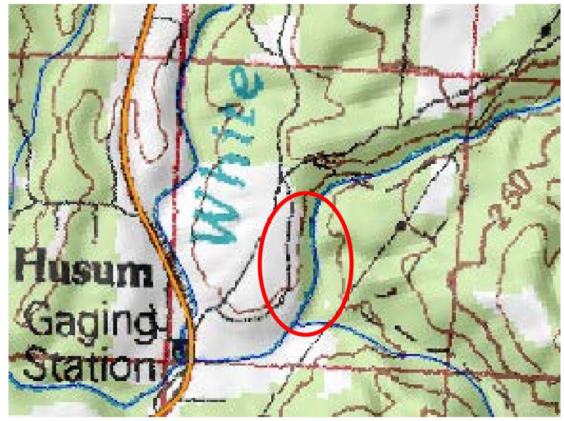
The following descriptions show examples of identifying a preliminary OHWM from aerial photographs and maps based on channel characteristics and patterns.

Valley-river characteristics: • Confinement: Confined; Stream gradient: 0-2%. • Valley shape: Low- to moderate-gradient hillslopes with limited floodplain. • Channel pattern: Single channel, variable sinuosity, patterns include straight and entrenched meanders, confined braiding. • Stream size: Variable. • Position in drainage: Variable, generally mid to lower in the drainage basin. • Dominant substrate: Boulder, cobble, bedrock with pockets of sand/gravel/cobble. *Skagit River*	
Description: Lateral channel migration may be controlled by bedrock outcrops, high terraces, or hillslopes along streambanks. Vertical migration, incision or aggradation, is more likely to occur than lateral migration. The river may be bound on one bank by hillslopes and lowlands on the other, and may have a narrow floodplain in places, particularly on the inside of meander bends. Stream terraces may be present, but they are generally above the current floodplain. The channels are often stable, with those confined by hillslopes or bedrock less likely to display bank erosion or scour than those confined by alluvial terraces.	
Level of effort: Adjustment of channel features is usually localized. OHWM elevation is less likely to change over time and is more consistent unless there is vertical change in bed elevation. OHWM is determined from the outer banks. • OHWM determined at the site level when channel is vertically stable. • Less stable channels may require determining OHWM for banks up and downstream of site as well as across the river if channel characteristics vary. • Side channels are within the OHWM.	

Valley-river characteristics:

- Confinement: Confined; Stream gradient: 0-2%.
- Valley shape: Low- to moderate-gradient hillslopes with limited floodplain.
- Channel pattern: Straight with side channels.
- Stream size: small to medium
- Position in drainage: Mid
    - Dominant substrate: Boulder, cobble, bedrock with pockets of sand/gravel/cobble.

Rattlesnake Creek near Husum, Klickitat County

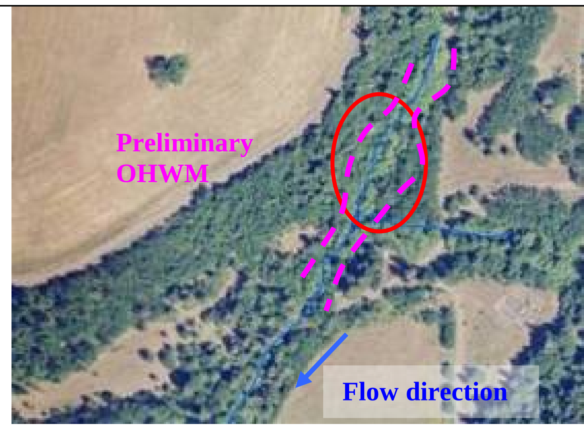


Description:

Lateral channel migration may be controlled by bedrock outcrops along right streambank. Vertical migration, incision or aggradation, is more likely to occur although lateral migration can occur in small floodplain on river left.

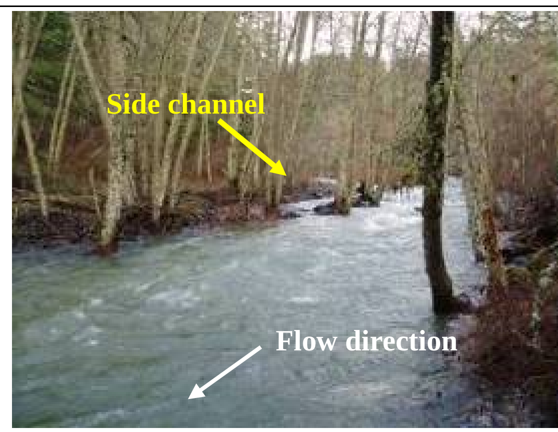
The channels are often stable, with those confined by hillslopes or bedrock less likely to display bank erosion or scour than those confined by alluvial terraces.

Since Rattlesnake Creek is relatively small, with a riparian corridor, the confined valley is not readily observable without DEM or other topographic information. In this case, use transition between more upland and riparian vegetation as preliminary OHWM.



Level of effort:

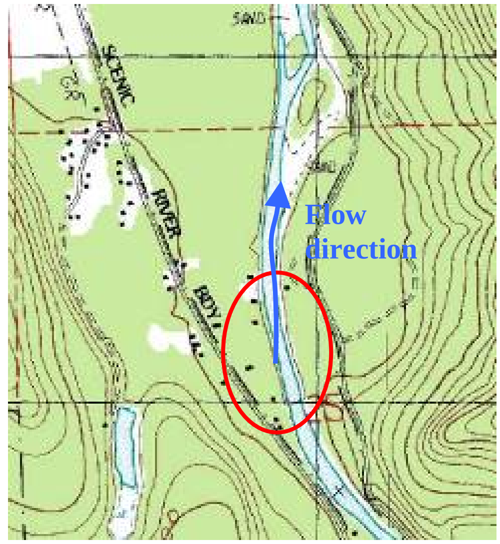
OHWM is from landward extent of side channels as seen on the small floodplain on river right.



Valley-river characteristics:

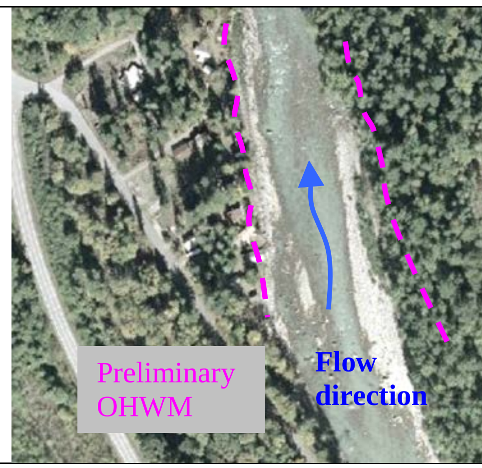
- Confinement: Moderate.
- Channel gradient ≤2%.
- Valley shape: Narrow valley with floodplain or narrow terrace development.
- Channel pattern: Usually single channel but can contain multiple channels, including straight, island braided, braided, meandering.
- Stream size: Variable.
- Position in drainage: Mid to lower portion of drainage basins.
- Dominant substrate: Gravel to small boulder.

Sauk River: Orange oval shows location of reach upstream of Darrington.



Description:

Channels with variable controls on channel confinement. Alternating valley terraces and/or adjacent mountain-slope, foot-slope, and hillslope landforms limit channel migration and floodplain development. A narrow floodplain is usually present, and may alternate from bank to bank. Bedrock steps with cascades may be present.



Level of effort:

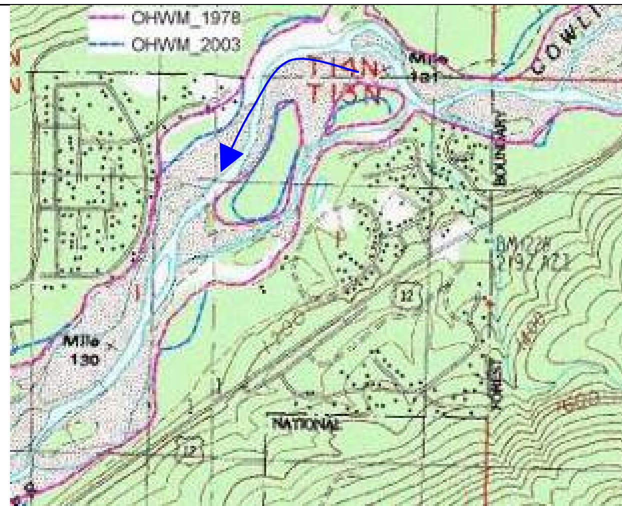
The clean cobbles and undercut trees indicate that the OHWM is just below top of bank.

The combination of a narrow floodplain and hill-slope or terrace controls act to produce channels that can be more responsive than moderately confined channels with <1% slope, with changes occurring rapidly. The combination of higher gradients and the presence of a floodplain set the stage for a dynamic channel system.

- OHWM is variable in space and time.
- Will need to include more points on site, upstream and downstream of site, including those across the river.
- Side channels are within the OHWM.

Valley-river characteristics:

- Confinement: Moderate to unconfined.
- Channel gradient: <2%.
- Valley shape: Confined entering unconfined.
- Channel pattern: Single to multiple channels, including meandering, braided, island braided.
- Stream size: Variable.
- Position in drainage: mid to upper, glacially influenced.
- Dominant substrate: Sand to cobble.



Upper Cowlitz 1978 USGS map, blue arrow shows flow direction.

Description:

Channels are located in moderate to unconfined valley bottoms just downstream of higher gradient reaches, often influenced by alpine glaciers, and carry high sediment loads which are deposited as channel gradient decreases. They may be directly downstream of a small alluvial fan and contain wetlands and side channels. Higher gradient tributaries generally flow into these channels and may dissect the larger floodplain. This channel type is very dynamic and changes can occur rapidly.

These channels can be associated with a large floodplain complex and may be influenced by flooding of tributary streams.

Upper Cowlitz November 2006, blue arrow shows flow direction.

Level of effort:

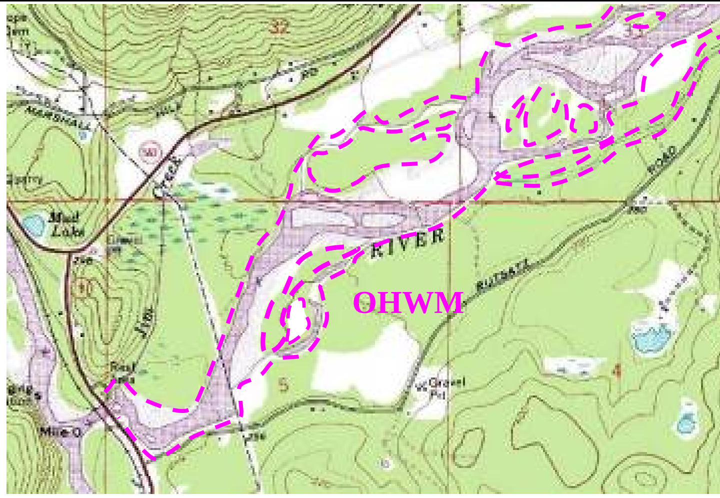
Unconfined channel and finer sediment allows both vertical and lateral movement so OHWM is variable in space and time.

- Will need to include more points on site, upstream and downstream of site including those across the river.
- Side channels are within the OHWM.
- Use channel migration assessments to better define OHWM variability.
- When tributary channels are influenced by flooding in adjacent mainstem streams, determining OHWM will require evaluating the reach above backwater effect.
- Use different year aerial photos and topographic maps.

Valley-river characteristics:

- Confinement: Unconfined.
- Channel gradient: <1%.
- Valley shape: Broad valley, floodplain.
- Channel pattern: Sinuous, single to multiple channels includes wandering, meandering, island braided, anastomosing.
- Stream size: Large.
- Position in drainage: Bottom, low in drainage.
- Dominant substrate: Sand to cobbles.

