WASHINGTON NATURAL HERITAGE PROGRAM

Ecological Systems of Washington State. A Guide to Identification

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October 19, 2015

Natural Heritage
Report 2015-04

WASHINGTON STATE DEPARTMENT OF
Natural Resources

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Cover Photos: All photos by Joe Rocchio.
Left column (top to bottom: Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest; Inter-Mountain Basins Alkaline Closed Depression, North Pacific Hypermaritime Shrub and Herbaceous Headland, North Pacific Maritime Mesic-Wet Douglas-Fir Western Hemlock Forest)
Right column (top to bottom: North Pacific Maritime Coastal Sand Dune and Strand; Rocky Mountain Subalpine-Montane Riparian Woodland)

ACKNOWLEDGEMENTS

Development of this guide was initiated in 2008 and a draft version was made available on the Washington Department of Natural Resources, Natural Heritage Program's website. Since then, we have received feedback and suggested edits from Steve Acker, Paul Adamus, Jeff Azzerad, Chris Chappell, Richard Easterly, Jim Evans, Ryan Haugo, Tom Hruby, Gwen Kittel, Jennifer Miller, Steve Rust, and Debra Salstrom. We appreciate their assistance in making this final version a more useful document.

We appreciate the efforts of Dave Hays (Washington Department of Fish and Wildlife) for securing funding to update and finalize this guide.

Unless otherwise noted, all photographs in the document were taken by Joe Rocchio.

TABLE OF CONTENTS

Introduction

Ecosystem classification is used to summarize complex ecological patterns using a limited number of units. Classification provides a framework for systematic and transparent communication about ecological diversity. Classification frameworks are developed to address specific needs and objectives. Consequently, the specific factors used to develop a classification scheme will vary according to the desired uses of the classification.

One of the primary objectives of the Washington Natural Heritage Program (WNHP) is to maintain a classification and inventory of Washington's natural heritage resources and prioritize them for conservation action. To achieve this, a coarse filter/fine filter approach is used to account for the different components to biodiversity. The coarse filter consists of all of the ecosystems (both terrestrial and aquatic) occurring within Washington. The fine filter consists of rare species and rare ecosystems that may not be adequately protected by using only the coarse filter. The basic assumption of this approach is that by ensuring the conservation of ecosystem types, the conservation of the common species associated with those types can be achieved in an efficient manner. The success of the coarse filter approach is having a well-developed ecosystem classification. Species and ecosystems that are rare or have very limited distributions warrant their own specific conservation efforts.

WNHP primarily uses two classification schemes to classify Washington's ecosystems and vegetation types: (1) Ecological Systems and (2) U.S. National Vegetation Classification (USNVC). The Ecological Systems classification is primarily used to represent a coarse-filter for biodiversity conservation, management plans and ecosystem mapping at a mid-scale (between ecoregions and plant communities). WNHP uses the USNVC to represent a fine-scale, ecosystem filter (i.e., Associations) for biodiversity conservation, management plans and vegetation mapping at fine-scales.

This guide focuses on the Ecological System classification and is intended to provide a tool to identify all the Ecological Systems which occur in Washington. We anticipate this guide to be useful for natural resource professionals, such as wildlife biologists, botanists, ecologists, land managers, land use planners, etc., or interested citizens with a need or desire to learn more about the ecological diversity found across the State's landscapes. The guide can be used for field-based, site specific work where knowledge of ecosystem types can help natural resource professionals make ecologically informed decisions and inferences. In addition, NatureServe has developed a map of Ecological Systems of the United States (Sayre et al. 2009). That map can be (and has been) used for various coarse-scale planning and modelling efforts. This guide will help users better understand the units depicted in that map.

Dichotomous keys and brief descriptions are included to assist in identification of the different Ecological Systems which occur in Washington.

Background information about ecosystems classification used by the Washington Natural Heritage Program and an overview of the structure and content of the keys and descriptions are provided below.

CLASSIFICATIONS USED BY THE WASHINGTON NATURAL HERITAGE PROGRAM

Ecosystem classification is used to recognize and describe repeating assemblages of species in similar habitats. Classification of these repeating assemblages can be based on site-level to regional-scale comparisons. The two primary ecological classification schemes used by the Washington Natural Heritage Program (WNHP) are (1) Ecological Systems Classification (Comer et al. 2003) and (2) U.S. National Vegetation Classification (USNVC; FGDC 2008). To date, the Ecological Systems classification has been used primarily for large-scale conservation planning and as a means to communicate the regional diversity of ecosystems. The USNVC has been used as the primary measure of ecological diversity in the State. USNVC units (primarily Associations) have historically been the focus of WNHP's conservation prioritization efforts. However, both classifications schemes offer a complementary approach for describing Washington's ecological diversity. Each classification framework is discussed in more detail below.

ECOLOGICAL SYSTEMS CLASSIFICATION

The Ecological Systems classification was developed by NatureServe to provide a mid-scale ecological classification, for uplands and wetlands, useful for conservation and environmental planning (Comer et al. 2003). Ecological Systems represent recurring groups of terrestrial plant communities that are found in similar climatic and physical environments and are influenced by similar dynamic ecological processes, such as fire or flooding, share similar substrates, and/or environmental gradients (Comer et al. 2003). Ecological systems include natural to semi-natural vegetation. Natural to semi-natural vegetation has a species composition primarily determined by nonhuman ecological processes (Faber-Langendoen et al. 2014). Cultural vegetation is primarily a response to human intervention and is not included in this guide. Nomenclature for Ecological System is based on three components: regional distribution (e.g. North Pacific), environmental characteristics (e.g. Mesic), and vegetation physiognomy and composition (e.g. Western Hemlock-Silver Fir Forest). The Ecological System name for this example is: North Pacific Mesic Western-Silver Fir Hemlock Forest.

Both temporal and spatial scales are used to define ecological system types. Temporal variability in biotic composition is accounted for by including early-, mid-, and later-seral vegetation (i.e. plant associations) into one classification unit, assuming succession progresses within a 50 year time frame. Ecological Systems occur at a spatial scale ranging from a few to 1000s of hectares and persist for more than 50 years. The spatial pattern in which each Ecological System occurs on the landscape can be described using four spatial categories:

(1) Matrix: contiguous cover ranging from 2,000 to 10,000 hectares; occur on the most extensive landforms and typically have wide ecological tolerances;
(2) Large patch: large areas of interrupted cover ranging from 50 to 2,000 hectares and have narrower range of ecological tolerance;
(3) Small patch: small, discrete areas ranging from 1-50 ha and limited in distribution by localized ecological processes;
(4) Linear: occur as linear strips ranging in distance from 0.5 to 100 km; often ecotonal between terrestrial and aquatic ecosystems.

These spatial patterns are hierarchical in that the large patch, small patch, and linear Ecological Systems are, in a natural landscape, nested within a matrix Ecological System. This does not imply that each occurrence of a matrix Ecological System will have a finer-scale type within it, but smaller patch types will always occur within or adjacent to larger-scale patch types.

The Ecological Systems classification describes over 800 upland and wetland ecological system types found in the United States, and in adjacent portions of Mexico and Canada. Ecological Systems facilitate mapping at meso-scales (1:24,000 – 1:100,000; Comer et al. 2003). Terrestrial ecological systems have formed the basis for map legends on national mapping efforts, including the inter-agency LANDFIRE (http://www.landfire.gov/) and Gap Analysis Program efforts (http://gapanalysis.usgs.gov/gap-analysis/). The results of these large-scale mapping projects have been combined into a map of ecological systems for the United States (Sayre et al. 2009). The Washington portion of the map can be viewed on Landscope (http://www.landscope.org/washington/ecosystems/). Due to the scale of the mapping, many small patch systems are either underrepresented or not included in the map.

The original concepts for the Ecological Systems presented in this guide were developed by the Natural Heritage Network/NatureServe. The Washington Natural Heritage Program provided specific input on types that are restricted or predominantly found in Washington. Descriptions for each Ecological System available on NatureServe Explorer (http://www.natureserve.org/explorer/) were modified by DNR-Natural Heritage ecologists to provide additional detail specific to their occurrence in Washington.

U.S. National Vegetation Classification

The U.S. National Vegetation Classification (USNVC), supported by the Federal Geographic Data Committee (FGDC 2008), NatureServe (Faber-Langendoen et al. 2009), and the Ecological Society of America (Jennings et al. 2009) is a hierarchical classification that integrates biogeography, bioclimatology, and land cover data that allows for interpretation of vegetation patterns at all scales. The USNVC provides a common language for the effective management and conservation of plant communities in the United States. The classification standard (FGDC 2008) was developed over many years by the FGDC Vegetation Subcommittee, with members from a diversity of federal agencies, the Vegetation Panel of the Ecological Society of America, and NatureServe (http://usnvc.org/overview/). The intent of the USNVC is to allow federal agencies to produce uniform statistics about vegetation resources across the nation, facilitate interagency cooperation on vegetation management issues that transcend jurisdictional boundaries, and encourage non-Federal partners to utilize and contribute to a common system when working with their Federal partners.

The USNVC is an application of EcoVeg, a physiognomic-floristic-ecological classification approach applied to existing vegetation (Faber-Langendoen et al. 2014). The USNVC is based on vegetation criteria such as physiognomy (growth form, structure) and floristics (species compositional similarity) as related to ecological characteristics such as site factors, disturbance, bioclimate, and biogeography. The USNVC is a hierarchical system and consists of eight levels. The three upper levels are based primarily on the relation between global-scale vegetation patterns and macroclimate, hydrology, and substrate. The middle three levels represent regional floristic-physiognomic types related to meso-scale biogeographic, climatic, disturbance, and site factors.

The two lower levels reflect detailed floristic similarities related to local to regional topo-edaphic and disturbance gradients (Faber-Langendoen et al. 2014).

The Association is the finest unit of the USNVC. The Association is defined on the basis of a characteristic range of species composition, diagnostic species occurrence, habitat conditions and physiognomy (Jennings et al. 2002). Associations reflect topo-edaphic climate, substrates, hydrology, and disturbance regimes.

WNHP plays a key role in the identification and development of Associations for Washington State. WNHP ecologists accomplish this through synthesis of various vegetation classification efforts conducted within or applicable to Washington as well as collecting and analyzing vegetation plot data. WNHP maintains a statewide database of plant associations and works with NatureServe to integrate these concepts into the USNVC.

Relationship between the USNVC and Ecological Systems Classifications

Ecological Systems and the USNVC Groups are very similar in concept and spatial scale. However, they differ in a few ways: (1) Ecological Systems are not part of a hierarchical system and (2) Ecological Systems often emphasize abiotic factors over biotic factors such as physiognomy (i.e, various physiognomic units could be lumped into a single Ecological System while in the USNVC they are split at the uppermost level of the classification). Thus, although USNVC Groups are roughly equivalent to Ecological Systems, sometimes one or the other is more coarsely defined. And, Associations (e.g. the finest level of the USNVC), despite being restricted to a single USNVC Group, are often associated with multiple Ecological Systems. The related USNVC Groups and Associations for each Ecological System are listed within the System descriptions provided in this guide. Appendix A provides the reverse cross-walk and shows Ecological Systems nested within each USNVC Group.

Ecological Systems facilitate mapping at meso-scales (1:24,000 – 1:100,000) and addressed one of the short-comings of the 1997 USNVC (FGDC 1997)--that vegetation types were not spatially cohesive concepts and thus limiting for mapping objectives. However, the 2008 revision of the USNVC (FGDC 2008) resulted in more explicit aggregation of vegetation relative to ecological drivers in the mid- to lower level units. The result is that USNVC Groups are now conceptually and spatially roughly equivalent to Ecological Systems. As such, USNVC Groups are conducive for mapping than units associated with the 1997 USNVC. In fact, during their upcoming revision to the Ecological Systems national map, LANDFIRE will also be produce a national map of USNVC Groups. That mapping effort will begin sometime in 2016 (Don Faber-Langendoen, personal communication).

Why Use the Ecological Systems Classification?

Classification frameworks are developed to address specific needs. Users should choose a classification scheme with assumptions, criteria, and scale that best fit the needs of a given objective. Below are examples of how WNHP employs both the Ecological Systems and USNVC classification. These examples may help readers assess whether the Ecological Systems classification is best suited for their particular objective.

In general, WNHP uses Ecological Systems for large-scale objectives and the USNVC to address fine-scale objectives. Specifically, WNHP uses the Ecological Systems classification to provide a framework and common language to:

- Represent a coarse-filter for biodiversity conservation and/or management plans at a mid-scale classification -between ecoregions and associations;
- Map existing vegetation at the coarse scale, which can provide the foundation for various GIS models. The availability of wall-to-wall map of Ecological Systems allows the classification framework to be used for a variety of modeling applications. For example, species distribution modeling, landscape integrity assessments, habitat loss models, etc.;
- Promote study and appreciation of native ecosystems in Washington. Ecological Systems are often a more intuitive concept for the nonspecialist to grasp compared to the USNVC.

In contrast, WNHP uses the USNVC to provide a framework and common language to:

- Represent a fine-scale, ecosystem filter (i.e., Associations) for biodiversity conservation and/or management plans;
- Map existing vegetation at fine (i.e. Associations) to very coarse (Formations Class), which can provide the foundation for various conservation and management objectives, ecological monitoring, and scientific research;

Once a wall-to-wall map for USNVC Groups is available (as noted above), many of the advantages of the Ecological Systems classification (relative to USNVC Groups) will be negated. However, Ecological Systems may still provide a more intuitive concept for communication with decision makers and the public. In addition, many of WNHP's partners use Ecological Systems for their conservation planning efforts. For example, the Washington Department of Fish and Wildlife has incorporated Ecological Systems into their Statewide Wildlife Action Plan and a Habitat Conservation Plan.

Prioritizing Ecosystem Conservation

Information about the rarity or potential risk of elimination or extirpation of ecosystems can help prioritize and guide conservation and/or management actions toward those ecosystems that are of most concern. Since the early 1980s, the NatureServe/Natural Heritage Network has conducted conservation assessments of species and ecosystems to help prioritize conservation actions (Master et al. 2012). The outcome of those assessments is a **conservation status rank** which indicates the rarity and risk of extinction (species) or elimination (ecosystems) of the elements of biodiversity and is an integral part of Natural Heritage Methodology (Master et al. 2012, Faber-Langendoen et al. 2012). This method is summarized in Master et al. (2012) and Faber-Langendoen et al. (2012). Additionally, NatureServe developed a Rank Calculator that automates much of the ranking process: http://www.natureserve.org/conservation-tools/conservation-rank-calculator.