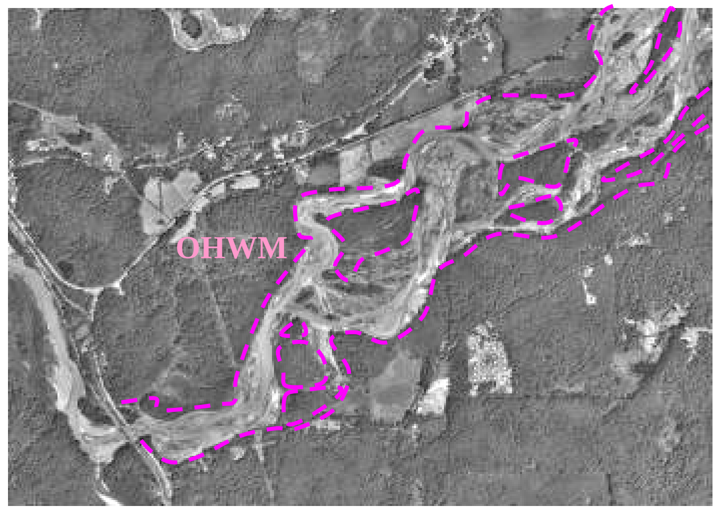
North Fork of the Nooksack River.



Description:

Channels are lowland and valley bottom channels. Normally, these channels have extensive valley floodplains and stream terraces. Sloughs, oxbows, wetlands, and abandoned channels are common in river corridors. Smaller tributary streams may flow through channels abandoned by the main river.

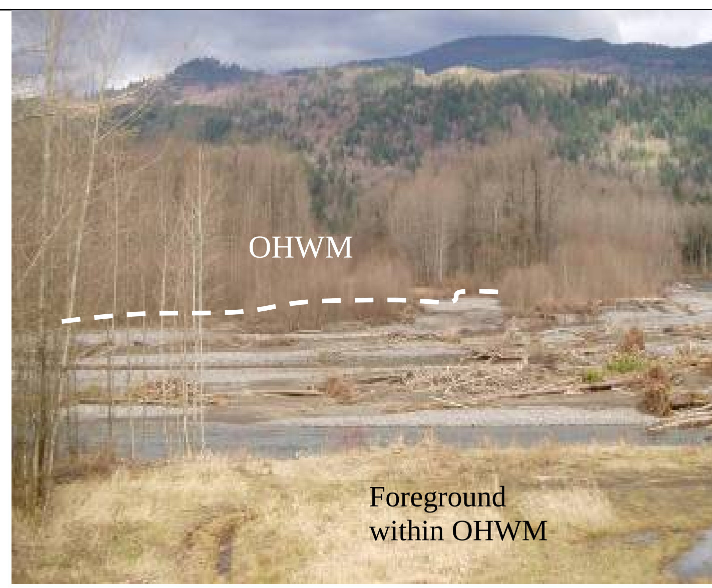
Numerous overflow side-channels, extensive gravel bars, avulsions, and log jams in forested basins are characteristic. They may be bordered on one bank by steep bluffs, marine terraces, or gentle slopes. These channels function as sediment deposition systems with storage of sediment.



Level of effort:

Unconfined channel features and fine substrate allow the stream to move both laterally and vertically. These larger channels can mobilize large amounts of sediment during high flows. This often results in channel migration and new channel formation.

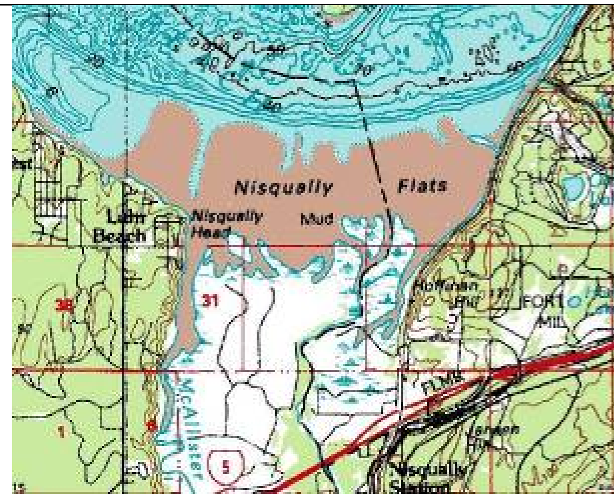
- OHWM delineation is complex and may require topographic surveys where indicators are not obvious and there are multiple channels.
- The figures illustrate the changes in the main channel, further complicating the OHWM call.
- There are more wooded islands in this valley-river class which may have OHWM independent of the main channel OHWM.



Valley-river characteristics:

Special case: River deltas

- Channel confinement: Variable.
- Stream gradient: <1%.
- Valley shape: Where streams empty into broad open water such as a lake or sea.
- Channel pattern: Single to multiple channels spread across the fan surface. Multiple channels are usually distributary channels.
- Stream size: Small to large.
- Position in drainage: At the intersection between stream and open water.
- Dominant substrate: Fine silt and sands, some gravel.



Nisqually Delta

Description:

Located on foot-slope landforms in a transitional area between valley floodplains and sea or steep mountain slopes and lakes. Channel pattern is highly variable, often dependent on substrate size and age of the landform. Channels may change course frequently, resulting in a many branched stream network of distributary channels and channel avulsions. Channels can also be deeply incised where levees or other confinement occurs. Smaller streams may flow into the delta and increase the delta size.

Level of effort:

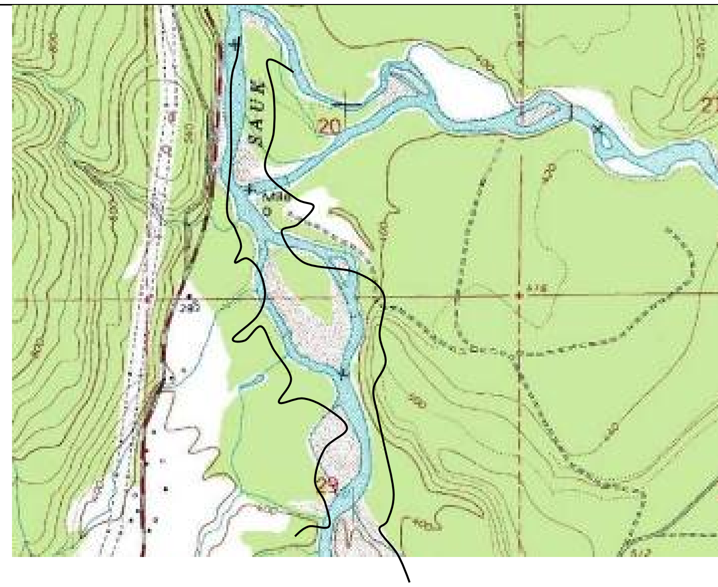
Response is dependent on gradient, substrate size, and channel form. Single-thread channels confined by high banks are likely to be less responsive than an actively migrating multiple-channel delta.

Valley-river characteristics:

Special case: Alluvial fans

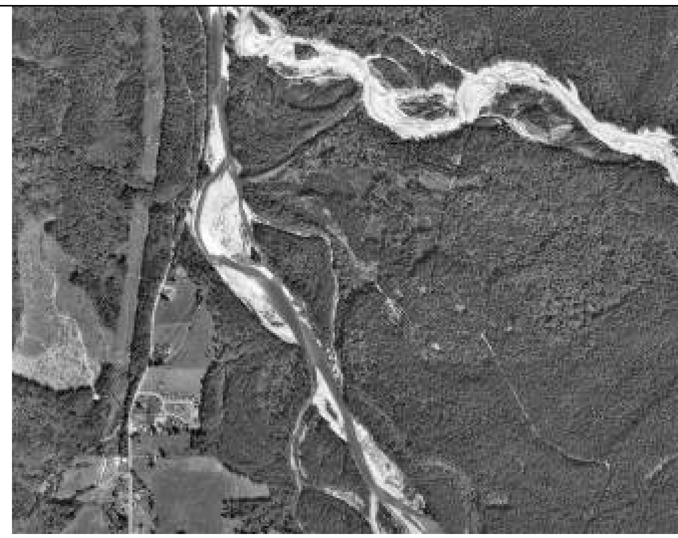
- Channel confinement: Variable.
- Stream gradient: 1-12%.
- Valley shape: Where hillslopes open into broad valley.
- Channel pattern: Single to multiple channels spread across the fan surface. Multiple channels are usually distributary channels.
- Stream size: Small to medium.
- Position in drainage: At the intersection between steep gradient tributaries and floodplains.
- Dominant substrate: Fine gravel to large cobble.

Confluence Sauk and Suiattle Rivers



Description:

Located on foot-slope landforms in a transitional area between valley floodplains and steep mountain slopes. Channel pattern is highly variable, often dependent on substrate size and age of the landform. Channels may change course frequently, resulting in a many branched stream network of distributary channels and channel avulsions. Channels can also be deeply incised within high erosion in alluvial material.

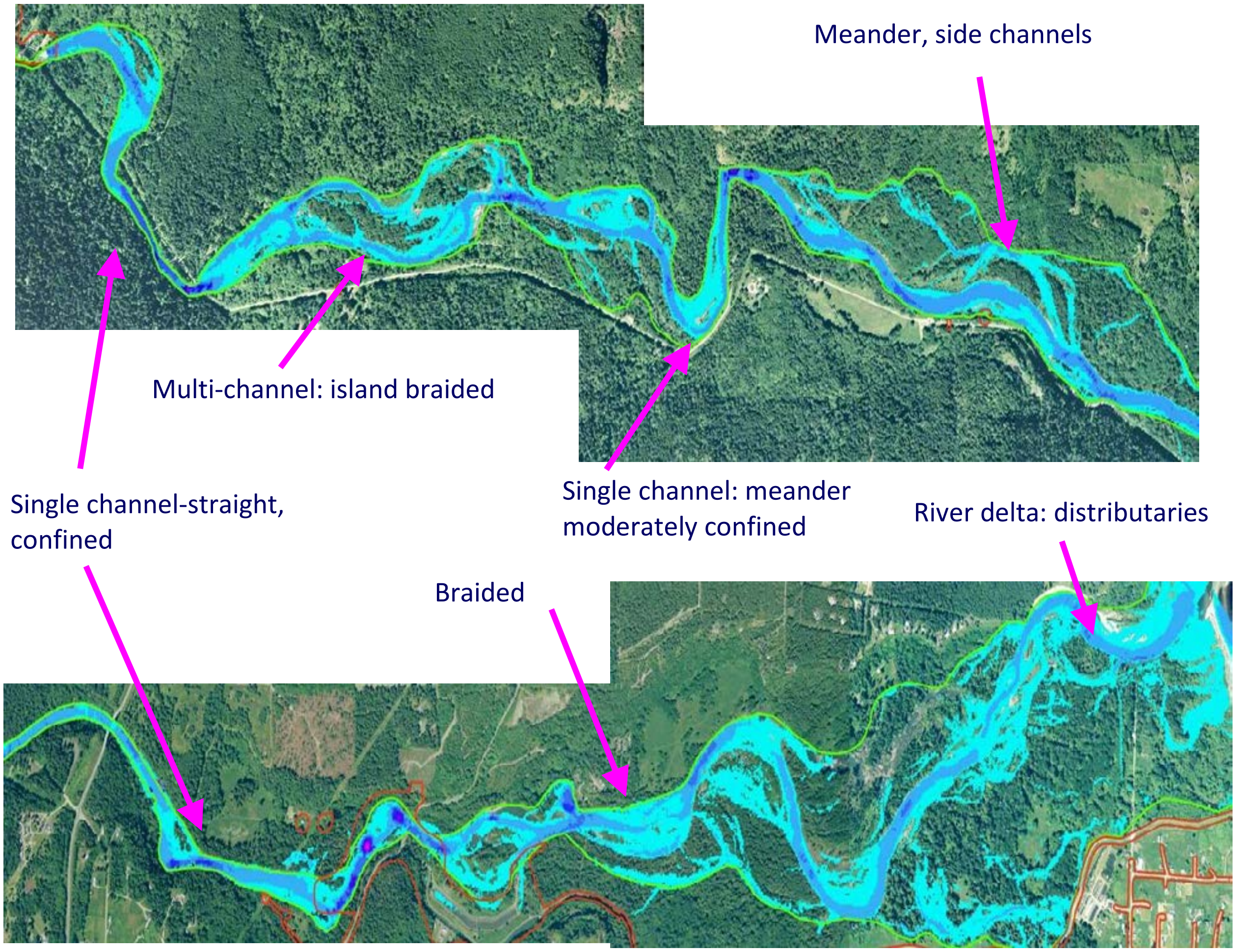


Level of effort:

Response is dependent on gradient, substrate size, and channel form. Single-thread channels confined by high banks are likely to be less responsive than an actively migrating multiple-channel fan.

Additional Example

OHWM maps of the Elwha River below the dams illustrate location of OHWM in relation to channel patterns. Area water, waterward of the OHWM, is identified by light blue fill.



Appendix E: Example report outline

It has been common practice to report an OHWM determination without any supporting evidence or documentation. In many cases, OHWM boundaries have been noted on site plans as an elevation without any corroborating data, analysis, or other reporting. Recent court and Shorelines Hearings Board decisions have ruled in favor of determinations that are supported by data tied to criteria in the definition over those with undocumented and unsupported determinations.

The purpose of a defensible report is to support an OHWM determination with field indicators that satisfy the criteria in the definition of ordinary high water. This outline provides recommendations for preparing an OHWM report that includes the type and scope of evidence in support of a determination.

1. Introduction
    - Site description, project proposal, land ownership, vicinity map.
    - Experience and training of individual or team conducting determination.
2. Summary of Office Assessment
3. Summary of Site Visit
    - Include sketches of water type cross-sectional profiles, and photos.
4. Hydrologic Assessment (if applicable)
5. Discussion
    - Explain how interpretation of field indicators (hydrologic, soils, vegetation, other) support your OHWM determination.
6. Conclusions
7. References

Appendix F: Glossary

Abandoned channel – Abandoned channels are historic and current floodplain features of pool-riffle, regime, and multi-channel reaches with no connection to surface water during low flows but may be connected during higher flows. The channels may be ephemeral during low flows or maintained by subsurface flow. They are formed by bars deposited along the margin of the main stream that isolate secondary channels at low flow or by channel incision. Inlet and outlets of the channel may be blocked with woody material. They can be formed from active and recent processes or processes and conditions no longer operating and masked by sediment and organic material infilling.

Accretion – The gradual addition of substrate to the channel or shoreline. Compare to reliction, erosion.

Active channel – That portion of the channel or floodplain network that receives periodic scour and/or fill during sediment transport events.

Adventitious roots – Roots that originate from the stem of a plant.

Aggradation – An increase in sediment supply and/or decrease in sediment transport capacity that leads to an increase in the channel/shore bed elevation and subsequent increase in the downstream gradient. An increase in base level can also decrease sediment transport capacity, thereby initiating aggradation.

Algal mat – Living or dried deposits from green algae (Chlorophyta) and bluegreen algae (cyanobacteria) found on the ground surface or attached to low-lying fixed objects and vegetation. These deposits are the result of algae growing in areas subject to prolonged inundation.

Alluvial – Pertaining to material or processes associated with transportation and/or deposition by concentrated running water.

Alluvial soil – A soil developing from recently deposited alluvium and exhibiting limited soil gensis. Alluvial soils are characterized by little soil development (most are Entisols), an irregular decrease in organic carbon with depth, and landscape position.

Alluvial terrace – see terrace.

Alluvium – Unconsolidated, clastic material deposited by running water, including gravel, sand, silt, clay, and various mixtures of these.

Anabranch – A diverging branch or *secondary channel* of a river, which reenters the main stream some distance downstream.

Anabranching rivers – A highly diverse type of river that occur as both laterally stable and laterally active forms. Anabranching rivers consist of multiple channels separated by vegetated semi-permanent alluvial floodplain islands excised from existing floodplain or formed by within-channel or deltaic accretion. These rivers occupy a wide range of environments from low to high energy. They occur concurrently with other types of channel patterns including straight, sinuous, meandering, or braiding channels. Specific requirements include a flood-dominated flow regime and banks that are resistant to erosion, with some systems characterized by mechanisms to block or constrict channels causing *avulsions*.

Anastomosing channel – A river pattern (subset of anabranching) with multiple, interconnected, coexisting channels separated by terraces or floodplain *islands*, with erosion-resistant cohesive banks, and relatively low width-depth ratios of individual channels.

Associated wetlands – Those wetlands which are in proximity to and either influence or are influenced by tidal waters or a lake or stream subject to the Shoreline Management Act [WAC 173-22-030].

Avulsion – Relatively sudden and major shifts in the position of the channel to a new part of the floodplain (first-order avulsion) or sudden reoccupation of an old channel on the floodplain (second-order avulsion) or relatively minor switching of channels within a braid train or other active channels (third-order avulsion).

Bankfull depth – The average depth measured at *bankfull discharge*.

Bankfull discharge – The most effective channel-forming flood with a recurrence interval seldom greater than the 2-year flood in undisturbed channels. The bankfull discharge may be > than the 2-year flood for incised channels. Bankfull discharge occurs at the maximum product of flow frequency and sediment transport. Bankfull discharge may be exceeded multiple times within a given year. This may occur in a single event, or it might occur in different isolated events.

Bankfull stage – The height or elevation at the point of initial flooding, indicated by silt to cobble deposits at the active scour line, break in bank slope, perennial vegetation limit, rock discoloration, and root hair exposure.

Bankfull width – Channel width at bankfull discharge.

Bank – The sloping land bordering a channel or water body. The bank has a steeper slope than the bottom of the channel and is usually steeper than the land surrounding the channel.

Bar – [streams] A general term for a ridge-like accumulation of sand, gravel, or other alluvial material formed in the channel, along the banks, or at the mouth of a stream where a decrease in velocity induces deposition; e.g. a channel bar or a meander bar. Examples include:

> ***Point bars* –** Bars that are formed on the inside of meander channels.
> ***Side bars* –** Bars that are formed along the edges of relatively straight sections of rivers.
> ***Mid-channel bars* –** Bars found within the channel that become more noticeable during low flow periods.
> ***Delta bars* –** Bars formed immediately downstream of the main confluences of a tributary and the main channel.

Bar – [coast] A generic term for any of various elongate offshore ridges, banks, or mounds of sand, gravel, or other unconsolidated material submerged at least at high tide, and built up by the action of waves or currents, especially at the mouth of a river or estuary, or at a slight distance offshore from the beach.

Bar and channel topography – A local-scale topographic pattern of recurring, small, sinuous, or arcuate ridges separated by shallow troughs irregularly spaced across low-relief floodplains (slopes generally two to six percent); the effect is one of a subdued, sinuously undulating surface that is common on active, meandering flood-plains. Small elevation differences between bars and channels generally range from <0.5 to 2 m and are largely controlled by the competency of the stream. The ridge-like bars often consist of somewhat coarser sediments compared to the finer textured sediments of the micro-low troughs. See also **– meander scroll, meander belt**.

Barrier beach – A stretch of sand dune or cobble bar that separates a coastal body of water from ocean waters in all but exceptionally high tides, or during storms.

Braided – A channel pattern that is divided into several channels that branch and re-join around bare or sparsely vegetated sand/gravel/cobble bars.

Braided stream – A channel or stream with interconnecting channels formed by flow that repeatedly divides and converges around mid-channel bars. In the plan view, the channel resembles strands of a complex braid. Braiding is generally confined to broad, shallow streams of low sinuosity, variable discharge, high bedload, non-cohesive bank material, and a steep gradient. At bankfull discharge, braided streams often have steeper slopes and shallower, broader, and less stable channel cross sections than meandering streams. During periods of high discharge, the entire stream channel may contain water and the islands are covered to become submerged bars. During such high discharge, some of the islands could erode, but the sediment would be re-deposited as the discharge decreases, forming new islands or submerged bars. Islands may become resistant to erosion if they become inhabited by vegetation.

Boulder – Rock fragments larger than 24 inches in diameter.

Bulkhead – A vertical structure or partition, placed on a bank or bluff and usually running parallel to the shoreline, for the purpose of retaining upland soils while providing protection of the inland area from wave action. Bulkheads are generally smaller than seawall structures and are designed to retain upland soils while providing protection from minimal wave action.

Channel – [stream] a) The hollow bed where a natural body of surface water flows or may flow. The deepest or central part of the bed of a stream, containing the main current and occupied more or less continuously by water. b) (colloquial: western U.S.A.) The bed of a single or braided watercourse that is commonly barren of vegetation and formed of modern alluvium. Channels may be enclosed by banks or splayed across and slightly mounded above a fan surface and include bars and mounds of cobbles and stones. c) [Microfeature] Small, trough-like, arcuate or sinuous channels separated by small bars or ridges, caused by fluvial processes; common to floodplains and young alluvial terraces; a constituent part of *bar and channel topography*

Clay – Soil with rock fragments less than 0.00008 inches in diameter; a fine-grained, firm natural material, plastic when wet, that consists primarily of hydrated silicates of aluminum.

Coastal lagoon – Coastal waterways in which waves are the principal factor that shapes the overall geomorphology. Characterized by a sandy barrier that can partially or totally constrict the entrance, backed by a mud basin, and typically have negligible river input. When vegetated, typically dominated by *salt tolerant vegetation*.

Cobbles – Soils with rock fragments three to 10 inches in diameter.

Cutoff [streams] **–** The new and relatively short channel formed when a stream cuts through a narrow strip of land and thereby shortens the length of its channel.

Debris flow – A moving mass of rock fragments, soil, and mud, more than half of the particles being larger than sand size.

Delta – A body of alluvium consisting mostly of stratified clay, silt, sand, and gravel, nearly flat and fan-shaped, deposited at or near the mouth of a river or stream where it enters a body of relatively quiet water, usually a sea or lake. The upstream extent of a river delta is that limit where it no longer forms distributary channels [WAC 173-22-030].

Delta plain – The level or nearly level surface composing the landward part of a large delta; strictly, a floodplain characterized by repeated channel bifurcation and divergence, multiple *distributary channels,* and interdistributary flood basins.

Dike – An embankment to confine or control water, especially one built along the banks of a river to prevent overflow of lowlands; a levee.

Discharge – A rate of runoff in streams or other channels usually expressed in terms of volume per unit time, e.g., cubic feet per second (cfs), acre-feet per day. Discharge is often expressed as averages of individual events:

- *Average (Mean) daily* **–** The average for all flow measurements taken over the 24-hour day.
- *Average (Mean) monthly* **–** The average for all mean daily flow in a given month. Can be calculated for a specific water year or a series of water years or all water years. The time series in water years must be specified.
- *Average (Mean) annual* **–** The average for all mean daily flows in a year for a specific water year or all water years. The time series in water years must be specified.

Distributary channel – A divergent stream flowing away from the main stream and not returning to it, as in a delta or on a flood plain. It may be produced by stream deposition choking the original channel. These typically occur at the mouth or delta of a river where it empties into a lake or ocean or on an alluvial fan.

Disturbed – Directly or indirectly altered, by humans or a natural condition, yet retaining some natural characteristics.

Ditch – An open and usually unpaved (unlined) channel or trench excavated to convey water for drainage (removal) or irrigation (addition) to or from a landscape; smaller than a canal; some ditches are modified natural waterways.

Dominant – are species that control the environment.

Drainage pattern – a) The configuration of arrangement, in plan view, of the stream channels in an area. Patterns are influenced by local geologic and geomorphic features. b) Flow patterns visible on the soil surface or eroded into the soil, low vegetation bent over in the direction of flow, absence of leaf litter or small woody debris due to flowing water, and similar evidence that water flowed across the ground surface.

Drift deposits – Consist of rafted debris that has been deposited on the ground surface or entangled in vegetation or other fixed objects. Debris consists of remnants of vegetation (e.g., branches, stems, and leaves), man-made litter, or other waterborne materials. Drift material may be deposited at or near the high water line in ponded or flooded areas, piled against the upstream side of trees, rocks, and other fixed objects, or widely distributed within the dewatered area.