The conservation status of a species or ecosystem is designated by a number from 1 to 5, preceded by a letter reflecting the appropriate geographic scale of the assessment (G = Global and S = State or Subnational). The Global rank characterizes the relative rarity or endangerment of the element across its entire global range whereas the Subnational rank characterizes the relative rarity or endangerment within a subnational unit (in our case, the State of Washington.)

The conservation status ranks have the following meaning:

- **G1 or S1 = Critically Imperiled.** At very high risk of extirpation Globally (G) or in Washington (S) due to a very restricted range, very few occurrences, very steep declines, severe threats, or other factors.
- **G2 or S2 = Imperiled**. At high risk of extirpation Globally (G) or in Washington (S) due to restricted range, few occurrences, steep declines, severe threats, or other factors.
- **G3 or S3 = Vulnerable.** At moderate risk of extirpation Globally (G) or in Washington (S) due to a fairly restricted range, relatively few occurrences, recent and widespread declines, threats, or other factors.
- **G4 or S4 = Apparently Secure.** At a fairly low risk of extirpation Globally (G) or in Washington (S) due to an extensive range and/or many occurrences but with possible cause for some concern as a result of local recent declines, threats, or other factors.
- **G5 or S5 = Secure.** At very low or no risk of extirpation Globally (G) or in Washington (S) due to a very extensive range, abundant occurrences, with little to no concern from declines or threats.
- **GU or SU = Unrankable.** Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.
- **GH or SH = Possibly Extirpated.** Known from only historical records (either Globally or in Washington) but still with some hope of rediscovery. There is evidence that the species or ecosystem may no longer be present in the jurisdiction, but not enough to state this with certainty. Examples of such evidence include (1) that a species has not been documented in approximately 20-40 years despite some searching and/or some evidence of significant habitat loss or degradation; (2) that a species or ecosystem has been searched for unsuccessfully, but not thoroughly enough to presume that it is no longer present in the jurisdiction.
- **GNR or SNR = Unranked.** Sufficient time and effort have not yet been devoted to ranking this taxon.
- **GNA or SNA = Not Applicable.** A conservation status rank is not applicable because the species or ecosystem is not a suitable target for conservation activities.
- **GX or SX = Presumed Extinct.** Species or ecosystem is believed to be extirpated Globally (G) or in Washington (S). Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.
- **G? or S? = Inexact Numeric Rank.** Denotes inexact numeric rank; this should not be used with any of the Variant National or Subnational Conservation Status Ranks, or NX, SX, NH, or SH.
- **G#G# or S#S# = Range Rank.** Numeric range rank (e.g., S2S3 or S1S3) is used to indicate any range of uncertainty about the status of the species or ecosystem. Ranges cannot skip more than two ranks (e.g., SU is used rather than S1S4).

A G1 rank indicates critical imperilment on a global basis; the species (or ecosystem) is at great risk of extinction. S1 indicates critical imperilment within a particular state or province, regardless of its status elsewhere. Conversely, a G5 or S5 indicates that an element is secure, widespread, and abundant throughout its global or state range.

Uncertainty in the Conservation Status Rank is expressed as a Range Rank. For example, S2S3 indicates a range of uncertainty such that there is a roughly equal chance of it being a S2 or S3 and that other ranks are less likely. Range ranks can span three ranks, e.g., S2S4, meaning that the appropriate rank is somewhere between S2 and S4. A rank of SU indicates that a rank is unable to be assigned due to a lack of information or due to conflicting information about status or trends. When the taxonomic distinctiveness of an element is questionable, it is given a modifier of "Q" in combination with a standard numerical S rank. For example S3Q, indicates that the element is considered vulnerable within Washington but that there is uncertainty about the taxonomic status of the element.

Global ranks are assigned through a collaborative process involving both NatureServe and individual Natural Heritage Program scientists. Subnational ranks are assigned by state or provincial scientists with the proviso that the subnational rank cannot be rarer than indicated by the global rank. WNHP scientists have responsibility for assigning Washington's State ranks. A number of factors, such as the total range, the number of occurrences, severity of threats, and resilience contribute to the assignment of global and state ranks. Natural Heritage scientists apply their field experience along with herbarium records, plot data, and published research to assign a G/S rank.

With funding from the Washington Department of Fish and Wildlife, the Washington Department of Natural Resources Natural Heritage Program (WNHP) used the Conservation Status Rank calculator to systematically rank rarity/risk of Washington's Ecological Systems (Rocchio and Crawford 2015). WNHP has assessed the conservation status rank of most of the USNVC Associations which occur in the State.

Using This Guide

The purpose of this document is to provide the user a tool to identify and understand all the Ecological Systems which occur in the State of Washington. This guide provides dichotomous keys and brief descriptions of each Ecological System to assist in identification both on the ground and for remote mapping objectives. It is suggested users start with the keys and then use the Ecological Systems descriptions as confirmation that the correct Ecological System has been identified. The template for the descriptions is found below.

Concept: The section provides a succinct characterization of the Ecological System.

Conservation Status: The State Conservation Status Rank, as assigned by Rocchio and Crawford (2015). Additional details explaining the Rank are sometimes provided.

Distribution: The global range and distribution within Washington State are noted. A Washington distribution map is also included. Ecoregions used by the Washington Natural Heritage Program are depicted in each map. The Ecological Systems map (Sayre et al. 2009) provides the foundation for most of the distribution maps presented in this report. However, other resources (e.g., National Wetland Inventory maps, WNHP inventory data, etc.) are sometimes used.

Environment: The specific environmental characteristics or site factors associated with the Ecological System are noted. These include climate, topographic positions, hydrology, and substrate, etc.

Vegetation: Vegetation patterns are discussed and diagnostic and dominant species are listed.

USNVC Associated Types: The U.S. National Vegetation Classification Groups and Associations are listed in the following table format. Global/State Rank = Global/ State Conservation Status Rank while NatureServe/WNHP Code is the unique identifier assigned to the Association.

USNVC Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
USNVC Association	G/S	XXXX

Ecological Processes: The primary ecological drivers that are diagnostic and which determine vegetation patterns are described.

Threats: Significant threats to the ecological integrity of the Ecological System are discussed.

Classification Comments: Diagnostic classification criteria that distinguish the Ecological System from similar types are discussed.

Related Concepts: Relationships of the Ecological System to habitat/ecological types identified by other regional classification schemes are identified. Wildlife habitat types identified in Johnson and O'Neil (2001) are specifically discussed given their regional use for wildlife habitat applications.

References: Literature and other sources cited in the System description are listed.

Description Author: The individual(s) with a primary role in developing the Ecological System concept and/or description are listed. DNR-Natural Heritage ecologists (Joe Rocchio and Rex Crawford) are listed first if they provided additional, Washington-specific details for this guide.

REFERENCES

Comer, P., D. Faber-Langendoen, R. Evans, S. Gawler, C. Josse, G. Kittel, S. Menard, M. Pyne, M. Reid, K. Schulz, K. Snow, and J. Teague. 2003. Ecological Systems of the United States: A Working Classification of U.S. Terrestrial Systems. NatureServe, Arlington, VA.

Federal Geographic Data Committee. 1997. National Vegetation Classification Standard, FGDC-STD-005. Vegetation Subcommittee, Federal Geographic Data Committee. FGDC Secretariat, U.S. Geological Survey. Reston, VA.

Federal Geographic Data Committee. 2008. National Vegetation Classification Standard, Version 2. FGDC-STD-005-2008. Vegetation Subcommittee, Federal Geographic Data Committee. FGDC Secretariat, U.S. Geological Survey. Reston, VA.

Faber-Langendoen, D., D.L. Tart, and R.H. Crawford. 2009. Contours of the revised U.S. National Vegetation Classification standard. Bulletin of the Ecological Society of America 90:87-93.

Faber-Langendoen, D., J. Nichols, L. Master, K. Snow, A. Tomaino, R. Bittman, G. Hammerson, B. Heidel, L. Ramsay, A. Teucher, and B. Young. 2012. NatureServe Conservation Status Ranking System: Methodology for Rank Assignment. NatureServe, Arlington, VA. Online: http://www.natureserve.org/sites/default/files/publications/files/natureserveconservationstatusmethodology_jun12_0.pdf

Faber-Langendoen, D., T. Keeler-Wolfe, D. Meidinger, D. Tart, B. Hoagland, C. Josse, G. Navarro, S. Ponomarenko, J.P. Saucier, A. Weakley, and P. Comer. 2014. EcoVeg: a new approach to vegetation description and classification. Ecological Monographs 84 (4) pp. 533-561.

Jennings, M.D., D. O.L. Loucks, D.C. Glenn-Lewin, R.K. Peet, Faber-Langendoen, D.H. Grossman, A. Damman, M.G. Barbour, R. Pfister, M. Walker, S.S. Talbot, J. Walker, G.S, Hartshorn, G. Waggoner, M.D. Abrams, A. Hill, M. Rejmanek, D. Roberts, and D. Tart. 2002. Standards for Associations and Alliances of the U.S. National Vegetation Classification, Version 1.0. Ecological Society of America, Vegetation Classification Panel. Washington DC.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Master, L. L., D. Faber-Langendoen, R. Bittman, G. A. Hammerson, B. Heidel, L. Ramsay, K. Snow, A. Teucher, and A. Tomaino. 2012. NatureServe Conservation Status Factors. NatureServe, Arlington, Virginia, U.S.A. Online: http://www.natureserve.org/sites/default/files/publications/files/natureserveconservationstatusfactors_apr12_1.pdf

Regan, T.J., L.L. Master, and G. Hammerson. 2004. Capturing expert knowledge for threatened species assessments: a case study using NatureServe conservation status ranks. Acta Oecologica 26: 95-107.

Rocchio, F.J. and R.C. Crawford. 2015. Conservation Status Ranks of Washington's Ecological Systems. Prepared for Washington Department of Fish and Wildlife. Washington Department of Natural Resources, Natural Heritage Program. Natural Heritage Report 2015-03. Olympia, WA.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

KEY TO WASHINGTON'S ECOLOGICAL SYSTEMS

The following keys are intended to help in the identification of Ecological Systems that occur within the State of Washington[1]. The keys are "dichotomous," which means the user makes a choice between the two options presented in a couplet. The ordering of the couplets in each key does matter, and the user should choose the option in each couplet that best fits the data or field situation. A choice leads the user to the next couplet to be utilized in the keying process, via a number at the far right, or else leads to a final result (an Ecological System type).

Although plant names may be used in the couplet descriptions, Ecological System names do not include Latin species names (see Ecological Systems section on page 2). Plant names are almost always in Latin. In limited cases, synonyms are included for some taxa.

All the keys follow the same logic. First the user determines which Group Key to use then utilizes that key to identify the Ecological System type. Keys are generally based on dominance within vegetation strata, with tree cover generally considered first, then that of shrubs, then the herbaceous component. Codominant species within a given strata are important as well; in some cases a system type will have two or more codominant species, which may or may not be present in all stands. Many ecological systems will have a variable physiognomy; where appropriate these variable systems have been placed into the keys in several places (i.e. some grassland systems have a "shrub-steppe" physiognomy and hence will be in both Key B (Herbaceous) and Key E (Upland Shrublands).

Some terminology is commonly employed throughout the keys that distinguishes general spatial characteristics of the vegetation or environmental setting. For example 'matrix' types of vegetation are dominant across the majority of a given landscape, while 'large patch' types tend to occur as distinctive patches within the larger 'matrix.' (see Ecological Systems section on page 2). Elevation-based life zones are commonly used, with reference to 'alpine,' 'subalpine,' 'montane,' or 'foothill' zones.

It is important to remember that **the key is not the classification**. Users should always check the Ecological System descriptions to ensure proper identification. If both the key and descriptions do not provide satisfactory identification, considerations should be given as to whether the type could be ruderal vegetation (see Appendix C). If not, users should try the key again but relax some of the criteria used in the couplets. For example, if a couplet is differentiated by greater or less than 10% cover, follow the key break not used initially.