Duration – a) [inundation/soil saturation] Means the length of time during which water stands at or above a soil surface (inundation), or during which the soil is saturated. As used herein, duration typically refers to a period during the growing season; b) the time during which the value of a given parameter, e.g. water level, is equaled or exceeded, regardless of continuity in time (see also f*lood duration*).

Ecotone – The boundary between adjacent plant communities.

Edaphic – Any physical or chemical properties of the soil that influences plants growing in it; influenced by the soil rather than by the climate.

Emergent plant – A rooted herbaceous plant species that has parts extending above a water surface.

Entisol – Soils that have little or no evidence of horizon development, usually as a result of recent flood deposition.

Erosion – The wearing away of land surfaces by running water, waves, moving ice, and wind, or by such processes as mass movement and corrosion, and transported elsewhere.

Estuarine deposit – Fine-grained sediments (very fine sand, silt and clay) of marine and fluvial origin with a high proportion of decomposed terrestrial organic matter, laid down in the brackish waters of an estuary; characteristically finer sediments than deltaic deposits.

Estuary – a) A seaward end or the widened funnel-shaped tidal mouth of a river valley where fresh water comes into contact with seawater and where tidal effects are evident; e.g., a tidal river, or a partially enclosed coastal body of water where the tide meets the current of a stream. b) A portion of an ocean or an arm of the sea affected by fresh water; e.g., the Salish Sea. c) A drowned river mouth formed by the subsidence of land near the coast or by the drowning of the lower portion of a non-glacial valley due to the rise of sea level.

Facultative plants (FAC) – A plant species that is equally likely to occur in wetlands or uplands.

Facultative upland plants (FACU) – A plant species that usually occurs in uplands, but is occasionally found in wetlands.

Facultative wetland plants (FACW) – A plant species that usually occurs in wetlands, but is occasionally found in uplands.

Fetch – The distance over water in which waves are generated by a wind having a constant direction and speed. Generally considered synonymous with the maximum open water distance in the direction from which the strongest and most constant winds blow.

Flood duration – The length of time a stream or water body is above a flood stage.

Flood frequency – Number of times a flood above a given discharge or stage is likely to be exceeded or equaled in any given year. It is often calculated as a recurrence interval (e.g., 2-year flood) or a probability of occurrence (e.g., 50 percent probability of occurring). (See recurrence interval).

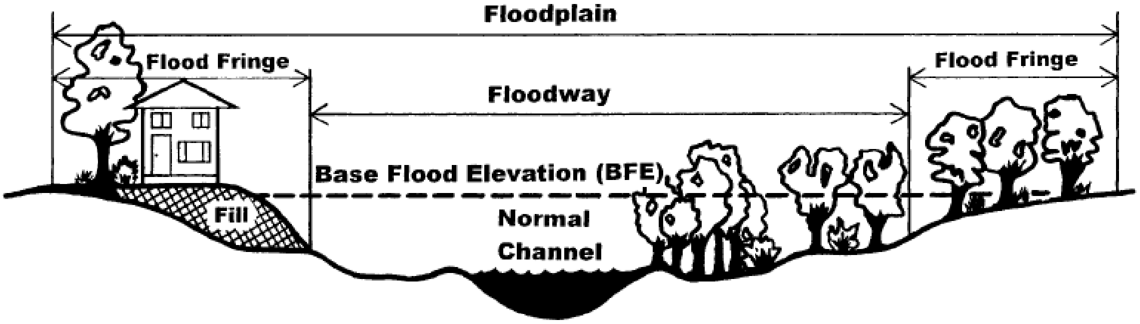
Flood storage – The floodplain provides temporary storage space for floodwaters and sediment produced by the watershed. A floodplain function by which peak flows (from precipitation, runoff, groundwater discharge, etc.) enter floodplain depressions e.g., wetland, and are delayed in their downslope journey.

Flooded – A condition in which the soil surface is temporarily covered with water from any source, such as streams overflowing their banks and runoff from adjacent surrounding slopes.

Floodplain – The relatively flat area or berm adjoining a river channel or water body and constructed by the river in the present climate by a combination of progressive lateral migration, channel creation and abandonment, and overbank sediment deposition from periodic inundation. Floodplains may not be uniform or homogeneous flat surfaces, and can consist of irregular or multiple surfaces at different elevations that reflect vertical differences in the channel bed resulting from local scour, changes in flow regime, sediment supply, and wood loading.

Floodway – a) A large-capacity channel constructed to divert floodwaters or excess streamflow from populous, flood-prone areas, such as a bypass route bounded by levees. b) The part of the floodplain kept clear of encumbrances and reserved for emergency diversion of floodwaters. c) [FEMA] the regulatory floodway means that portion of the floodplain which is effective in carrying flow, within which this carrying capacity must be preserved and where the flood hazard is generally highest, usually where water depths and velocities are the greatest. It is that area which provides for the discharge of the base flood (one percent probability flood) so the cumulative increase in water surface elevation is no more than one foot. It is the area of the floodplain that should be reserved (kept free of obstructions) to allow floodwaters to move downstream. d) [Shoreline Management Act] floodway means those portions of the area of a river valley lying streamward from the outer limits of a watercourse upon which flood waters are carried during periods of flooding that occur with reasonable regularity, although not necessarily annually, with said floodway being identified, under normal condition, by changes in surface soil conditions or changes in types or quality of vegetative ground cover condition.

(RCW 90.58.030(2)(g) While this sounds similar to OHWM definition, they are not synonymous.



Flotsam – Debris floating on the water surface.

Fluvial – [adjective] Of or pertaining to rivers or streams; produced by stream or river action, e.g. fluvial landform.

Forb – Any herbaceous plant, usually broad-leaved, that is not a grass or grass-like plant.

Forested wetland (Cowardin et al. 1979) – A class of wetland habitat characterized by woody vegetation that is 6 m (20 ft) tall or taller.

Frequently flooded – A class of flood frequency in which flooding is common in most years (more than a 50 percent chance of flooding in any year).

Freshwater impounded wetland – A palustrine or lacustrine wetland formed in a topographic depression or by the natural or artificial damming of a river, stream, or other channel.

Glacial outwash – Stratified sand and gravel carried, sorted, and deposited by water that originated mainly from the melting of glacial ice.

Glacial till – Unsorted, unstratified glacial drift, generally unconsolidated, that is deposited directly by a glacier without subsequent reworking by water from the glacier.

Gradient – The slope of the stream channel, valley, floodplain, or terrace in the downstream direction usually expressed as a ratio of vertical rise to horizontal run. Channel gradient can either be measured as the thalweg slope or water surface slope.

Graminoid – Refers to grass or grasslike plants such as grasses, sedges, and rushes.

Gravel – A soil mixture composed primarily of rock fragments 0.08 inch to 3 inches in diameter. Usually contains much sand.

Groundwater – Water occupying the interconnected pore spaces in the soil or geologic material below the water table; this water has a positive pressure.

Growing season – Dates as determined through onsite observations of the following indicators of biological activity in a given year: (1) above-ground growth and development of vascular plants, and/or (2) soil temperature (see U.S. Army Corps of Engineers 2008 and 2010).

High flows – Flows in excess of annual mean daily flows plus the standard deviation.

Hillslope – A generic term for the steeper part of a hill between its summit and the drainage line, valley flat, or depression floor at the base of the hill.

Hydraulic continuity – The existence of some degree of interconnection between two or more sources of water, either surface water or ground water or two ground water sources.

Hydric soil – Soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part.

Hydrochory – Dispersal of seeds by water; a plant which uses this method in its lifecycle is termed a **hydrochore**.

Hydrogeology – The study of the geologic aspects of subsurface waters.

Hydrograph – A graph of the rate of runoff (discharge) or water level plotted against time for a point on a channel or hillside.

Hydrophytes – Wetland plants are known as **hydrophytes** and are distinctive from upland plants due to their special adaptations to wet environments. Hydrophytes have morphological, physiological, and reproductive adaptations that allow them to survive in inundated or saturated soils where non-hydrophytes cannot. Communities dominated by hydrophytes are referred to as hydrophytic plant communities.

Hydrophytic vegetation – The sum total of macrophytic plant life growing in water or on a substrate that is at least periodically deficient in oxygen as a result of excessive water content. When hydrophytic vegetation comprises a community where indicators of hydric soils and wetland hydrology also occur, the area has wetland vegetation.

Hydroriparian plants (hydrophytes) **–** Are true aquatic plants that need total inundation or continual surface wetness. They include rushes or cattails. These plants have to be in contact with the water table, which is why they can be used as indicators of soil moisture conditions. Compare to mesoriparian and xeroriparian.

Indicator plant – A plant whose presence or abundance indicates certain environmental conditions and the presence of a habitat type, association, or community type.

Inundation – a condition in which water temporarily or permanently covers a land surface.

Lake (WAC 173-22-030) **–** Means a body of standing water in a depression of land or expanded part of a river, including reservoirs, of twenty acres or greater in total area. A lake is bounded by the ordinary high water mark or, where a stream enters a lake, the extension of the elevation of the lake's ordinary high water mark within the stream.

Levee (natural) **–** A long, broad, low ridge or embankment of sediments (sand to boulders), built by a stream on its flood plain and along a stream channel, especially in time of flood when water overflowing the normal banks is forced to deposit the coarsest part of its load. It has a gentle slope away from the river and toward the surrounding floodplain, and its highest elevation is closest to the river bank. Natural levees occur where water passes from a deep channel to shallow flow and where turbulence abruptly drops along channel margins. Often the levee will build up the channel bank to an elevation higher than the floodplain.

Levee (artificial) – An artificial embankment built along the margin of a watercourse or an arm of the sea, to protect land from inundation or to confine streamflow to the main channel.

Lichen – A mutualistic association of a fungus and photosynthetic organism, either a unicellular alga or a cyanobacterium.

Littoral zone – The nearshore area of a water body where water is shallow enough to support the growth of rooted aquatic vegetation.

Load – The rock particles and dissolved ions carried by the stream are the called the stream's load. Stream load is divided into three parts:

- *Suspended Load* **–** particles that are carried along with the water in the main part of the streams.
- *Bed Load* **–** coarser and denser particles that remain on the bed of the stream most of the time but move by a process of saltation (jumping) as a result of collisions between particles, and turbulent eddies.
- *Dissolved Load* **–** Dissolved ions that have been introduced into the water by chemical weathering of rocks.

Long duration – A period of inundation from a single event that ranges from seven days to one month.

Long-duration flooding – A duration class in which inundation for a single event ranges from seven days to one month.

Main channel – The main stream channel is the dominant channel with the deepest or lowest thalweg, the widest width within defined banks, and the most water during low flow periods. Main channel locations can be transient over time. Braided channels may not have a defined main channel, especially as stages reach bankfull.

Mean higher high water (MHHW) – The tidal elevation obtained by averaging each day's highest tide at a particular location over a period of 19 years (the National Tidal Datum Epoch). It is measured from the MLLW = 0.0 tidal elevation. [WAC 220-110-020]. MHHW is a tidal datum.

Mean Sea Level – This commonly used term really refers to local mean sea level and is defined as the arithmetic mean of hourly heights observed over the National Tidal Datum Epoch. Shorter series are specified in the name; e.g., monthly mean sea level and yearly mean sea level. MSL is not the standardized plane of reference adopted by the United States and Canada. (See NGVD).

Meander – A meander is one of a series of freely developing sinuous bends, curves, turns or loops, with sine-wave form, in the course of a stream. Highly meandering stream channels commonly have cross sections with low width-to-depth ratios, fine-grained bank materials, and low gradient.

Meandering channel – The term "meandering" should be restricted to loops with channel length more than 1.5 to 2 times the meander wave length. Meandering stream channels commonly have cross sections with low width-to-depth ratios, cohesive (fine-grained) bank materials, and low gradient. At a given bank-full discharge, meandering streams have gentler slopes, and deeper, narrower, and more stable channel cross sections than braided streams.

Mesoriparian plants – Cottonwoods and willows found along streams and on regularly inundated floodplains and shallow water tables. These areas are seasonally saturated to the surface. Compare to hydroriparian and xeroriparian.

Moss – A type of primitive plant in the division Bryophyta which does not have a vascular system and lacks roots. Peat mosses (class Sphagnopsida) are plants which form spongy, pale-green mats in still freshwater environments like pools, bogs, swamps, and the shores of lakes and ponds.

National Tidal Datum Epoch – Specific 19-year periods adopted by the National Ocean Service as the official time segment during which tide observations are taken and calculated to mean (average) values for tidal datums.

NAVD [North American Vertical Datum of 1988 (NAVD 1988)] **–** A new geodetic datum implemented by the National Ocean Service to replace NGVD 1929.

NGVD [National Geodetic Vertical Datum of 1929 (NGVD 1929)] **–** A fixed reference adopted as a standard geodetic datum for elevations determined by leveling. Observations at twenty one stations in the U.S. and five in Canada were used to establish a "first order" leveling net that is fixed and does not take into account the changing stands of sea level. The NGVD is fixed over a broad area and thus does not correlate to local sea level and should not, therefore, be confused with mean sea level. The U.S. Geological Survey uses this datum as a reference for land elevations on topographic maps.

Obligate – Plant species capable of surviving in only one environment.

Obligate wetland plants – A plant species that occurs almost always under natural conditions in wetlands and is rarely found in uplands.

Ordinary High Water (WAC 173-22-030) **–** On all lakes, streams, and tidal water is that mark that will be found by examining the bed and banks and ascertaining where the presence and action of waters are so common and usual, and so long continued in all ordinary years, as to mark upon the soil a character distinct from that of the abutting upland, in respect to vegetation as that condition exists on June 1, 1971, as it may naturally change thereafter, or as it may change thereafter in accordance with permits issued by a local government or the department. The definition is further refined by water type:

- *Tidal waters –*
    - In high energy environments where the action of waves or currents is sufficient to prevent vegetation establishment below mean higher high tide, the ordinary high water mark is coincident with the line of vegetation. Where there is no vegetative cover for less than one hundred feet parallel to the shoreline, the ordinary high water mark is the average tidal elevation of the adjacent lines of vegetation. Where

the ordinary high water mark cannot be found, it is the elevation of mean higher high tide.

  - In low energy environments where the action of waves and currents is not sufficient to prevent vegetation establishment below mean higher high tide, the ordinary high water mark is coincident with the landward limit of salt tolerant vegetation. "Salt tolerant vegetation" means vegetation which is tolerant of interstitial soil salinities greater than or equal to 0.5 parts per thousand.

- *Lakes* **–** Where the ordinary high water mark cannot be found, it shall be the line of mean high water.

- *Streams* **–** Where the ordinary high water mark cannot be found, it shall be the line of mean high water. For braided streams, the ordinary high water mark is found on the banks forming the outer limits of the depression within which the braiding occurs.

Overbank flooding – Any situation in which inundation occurs as a result of the water level of a river or stream rising above banks and entering the floodplain.

Overflow channel – A generally dry channel that conducts flood waters from large storms, annual meltwater, or glacial meltwaters. These channels can be continuous or interrupted in space in terms of channel dimensions and scour and fill. They often are a response to episodic flood scour and fill during floodplain inundation and drainage. They also can partially fill in between episodic flood events or become *abandoned* completely or be blocked by deposits of sediment or wood at their head.

Oxbow – A closely looping stream meander having an extreme curvature such that only a neck of land is left between the two parts of the stream.

Oxbow lake – A crescent-shaped body of standing water situated by the side of a stream in the abandoned channel (oxbow) of a meander after a meander bend cutoff or avulsion. Once isolated, oxbow lakes will slowly fill up with sediment, as point bar sands and gravels are buried by silts, clays, and organic material carried in by river floods and by sediment slumping in from sides as rain fills up lake.

Pedogenic – Pertaining to processes that add, transfer, transform, or remove soil constituents.

Permanently flooded – Water covers the land surface throughout the year in all years (may be absent during extreme drought periods).

Pioneer plants – Herbaceous annual and seedling perennial plants that colonize bare areas such as gravel bars as a first stage in secondary succession.

Point bar – One of a series of low, arcuate ridges of sand and gravel developed on the inside of a growing meander by the slow addition of individual accretions accompanying migration of the channel toward the outer bank.

Poorly drained – Water is removed from the soil so slowly that the soil is saturated periodically during the growing season or remains wet for periods greater than seven days.

Recurrence interval – The average interval of time within which the given discharge will be equaled or exceeded once. Also called the return period.

Reliction – The gradual and imperceptible withdrawal of water resulting in the uncovering of land once submerged. Compare to accretion, erosion.

Riparian or wetland ecosystem – The ecosystem located between aquatic and terrestrial environments. This classification treats this concept rather broadly or loosely by including transitional (also known as xeroriparian) ecosystems lying between riparian and terrestrial ecosystems. Thus, in the broad sense, these ecosystems are identified by the presence of vegetation that requires or tolerates free or unbound water or conditions that are more moist than normal.

Riparian species – Plant species that occur in the riparian zone.

Riparian wetland – An out-of-channel, palustrine wetland associated with the flowing water of a riparian system.

Riprap – Rock, concrete, or other material used as a hard, artificial shoreline facing to reduce erosion.

River (streams) – A general term for a natural, freshwater surface stream of considerable volume and generally with a permanent base flow, moving in a defined channel toward a larger river, lake, or sea (see *stream*).

Salt tolerant vegetation – Vegetation which is tolerant of interstitial soil salinities greater than or equal to 0.5 parts per thousand [WAC 173-22-030].

Sand – Composed predominantly of coarse-grained mineral sediments with diameters larger than 0.003 inches and smaller than 0.08 inches in diameter.

Saturated – A soil condition in which all voids (pore spaces) between soil particles are filled with water.

Scour – a) The powerful and concentrated clearing and digging action of flowing air, water, or ice, especially the downward erosion by stream water in sweeping away mud and silt on the outside curve of a bend, or during the time of a flood; a process. b) A place in a stream bed swept (scoured) by running water, generally leaving a gravel bottom.

Scour and fill – A process of alternate excavation and refilling of a channel, as by a stream or the tides; especially such a process occurring in time of flood, when the discharge and velocity of an aggrading stream are suddenly increased, causing the digging of new channels that become filled with sediment when the flood subsides.

Scour line – (Colloquial) The line along a stream channel created by scour and kept unvegetated by running water.

Seasonally flooded – Surface water is present for extended periods especially early in the growing season, but is absent by the end of the season in most years. When surface water is absent, the water table is often near the land surface (see also *semi-permanently flooded*).

Secondary channel – Any *channel* on or in a floodplain that carries water (intermittently or perennially in time; continuously or interrupted in space) away from, away from and back into, or along the main channel. Secondary channels include: *side channels, wall-based channels, distributary channels, anabranch channels, abandoned channels, overflow channels, chutes, and swales*.

Sediment deposits – Thin layers or coatings of mineral material (e.g., silt or clay) or organic matter (e.g., pollen), sometimes mixed with other detritus, remaining on plant stems or leaves, rocks, and other objects after inundation and dewatering.

Sediment trapping – The process by which particulate matter is deposited and retained (by any mechanism or process) within a wetland, channel or floodplain.

Sediment – Solid material, both mineral and organic, that is in suspension, is being transported or has been moved from its site of origin by water, and has come to rest on the earth's surface.

Seep – Groundwater discharge areas where the water table comes close to the soil surface. In general, seeps have less flow than a spring and may not result in water forming an unconfined flow.

Semi-permanently flooded – Surface water persists throughout the growing season in most years. When surface water is absent, the water table is usually at or very near the land surface.

Side channel – A *secondary or anabranch channel* that is at least partially connected to the main river channel with its channel thalweg at or below the range of bankfull flow elevations. Side channel inlets are often blocked by wood jams or large accumulations of gravel and sand. (compare to *overflow channel*).

Silt – Rock fragments between 0.0008 inches and 0.00008 inches in diameter; as a textural class, a mixture of 20 to 50 percent sand, 30 to 80 percent silt, and 10 to 30 percent clay-sized particles.

Slope – (also called slope gradient or gradient) The inclination of the land surface from the horizontal. Percent slope is the vertical distance divided by the horizontal distance, and then multiplied by 100.

Slough – An area of slack (not moving) water formed in a *meander scroll* deposit (*swale*) or an *abandoned channel* still partially connected to the main river at its downstream end. During flood stage, sloughs can become reconnected at their upstream end.

Stone – Rock fragments larger than 10 inches but less than 24 inches.

Stream – a) Any body of running water that moves under gravity to progressively lower levels, in a relatively narrow but clearly defined channel on the ground surface, in a subterranean cavern, or beneath or in a glacier and transports sediment and dissolved particles. b) A term used in quantitative geomorphology interchangeably with channel. c) A natural waterway that is defined as first to third stream order. d) (under the Shoreline Management Act) A naturally occurring body of periodic or continuously flowing water where: (1) The mean annual flow is greater than twenty cubic feet per second; and (2) The water is contained within a channel. A channel is an open conduit either naturally or artificially created. This definition does not include artificially created irrigation, return flow, or stockwatering channels [WAC 173-22-030]. Rivers, creeks, brooks, and runs are all streams.

Stream order – A classification of streams according to the number of the tributaries. Order 1 streams have no tributaries; a stream of any higher order has two or more tributaries of the next lower order.

Streambank – The portion of the channel cross section that controls the lateral movement of water

Swales – Small *secondary channel* or linear depressional features on point bar deposits. Associated with the point bar are a series of arcuate *ridges* and *swales*. The ridges are formed by lateral channel movement and are relic lateral bars separated by low-lying swales. Swales are locations where fine-grained sediments accumulate following original creation. See also *bar and channel topography*, *meander scrolls.*

Terrace – A step-like surface bordering a valley floor or shoreline that represents the former position of a flood plain, lake, or sea shore. The term is usually applied to both the relatively flat summit surface (tread), cut or built by stream or wave action, and the steeper descending slope (scarp, riser), graded to a lower base level of erosion. In this classification it refers to the often multiple terraces beyond the 1- to 3-year floodplain (see *alluvial terrace*).

Thalweg – The longitudinal line connecting the lowest points along the bed of a stream.

Tidal datum – See *national tidal datum epoch*.

Toe slope – The geomorphic component that forms the outermost gently inclined surface at the base of a hillslope.

Topography – The relative positions and elevations of the natural or human-made features of an area that describe the configuration of its surface.

Transition zone (ecosystem) – The interface between the riparian or wetland and adjacent terrestrial ecosystems that is identified by seasonally saturated soils. Soils are briefly saturated only in the spring, if at all, although soil moisture relationships are excellent due to the proximity to riparian or wetland sites. Also called *xeroriparian*.

Typically adapted – Term that refers to a species being normally or commonly suited to a given set of environmental conditions, due to some feature of its morphology, physiology, or reproduction [WAC 173-22-030].

Upland – A general term for a) the higher ground of a region, in contrast with a low-lying, adjacent land such as a valley, plain, or wetland; b) land at a higher elevation than the flood plain or low stream terrace; land above the footslope zone of the hillslope continuum.

Valley – An elongate, relatively large, externally drained depression that is primarily developed by stream erosion or glacial activity.

Valley floor – The lowest surface of a valley that includes landforms such as channels, the floodplain, floodplain steps, and, in some areas, low terrace surfaces.

Valley gradient – The lengthwise slope of the valley floor expressed as a percentage. The following classes are used in this classification:

Very low: <1 percent.
Low: 1 to 3 percent.
Moderate: 4 to 5 percent.
Steep: 6 to 8 percent.
Very steep: >8 percent.

Valley side – The sloping to very steep surfaces between the valley floor and summits of adjacent uplands. Well-defined, steep valley sides have been termed valley walls. Closely related terms are hillslope or mountain slope.