KEY TO GROUPS

1a. Total woody canopy cover generally < 10%...**2**

[1] Compiled and modified from three separate keys developed by NatureServe, including: (1) Field Key to Ecological Systems and Target Alliances of the Northern Rocky Mountains, United States; (2) Field Key to Ecological Systems and Target Alliances of Group XI: Pacific Northwest – Coastal Mountains, Puget Lowlands, Willamette Valley, Cascade Mountains of WA and OR, and the Modoc Plateau, CA United States (Map Zones 1, 2, and 7); and (3) Field Key to Ecological Systems and Target Alliances of Group VII: Columbia Plateau, United States (Map Zones 8, 9, and 18)

1b. Total woody canopy cover generally > 10% **3**

2a. Typically small patch land cover with total canopy cover (woody and herbaceous vascular plants) generally < 10%...**Key A Sparsely Vegetated, page 12**

2b. Small or large patch land cover (occasional matrix land cover) with total herbaceous cover >10%, some woody species may be present ....**Key B Herbaceous, page 14**

3a. Linear or small patch land cover restricted to riparian areas, inundated valley floors, semi-riparian flats, springs or seeps, or other areas with high water tables, including ephemeral washes ....**Key C Woody Wetland and Riparian, page 21**

3b. Land cover is upland, sloping or flat, but without a high water table, no potential for flooding, or discharging groundwater **4**

4a. Typically large patch or matrix land covered in trees, from savannas (10-25% cover of trees and >25% cover graminoids) to woodlands (25-60%) or forests (60-100%) ....**Key D Upland Forests and Woodlands, page 25**

4b. Small or large patch land covered in tall or dwarf shrubs; scattered trees may be present, these less than 10%; significant cover of herbaceous species may occur (i.e. shrub-steppe) .... **Key E Upland Shrublands, page 30**

KEY A: SPARSELY VEGETATED TYPES

1a. Permanent snow or ice fields ....**North American Glacier and Ice Field, page 207**

1b. Barren and sparsely vegetated substrates consisting of rock or soil **2**

2a. Alpine or upper subalpine land cover which has sparse to moderately dense amounts (10-50% cover) of vascular plant cover and high cover (50-90%) of exposed rock cover. .... **Rocky Mountain Alpine Dwarf-shrubland, Fell-field, and Turf, page 239**

2b. Land cover is mostly exposed rock; nonvascular cover (lichens) may be significant **3**

3a. Site is near or above upper tree line, alpine or upper subalpine...**4**

3b. Site is below upper tree line, upper montane to lowlands...**5**

4a. Exposed rock at alpine elevations east of the Cascade Crest ....**Rocky Mountain Alpine Bedrock and Scree, page 222**on page 222

4b. Exposed rock at alpine or upper subalpine elevations west of or near the Cascade Crest...................... ....**North Pacific Alpine and Subalpine Bedrock and Scree, page 212**

5a. Volcanic substrates such as basalt lava, pyroclastic deposits, basalt cliff faces and associated colluvium, ash, cinder cones or cinder fields ....**North Pacific Active Volcanic Rock and Cinder Land, page 210**

5b. Land cover is not of recent volcanic origin...**6**

6a. Steep cliff or narrow canyon faces, small rock outcrops, or talus slopes at the base of cliffs **7**

6b. Land surface consists of loose, shifting or eroding materials finer than talus, or if talus then not below a cliff face..**10**

7a. Found west or near the Cascade crest **8**

7b. Found east of the Cascade crest **9**

8a Found along the Pacific Ocean and major straits into Puget Sound; exposure to waves, eroding and desiccating winds, slope failures and sheet erosion creates gravelly to rocky substrates that are often unstable. There can be a sparse cover of forbs, grasses, lichens and low shrubs.................................... .... **North Pacific Coastal Cliff and Bluff, page 214**

8b. Not found along coast or not exposed to offshore winds; nonvascular plant cover can be high; fractures in the rock surface and less steep or more stable slopes may be occupied by small patches of scattered trees and/or shrubs. May be found in lowland or montane elevations. Characteristic species include *Chamaecyparis nootkatensis*, *Tsuga* spp., *Thuja plicata*, *Pseudotsuga menziesii*, *Abies* spp., *Acer circinatum*, *Alnus* spp., and *Ribes* spp.. ....**North Pacific Montane Massive Bedrock, Cliff & Talus, page 217**

9a. Found above lower treeline, in the Okanogan Highlands, northeastern Olympic Mountains, East Cascades, northeastern Washington and Blue Mountains. Scattered trees/shrubs of Rocky Mountain flora are often present .... **Rocky Mountain Cliff, Canyon and Massive Bedrock, page 224**

9b. Found below lower treeline in the Columbia Basin; widely scattered trees and shrubs may include *Amelanchier spp. Celtis reticulata, Rhus glabra, Juniperus spp., Artemisia tridentata, Purshia tridentata, Cercocarpus ledifolius,* and other species from adjacent plant communities. .... **Inter-Mountain Basins Cliff and Canyon, page 203**

10a. Land cover is shifting or stabilized sand dunes..**11**

10b. Not as above..**12**

11a. Active or stabilized dunes and sandsheets along ocean coast. Vegetation forms patchy or open grasslands, shrublands, and occasionally woodlands ....**North Pacific Maritime Coastal Sand Dune and Strand, page 232**

11b. Active or stabilized dunes and sandsheets in the Columbia Basin. Vegetation forms patchy or open grasslands, shrublands or steppe, and occasionally woodlands... ....**Inter-Mountain Basins Active and Stabilized Dune, page 228**

12a. Serpentine barrens; steep slopes with loosely consolidated soils (large rock outcrops and gravelly soil); and harsh soil chemical conditions. Occurs primarily on Cypress Island and in the Wenatchee Mountains in the East Cascades on thin rocky, ultramafic (peridotite, serpentine) soils .... **North Pacific Serpentine Barren, page 220**

12b. Not as above..**13**

13a. Mudflats or sandflats associated with freshwater or intertidal wetlands; west side of Cascades, mostly coastal and along the Columbia River..**14**

13b. Site is located within the Columbia Basin **15**

14a. Barren to sparsely vegetated flats that form a narrow band along oceanic inlets, and are more extensive at the mouths of larger rivers. Algae are the dominant vegetation; little vascular vegetation is present due to daily tidal flooding of salt or brackish water. Characteristic species include *Vaucheria longicaulis* and *Enteromorpha* spp. .... **Temperate Pacific Intertidal Flats, page 374**

14b. Freshwater sparsely vegetated mudflats that occur primarily in seasonally flooded shallow lakebeds on floodplains, especially along the lower Columbia River. Predominant species include *Eleocharis obtusa, Lilaeopsis occidentalis, Crassula aquatica, Limosella aquatica, Gnaphalium palustre, Eragrostis hypnoides*, and *Ludwigia palustris* .... **Temperate Pacific Freshwater Mudflat, page 372**

15a. Ephemeral stream bed subject to intermittent flooding; vegetation is distinct from adjacent areas. Streambed and banks are often lined with shrubs such as *Sarcobatus vermiculatus*, *Ericameria nauseosa*, *Artemisia tridentata* ssp. *tridentata*, and *Philadelphus lewisii*. If *Sarcobatus vermiculatus* extends away from the wash then the occurrence may be classified as the Inter-Mountain Basins Greasewood Flat system (page 348)................................... **Inter-Mountain Basins Wash, page 248**

15b. Sparse to patchy vegetation cover on saline soils; salt crusts are often visible on soil surface; vegetation is limited to halophytic species; Often co-occurs with Inter-Mountain Basins Alkaline Closed Depression (page 344).. **Inter-Mountain Basins Playa, page 351**

KEY B: HERBACEOUS TYPES

1a. Herbaceous wetlands; site is restricted to riparian areas, fringes of lakes and ponds, seeps/springs, or depressions .... **Wetland Herbaceous Types, page 14**

1b. Site is mesic to dry with upland herbaceous vegetation .... **Upland Herbaceous Types, page 17**

WETLAND HERBACEOUS TYPES

2a. Upper soil horizons (within 40 cm of surface) are composed of relatively undecomposed (hemic to fibric) peat; surface water depths rarely exceed a few centimeters above the soil surface, small freshwater pools may be present; hummock/hollow topography may be present; acid-loving shrubs, *Betula glandulosa*, *Alnus* spp. *Salix* spp., or *Carex* spp. are dominant; *Sphagnum* spp. or other bryophytes are often abundant.. **3**

2b. Wetland has mineral soils or < 40 cm of accumulated organic soil; OR if organic soils are present they are usually well decomposed (sapric or muck); site is semi-permanently flooded with deep (1-2 m) surface water; variable species composition **4**

3a. Bogs or fens found west of or near the Cascade crest; sites can be found in depressions, oxbows, pond or lake shorelines, behind coastal sand dunes, or seepage slopes. Diagnostic species include *Ledum groenlandicum, Kalmia microphylla, Vaccinium uliginosum, Myrica gale, Vaccinium oxycoccos, Drosera rotundifolia, Pinus contorta var. contorta, Picea sitchensis, Tsuga heterophylla, Thuja plicata, Gaultheria shallon, Empetrum nigrum, Carex aquatilis var. dives, C. livida, C. lasiocarpa, C. obnupta, Sphagnum austinii, S. papillosum, S. rubellum, S. subnitens, S. mendocinum, S. pacificum* .... **North Pacific Bog and Fen, page 291**

3b. Fens associated with groundwater discharge, depressions, or pond or lake margins east of the Cascade crest; sites are primarily above lower treeline; Diagnostic species include *Carex aquatilis* var. *aquatilis*, *C. utriculata*, *C. scopulorum* var. *prionophylla*, *C. buxbaumii*, *C. limosa*, *Comarum palustre*, *Scheuchzeria palustris*, *Betula glandulosa*, *Alnus incana*, *A. viridis* ssp. *sinuata*, *Salix farriae*, *S. planifolia*, and *S. drummondiana*. *Sphagnum* may be present but are typically limited to scattered hummocks or lawns of (mostly) *Sphagnum teres*, *S. squarrosum*, *S. warnstorfii*, and *S. capillifolium*. *Aulacomnium palustre*, *Bryum pseudotriquetrum*, *Calliergon stramineum*, *Drepanocladus aduncus*, *Polytrichum commune* and other mosses are often abundant. Sites near Cascade Crest should be keyed based on floristics;...**Rocky Mountain Subalpine-Montane Fen, page 302**

4a. Site subjected to daily tidal flow OR associated with coastal sand dunes **5**

4b. Site not exposed to tidal fluctuations or associated with coastal sand dunes.......................................**8**

5a. Site found in interdunal depressions or extensive deflation plains behind stabilized foredunes. *Carex obnupta*, *Argentina egedii, Juncus lesueurii, and Juncus nevadensis.*...
....**North Pacific Coastal Interdunal Wetland**, **page 355**

5b. Site exposed to tidal fluctuations **6**

6a. Intertidal zones associated with clear water in bays, inlets and lagoons and dominated by rooted aquatic vegetation (i.e. eelgrass (*Zostera marina*))..............**North Pacific Maritime Eelgrass Bed, page 366**

6b. Wetland associated with tidal flow but dominated by emergent vegetation...**7**

7a. Narrow strips to more extensive patches of freshwater wetlands along tidally influenced portions of rivers along the outer coastal margin and Columbia River. Dominant species include *Carex obnupta*, *Cornus sericea*, *Lysichiton americanus* and *Athyrium filix-femina*. Where small areas of mudflat occur in tidally influenced freshwater areas, they are included in this intertidal freshwater wetland and not in Temperate Pacific Freshwater Mudflat.... . **North Pacific Intertidal Freshwater Wetland, page 359**

7b. Intertidal salt and brackish marshes found along the outer coast and in the Puget Sound, primarily associated with estuaries or coastal lagoons. Diagnostic species includes *Distichlis spicata*, *Deschampsia caespitosa*, *Salicornia virginiana*, *Carex lyngbyei, Glaux maritima, Triglochin maritimum*, and *Jaumea carnosa* ......**Temperate Pacific Tidal Salt and Brackish Marsh, page 363**

8a. Wetlands located west of or near the Cascade Crest...**9**

8b. Wetlands located east of the Cascade Crest..**15**

9a. Shallow, ephemeral water bodies found in bedrock depressions throughout the San Juan Islands Characteristic plant species include *Triteleia hyacinthina*, *Eleocharis* spp., *Plagiobothrys figuratus*, *Plagiobothrys scouleri*, and *Plantago bigelovii*; Concentric rings of similar vegetation are common......
....**North Pacific Hardpan Vernal Pool, page 342**

9b. Wetlands not small pools in bedrock and not restricted to San Juan Islands **10**

10a. Sites with alkaline/saline soils near or below lower treeline in the Columbia Basin. Sites are moderately to densely covered by salt-tolerant and halophytic species such as *Distichlis spicata, Carex praegracilis, C. douglasii, Argentina anserina, Puccinellia lemmonii, Poa secunda, Muhlenbergia* spp., *Leymus cinereus, Leymus triticoides (= Elymus triticoides), Amphiscirpus nevadensis, Juncus balticus*, *Schoenoplectus maritimus*, *Schoenoplectus americanus, Spartina gracilis,* and *Triglochin maritima*. Often co-occurs with Inter-Mountain Basins Playa (page 351) ....
.... **Inter-Mountain Basins Alkaline Closed Depression, page 344**

10b. Sites lack alkaline or saline soils...**11**

11a. Mudflats with sparse to extensive sods of herbaceous vegetation primarily in seasonally flooded shallow floodplain depressions, especially along the lower Columbia River. Species include *Eleocharis obtusa, Lilaeopsis occidentalis, Crassula aquatica, Limosella aquatica, Gnaphalium palustre, Eragrostis hypnoides*, and *Ludwigia palustris*. ... **Temperate Pacific Freshwater Mudflat, page 372**

11b. Wetlands not occurring on mudflats **12**

12a. Wetlands associated with deep water (up to 2 meters); semi-permanently flooded marshes and open water **13**

12b. Wetlands may be flooded in early spring but more typically are saturated within the top 20 cm of the soil surface but typically draw down in summer; mineral soils dominate but histic epipedons (e.g. organic soils < 40 cm thick) may be present **14**

13a. Floating or submerged aquatic plants dominate open water areas in lakes, ponds, pools and slow moving water. Diagnostic rooted or floating species include *Azolla* spp., *Hippuris vulgaris*, *Nuphar lutea* subsp. *polysepala*, *Brasenia schreberi*, *Polygonum* spp., *Potamogeton* spp., *Ranunculus* spp., *Sagittaria latifolia*, and *Wolffia* spp. Submerged vegetation, such as *Potamogeton* spp., *Isoetes* spp., *Myriophyllum* spp., *Ceratophyllum* spp., and *Elodea* spp., is often present. Water is too deep for extensive cover of emergent vegetation ....**Temperate Pacific Freshwater Aquatic Bed, page 369**

13b. Tall emergent species dominate. Diagnostic species include *Carex exsiccata*, *Schoenoplectus acutus, S. tabernaemontani*, *Typha latifolia*, *Oenanthe sarmentosa,* and *Eleocharis palustris.* Often occurs in a mosaic with other wetland systems ......**Temperate Pacific Freshwater Emergent Marsh, page 322**

14a. Wet meadows/grasslands found within the Willamette Valley Upland Prairie and Savanna system; limited to Pierce, Thurston, Lewis, Cowlitz, and Clark counties; Diagnostic species include *Deschampsia caespitosa, Danthonia californica, Camassia leichtlinii*, *Carex densa*, *Carex feta*, and *Carex unilateralis*... ....**Willamette Valley Wet Prairie, page 330**

14b. Wet meadows found in depressions, basins and flats among montane and subalpine forests in Olympic and Cascade Mountains. Seasonally wet, often drying by late summer. Some sites may have relatively decomposed (sapric or muck) organic soils. Some common species include *Carex nigricans*, *C. illota*, *C. cusickii*, *Calamagrostis canadensis*, *Caltha leptosepala* ssp. *howellii*, *Deschampsia caespitosa*, *Veratrum californicum*, and *Senecio triangularis*. *Picea engelmannii*, *Abies lasiocarpa*, *Abies amabilis*, *Tsuga mertensiana*, and *Chamaecyparis nootkatensis* may occur on elevated microsites. ....**Temperate Pacific Subalpine-Montane Wet Meadow, page 327**

15a. Seasonal or ephemeral wetlands associated with small depressions in Columbia River basalt (i.e. vernal pools); soils are typically very shallow...... ....**16**

15b. Wetlands with deep soils or if with shallow soils then not restricted to small depressions in basalt; semi-permanently flooded to seasonally saturated;..**17**

16a. Shallow, ephemeral water bodies found in very small depressions and swales in Klickitat County and are especially abundant within and near Horsethief State Park or at slightly higher elevations within the ponderosa pine zone. Diagnostic species include *Deschampsia danthonioides, Epilobium densiflorum (= Boisduvalia densiflora), Callitriche marginata, Cicendia quadrangularis, Eryngium vaseyi, Psilocarphus brevissimus*, and *Sedella pumila (= Parvisedum pumilum)*. ....**Modoc Basalt Flow Vernal Pool, page 338**

16b. Shallow, ephemeral wetlands found in small depressions throughout the exposed volcanic scablands of the Columbia Plateau. Inundation is highly irregular, sometimes not occurring for several years.

Hydrological input is from rainfall and snowmelt. Characteristic species include *Deschampsia danthonioides*, *Callitriche marginata*, *Camissonia tanacetifolia*, *Elatine* spp., *Epilobium densiflorum (= Boisduvalia densiflora)*, *Eryngium vaseyi*, *Juncus uncialis*, *Myosurus X clavicaulis*, *Plagiobothrys* spp., *Polygonum polygaloides ssp. confertiflorum*, *Polygonum polygaloides ssp. polygaloides*, *Psilocarphus brevissimus*, *Psilocarphus elatior*, *Psilocarphus oregonus*, and *Trifolium cyathiferum*. .... **Columbia Plateau Vernal Pool, page 334**

17a. Shallow freshwater water bodies found in small depressions gouged into basalt by Pleistocene floods. Occur throughout channeled scablands of the Columbia Plateau. Typically found at the bottom of a circular or linear depression lined with basalt cliffs. Characteristic shoreline vegetation includes species of *Scirpus* and/or *Schoenoplectus*, *Typha*, *Juncus*, *Potamogeton*, *Polygonum*. *Populus tremuloides*, *Salix exigua*, *Crataegus douglasii*, or *Rosa woodsii* may occur adjacent to more northerly potholes. This may be a subset of North American Arid West Emergent Marsh (see below), or it could be a freshwater aquatic system with primarily zoological species composition (amphibians and invertebrates). .... **Northern Columbia Plateau Basalt Pothole Ponds, page 316**

17b. Wetlands not occurring as ponds in basalt "pothole" landform **18**

18a. Semi-permanently flooded wetlands dominated by tall emergent plants. Occurs below lower treeline in depressions, along pond/lake shorelines, and along slow-flowing streams and rivers (e.g. sloughs). Site is frequently or continually inundated, with water depths up to 2 m. Soils can be mineral or organic (muck). Common emergent and floating vegetation includes species of *Schoenoplectus acutus*, *S. tabernaemontani*, *Typha latifolia*, *Eleocharis palustris*, *Potamogeton spp.*, and *Polygonum amphibium*. Floating-leaved plants (*Lemna*, *Potamogeton*, *Nuphar lutea ssp. polysepala*) and submergent and floating plants (*Myriophyllum*, *Ceratophyllum*, and *Elodea*) may be present. .... **North American Arid West Emergent Marsh, page 311**

18b. Wet meadows found in depressions, basins and flats among montane and subalpine forests. Soils are mineral but may contain histic epipedons. In alpine regions, sites typically are located below late-melting snow patches or on snowbeds. Characteristic species include *Calamagrostis stricta*, *Caltha leptosepala ssp. howellii*, *Carex illota*, *C. aperta*, *C. vesicaria*, *C. nigricans*, *C. scopulorum*, *C. utriculata*, *Deschampsia caespitosa*, *Juncus drummondii*, *Rorippa alpina*, *Senecio triangularis*, and *Trifolium parryi*....... .... **Rocky Mountain Alpine-Montane Wet Meadow, page 318**

UPLAND HERBACEOUS TYPES

18a Alpine, subalpine, upper montane vegetation **19**

18b Lower montane, foothill and Columbia Basin vegetation **27**

19a Alpine herbaceous and/or fell-field vegetation **20**

19b Subalpine and montane vegetation **24**

20a. Fells fields; plant cover 10-50%, snow cover is scoured away by wind, plants generally exposed in winter, rock cover can be high, often in close proximity/ intermixed with alpine tundra **21**

20b. Alpine meadows, plant cover > 50%, rocks, if present, are a minor portion of the landscape **22**

21a. Alpine fell fields west of or near the Cascade crest. Occurs as a mosaic with small patches of dwarf shrublands and meadow vegetation. Dominated by graminoids, foliose lichens, dwarf-shrubs, and/or forbs, with species such as *Arabis lyallii*, *Carex breweri*, *C. capitata*, *C. nardina*, *C. pellita*, *C. proposita*, *C. scirpoidea var. pseudoscirpoidea*, *C. spectabilis*, *Empetrum nigrum*, *Erigeron aureus*, *Eriogonum pyrolifolium, Festuca roemeri, Luetkea pectinata, Lupinus sellulus, Luzula piperi, Oreostemma alpigenum, Packera cana, Phlox diffusa, Phlox diffusa ssp. longistylis, Salix cascadensis*, or *Saxifraga tolmiei* ....**North Pacific Dry and Mesic Alpine Dwarf-Shrubland, Fell-field and Meadow, page 236**

21b. Alpine fell fields east of the Cascadian crest. Small areas may be dominated by *Arenaria capillaris, Geum rossii, Kobresia myosuroides, Minuartia obtusiloba, Myosotis asiatica, Phlox pulvinata, Sibbaldia procumbens, Silene acaulis, Trifolium dasyphyllum,* and *Trifolium parryi.* ....**Rocky Mountain Alpine Dwarf Shrubland, Fell-Field, and Turf, page 239**

22a. Found east of Cascade crest. Dominant species include *Artemisia arctica, Carex* spp., *Deschampsia caespitosa, Festuca brachyphylla, Geum rossii, Kobresia myosuroides*, and *Trifolium dasyphyllum*. Cover of cushion plants is generally low.. ....**Rocky Mountain Alpine Dwarf Shrubland, Fell-Field, and Turf, page 239**

22b. Found west of or near the Cascade crest, including Olympic Mountains. Alpine meadows and dry grasslands. **23**

23a. Alpine dwarf-shrublands and meadows, typical dominant species include *Cassiope mertensiana, Phyllodoce empetriformis, Phyllodoce glanduliflora, Luetkea pectinata, Saxifraga tolmiei*, and *Carex* spp. ....**North Pacific Dry and Mesic Alpine Dwarf-Shrubland, Fell-field and Meadow, page 236**

23b. Alpine dry grasslands; typical dominant species include *Festuca idahoensis, Festuca viridula*, and *Festuca roemeri* (the latter species occurring only in the Olympic Mountains) ....**North Pacific Alpine and Subalpine Dry Grassland, page 180**

24a. Subalpine dry grasslands found west of or near the Cascade crest; Typical dominant species include *Festuca idahoensis, Festuca viridula,* and *Festuca roemeri* (the latter species occurring only in the Olympic Mountains).......................**North Pacific Alpine and Subalpine Dry Grassland, page 180**

24b. Subalpine to montane herbaceous vegetation found east of the Cascade crest.................................**25**

25a. Subalpine meadows typically dominated or codominated by perennial forbs. Important taxa include *Senecio triangularis*, *Erigeron peregrinus*, *Erythronium grandiflorum*, *Ligusticum* species, *Veratrum viride*, *Valeriana* spp., *Arnica chamissonis, Camassia quamash*, *Erigeron speciosus*, *Eucephalus* and *Symphyotrichum* species, *Mertensia* spp., *Chamerion angustifolium*, *Penstemon procerus, Geum macrophyllum, Campanula rotundifolia*, *Solidago canadensis*, *Zigadenus elegans*, *Thalictrum occidentale*, *Senecio hydrophiloides* and *Senecio serra.* Grass species such as *Deschampsia caespitosa, Koeleria macrantha,* perennial *Bromus* spp., and species of *Carex* spp. can be present...... ....**Rocky Mountain Subalpine-Montane Mesic Meadow, page 196**

25a. Subalpine to montane herbaceous vegetation dominated or codominated by perennial graminoids. **26**

26a. Subalpine dry grasslands which occur as small meadows to large open parks surrounded by conifer trees, but lack tree cover within them. Dominant species include *Koeleria macrantha*, *Festuca campestris, F. idahoensis, F. viridula, Achnatherum occidentale, A. richardsonii, Bromus inermis ssp. pumpellianus, Elymus trachycaulus, Phleum alpinum, Trisetum spicatum,* and a variety of Carices, such as *Carex hoodii*, *C. obtusata*, and *C. scirpoidea*. Important forbs include *Lupinus argenteus var. laxiflorus, Potentilla diversifolia, Potentilla flabellifolia, Fragaria virginiana, Chamerion angustifolium* ....**Northern Rocky Mountain Subalpine - Upper Montane Grassland, page 192**

26b. Grasslands ranging from small meadows to large open parks surrounded by conifers in the lower montane, to foothills and valley ridges slightly below lower tree line. *Pseudoroegneria spicata*, *Festuca campestris, F. idahoensis*, or *Hesperostipa comata* commonly dominate sites on all aspects of level to moderate slopes and on certain steep slopes with a variety of other grasses, such as *Achnatherum hymenoides, A. occidentale, A. richardsonii, Hesperostipa curtiseta, Koeleria macrantha, Leymus cinereus, Elymus trachycaulus, Bromus inermis ssp. pumpellianus (= Bromus pumpellianus), Pascopyrum smithii*, and other graminoids such as *Carex filifolia* and *Danthonia intermedia*.. ....**Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland, page 188**

27a. Located west of or near the Cascade crest **28**

27b. Located east of the Cascade crest **30**

28a. Coastal or lowland and montane, small patch grasslands that are often surrounded by forests; sites are steep and often with shallow soils, ...**29**

28b. Lowland, large patch grasslands found on coarse and well-drained soils (typically glacial outwash). Dominated by perennial bunch grasses, especially *Festuca roemeri* and, to a lesser degree, *Danthonia californica*, with abundant and diverse forbs. Primarily limited to Pierce, Thurston, Lewis, Cowlitz, and Clark counties but small remnants are also found in San Juan, Island, and Mason counties. Scattered deciduous (*Quercus garryana*) and/or coniferous (*Pseudotsuga menziesii, Pinus ponderosa*) trees historically occurred as a savanna and covered about one-third of the total acreage; many areas are now dense with *Pseudotsuga menziesii* due to fire suppression... .... **Willamette Valley Upland Prairie and Savanna, page 199**

29a. Sites are steep slopes on coastal bluffs, headlands, or small islands within the hypermaritime salt spray and fog zone; sometimes on relatively level tops of headlands or islands. Diagnostic species include *Gaultheria shallon*, *Vaccinium ovatum*, *Lonicera involucrata*, *Rubus spectabilis*, *Rubus parviflorus*, *Vaccinium alaskaense*, *Vaccinium ovalifolium*, *Festuca rubra*, *Calamagrostis nutkaensis*, *Elymus glaucus*, *Danthonia californica*, *Bromus sitchensis*, *Solidago canadensis*, *Lomatium martindalei*, *Vicia gigantea*, *Equisetum telmateia*, *Artemisia suksdorfii*, *Pteridium aquilinum* and *Blechnum spicant*. Scattered stunted trees such as *Picea sitchensis*, *Tsuga heterophylla*, *Pseudotsuga menziesii*, or *Alnus rubra* are often present. ....**North Pacific Hypermaritime Shrub and Herbaceous Headland, page 138**

29b. Herbaceous balds away from coastal influences. Grasslands and shrublands on steep, hilly terrain in the lowlands to mid-montane elevations away from the hypermaritime salt spray and fog zone. Sites are too dry or marginal for tree growth due to shallow soils, steep slopes, sunny aspect, and/or upper slope position. Diagnostic species include *Festuca roemeri*, *Danthonia californica, Achnatherum lemmonii*, *Festuca rubra* (near saltwater), *Koeleria macrantha, Camassia quamash, Camassia leichtlinii*, *Triteleia hyacinthina*, *Mimulus guttatus* (seeps), *Plectritis congesta, Lomatium martindalei*, *Allium cernuum*, *Phlox diffusa*, *Arctostaphylos uva-ursi*, *Arctostaphylos nevadensis*, and *Juniperus communis*. *Pseudotsuga menziesii*, *Arbutus menziesii* or *Quercus garryana* are often adjacent. .... **North Pacific Herbaceous Bald and Bluff, page 184**

30a. Grasslands ranging from small meadows to large open parks surrounded by conifers in the lower montane, to foothill and valley ridges slightly below lower tree line. *Pseudoroegneria spicata, Festuca campestris, F. idahoensis*, or *Hesperostipa comata* commonly dominate sites on all aspects of level to moderate slopes and on certain steep slopes with a variety of other grasses, such as *Achnatherum hymenoides, A. occidentale, A. richardsonii, Hesperostipa curtiseta, Koeleria macrantha, Leymus cinereus, Elymus trachycaulus, Bromus inermis ssp. pumpellianus (= Bromus pumpellianus),* *Pascopyrum smithii*, and other graminoids such as *Carex filifolia* and *Danthonia intermedia* ....**Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland, page 188**

30b. Grasslands occurring below lower tree line **31**

31a. Scattered shrubs such as *Chrysothamnus viscidiflorus, Ericameria nauseosa, Tetradymia canescens, Rosa nutkana*, and *Symphoricarpos albus* may be present but general aspect of the vegetation is that of a grassland..**32**

31b. Mosaic of open to moderately dense (5-30% cover) shrub layer and with > 25% total perennial herbaceous cover. Dominant species include.*Artemisia tridentata ssp. tridentata*, *A. tridentata ssp. xericensis, A. tridentata ssp. wyomingensis, A. tripartita ssp. tripartita*, and/or *Purshia tridentata*. Associated graminoids can include *Pseudoroegneria spicata, Poa secunda, Poa cusickii, Koeleria macrantha Hesperostipa comata*, and *Achnatherum thurberiana*. The natural fire regime of this ecological system likely maintains a patchy distribution of shrubs, so the general aspect of the vegetation can be that of a grassland;......**Inter-Mountain Basins Big Sagebrush Steppe, page 156**