Valley width –The width of the valley floor in feet (meters). The following classes are used in this classification:
Very broad >984 feet (300.1 m).
Broad 328 to 984 feet (100.1 to 300 m).
Moderate 99 to 327 feet (30.1 to 100 m).
Narrow 33 to 98 feet (10 to 30 m).
Very narrow 33 feet (<10 m).

Valley – An elongate, relatively large, externally drained depression of the earth's surface that is primarily developed by stream erosion.

Very long duration flooding – A duration class in which inundation for a single event is greater than one month.

Very long duration – A period of inundation from a single event that is greater than one month.

Very poorly drained – Water is removed so slowly that free water remains at or near the soil surface during most of the growing season.

Water marks – Water marks are discolorations or stains on bark of woody vegetation, rocks, bridge pillars, buildings, fences, or other fixed objects as a result of inundation.

Water-stained leaves – Fallen leaves that have turned dark grayish or blackish in color due to inundation for long periods. Not common in arid areas; found along streams in shrub-dominated or forested habitats. Staining occurs in leaves that are in contact with the soil surface while inundated for long periods. Water-stained leaves maintain their blackish or dark grayish colors when dry. They should contrast strongly with fallen leaves in nearby upland landscape positions.

Wetlands – Areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. Wetlands do not include those artificial wetlands intentionally created from nonwetland sites, including, but not limited to, irrigation and drainage ditches, grass-lined swales, canals, detention facilities, wastewater treatment facilities, farm ponds, and landscape amenities, or those wetlands created after July 1, 1990, that were unintentionally created as a result of the construction of a road, street, or highway. Wetlands may include those artificial wetlands intentionally created from nonwetland areas to mitigate the conversion of wetlands [WAC 173-22-030].

Wrack – Flotsam and other floating debris, e.g., seaweed, plant litter, trash. Often deposited by tides along the daily high tide levels in a “wrack line.”

Xeroriparian plants – Are those found in the upland to wetland intergrades where soils are never saturated but the benefits of limited moisture are present. These may include upland plants that take advantage of greater moisture availability and grow to larger stature, as well as species found in drier riparian environments that cannot tolerate saturated conditions. Compare to mesoriparian and hydroriparian.

Appendix G: Comparison of different OHWM definitions in various statutes and rules

Shoreline Management Act RCW 90.58.030(2)(b) and WAC 173-22-030(5)
"**Ordinary high water mark**" on all lakes, streams, and tidal water is that mark that will be found by examining the bed and banks and ascertaining where the presence and action of waters are so common and usual, and so long continued in all ordinary years, as to mark upon the soil a character distinct from that of the abutting upland, in respect to vegetation as that condition exists on June 1, 1971, as it may naturally change thereafter, or as it may change thereafter in accordance with permits issued by a local government or the department: PROVIDED, That in any area where the ordinary high water mark cannot be found, the ordinary high water mark adjoining salt water shall be the line of mean higher high tide and the ordinary high water mark adjoining fresh water shall be the line of mean high water.

Hydraulic Code Rules WAC 220-110-020(31)
"**Ordinary high water line**" means the mark on the shores of all waters that will be found by examining the bed and banks and ascertaining where the presence and action of waters are so common and usual and so long continued in ordinary years, as to mark upon the soil or vegetation a character distinct from that of the abutting upland: Provided, That in any area where the ordinary high water line cannot be found the ordinary high water line adjoining saltwater shall be the line of mean higher high water and the ordinary high water line adjoining freshwater shall be the elevation of the mean annual flood.

DNR Rules (General) WAC 332-30-106(46)
"**Ordinary high water**" means, for the purpose of asserting state ownership, the line of permanent upland vegetation along the shores of nontidal navigable waters. In the absence of vegetation, it is the line of mean high water.

DNR Forest Practice Rules WAC 222-16-010
"Ordinary high-water mark" means the mark on the shores of all waters, which will be found by examining the beds and banks and ascertaining where the presence and action of waters are so common and usual, and so long continued in all ordinary years, as to mark upon the soil a character distinct from that of the abutting upland, in respect to vegetation: Provided, That in any area where the ordinary high-water mark cannot be found, the ordinary high-water mark adjoining saltwater shall be the line of mean high tide and the ordinary high-water mark adjoining freshwater shall be the line of mean high-water.

Corps of Engineers 33 CFR 329.11(a)(1)
The “ordinary high water mark” on non-tidal rivers is the line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank; shelving; changes in the character of soil; destruction of terrestrial vegetation; the presence of litter and debris; or other appropriate means that consider the characteristics of the surrounding areas.

Appendix H: References and suggested reading

In compliance with RCW 34.05.272, each reference is followed by a bracketed number which indicates the type of the information source. The types of sources are listed below, by number.

1. Peer review is overseen by an independent third party.
2. Review is by staff internal to the Department of Ecology.
3. Review is by persons that are external to and selected by the Department of Ecology.
4. Documented open public review process that is not limited to invited organizations or individuals.
5. Federal and state statutes.
6. Court and hearings board decisions.
7. Federal and state administrative rules and regulations
8. Policy and regulatory documents adopted by local governments.
9. Data from primary research, monitoring activities, or other sources, but that has not been incorporated as part of documents reviewed under other processes.
10. Records of best professional judgment of Department of Ecology employees or other individuals.
11. Sources of information that do not fit into one of the other categories listed.

Arup, U. 1995. Littoral Species of Caloplaca in North America: A Summary and a Key. The Bryologist, Vol. 98, No. 1 (Spring 1995), pp. 129-140. [1]

Auble, G. T., J. M. Friedman, and M. L. Scott. 1994. Relating riparian vegetation to present and future streamflows. Ecological Applications 4:544-554. [1]

Bagstad, K.J, J.C. Stromberg, and S.J. Lite. 2005. Response of herbaceous riparian plants to rain and flooding on the San Pedro River, Arizona, USA. Wetlands 25(1):210-223. [1]

Bahls, P., C. Kindberg, M. Wait, and J. Glasgow. 2006. An assessment of error in state shoreline designation for lakes of Washington. Northwest Watershed Institute and Washington Trout. Available at: http://www.wildfishconservancy.org/ [3]

Bendix, J. 1997. Flood disturbance and the distribution of riparian species diversity. The Geographical Review, 87:468–483. [1]

Bendix, J. 1998. Impact of a flood on southern California riparian vegetation. Physical Geography, 19:162–174. [1]

Bendix, J. and C.R. Hupp. 2000. Hydrological and geomorphological impacts on riparian plant communities. Hydrological Processes 14:2977-2990. [1]

Blom, C.W.P.M. 1999. Adaptations to flooding stress. From plant community to molecule. Plant Biology 1:261-273. [1]

Blom, C.W.P.M., et al. 1994. Physiological ecology of riverside species: adaptive responses of plants to submergence. Annals of Botany 74:253-263. [1]

Blom, C.W.P.M., and L.A.C.J. Voesenek. 1996. Flooding: the survival strategies of plants. Trends in Ecology and Evolution 11:290-295. [1]

Boggs, K. and T. Weaver.1994. Changes in vegetation and nutrient pools during riparian succession. Wetlands 14(3):98-109. [1]

Boulton, A.J., S. Findlay, P. Marmonier, E.H. Stanley, and H.M. Valett. 1998. The functional significance of the hyporheic zone in streams and rivers. Annual Review of Ecology and Systematics 29:59-81. [1]

Burns, R.M., and B. Honkala, tech. coords. 1990. Silvics of North America: Volume 1. Conifers; Volume 2. Hardwoods. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC. vol.2, 877 p. Available at: http://www.na.fs.fed.us/spfo/pubs/silvics_manual/table_of_contents.htm [4]

Castro, J.M., and P.L. Jackson. 2001. Bankfull discharge recurrence intervals and regional hydraulic geometry relationships: patterns in the Pacific Northwest, USA. Journal of the American Water Resources Association 37(5):1249-1262. [1]

Chapin, D.M., R.L. Beschta, and H.W. Shen. 2002. Relationships between flood frequencies and riparian plant communities in the upper Klamath Basin, Oregon. Journal of the American Water Resources Association 38:603-617. [1]

Chapman, R. J., T. M. Hinckley, L. C. Lee, and R. O. Teskey. 1982. Impact of water level changes on woody riparian and wetland communities. Vol. X. Index and Addendum to Volumes I VIII. FWS/OBS 82/23. 111pp. [4]

Church, M. 1992. Channel Morphology and Typology. In The Rivers Handbook Vol 1, edited by P. Calow and G. E. Petts. Oxford: Blackwell Scientific Publications. [1]

Church, M. 2002. Geomorphic thresholds in riverine landscapes. Freshwater Biology 47:541-557. [1]

Cooke, S.S. (ed.). 1997. A Field Guide to the Common Wetland Plants of Western Washington and Northwestern Oregon. Seattle Audubon Society. [1]

Cooper, D.J., D.C. Andersen, and R.A. Chimner. 2003. Multiple pathways for woody plant establishment on floodplains at local to regional scales. Journal of Ecology 91(2):182-196. [1]

Cooper, D.J., et al. 2006. Hydrologic, geomorphic and climatic processes controlling willow establishment in a montane ecosystem. Hydrological Processes 20:1845-1864. [1]

Cordes, L.D., F.M.R.Hughes, and M. Getty. 1997. Factors affecting the regeneration and distribution of riparian woodlands along a northern prairie river: Red Deer River, Alberta, Canada. Journal of Biogeography 24:675-695. [1]

(COSLRCOW) Committee on Sea Level Rise in California, Oregon, and Washington; Board on Earth Sciences and Resources; Ocean Studies Board; Division on Earth and Life Studies;

National Research Council. 2012. Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future. The National Academies Press, Washington, D.C. [1]

Crooks, G. 1974. The Washington Shoreline Management Act of 1971. Washington Law Review 49:423-425. [1]

Davis, M.M., W.A. Mitchell, J.S. Wakeley, J.C. Fischenich, and M.M. Craft. 1996. Environmental value of riparian vegetation. Technical Report EL-96-16, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. [4]

Desloges, J.R. and Church, M. 1989. Wandering gravel-bed rivers. The Canadian Geographer, 33, 4:360-364. [1]

del Tanago, M.G. and D.G. de Jalon. 2006. Attributes for assessing the environmental quality of riparian zones. Limnetica 25(1-2):389-402. [1]

DiTomaso, J.M., and E.A. Healy. 2003. Aquatic and Riparian Weeds of the West. University of California, Agriculture and Natural Resources, Publication 3421. [4]

Dixon, M.D., M.G. Turner, and C. Jin. 2002. Riparian tree seedlings distribution on Wisconsin river sandbars: controls at different spatial scales. Ecological Monographs 72(4):465-485. [1]

Dunne, T., and L.B. Leopold. 1978. Water in environmental planning. San Francisco, CA. W.H. Freeman. [1]

Dykaar, B.B. and D.A. Schrom. 2003. Public ownership of US streambeds and floodplains: a basis for ecological stewardship. BioScience 53(4):2-7. [1]

Ewing, K. 1996. Tolerance of four wetland plant species to flooding and sediment deposition. Environmental and Experimental Botany. 36(2):131-145. [1]

Federal Interagency Stream Restoration Working Group (FISRWG). 1998. Stream Corridor Restoration: Principles, Processes, and Practices. Federal Interagency Stream Restoration Working Group (FISRWG). GPO Item No. 0120-A; SuDocs No. A 57.6/2:EN 3/PT.653. ISBN-0-934213-59-3. http://www.nrcs.usda.gov/technical/stream_restoration/newgra.html. [4]

Federal Register, Vol. 70:170, 52630-52858. [1]

Fetherston, K., R. Naiman, and R. Bilby. 1995. Large woody debris, physical process, and riparian forest development in montane river networks of the Pacific Northwest. Geomorphology 13:133-144. [1]