32a. Site is located in the southeast portion of the Columbia Basin; grassland is composed of productive dense cool season bunchgrass cover with a high diversity of forbs on a dune-like topography composed of loess hills and plains over basalt. Soils are typically deep, well-developed, and old. Characteristic species are *Pseudoroegneria spicata* and *Festuca idahoensis* with *Hesperostipa comata, Leymus cinereus, Koeleria macrantha,* or *Poa secunda*. Shrubs commonly found include *Amelanchier alnifolia*, *Rosa nutkana*, *Eriogonum* spp., *Symphoricarpos albus*, and *Crataegus douglasii*. *Rosa nutkana* and *Symphoricarpos albus* typically have a dwarf form. This type has nearly been extirpated from the landscape. Remnant grasslands are typically associated with steep (e.g., eyebrows) and rocky sites or small and isolated sites within an agricultural landscape.. ....**Columbia Basin Palouse Prairie, page 172**

32b. Site not on loess hills in the southeast part of the Columbia Basin; grassland typically does not have a closed canopy and dwarf statured *Rosa nutkana* and *Symphoricarpos albus* lacking....................**33**

33a. Sites found on steep open slopes in the canyons and valleys of the Columbia Basin, particularly along the Snake River canyon, the lower foothill slopes of the Blue Mountains, and along the main stem of the Columbia River. Settings are primarily long, steep slopes of 100 m to well over 400 m, and slope failure is a common process. Vegetation is dominated by patchy graminoid cover, cacti, and some forbs. *Pseudoroegneria spicata, Festuca idahoensis,* and *Opuntia polyacantha* are common species. Deciduous shrubs *Symphoricarpos* spp., *Physocarpus malvaceus, Holodiscus discolor*, and *Ribes* spp. are infrequent native species that may increase with fire exclusion. .... **Columbia Basin Foothill and Canyon Dry Grassland, page 168**

33b. Sites are located within the shrub-steppe zone of the central Columbia Basin; these grasslands occur over large areas, occasionally entire landforms, and is an alternative state of the Inter-Mountain Basins Big Sagebrush Steppe ecological system type where frequent fire (< 20 years) or fire severity results in an absence or very low cover (<10%) of deep-rooted, fire intolerant shrubs; dominated by perennial bunch grasses and forbs (>25% cover) sometimes with a sparse (<10% cover) shrub layer; *Chrysothamnus viscidiflorus, Ericameria nauseosa, Tetradymia canescens,* or *Artemisia* spp. may be present in disturbed stands. Associated graminoids include *Achnatherum hymenoides, Achnatherum thurberianum, Elymus elymoides, E. lanceolatus ssp. lanceolatus, Hesperostipa comata, Festuca idahoensis, Koeleria macrantha, Poa secunda*, and *Pseudoroegneria spicata*. ....**Columbia Plateau Steppe and Grassland, page 176**

KEY C: WOODY WETLAND AND RIPARIAN ECOLOGICAL SYSTEMS

1a. Narrow strips to more extensive patches of freshwater wetlands (forested and scrub-shrub) along tidally influenced portions of rivers along the outer coastal margin and Columbia River. Dominant species include *Picea sitchensis, Alnus rubra, Cornus sericea, Salix spp., Carex lyngbyei, Cornus sericea,* and *Athyrium filix-femina*.............................**North Pacific Intertidal Freshwater Wetland, page 359**

1b. Sites not tidally influenced...**2**

2a. Riparian areas; sites adjacent to flowing water (i.e. creek, stream, and river) or occurring on stream terraces or floodplains exposed to seasonal overbank flooding and does not develop under stagnant hydrological regimes. **3**

2b. Sites occurring in depressions, off-channel low lying areas, or associated with perennial groundwater discharge..**11**

3a. Sites west of or near the Cascade crest **4**

3b. Sites east of the Cascade crest...**5**

4a.Occurring on steep streams and narrow floodplains above the *Tsuga heterophylla* zone but below the alpine environments throughout subalpine-montane areas of the Olympic and Cascade Mountains and Willapa Hills. Dominant species include *Abies amabilis, Abies lasiocarpa, Tsuga mertensiana* or *Pinus contorta.* Lower elevation occurrences with less confined channels may contain *Populus balsamifera* ssp. *trichocarpa, Alnus incana* ssp. *tenuifolia* (= *Alnus tenuifolia)* and *Alnus rubra*. Other common species include *Alnus viridis* ssp. *sinuata, Acer circinatum, Salix sitchensis, Oplopanax horridus, Rubus spectabilis, Ribes bracteosum, Senecio triangularis, Saxifraga arguta,* and *Petasites frigidus*............................ **North Pacific Montane Riparian Woodland and Shrubland, page 256**

4b. Forests and tall shrublands occurring as narrow strips or extensive areas along low-elevation, alluvial floodplains or lower terraces of rivers and streams; most abundant throughout low elevations in western Washington but also found along the eastern base of the Cascades generally south of Chelan. Found below *Abies amabilis* forests. Dominant species include *Acer macrophyllum, Alnus rubra, Populus balsamifera ssp. trichocarpa, Fraxinus latifolia, Abies grandis, Picea sitchensis,* and *Thuja plicata, Salix sitchensis, Salix lucida ssp. lasiandra,* and *Cornus sericea*. ....**North Pacific Lowland Riparian Forest and Shrubland, page 251**

5a. Open to moderately dense shrublands dominated by *Sarcobatus vermiculatus*; saline or alkaline soils present; occurring below lower treeline in the driest portions of the Columbia Plateau; occurs on stream terraces; *Artemisia tridentata ssp. wyomingensis* or *Artemisia tridentata ssp. tridentata,* may also be present. The herbaceous layer, if present, is usually dominated by graminoids such as *Distichlis spicata* and *Poa secunda*................ **Inter-Mountain Basins Greasewood Flat, page 348**

5b. Soils not saline or alkaline **6**

6a. Subalpine to montane sites;..**7**

6b. Lower montane to foothill and Columbia Basin sites...**9**

7a. Subalpine to montane shrublands occurring as narrow or extensive bands along streambanks and alluvial terraces in narrow to wide low-gradient valley bottoms and floodplains with sinuous stream channels. Beaver activity is common and these shrublands are often found behind beaver ponds. Sites can be quite wet, with saturated soils and standing water occasionally present. Includes above-treeline,

willow-dominated, snowmelt-fed basins that feed into streams. *Salix* spp. and *Alnus incana* are dominant along unconfined, gently sloped streams with finer sediment. Tall willow species (e.g., *Salix bebbiana*, *S. boothii*, *S. drummondiana*, *S. geyeriana*, *S. lasiandra*, etc.) are dominant at low to moderate elevations while short willow species (e.g., *S. cascadensis*, *S. commutata*, *S. planifolia*, *S. farriae*, etc.) are dominant in subalpine and alpine shrublands. *Carex utriculata*, *C. scopulorum*, *C. spectabilis*, *C. disperma*, *Eleocharis* spp., *Calamagrostis canadensis*, *Glyceria elata* are common understory codominants; scattered *Picea engelmannii*, *Abies lasiocarpa*, *Populus balsamifera* ssp. *trichocarpa*, and *Thuja plicata* can occur..
.... **Rocky Mountain Subalpine-Montane Riparian Shrubland, page 265**

7b. Sites dominated by conifers or a mosaic of conifers and shrublands.. **8**

8a. Occurring on steep streams and narrow floodplains above the *Tsuga heterophylla* zone but below the alpine environments near the Cascade crest and generally south of Chelan. Dominant species include *Abies amabilis, Abies lasiocarpa, Tsuga mertensiana* or *Pinus contorta* var. *murrayana.* Lower elevation occurrences with less confined channels may contain *Populus balsamifera* ssp. *trichocarpa, Alnus incana* ssp. *tenuifolia* (= *Alnus tenuifolia)* and *Alnus rubra*. Other common species include *Alnus viridis* ssp. *sinuata, Acer circinatum, Salix sitchensis, Oplopanax horridus, Rubus spectabilis, Ribes bracteosum, Senecio triangularis, Saxifraga arguta,* and *Petasites frigidus* ....
.... **North Pacific Montane Riparian Woodland and Shrubland, page 256**

8b. Conifer and aspen forests and woodlands that line subalpine and montane streams generally north of Chelan in the East Cascades, and throughout the Okanogan Highlands, Northern Rocky Mountains and Blue Mountains. Confined to floodplains or terraces of rivers and streams, in V-shaped, narrow valleys and canyons (with cold-air drainage). Less frequently sites are found in moderate-wide valley bottoms. Dominant species include *Abies lasiocarpa, Picea engelmannii, Populus tremuloides, Betula papyrifera*, *Alnus incana*, *Alnus viridis* ssp. *sinuata*, *Lonicera involucrata*, *Cornus sericea*, *Symphoricarpos albus*, *Oplopanax horridus*, *Ribes lacustre*, *Rosa gymnocarpa*, *Rubus parviflorus*, *Ledum glandulosum*, *Senecio triangularis*, *Maianthemum stellatum*, *Streptopus amplexifolius*, *Athyrium filix-femina*, *Gymnocarpium dryopteris*, *Carex scopulorum* var. *prionophylla*, *C. disperma*, *Elymus glaucus*, *Aralia nudicaulis*, *Streptopus amplexifolius*, *Gymnocarpium dryopteris*, and *Equisetum* ssp. ....**Rocky Mountain Subalpine-Montane Riparian Woodland, page 272**

9a. Sites occur within the Columbia Basin, at or below lower treeline along rivers, streams, narrow V-shaped draws or subirrigated sites. Sites are subject to temporary overbank flooding during spring runoff. Important and diagnostic trees include *Populus balsamifera ssp. trichocarpa, Alnus rhombifolia, Populus tremuloides, Celtis laevigata var. reticulata, Betula occidentalis*, *Pinus ponderosa*, *Crataegus douglasii*, *Philadelphus lewisii*, *Cornus sericea*, *Salix lucida ssp. lasiandra*, *Salix eriocephala*, *Rosa nutkana*, *Rosa woodsii*, *Amelanchier alnifolia*, *Prunus virginiana*, and *Symphoricarpos albus* ...**Columbia Basin Foothill Riparian Woodland and Shrubland, page 242**

9b. Sites at or above lower tree line in the East Cascades, Okanogan Highlands, Northern Rocky Mountains, and Blue Mountains... **10**

10a. Forests and tall shrublands occurring as narrow strips along low-elevation, alluvial floodplains or lower terraces of rivers and streams; along the eastern base of the Cascades generally south of Chelan. Dominant species include *Acer macrophyllum, Alnus rubra, Populus balsamifera ssp. trichocarpa, Fraxinus latifolia, Abies grandis, Picea sitchensis,* and *Thuja plicata*, *Salix sitchensis, Salix lucida ssp. lasiandra*, *Cornus sericea*. Vancouverian species are dominant in the understory.........................
.... **North Pacific Lowland Riparian Forest and Shrubland, page 251**

10b. Sites occur above lower treeline along streambanks and river floodplains of the lower montane and foothill zones along the eastern base of the Cascades generally north of Chelan, Okanogan Highlands, Northern Rocky Mountains, and Blue Mountains. Mosaic of forests, shrublands, and herbaceous communities may be present. Important species include *Populus balsamifera* ssp. *trichocarpa*, *Populus tremuloides*, *Betula papyrifera*, *Betula occidentalis*, *Betula papyrifera*, *Tsuga heterophylla*, *Thuja plicata*, *Cornus sericea*, *Acer glabrum*, *Alnus incana*, *Oplopanax horridus*, *Symphoricarpos albus*, *Athyrium filix-femina*, *Gymnocarpium dryopteris*, and *Senecio triangularis*. Rocky Mountain species are dominant in the understory .... **Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland, page 260**

11a. Sites west of or near the Cascade crest **12**

11b. Sites east of the Cascade crest..**14**

12a. Bog woodlands or wooded fens found west of or near the Cascade crest; canopies are relatively open to sparse; trees are typically short, stunted, and exhibit bonsai-like growth, often with rounded tops; despite small size many trees show deep furrowed bark due to being very old; site can be found in depressions, oxbows, pond or lake shorelines, behind coastal sand dunes, or on slopes. Upper peat layers are mostly *Sphagnum* or sedge derived peat (fibric or hemic organic soils). Diagnostic species include *Pinus contorta var. contorta, Picea sitchensis, Tsuga heterophylla, Thuja plicata, Ledum groenlandicum, Kalmia microphylla, Gaultheria shallon, Empetrum nigrum, Vaccinium uliginosum, Myrica gale, Vaccinium oxycoccos, Drosera rotundifolia, Carex aquatilis var. dives, C. cusickii, C. livida, C. obnupta, Sphagnum austinii, S. papillosum, S. rubellum, S. subnitens, S. mendocinum, S. pacificum* .... **North Pacific Bog and Fen, page 291**

12b. Organic soils, if present, are relatively decomposed (sapric or muck); tree canopies range from moderately open to closed; tree species, especially *Thuja plicata*, may show stressed growth (e.g., candelabra tops) but are typically more similar in height and girth to upland sites than those in North Pacific Bog and Fen; shrubland sites are predominantly dominated by broadleaf deciduous shrubs rather than ericaceous shrubs..**13**

13a. Forested swamps occurring in glacial depressions, river valleys, flats, around the edges of lakes and marshes, or on seepage slopes. Soils are mostly muck or mineral, but woody-derived peat could be present. Relative to wooded bogs and fens, tree sizes can be quite large in undisturbed stands and growth forms more closely resemble those found in uplands; tree canopies are typically closed; conifer and hardwood species occur as mixed or pure stands of *Tsuga heterophylla, Picea sitchensis, Tsuga mertensiana, Chamaecyparis nootkatensis, Pinus contorta var. contorta, Alnus rubra, Fraxinus latifolia*; may be found east of the Cascade crest at high elevations (typically south of Chelan). .... **North Pacific Hardwood-Conifer Swamp, page 278**