Finlayson, D. 2006. The geomorphology of Puget Sound beaches. Puget Sound Nearshore Partnership Report No. 2006-02. Published by Washington Sea Grant Program, University of Washington, Seattle, Washington. Available at: http://pugetsoundnearshore.org. [4]

Fischer, R.A., C.O. Martin, J.T. Ratti and J. Guidice. 2001. Riparian terminology: confusion and clarification. U.S. Army Engineer Research and Development Center, Vicksberg, MS. www.wes.army.mil/el/emrrp. ERDC TN-EMRRP-SR-25. [4]

Gage, E.A. and D.J. Cooper. 2004. Constraints on willow seedling survival in a rocky mountain montane floodplain. Wetlands 24(4):908-911. [1]

Gill, C. J. 1970. The flooding tolerance of woody species — A review. Forestry Abstracts 31:671–88. [1]

Gregory, S.V., F.J. Swanson, W.A. McKee, and K.W. Cummins. 1991. An ecosystem perspective of riparian zones. BioScience 41:540-551. [1]

Grimm, N.B. et al. 2003. Merging aquatic and terrestrial perspectives of nutrient biogeochemistry. Oecologia 442:485-501. [1]

Groffman, P.M. et al. 2003. Down by the riverside: urban riparian ecology. Frontiers in Ecology and the Environment 1(6):315-321. [1]

Gurnell, A. et al. 2005. Effects of deposited wood on biocomplexity of river corridors. Frontiers in Ecology and the Environment 3(7):377-382. [1]

Hamann, R., and J. Wade. 1990. Ordinary high water line determination: legal issues. 42 Florida Law Review 323-397. [1]

Hitchcock, C.L., and A. Cronquist. 1973. Flora of the Pacific Northwest. University of Washington Press, Seattle, WA. [1]

Hill, M. T., W. S. Platts, and B. L. Beschta. 1991. Ecological and Geomorphological Concepts for Instream and Out-of-Channel Flow Requirements. Rivers 2:198-210 [1]

Hood, WG. 2006. Depositional Tidal Channel Development 1. Earth Surface processes and Landforms, Wiley Interscience, DOI: 10. 1002/esp. 1381. [1]

Huggenberger, P., E. Hoehn, R. Beschta, and W. Woessner. 1998. Abiotic aspects of channels and floodplains in riparian ecology. Freshwater Biology 40, 407-426. [1]

Integrated Taxonomic Information System (ITIS) (http://www.itis.gov). [4]

Jackson, M.B. and T.D. Colmer. 2005. Response and adaptation by plants to flooding stress. Annals of Botany 96:501-505. [1]

Johannessen, J. and A. MacLennan. 2007. Beaches and bluffs of Puget Sound and the Northern Straits. Puget Sound Nearshore Partnership Report 2007-04. Published by Seattle District, U.S. Army Corps of Engineers, Seattle, Washington. [4]

Johansson, M.E. and C. Nilsson. 2002. Responses of riparian plants to flooding in free-flowing and regulated boreal rivers: an experimental study. Journal of Applied Ecology 39:971-986. [1]

Johnson, S.L. et al. 2000. Riparian forest disturbances by a mountain flood – the influence of floated wood. Hydrological Processes 14:3031-3050. [1]

Johnson, W.C. 2002. Riparian vegetation diversity along regulated rivers: contribution of novel and relict habitats. Freshwater Biology 47:749-759. [1]

Johnston, C.A. 2003. Shrub species as indicators of wetland sedimentation. Wetlands 23(4):911-920. [1]

Kamisako, M. et al. 2006. Does understory vegetation reflect the history of fluvial disturbance in a riparian forest? Ecological Research 22:67-74. [1]

Karrenberg, S. et al. 2002. The life history of *Salicaceae* living in the active zone of floodplains. Freshwater Biology 47:733-748. [1]

Kartesz, J.T. 2009. Floristic Synthesis of North America, Version 1.0. Biota of North America Program (BONAP) (http://www.bonap.org/). [1]

Kauffman, J.B. et al. 1997. An ecological perspective of riparian and stream restoration in the Western United States. Fisheries 22(5):12-24. [1]

Kauffman, J.B., M. Mahrt. L.A. Mahrt & W.D. Edge. 2001. Wildlife of Riparian Habitats. In: D.H. Johnson & T.A. O'Neil (eds), Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis. 361-388. [1]

Kercher, S.M., and J.B. Zedler. 2004. Flood tolerance in wetland angiosperms: a comparison of invasive and noninvasive species. Aquatic Botany 80:89-102. [1]

Klinka, K. et al. 1989. Indicator plants of coastal British Columbia. Vancouver, B.C.: University of British Columbia Press. [1]

Klinkenberg, B. (Editor) 2006. E-Flora BC: Electronic Atlas of the Plants of British Columbia [http://www.eflora.bc.ca]. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver. [4]

Kovalchik, B.L., and R.R. Clausnitzer. 2004. Classification and management of aquatic, riparian, and wetland sites on the national forests of eastern Washington: series description. Gen. Tech. Rep. PNW-GTR-593. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 354 p. http://www.fs.fed.us/pnw/publications/gtr593/ [4]

Kozlowski, T.T. 1984. Plant responses to flooding of soil. BioScience 34(3):162-167. [1]

Kozlowski, T.T. 1997. Responses of woody plants to flooding and salinity. Tree Physiology monograph No. 1. www.heronpublishing.com. [1]

Kozlowski, T.T. 2002. Physiological-ecological impacts of flooding on riparian forest ecosystems. Wetlands 22(3):550-561. [1]

Krasny, M.E., Zasada, J.C., and Vogt, K.A. 1988. Adventitious rooting of four Salicaceae species in response to a flooding event. Canadian Journal of Botany 66:2597-2598. [1]

Lacoul, P., and B. Freedman. 2006. Environmental influences on aquatic plants in freshwater ecosystems. Environmental Review 14:89-136. [1]

Latterell, J. et al. 2006. Dynamic patch mosaics and channel movement in an unconfined river valley of the Olympic Mountains. Freshwater Biology 51:523-544. [1]

Leonard, W. P., H. A. Brown, L. L. C. Jones, K. R. McAllister, and R. M. Storm. 1993. Amphibians of Washington and Oregon. Seattle Audubon Society, Seattle, WA. [1]

Leopold, L.B., Wolman, M.G., 1957. River channel patternsbraided, meandering and straight. U.S. Geolological Survey Professional Paper 282B, 39– 85. [4]

Lewis, L. et al. 2003. Riparian Area Management: Riparian-Wetland Soils. Technical Reference 1737-19. Bureau of Land Management, Denver, CO. BM/ST/ST-03/001 +1737. 109 pp. [4]

Lichvar, R.W., and J.S. Wakeley (eds.). 2004. Review of ordinary high water mark indicators for delineating arid streams in the southwestern United States. US Army Corps of Engineers, Engineer Research and Development Center. Publication ERDC TR-04-1. 138 pages. Available: http://www.crrel.usace.army.mil/techpub/CRREL_Reports/reports/ERDC-TR-04-1.pdf [4]

Lichvar, R.W. et al. 2006. Distribution of ordinary high water mark (OHWM) indicators and their reliability in identifying the limits of "waters of the united states" in arid southwest channels. US Army Corps of Engineers ERDC/CRREL TR-06-5. URL: http://www.crrel.usace.army.mil/techpub/CRREL_Reports/reports/TR06-5.pdf [4]

Lichvar, R.W., W.R. Ochs, and S.M. Gaines. 2008. Evaluation of surface features for delineating the ordinary high water boundary on playas in the arid Western United States. Wetlands 28(1):68-9-80. [1]

Lichvar,R.W., W. Brostoff, and S. Sprecher. 2006. Surficial features associated with ponded water on playas of the arid southwestern United States: indicators for delineating regulated areas under the Clean Water Act. Wetlands 26(2):385-399. [1]

Lichvar, R.W., and S.W. McColley. 2008. A field guide to the identification of the Ordinary High Water Mark (OHWM) in the arid west region of the western United States. US Army Corps of Engineers ERDC/CRREL TR-08-12. [4]

Lytle, D.A. and N.L. Poff. Adaptation to natural flow regimes. Trends in Ecology and Evolution 19(2):94-100. [1]

Maloney, F.E. 1978. The ordinary high water mark: attempts at settling an unsettled boundary line. Land & Water L. Review, University of Wyoming, Volume 13(2):1-35. [1]

Maloney, F.E. and R. Ausness. 1974. The Use and Legal Significance of the Mean High Water Line in Coastal Boundary Mapping. North Carolina Law Review, Vol. 53, No. 2. [1]

Maun, M.A. 1998. Adaptations of plants to burial in coastal sand dunes. Canadian Journal of Botany 76(5):713–738. [1]

McBride, J.R., and J. Strahan. 1984. Establishment and survival of woody riparian species on gravel bars of an intermittent stream. American Midland Naturalist 112(2):235-245. [1]

MGS Engineering Consultants. 2004. Climatic regions for precipitation-frequency study for Western Washington. Supplement to May 2004 Progress Report on Eastern Washington Precipitation-Frequency Study. Olympia, WA. [3]

Middleton, B.A. 2002. The flood pulse concept in wetland restoration. Chapter 1 in: Middleton, BA (ed), Flood pulsing in wetlands: Restoring the natural hydrological balance. John Wiley & Sons, Inc. [1]

Miller, J.F., Frederick, R.H., and Tracey, R.S. 1973. Precipitation-frequency Atlas of the Western United States. NOAA Atlas 2, Volume IX * Washington. U.S. Dept. of Commerce, NOAA National Weather Service, Washington, D.C. [4]

Mitsch, W.J., and J.G. Gosselink. 2000. Wetlands. 3rd edition.Wiley & Sons. [1]

Mofjeld, H.O., et al. 2002. Tidal datum distributions in Puget Sound, Washington, based on a tidal model. NOAA Technical Memorandum OAR PMEL-122. [4]

Mommer, L., et al. 2006. Ecophysiological determinants of plant performance under flooding: a comparative study of seven plant families. Journal of Ecology 94:1117-1129. [1]

Morton R.A. and Speed F.M. 1998. Evaluation of shorelines and legal boundaries controlled by water levels on sandy beaches. Journal of Coastal Research 14:1373–1384. [1]

Mote, P., A. Petersen, S. Reeder, H. Shipman and L.W. Binder. 2008. Sea Level Rise in the Coastal Waters of Washington State. University of Washington Climate Impacts Group and the Washington Department of Ecology, Seattle, WA. [2]

Naiman, R., T.J. Beechie, L.E. Benda, D.R. Berg, L.H. MacDonald, M.D. O'Connor, P.L. Olson, et al. 1992. Fundamental Elements of Ecologically Healthy Watersheds in the Pacific Northwest Coastal Ecoregion. Pages 127-188 in: R.J. Naiman (editor), Watershed Management: Balancing Sustainability with Environmental Change. Springer-Verlag, New York. [1]

Naiman, R.J. and H. Decamps. 1997. The ecology of interfaces: riparian zones. Annual Review of Ecology and Systematics 28:621-58. [1]

Naiman, R.J., H. Decamps, and M. Pollock. 1993. The role of riparian corridors in maintaining regional biodiversity. Ecological Applications 3:209-212. [1]

Naiman, R.J., K.L. Fetherston, S.J. McKay, and J. Chen. 1998. Riparian Forests. Chapter 12 in: Naiman & Bilby (eds): River ecology and management. Lessons learned from the pacific coastal ecoregion. Springer-Verlag, NY. [1]

Naiman, R.J., R.E. Bilby, D.E. Schindler, and J.M. Helfield. 2002. Pacific salmon, nutrients, and the dynamics of freshwater and riparian ecosystems. Ecosystems 5:399-417. [1]

Nanson, G.C., Croke, J.C., 1992. A genetic classification of floodplains. Geomorphology 4, 459–486. [1]

National Research Council. 2002. Riparian Areas: Functions and Strategies for Management. National Academy Press, Washington, D.C. [1]

Natural Heritage Program, Washington State Department of Natural Resources. 2011 Ecological Integrity Assessments, North Pacific Coastal Interdunal Wetland, Version 2.22.2011. Accessed 1-9-2012 http://www1.dnr.wa.gov/nhp/refdesk/communities/pdf/eia/np_interdunal_wetland.pdf. [1]

Nillson, C., and M. Svedmark. 2002. Basic principles and ecological consequences of changing water regimes: riparian plant communities. Environmental Management 30(4):468-480. [1]

Nilsson, C. R. Jansson, and U. Zinko. 1997. Long-term responses of river-margin vegetation to water-level regulation. Science 276:798-800. [1]

Nilsson, C., A. Ekblad, M. Dynesius, S. Backe, M. Gardfjell, B. Carlberg, S. Hellqvist, and R. Jansson, 1994. A comparison of species richness and traits of riparian plants between a main river channel and its tributaries. Journal of Ecology 82, 281–295. [1]

Nilsson, C., G. Grelsson, M. Dynesius, M.E. Johansson, and U. Sperens. 1991. Small rivers behave like large rivers: Effects of postglacial history on plant species richness along riverbanks. Journal of Biogeography. 18(5):533-541. [1]

O'Connell, J. 2005. Documenting short-term variability of beach reference features using a volunteer beach & dune profiling program in Massachusetts. Proceedings of the 14th Biennial Coastal Zone Conference, New Orleans, Louisiana. [1]

Pabst, J., and T.A. Spies. 1998. Distribution of herbs and shrubs in relation to landform and canopy cover in riparian forests of coastal Oregon. Canadian Journal of Botany 76:298-315. [1]

Parker, K., and J. Bendix. 1996. Landscape-scale geomorphic influences on vegetation patterns in four environments. Physical Geography 17(2):113-141. [1]

Penttila, D. 2007. Marine Forage Fishes in Puget Sound. Puget Sound Nearshore Partnership Report No. 2007-03. Published by Seattle District, U.W. Army Corps of Engineers, Seattle, Washington. [4]

Poff, N.L., et al. 1997. The natural flow regime. A paradigm for river conservation and restoration. BioScience 47(11):769-784. [1]

Pojar, J., and A. MacKinnon. 1994. Plants of the Pacific Northwest Coast. Lone Pine Press. [1]

Pollock, M.M., R.J. Naiman, and T.A. Hanley. 1998. Plant species richness in riparian wetlands – a test of biodiversity theory. Ecology 79(1):94-105. [1]

Postel, S. and B. Richter. 2003. Rivers for Life. Managing Water for People and Nature. Island Press. [1]

Pringle, C. 2003. What is hydrologic connectivity and why is it ecologically important? Hydrological Processes 17:2685-2689. [1]

RCW 90.58.030. Shoreline Management Act of 1971. [2]

Renöfält, B. M., D. M. Merritt, and C. Nilsson. 2007. Connecting variation in vegetation and stream flow: the role of geomorphic context in vegetation response to large floods along boreal rivers. Journal of Applied Ecology 44:147-157. [1]

Riis, T., and B.J.F. Biggs. 2003. Hydrologic and hydraulic control of macrophyte establishment and performance in streams. Limnology and Oceanography 48:1488-1497. [1]

Riis, T. and I. Hawes. 2003. Effect of wave exposure on vegetation abundance, richness and depth distribution of shallow water plants in a New Zealand Lake. Freshwater Biology 48(1):75-87. [1]

Riis, T., and K. Sand-Jensen. 2006. Dispersal of plant fragments in small streams. Freshwater Biology 51(2):274-286. [1]

Rood, S.B. et al. 2003. Flows for floodplain forests: a successful riparian restoration. BioScience 53:647–656. [1]

Rood, S.B., J.H. Braatne, and F.M.R. Hughes. 2003. Ecophysiology of riparian cottonwoods: stream flow dependency, water relations and restoration. Tree Physiology 23:1113-1124. [1]

Rosen, J., 1977. Increasing shoreline erosion rates with decreasing tidal range in the Virginia Chesapeake Bay: Chesapeake Science, v. 18, p. 383-386. [1]

Ruggiero et al. 2003. Linking proxy-based and datum-based shorelines on a high-energy coastline: implications for shoreline change analyses. Journal of Coastal Research, special issue 38, pp. 57-82. [1]

Schaefer, M.G. 1989. Characteristics of extreme precipitation events in Washington State. Washington State Department of Ecology, publication #89-51. [2]

Scott, M.L., J.M. Friedman, and G.T. Auble. 1996. Fluvial process and the establishment of bottomland trees. Geomorphology 14(4):327-339. [1]

Scott, M.L., et al. 1997. Flood dependency of cottonwood establishment along the Missouri river, Montana, USA. Ecological Applications 7(2):677-690. [1]

Sigafoos, R.S. 1964. Botanical evidence of floods and floodplain deposition. Professional Paper 485-A. Washington, DC: U.S. Geological Society. [4]

Stallins, J.A. 2004. Geomorphology and ecology: unifying themes for complex systems in biogeomorphology. Geomorphology 77:207-216. [1]

Stanford, J. A. and J. V. Ward. 1993. An ecosystem perspective of alluvial rivers: connectivity and the hyporheic corridor. Journal of the North American Benthological Society 12:48-60. [1]

Steiger, J., et al. 2005. Hydrogeomorphic processes affecting riparian habitat within alluvial channel–floodplain river systems: a review for the temperate zone. River Research and Applications 21:719-737. [1]

Stromberg, J.C., J. Fry, and D.T. Patten. 1997. Marsh development after large floods in an alluvial, arid-land river. Wetlands 17:292-300. [1]

Sumioka, S.S., D.L. Kresch, and K.D. Kasnick. 1997. Magnitude and Frequency of Floods in Washington. U.S. Geological Survey, Water-Investigations Report 97-4277, Tacoma, WA. Available at http://wa.water.usgs.gov/pubs/wrir/flood_freq/. [4]

Tabacchi, E., et al. 1998. Development, maintenance and role of riparian vegetation in the river landscape. Freshwater Biology 40:497-516. [1]

Tabacchi, E., et al. 2000. Impacts of riparian vegetation on hydrological processes. Hydrological Processes 14:2959-2976. [1]

Tang, A.W. and D.R. Montgomery. 1995. Riparian buffers and potentially unstable ground. Environmental Management 19:741-749. [1]

Tang, Z.C., and T.T. Kozlowski. 1982. Some physiological and growth responses of *Betula papyrifera* seedlings to flooding. Physiologia Plantarum 55(4):415–420. [1]

Teskey, R.O. and T.M. Hinckley. 1977. Impact of water level changes on woody riparian and wetland communities. Vol. I. Plant and Soil Responses. FWS/OBS 77/58. 30 pp. [4]

Tiner, R. 1991. The concept of a hydrophyte for wetland identification. Bioscience 41(4):236-246. [1]

Trush, B. and S. McBain. 2000. Alluvial River Ecosystem Attributes. Stream Notes. Stream Systems Technology Center. Fort Collins, Colorado. [11]

U.S. Army Corps of Engineers. 2008. Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Arid West Region (Version 2.0), J.S. Wakeley, R.W. Lichvar, and C.V. Noble, eds.,Technical Report, U.S. Army Engineer Research and Development Center, Vicksburg, MS. [4]

U.S. Army Corps of Engineers. 2010. Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region (Version 2.0), J.S. Wakeley, R.W. Lichvar, and C.V. Noble, eds.,Technical Report, U.S. Army Engineer Research and Development Center, Vicksburg, MS. [4]

U.S. Army Corps of Engineers. 2014. Natonal Wetland Plant List. (http://rsgisias.crrel.usace.army.mil/NWPL/, August 8, 2014). [4]

USDA, NRCS. 2009. The PLANTS Database (http://www.plants.usda.gov, 29 August 2009). National Plant Data Center, Baton Rouge, LA. [4]

van der Nat, D., et al. 2002. Inundation dynamics in braided floodplains: Tagliamento River, northeast Italy. Ecosystems 5:636-647. [1]

van Eck, W.H.J.M., J.P.M. Lenssen, H.M. van de Steeg, C.W.P.M. Blom, and H. de Kroon. 2006. Seasonal dependent effects of flooding on plant species survival and zonation: a comparative study of 10 terrestrial grassland species. Hydrobiologia 565:59-69. [1]

Vannote, R. L., G. W. Minshall, K.W. Cummins, J.R. Sedell, and C.E. Cushing. 1980. The river continuum concept. Canadian Journal of Fisheries and Aquatic Sciences 37:130–37. [1]

Viers, J.H. et al. 2004. Geomorphic confinement as a predictor of riparian extent and vegetation composition. AWRA Summer Specialty Conference, Olympic Valley, CA. June 28-30, 2004. [11]

Visser, E.J.W., et al. 2000. Flooding tolerance of *Carex* species in relation to field distribution and arenchyma formation. New Phytologist 148:93-103. [1]

Walls, R.L., D.H. Wardrop, and R.P. Brooks. 2005. The impact of experimental sedimentation and flooding on the growth and germination of floodplain trees. Plant Ecology 176:203-213. [1]

Walters, M.A., R.O. Teskey, and T.M. Hinkley. 1980. Impact of water level changes on woody riparian and wetland communities. Volume VIII: Pacific Northwest and Rocky Mountain Regions. Biological Services Program, US Fish & Wildlife Service FWS/OBS-78/94. 54 pp. [4]

Ward, J.V. 1989. The four dimensional nature of lotic ecosystems. Journal of the North American Benthological Society 8:2-8. [1]

Ward, J.V. 1998. Riverine landscapes: biodiversity patterns, disturbance regimes, and aquatic conservation. Biological Conservation 83:269–278. [1]

Ward, J.V., G. Bretschko, et al. 1998. The boundaries of river systems: the metazoan perspective. Freshwater Biology 40:531-569. [1]

Ward, J.V, K. Tockner, B. Arscott, and C. Claret. 2002. Riverine landscape diversity. Freshwater Biology 47:517-539. [1]

Washington State Department of Ecology. 2010. Shoreline Master Program (SMP) Handbook. Available at: http://www.ecy.wa.gov/programs/sea/shorelines/smp/handbook/index.html [2]

Watershed Company, The. 2004. Lake Sammamish Ordinary High Water Mark Study, Final Report to the City of Bellevue, Planning and Community Development Department. [11]

Werner, K., and J.B. Zedler. 2002. How sedge meadow soils, microtopography, and vegetation respond to sedimentation. Wetlands 22(3):451-466. [1]

Whitlow, T. H., and R. W. Harris. 1979. Flood Tolerance in Plants: A State-of-the-Art Review. National Technical Information Service, U.S. Dept. of Commerce August:1-161. [4]

Wiedemann, A. 1984. The Ecology of Pacific Northwest Sand Dunes: A Community Profile. US Fish & Wildlife Service, FWS/OBS-84/04. 130 pp. [1]

Wiggington, P.J., et al. 2006. Coho salmon dependence on intermittent streams. Frontiers in Ecology and the Environment 4(10):513-518. [1]

Williams, D.G., R.L. Scott, et al. 2006. Sensitivity of riparian ecosystems in arid and semiarid environments to moisture pulses. Hydrological Processes 20:3191-3205. [1]

Williams, G.P. 1978. Bank-Full Discharge of Rivers. Water Resources Research 14(6):1141-1154. [1]

Wissmar, R.C. 2004. Riparian corridors of Eastern Oregon and Washington: Functions and sustainability along lowland-arid to mountain gradients. Aquatic Science 66:373-387. [1]

Wolcott, E.E. 1973. Lakes of Washington. Volume I, Western Washington, and Volume II, Eastern Washington. Water Supply Bulletin No. 14, State Water Program, Washington State Department of Ecology, Olympia, WA. [2]

Ziemer, R.R. and T.E. Lisle. 1998. Hydrology. Chapter 3, pages 43-68, *in:* Naiman, Robert J., and Robert E. Bilby, eds. River Ecology and Management: Lessons from the Pacific Coastal Ecoregion. Springer-Verlag, N.Y. [1]