13b. Deciduous, broadleaf tall shrublands located in depressions, around lakes or ponds, seeps/springs, or river terraces where water tables fluctuate seasonally and receive nutrient-rich waters. Soils are muck or mineral but woody-derived peat could be present. *Salix* spp., *Spiraea douglasii*, *Malus fusca*, *Cornus sericea*, *Alnus incana*, and *Alnus viridis* ssp. *sinuata* are major dominants ....**North Pacific Shrub Swamp, page 283**

14a. Open to moderately dense shrublands dominated or codominated by *Sarcobatus vermiculatus*; saline or alkaline soils present; occurring below lower treeline in the driest portions of the Columbia Plateau; typically occurs on saline/alkaline plains and basins, sometimes encircling playas; other shrubs that may be present and codominant include *Artemisia tridentata ssp. wyomingensis, Artemisia tridentata ssp. tridentata,* or *Krascheninnikovia lanata*. The herbaceous layer, if present, is usually dominated by graminoids such as *Sporobolus airoides, Pascopyrum smithii, Distichlis spicata* (where water remains ponded the longest), *Poa pratensis, Puccinellia nuttalliana*, or *Eleocharis palustris* ....**Inter-Mountain Basins Greasewood Flat, page 348**

14b. Soils not saline or alkaline **15**

15a. Trees are > 25% cover; **16**

15b. Shrubs are dominant; trees may occur in clumps or sporadically distributed **18**

16a. Trees typically < 60% cover and canopies are never closed; hemic peat soils (> 40 cm of organic matter) consisting primarily of sedge or moss-derived peat in upper layers; fens associated with groundwater discharge or along pond or lake margins; Diagnostic species include *Picea engelmannii*, *Pinus contorta* var. *latifolia*, *Betula glandulosa*, *Alnus incana*, *A. viridis* ssp. *sinuata*, *Salix farriae*, *S. planifolia*, *S. drummondiana*, *Carex aquatilis* var. *aquatilis*, *C. utriculata*, *C. scopulorum* var. *prionophylla*, and *C. buxbaumii*, *Sphagnum* may be present but are typically limited to scattered hummocks or lawns of (mostly) *Sphagnum teres*, *S. squarrosum*, *S. warnstorfii*, and *S. capillifolium*. *Aulacomnium palustre*, *Bryum pseudotriquetrum*, *Calliergon stramineum*, *Drepanocladus aduncus*, *Polytrichum commune* and other mosses are often abundant. Sites near Cascade Crest should be keyed based on floristics;.. **Rocky Mountain Subalpine-Montane Fen, page 302**

16b. Trees are > 60% cover; peat, if present, is relatively decomposed (sapric or muck); forested swamps **17**

17a. Forested swamps occurring in glacial depressions, river valleys, flats, around the edges of lakes and marshes, or on seepage slopes east of the Cascade crest at high elevations (typically south of Chelan). Soils are mostly muck or mineral, but woody-derived peat could be present. Relative to wooded bogs and fens, tree sizes can be quite large in undisturbed stands and growth forms more closely resemble those found in uplands; tree canopies are typically closed; conifer and hardwood species occur as mixed or pure stands of *Tsuga heterophylla, Picea sitchensis, Tsuga mertensiana, Chamaecyparis nootkatensis, Pinus contorta var. contorta, and Alnus rubra.* Vancouverian species are abundant in the understory.. **North Pacific Hardwood-Conifer Swamp, page 278**

17b. Conifer dominated sites (canopies are open to closed) on poorly drained soils that are saturated year-round or may have seasonal flooding or saturation in the spring. Occurs on flats, in depressions, around lake and pond shore margins, and on slopes where groundwater discharge occurs east of the Cascade crest (some occurrences near the crest could be part of the North Pacific Hardwood-Conifer Swamp system). Soils can be woody-derived peat, muck or mineral. Differs from wooded fens by having a denser and often closed canopy, typically mucky or mineral soils, less dominance of graminoids, and lacking a continuous carpet of bryophytes. Wetland phases of *Thuja plicata* and *Tsuga heterophylla* in northeastern Washington are diagnostic. Other important species include *Picea engelmannii, Athyrium filix-femina, Dryopteris* spp., *Lysichiton americanus, Equisetum arvense, Senecio triangularis, Mitella breweri, Mitella pentandra, Streptopus amplexifolius, Calamagrostis canadensis*, *Carex disperma,* and *C. scopulorum* var. *prionophylla*... ....**Northern Rocky Mountain Conifer Swamp, page 287**

17a. Hemic peat soils (> 40 cm of organic matter) consisting primarily of sedge or moss-derived peat in upper layers; fens associated with groundwater discharge or along pond or lake margins; Diagnostic species include *Betula glandulosa, Alnus incana, A. viridis* ssp. *sinuata*, *Salix farriae, S. planifolia*, and *S. drummondiana, Carex aquatilis* var. *aquatilis, C. utriculata*, *C. scopulorum* var. *prionophylla, C. buxbaumii*,. *Sphagnum* may be present but are typically limited to scattered hummocks or lawns of (mostly) *Sphagnum teres*, *S. squarrosum*, *S. warnstorfii*, and *S. capillifolium*. *Aulacomnium palustre*, *Bryum pseudotriquetrum*, *Calliergon stramineum*, *Drepanocladus aduncus*, *Polytrichum commune* and other mosses are often abundant.................... **Rocky Mountain Subalpine-Montane Fen, page 302**

17b. Sapric (muck) to hemic peat soils consisting primarily of woody-derived peat in upper layers; shrub swamps associated with groundwater discharge sites and beaver ponds, depressions, or other impoundments. Sites can be quite wet, with saturated soils and standing water occasionally present. Includes above-treeline, willow-dominated, snowmelt-fed basins that feed into streams. *Salix bebbiana*, *S. boothii*, *S. drummondiana*, *S. geyeriana*, *Alnus incana*, *Scirpus microcarpus*, *Carex utriculata*, *C. disperma*, *Eleocharis* spp., *Calamagrostis canadensis*, *Glyceria elata* are common understory codominants; scattered *Picea engelmannii*, *Abies lasiocarpa*, *Populus balsamifera* ssp. *trichocarpa*, and *Thuja plicata* can occur...**Rocky Mountain Subalpine-Montane Riparian Shrubland, page 265**

KEY D: UPLAND FORESTS AND WOODLANDS

1a. Broadleaf deciduous trees > 25% of the tree canopy. **2**

1b. Evergreen forests and woodlands; broadleaf deciduous trees < 25% of tree canopy **5**

DECIDUOUS FORESTS AND WOODLANDS

2a. *Populus tremuloides* is dominant or co-dominant with conifers, generally limited to east side of Cascade Mountains .... **Rocky Mountain Aspen Forest and Woodland, page 113**

2b. *Alnus rubra, Acer macrophyllum,* or *Quercus garryana* are dominant..**3**

3a. *Quercus garryana* > 25% of the relative tree canopy **4**

3b. Broadleaf, deciduous forest or woodland (or often tall shrubs) on steep slopes and bluffs subject to frequent mass wasting; *Alnus rubra* and *Acer macrophyllum* are major tree species. *Rubus spectabilis, Rubus parviflorus, Ribes bracteosum*, and *Oplopanax horridus* are major shrub species. *Polystichum munitum* and *Tellima grandiflora* present ....**North Pacific Broadleaf Landslide Forest and Shrubland, page 64**

Note: *Alnus rubra* and/or *Acer macrophyllum* dominated sites not on steep, mass wasting slopes and not in wetland/riparian areas are early successional stands of North Pacific Maritime Dry-Mesic Douglas-Fir-Western Hemlock Forests (page 71) or North Pacific Maritime Dry-Mesic Douglas-Fir-Western Hemlock Forests (page 71).

4a. Forests occur at or near lower tree line in foothills of the eastern Cascades in Washington; In the Columbia River Gorge, this type generally occurs east of White Salmon, with transition types between this and North Pacific Oak Woodland occurrences occurring in the Little White Salmon and White Salmon river drainages. Forests dominated by a mix of *Quercus garryana* and *Pinus ponderosa* or *Pseudotsuga menziesii;* Rocky Mountain species can be common in understory.. **East Cascades Oak-Ponderosa Pine Forest and Woodland, page 37**

4b. Forests occur primarily in the Puget Trough. In the Columbia River Gorge, this type generally occurs west of White Salmon, with transition types between this and East Cascades Oak-Ponderosa Pine Forest and Woodland system occurring in the Little White Salmon and White Salmon river drainages. Dominated primarily by *Quercus garryana* in pure stands or codominant with other conifers such as *Pseudotsuga menziesii, Pinus ponderosa,* or *Arbutus menziesii;* tree cover ranges from savanna and woodland to forest; Vancouverian species dominate understory ....**North Pacific Oak Woodland, page 44**

Note: *Quercus garryana* and *Pseudotsuga menziesii* are scattered within endemic grasslands in the Puget Trough and comprised the 'savanna' component to the Willamette Valley Upland Prairie and Savanna system (page 199). *Pseudotsuga menziesii* is now much denser than historically in those sites.

5a. Subalpine forests dominated by *Tsuga mertensiana, Abies amabilis, Chamaecyparis nootkatensis, Pinus contorta* var. *latifolia, Picea engelmannii, Abies lasiocarpa, Pinus albicaulis* or *Larix lyallii* **6**

5b. Montane, foothills or coastal forests dominated by *Abies amabilis, Picea sitchensis, Tsuga heterophylla, Thuja plicata, Pinus ponderosa, P. contorta* var. *latifolia, Pseudotsuga menziesii, Abies grandis, A. procera, Larix occidentalis,* or *Juniperus occidentalis*..**11**

SUBALPINE FORESTS, WOODLANDS AND PARKLANDS

6a. Tree clumps or open woodlands with stunted or relatively short trees with 10-50% canopy cover; parkland appearance with herb- or dwarf-shrub-dominated openings, occurring above closed forest ecosystems and below alpine communities, ...**7**

6b. Subalpine conifer trees forming forests and woodlands; trees reach normal height and canopy cover ranges from 25-100%; dominated by *Tsuga mertensiana, Pinus contorta* var. *latifolia, Picea engelmannii* and/or *Abies lasiocarpa* **8**

7a. Sites occur west of or near the Cascade crest where deep, late-lying snow pack occurs. Tree clumps are dominated by *Tsuga mertensiana, Abies amabilis, Chamaecyparis nootkatensis,* and/or *Abies lasiocarpa*. Distinguished from the next (more interior dry parkland) by the absence or paucity of *Pinus albicaulis* and *Larix lyallii* ...... **North Pacific Maritime Mesic Subalpine Parkland, page 89**

7b. Primarily occurring east of the Cascade crest, although disjunct occurrences are found in the northeastern Olympic Mountains; tree clumps dominated by *Pinus albicaulis,* woodlands of *Pinus albicaulis* or *Larix lyallii*. *Abies lasiocarpa* may also be present. ....**Northern Rocky Mountain Subalpine Woodland and Parkland, page 108**

8a. Forests dominated by *Pinus contorta var. latifolia*. *Populus tremuloides, Abies lasiocarpa* and *Picea engelmannii* may be present but are generally < 25% of tree canopy; dominance of *Pinus contorta* is related to fire history. Includes those stands which may succeed to spruce-fir forests. ....**Rocky Mountain Lodgepole Pine Forest, page 117**

8b. Forests typically dominated (> 25% of tree canopy) by one or more of these conifers: *Tsuga mertensiana, Abies lasiocarpa* and/or *Picea engelmannii,* sometimes with *Pinus contorta* var. *latifolia* codominating...**9**

9a. Forests west of or near the Cascade crest; *Tsuga mertensiana* > 5% cover, dominant to codominant, *Larix lyallii, Larix occidentalis, Pinus albicaulis,* or *Pinus monticola* < 5% cover............................... ....**North Pacific Mountain Hemlock Forest, page 99**

9b. Forests east of the Cascade crest; *Abies lasiocarpa* and/or *Picea engelmannii* dominant, sometimes with *Pinus contorta* var. *latifolia* codominating; *Tsuga mertensiana* < 5% cover..............................**10**

10a. Matrix subalpine conifer forests and woodlands of relatively dry environments; widespread in the Northern Rocky Mountains; *Pseudotsuga menziesii, Pinus contorta* var. *latifolia,* and *Larix occidentalis* can be present; important understory species include *Paxistima myrsinites, Vaccinium* *scoparium*, *Juniperus communis*, *Calamagrostis rubescens*, and *Carex geyeri*. .... **Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland, page 121**

10b. Large patch subalpine conifer forests and woodlands characteristic of relatively mesic local environments (e.g. north aspects or toe slopes), although may be matrix type. Mesic shrubs include *Menziesia ferruginea, Vaccinium membranaceum, Rhododendron albiflorum, Amelanchier alnifolia, Rubus parviflorus, Ledum glandulosum, Phyllodoce empetriformis*; forbs include *Actaea rubra, Maianthemum stellatum, Cornus canadensis, Erigeron eximius, Gymnocarpium dryopteris, Rubus pedatus, Saxifraga bronchialis, Tiarella* spp., *Lupinus arcticus ssp. subalpinus, Valeriana sitchensis*, and graminoids include *Luzula glabrata var. hitchcockii* or *Calamagrostis canadensis*....................... .... **Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland, page 125**

MONTANE, FOOTHILL AND COASTAL FORESTS AND WOODLANDS

11a. Conifer forests and woodlands within 25 km (15.5 miles) of the outer coast (not Puget Sound shoreline) and exposed to the salt spray or fog belt zone **12**

11b. Montane, foothill, or lowland forests and woodlands at least 25 km (15.5 miles) from coast; may occur along shorelines of Puget Sound or east of the Cascades **13**

12a *Picea sitchensis* > 10%, *Tsuga heterophylla and/or Thuja plicata* often codominant ....**North Pacific Seasonal Sitka Spruce Forest, page 80**

12b. *Picea sitchensis* <10% cover, *Thuja plicata* and *Tsuga heterophylla* can individually dominate or codominate stands, *Abies amabilis* is often present. Stands of *Thuja plicata* in the Olympic rain shadow (e.g., in the San Juan islands) are included in North Pacific Maritime Mesic-Wet Douglas-fir Western Hemlock system (page 71). ....**North Pacific Hypermaritime Western Hemlock-Western Red Cedar Forest, page 67**

13a. Woodlands and shrublands dominated by *Cercocarpus ledifolius*. Undergrowth is often very sparse and dominated by bunchgrasses, usually *Pseudoroegneria spicata* and *Festuca idahoensis*. .... **Inter-Mountain Basins Curl-leaf Mountain-mahogany Woodland and Shrubland, page 134**

13b. Woodland not dominated by *Cercocarpus ledifolius* **14**

14a. Forests mostly east of the Cascade crest, dominated by pure or mixed stands of *Pinus ponderosa*, *Juniperus occidentalis*, *Abies*, *grandis*, *Pseudotsuga menziesii*, *Larix occidentalis*, or *Pinus contorta* var. *latifolia* **15**

14b. Forests mostly west of or near the Cascade crest, dominated by pure or mixed stands of *Pseudotsuga menziesii*, *Thuja plicata, Tsuga heterophylla,* or *Abies amabilis* **23**

15a. Woodlands dominated by *Juniperus occidentalis*; limited to the eastern Columbia River Gorge (Klickitat County); *Pinus ponderosa* may be present ....**Columbia Plateau Western Juniper Woodland and Savanna, page 35**

15b. Conifer forests and woodlands not dominated by *Juniperus occidentalis*......................................**16**

16a. Forests dominated by *Pinus contorta var. latifolia*. *Populus tremuloides*, *Abies lasiocarpa* and *Picea engelmannii* may be present but are generally < 25% of tree canopy; dominance of *Pinus contorta* is related to fire history. Includes those stands which may succeed to spruce-fir forests. .... **Rocky Mountain Lodgepole Pine Forest, page 117**

16b. Other conifers are dominant or codominant with *Pinus contorta* var. *latifolia* **17**

17a. Foothill savannas and woodlands (open canopy) at or near lower tree line; *Pinus ponderosa* and *Pseudotsuga menziesii* are typically the only conifers present (alone or mixed); graminoids often dominate the understory **18**

17b. Montane forests (closed canopy) above lower tree line; canopies dominated by a mix or a few of the following species: *Pinus ponderosa*, *Pseudotsuga menziesii*, *Abies grandis*, *Tsuga heterophylla*, *Thuja plicata*, *Picea engelmannii*, *Larix occidentalis*, *Pinus monticola*, and *Pinus contorta* var. *latifolia* **19**

18a. Woodland to savanna that is substrate limited. Substrate will not support enough biomass to carry frequent fire. Occurs at the lower tree line ecotone typically on exposed, warm, dry, rocky or sandy sites that are too droughty to support a closed tree canopy. *Pinus ponderosa* and *Pseudotsuga menziesii* are the predominant conifers (not always together). *Larix occidentalis* can be abundant.................... .... **Northern Rocky Mountain Foothill Conifer Wooded Steppe, page 52**

18b. *Pinus ponderosa* is clear dominant species; other conifers, if present, are sparse; woodland to savanna maintained by fire. Inclusions of *Pseudotsuga menziesii* woodlands on cool aspects may be present. *Populus tremuloides* may be present, but is generally <25% of tree canopy. .... **Northern Rocky Mountain Ponderosa Pine Woodland and Savanna, page 55**

19a. *Larix occidentalis* dominates relatively open stands with canopy cover ranging 10-60%. *Pseudotsuga menziesii* or *Pinus contorta var. latifolia* may codominate. Shade-tolerant, more fire sensitive trees *Abies lasiocarpa*, *Picea engelmannii*, or *Abies grandis* can be common in the sub-canopy but are slow to establish on these sites and, given the fire-return intervals, rarely gain canopy dominance .... **Northern Rocky Mountain Western Larch Savanna, page 59**

19b Mixed conifer forests where *Larix occidentalis* does not dominate **20**

20a. Open to sparse cover of trees on (relatively) recent lava flows, excessively well-drained lahars, debris avalanches and pyroclastic flows near Mount Adams. With open to sparse tree cover; characteristic species include *Pseudotsuga menziesii, Pinus contorta, Pinus monticola*, and *Abies lasiocarpa*. Tree cover can range from scattered (5%) up to 70% or occasionally even more. Scattered to dense shrubs may be present including *Acer circinatum, Vaccinium membranaceum, Arctostaphylos uva-ursi* (very characteristic), *Mahonia nervosa, Amelanchier alnifolia*, and *Xerophyllum tenax*. Soil development is limited, and mosses and lichens often cover the soil or rock surface... .... **North Pacific Wooded Volcanic Flowage, page 62**

20b. Forests not as above **21**

21a. Forests dominated by a mix of *Pseudotsuga menziesii* with *Abies grandis* and/or *Tsuga heterophylla*. Several other conifers can dominate or codominate, including *Thuja plicata, Pinus contorta, Pinus monticola*, and *Larix occidentalis*. Stands are generally limited to mesic slopes and mesic "coves" which were historically protected from wildfires. Understory contains species typical of North Pacific flora such as *Acer circinatum*, *Achlys triphylla*, *Symphoricarpos hesperius*, and *Mahonia nervosa*.. .... **East Cascades Mesic Montane Mixed-Conifer Forest and Woodland, page 84**

21b. Mixed forests lacking North Pacific understory species; *Tsuga heterophylla* and *Thuja plicata* not present unless site occurs within the inland maritime zone of northeastern Washington................ **22**

22a. Mixed forests occurring in mesic land positions and cooler aspects dominated by *Abies grandis, Tsuga heterophylla*, *Thuja plicata*, and *Picea engelmannii*. *Pseudotsuga menziesii* commonly shares the canopy, and *Pinus monticola, Pinus contorta, Taxus brevifolia*, and *Larix occidentalis* are major associates. Mesic *Abies grandis* associations are included in this system, and *Abies grandis* is often the dominant in these situations; *Tsuga heterophylla* and *Thuja plicata* can both be absent. Key mesic understory species include *Asarum caudatum, Clintonia uniflora, Coptis occidentalis, Prosartes, Gymnocarpium dryopteris, Tiarella trifoliata, Trientalis borealis ssp. latifolia, Trillium ovatum, Viola glabella*................ **Northern Rocky Mountain Mesic Montane Mixed Conifer Forest, page 103**

22b. Dry mixed forests dominated by *Pseudotsuga menziesii* and *Pinus ponderosa* (there can be one without the other); *Pinus contorta, Pinus monticola, Larix occidentalis*, and *Abies grandis* are sometime present. Lacking the key mesic understory species listed above. *Calamagrostis rubescens* and *Carex geyeri* are common understory species. .... **Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest, page 48**

23a. Open forests of recent lava flows, excessively well-drained lahars, debris avalanches and pyroclastic flows. Characteristic species include *Pseudotsuga menziesii, Pinus contorta, Pinus monticola*, and *Abies lasiocarpa*. Tree cover can range from scattered (5%) up to 70% or occasionally even more. There may be scattered to dense shrubs present, such as *Acer circinatum, Vaccinium membranaceum, Arctostaphylos uva-ursi* (very characteristic), *Mahonia nervosa, Amelanchier alnifolia*, and *Xerophyllum tenax*. Soil development is limited, and mosses and lichens often cover the soil or rock surface .... **North Pacific Wooded Volcanic Flowage, page 62**

23b. Forests not as above **24**

24a. Forests of lowland, foothill, or lower montane zone. Dominated or codominated by *Pseudotsuga menziesii, Tsuga heterophylla* and/or *Thuja plicata*.. **25**

24b. Forests of upper montane; *Abies amabilis, Abies procera*, and/or *Tsuga mertensiana* dominant or codominant **27**

25a. Large to small patch forests limited to the Puget Trough. *Pseudotsuga menziesii* is dominant. *Arbutus menziesii, Pinus contorta* var. *contorta, Acer macrophyllum*, or *Abies grandis* may be codominant. Only small amounts of *Tsuga heterophylla* or *Thuja plicata* may be present...................................... .... **North Pacific Dry Douglas-fir Forest and Woodland, page 40**

25b. Forests of montane, foothill or lowland areas where *Tsuga heterophylla* and/or *Thuja plicata* are typically codominant with *Pseudotsuga menziesii*.. **26**

26a. Dry to mesic forests occurring as matrix; *Polystichum munitum* < 40% cover; overstory canopy is dominated by *Pseudotsuga menziesii*, with *Tsuga heterophylla* generally present in the subcanopy or as a canopy dominant in old-growth stands. *Abies grandis, Thuja plicata*, and *Acer macrophyllum* may be codominants. Dominant shrubs include *Gaultheria shallon, Mahonia nervosa, Rhododendron macrophyllum, Linnaea borealis, Achlys triphylla*, and *Vaccinium ovatum*. *Acer circinatum* is a common codominant. Comprises much of the lowland forests of western Washington...................... .... **North Pacific Maritime Dry-Mesic Douglas-fir-Western Hemlock Forest, page 71**

26b. Mesic forests, occurring as matrix or limited to moist microsites; *Polystichum munitum* > 40% cover; *Acer circinatum* is a very common codominant as a tall shrub; overstory canopy is dominated by *Tsuga heterophylla, Thuja plicata, Pseudotsuga menziesii*. *Pseudotsuga menziesii* is usually at least present to more typically codominant or dominant. *Acer macrophyllum* and *Alnus rubra* are commonly found in the canopy or subcanopy. Undergrowth is dominated by *Polystichum munitum* (>40% cover), *Oxalis oregana, Rubus spectabilis*, and *Oplopanax horridus*. *Gaultheria shallon, Mahonia nervosa, Rhododendron macrophyllum*, and *Vaccinium ovatum* are often present but are generally not as abundant as in the North Pacific Maritime Dry-Mesic Douglas-fir-Western Hemlock Forest. ....**North Pacific Maritime Mesic-Wet Douglas-fir-Western Hemlock Forest, page 71**

27a. Upper montane, *Tsuga mertensiana* >5% cover, dominant to codominant, *Abies amabilis* <5% cover. *Larix lyallii, Larix occidentalis, Pinus albicaulis*, or *Pinus monticola* <5% cover.............................. .... **North Pacific Mountain Hemlock Forest, page 99**

27b. Upper montane forests where *Abies amabilis* >5% cover and is typically dominant or codominant; mostly on west side but can spill over east of the Cascade crest; *Tsuga mertensiana* < 5 % cover **28**

28a. *Tsuga heterophylla* and/or *Abies amabilis* dominate, *Chamaecyparis nootkatensis* can be codominant. *Pseudotsuga menziesii* is relatively rare to absent. Understory dominated by *Vaccinium ovalifolium*. Other mesic to wet indicators that help distinguish this system from the next include *Oxalis oregana, Blechnum spicant*, and *Rubus pedatus* .... **North Pacific Mesic Western Hemlock-Silver Fir Forest, page 96**

28b. *Tsuga heterophylla* and/or *Abies amabilis* dominate the canopy of late-seral stands, and *Pseudotsuga menziesii* is usually common; *Chamaecyparis nootkatensis* can be codominant. *Abies procera* forests (usually mixed with *Abies amabilis*) are included in this system and occur in the Cascades from central Washington to central Oregon. *Vaccinium ovalifolium* may be present in moist microsites, but is not as abundant as above. Dry to mesic understory indicators include *Achlys triphylla*, *Mahonia nervosa, Xerophyllum tenax, Vaccinium membranaceum, Rhododendron macrophyllum*, and *Rhododendron albiflorum*. ...**North Pacific Dry-Mesic Silver Fir-Western Hemlock-Douglas-fir Forest, page 89**

KEY E: UPLAND SHRUBLANDS

1a. Alpine dwarf-shrublands (above upper treeline).. **2**

1b. Shrublands below upper tree-line **3**

ALPINE SHRUBLANDS

2a. Alpine and subalpine dwarf-shrublands, alpine tundra and fell fields in the Olympic and Cascade mountains. Commonly comprised of a mosaic of plant communities with characteristic species including *Cassiope mertensiana*, *Phyllodoce empetriformis*, *Phyllodoce glanduliflora*, *Luetkea pectinata*, *Saxifraga tolmiei*, and *Carex* spp.. .... **North Pacific Dry and Mesic Alpine Dwarf-Shrubland, Fell-field and Meadow, page 236**

2b. Alpine vegetation not as above, limited to east side of northern Cascades and western Okanogan Highlands; Dominated by *Dryas octopetala, Ledum glandulosum, Kalmia microphylla, Salix arctica, S. nivalis, S. petrophila, Salix reticulata*, and/or *Vaccinium* spp. ....**Rocky Mountain Alpine Dwarf-Shrubland, Fell-field, and Turf, page 239**

3a. Shrublands occurring mostly west of Cascade crest **4**

3b. Shrublands restricted to the eastside of the Cascade crest **8**

SHRUBLANDS WEST OF CASCADE CREST

4a. Sites are steep slopes on coastal bluffs, headlands, or small islands within the hypermaritime salt spray and fog zone; sometimes on relatively level tops of headlands or islands. Diagnostic species include *Gaultheria shallon, Vaccinium ovatum, Lonicera involucrata, Rubus spectabilis, Rubus parviflorus*, *Vaccinium alaskaense, Vaccinium ovalifolium*, *Festuca rubra*, *Calamagrostis nutkaensis*, *Elymus glaucus*, *Danthonia californica*, *Bromus sitchensis*, *Solidago canadensis*, *Lomatium martindalei*, *Vicia gigantea*, *Equisetum telmateia*, *Artemisia suksdorfii*, *Pteridium aquilinum* and *Blechnum spicant*. Scattered stunted trees such as *Picea sitchensis*, *Tsuga heterophylla*, *Pseudotsuga menziesii*, or *Alnus rubra* are often present. ....**North Pacific Hypermaritime Shrub and Herbaceous Headland, page 138**

4b. Lowland shrublands away from the hypermaritime salt spray and fog zone or montane or subalpine sites **5**

5a. Shrublands of steep slopes, either mass wasting or avalanche chutes **6**

5b. Shrublands in mountains or foothills, not on disturbed slopes **7**

6a. Shrublands of steep, frequently disturbed (e.g., snow or rock avalanches) slopes. Primarily on the west side of the Cascades, the major dominant species are *Acer circinatum, Alnus viridis ssp. sinuata, Rubus parviflorus*, and small trees, especially *Chamaecyparis nootkatensis*. Forbs, grasses, or other shrubs can also be locally dominant. *Prunus virginiana, Amelanchier alnifolia, Vaccinium membranaceum* or *Vaccinium scoparium*, and *Fragaria* spp. are common species on avalanche tracks on the east side of the Cascades..**North Pacific Avalanche Chute Shrubland, page 136**

6b. Deciduous shrubland that occur on steep slopes and bluffs subject to mass wasting, dominated by *Alnus rubra* and *Acer macrophyllum* are the major tree species. *Rubus spectabilis, Rubus parviflorus, Ribes bracteosum*, and *Oplopanax horridus* are some of the major shrub species. .... **North Pacific Broadleaf Landslide Forest and Shrubland, page 64**

7a. Shrublands of recently logged areas, tree stumps evident, shrub species present were once the understory shrub canopy and now exposed, i.e. shrubs were present prior to logging, not early seral, recent growth shrubs; typical shrub species of the matrix forested systems of the west slope include *Gaultheria shallon, Holodiscus discolor, Linnaea borealis, Mahonia nervosa, Menziesia ferruginea, Paxistima myrsinites, Polystichum munitum, Pteridium aquilinum, Rhododendron macrophyllum, Vaccinium membranaceum, V. ovatum, V. ovalifolium, V. parvifolium, Mahonia nervosa, Blechnum spicant*, and *Oxalis oregana* ....**Use Key D (page 25), based on conifers species that once comprised the tree canopy.**

7b. Long-lived, post-fire shrublands on ridge tops and upper to middle slopes, more common on sunny southern aspects. Species composition is highly variable, and some of most common species include *Acer circinatum, Vaccinium membranaceum, Ceanothus velutinus, Holodiscus discolor, Xerophyllum tenax* and *Rubus parviflorus;* huckleberry fields near Mount Adams are an example........................... .... **North Pacific Montane Shrubland, page 141**

Shrublands East of Cascade Crest

8a. Shrublands dominated by *Cercocarpus ledifolius*. Undergrowth is often very sparse and dominated by bunchgrasses, usually *Pseudoroegneria spicata* and *Festuca idahoensis*. *Comata*. .... **Inter-Mountain Basins Curl-leaf Mountain-mahogany Woodland and Shrubland, page 134**

8b. Shrubland not dominated by *Cercocarpus ledifolius*..**9**

9a. Montane or subalpine shrub-steppe dominated or codominated by *Artemisia tridentata* ssp. *vaseyana* and related taxa such as *Artemisia tridentata* ssp. *spiciformis (= Artemisia spiciformis)*. *Purshia tridentata* may co-dominate some stands. Other common shrubs include *Symphoricarpos* spp., *Amelanchier* spp., *Ericameria nauseosa, Ribes cereum*, and *Chrysothamnus viscidiflorus*. *Festuca*

idahoensis and *F. campestris* typically present ....
.... **Inter-Mountain Basins Montane Sagebrush Steppe, page 162**

9b. Shrublands or shrub-steppe not dominated or codominated by *Artemisia tridentata ssp. vaseyana* . **10**

10a. Low shrublands dominated by *Artemisia arbuscula*, typically on mountain ridges and flanks and broad terraces; surrounded by *Pseudotsuga menziesii* and *Pinus ponderosa* forests. Substrates are shallow and fine-textured but almost always very stony. *Artemisia rigida*, *Artemisia tridentata* ssp. *wyomingensis* or *vaseyana*, *Purshia tridentata* and *Eriogonum* spp. can also be present. *Festuca idahoensis*, *Poa secunda*, *Pseudoroegneria spicata*, and *Koeleria macrantha*. Other shrubs and dwarf-shrubs present may include. .... **Columbia Plateau Low Sagebrush Steppe, page 153**

10b. Shrubland or shrub-steppe not dominated by *Artemisia arbuscula* **11**

11a. Open dwarf-shrub canopy dominated by *Artemisia rigida* and/or woody *Eriogonum* species (*E. compositum, douglasii, sphaerocephalum, strictum* or *thymoides*). Some sites can be dominated by grasses and semi-woody forbs, such as *Stenotus stenophyllus*. More than a presence of other *Artemisia* species besides *A. rigida* indicates a different ecological system. Bunchgrass cover is low and primarily limited to *Poa secunda*. The substrate is rocky and/or soils are very shallow ....
.... **Columbia Plateau Scabland Shrubland, page 130**

11b. Shrubland or shrub-steppe not dominated by *Artemisia rigida* and/or woody *Eriogonum* species (*compositum, douglasii, sphaerocephalum, strictum* or *thymoides*) **12**

12a. Open shrub to moderately dense woody layer dominated by *Grayia spinosa* or *Krascheninnikovia lanata* with *Ericameria nauseosa. Artemisia tridentata* may be present but typically does not dominate, although it will increase with disturbance. On stonier sites, *Salvia dorrii* can be present to common. Graminoids are >25% cover but rarely closed. Characteristic grasses include *Achnatherum hymenoides, A. thurberiana, Elymus elymoides, Poa secunda, Sporobolus airoides,* and *Hesperostipa comata*. ....**Inter-Mountain Basins Semi-Desert Shrub-Steppe, page 165**

12b. Not as above **13**

13a. Shrub-steppe of below lower treeline within the Columbia Basin **14**

13b. Shrublands above lower treeline within montane regions **15**

14a. Absence or very low cover (<10%) of deep-rooted, fire intolerant shrubs over large areas; dominated by perennial bunch grasses and forbs (>25% cover) sometimes with a sparse (<10% cover) shrub layer; Sites are located within the shrub-steppe zone of the central Columbia Basin; these grasslands occur over large areas, occasionally entire landforms, and is an alternative state of the Inter-Mountain Basins Big Sagebrush Steppe ecological system type where frequent fire (< 20 years) or fire severity results in a grassland. However, *Chrysothamnus viscidiflorus, Ericameria nauseosa, Tetradymia* spp., or *Artemisia* spp. may be present in disturbed stands. Associated graminoids include *Achnatherum hymenoides, Achnatherum thurberianum, Elymus elymoides, E. lanceolatus ssp. lanceolatus, Hesperostipa comata, Festuca idahoensis, Koeleria macrantha, Poa secunda*, and *Pseudoroegneria spicata*. .... **Columbia Plateau Steppe and Grassland, page 176**

14b. Mosaic of open to moderately dense (5-30% cover) shrub layer and with > 25% total perennial herbaceous cover. Dominant species include.*Artemisia tridentata ssp. tridentata*, *A. tridentata ssp. xericensis, A. tridentata ssp. wyomingensis, A. tripartita ssp. tripartita*, and/or *Purshia tridentata*. Associated graminoids can include *Pseudoroegneria spicata, Poa secunda, Poa cusickii, Koeleria macrantha Hesperostipa comata*, and *Achnatherum thurberiana*. The natural fire regime of this ecological system likely maintains a patchy distribution of shrubs, so the general aspect of the vegetation can be that of a grassland;...... **Inter-Mountain Basins Big Sagebrush Steppe, page 156**

15a. Shrubland occurs on the lower portions and runout zones of avalanche tracks throughout the northern Rocky Mountains in northeastern Washington. Slopes are generally steep and sites are mesic to wet. Stands are composed of a moderately dense, diverse mix of dwarfed and snow-damaged conifers and small, deciduous trees/shrubs. Characteristic species include *Abies lasiocarpa, Acer glabrum, Alnus viridis ssp. sinuata* or *Alnus incana, Populus balsamifera ssp. trichocarpa, Populus tremuloides*, or *Cornus sericea*. Other common woody plants include *Paxistima myrsinites, Sorbus scopulina*, and *Sorbus sitchensis*. Ground cover is moderately dense to dense with mesic forbs. .... **Northern Rocky Mountain Avalanche Chute Shrubland, page 145**

15b. Shrublands not in avalanche chutes **15**

15a. Shrubland occurs within a matrix of continuous forest in the upper montane and lower subalpine zones. Dominated by *Menziesia ferruginea, Rhamnus alnifolia, Ribes lacustre, Rubus parviflorus, Alnus viridis, Rhododendron albiflorum, Sorbus scopulina, Sorbus sitchensis, Vaccinium myrtillus, V. scoparium*, and *V. membranaceum*; these occurring alone or in any combination. Other shrubs can include *Shepherdia canadensis* and *Ceanothus velutinus* .... **Northern Rocky Mountain Subalpine Deciduous Shrubland, page 150**

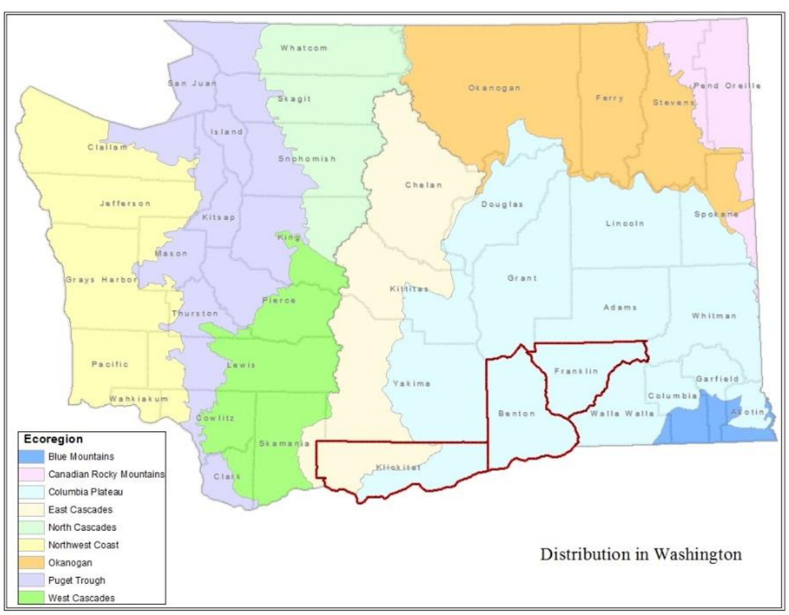
15b. Shrublands of lower montane and foothill zones dominated by *Physocarpus malvaceus, Spiraea douglasii, Amelanchier alnifolia, Prunus emarginata, P. virginiana, Holodiscus discolor*; in more mesic areas, *Symphoricarpos albus, Menziesia ferruginea, Crataegus douglasii*, or *Rosa* spp. can be predominant; typically occurring around the fringes of the Columbia Basin and in northeastern Washington....... **Northern Rocky Mountain Montane-Foothill Deciduous Shrubland, page 147**

COLUMBIA PLATEAU WESTERN JUNIPER WOODLAND AND SAVANNA

Concept: Woodlands and savannas dominated by *Juniperus occidentalis* ranging from eastern Klickitat, southern Benton and Franklin counties. These sites are restricted to areas with excessively drained soils, such as sand dunes, rock outcrops or escarpments.

Conservation Status: Vulnerable (S3S4). The system is uncommon. It is not clear if it occurred in the state prior to European settlement (~1850) but now appears to be increasing, possibly due to fire suppression and grazing. However, suitable habitat is limited by agriculture.

Distribution: Within Washington the system is scattered in eastern Klickitat, southern Benton and Franklin counties. The system may occur along the mid-length of a few drainages flowing into the Columbia River. Outside of Washington, it occurs as a large patch system along the northern and western margins of the Great Basin, from southwestern Idaho, along the eastern foothills of the Oregon Cascades, and south to the Modoc Plateau of northeastern California. Mapped occurrences (Sayre et al. 2009) are too small to be visible at the scale of the map below, thus the map displays the counties in which the system is known to occur.



Environment: Across its global range, average annual precipitation ranges from approximately 10 to 13 inches (25 to 33 cm), with most occurring as winter snow. Generally soils are medium-textured, with abundant coarse fragments, and derived from volcanic parent materials.

Vegetation: *Juniperus occidentalis* is the dominant tree species, although *Pinus ponderosa* and *Quercus garryana* may be present in some stands. *Artemisia tridentata* is the most common shrub; others are *Purshia tridentata*, *Ericameria nauseosa*, *Chrysothamnus viscidiflorus*, *Ribes* *cereum*, and *Tetradymia* spp. Graminoids include *Carex filifolia, Festuca idahoensis, Poa secunda*, and *Pseudoroegneria spicata*.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system:

G248 Columbia Plateau Western Juniper Woodland & Savanna Group	Global/ State Rank	NatureServe/ WNHP Code
Juniperus occidentalis / Artemisia tridentata / Festuca idahoensis Wooded Herbaceous Vegetation	G3/S1	CEGL001720
Juniperus occidentalis / Artemisia tridentata / Pseudoroegneria spicata Wooded Herbaceous Vegetation	G3G4/SNR	CEGL001721
Juniperus occidentalis / Festuca idahoensis Wooded Herbaceous Vegetation	G2/SNR	CEGL001724
Juniperus occidentalis / Pseudoroegneria spicata Wooded Herbaceous Vegetation	G3/SNR	CEGL001728

Ecological Processes: These woodlands are composed of two very different types. There are old-growth *Juniperus occidentalis* woodlands with trees and stands often over 1,000 years old, with fairly well-spaced trees with rounded crowns. The second woodland type includes large areas where juniper has expanded into sagebrush steppe and bunchgrass-dominated areas (mostly due to fire suppression), with young, pointed-crowned trees growing closely together. The latter type is what is found in Washington. Western juniper is not tolerant of fire, thus these woodlands are generally restricted to rocky areas where fire frequency is natural low or in areas where fire suppression has occurred. A higher fire frequency can result in juniper dominated savannas. A fire-return interval of 30-50 years typically arrests juniper invasion and maintains savanna like structure.

Threats: Over the past 150 years, with fire suppression, overgrazing, and changing climatic factors, western juniper stands have become denser (i.e. less herbaceous understory) and this system has expanded its range into adjacent shrub-steppe, grasslands, and savannas. Thus, the elimination of periodic low-intensity fires has degraded existing juniper woodlands while also allowing expansion of this same type into other ecological systems.

Classification Comments: These woodlands are dominated by *Juniperus occidentalis* as the only tree species although *Pinus ponderosa* or *Quercus garryana* may be present.

Related Concepts: This ecological system falls within the Western Juniper and Mountain Mahogany Woodlands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the Columbia Plateau Western Juniper and Savanna as one of their standard mapping units.

References

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

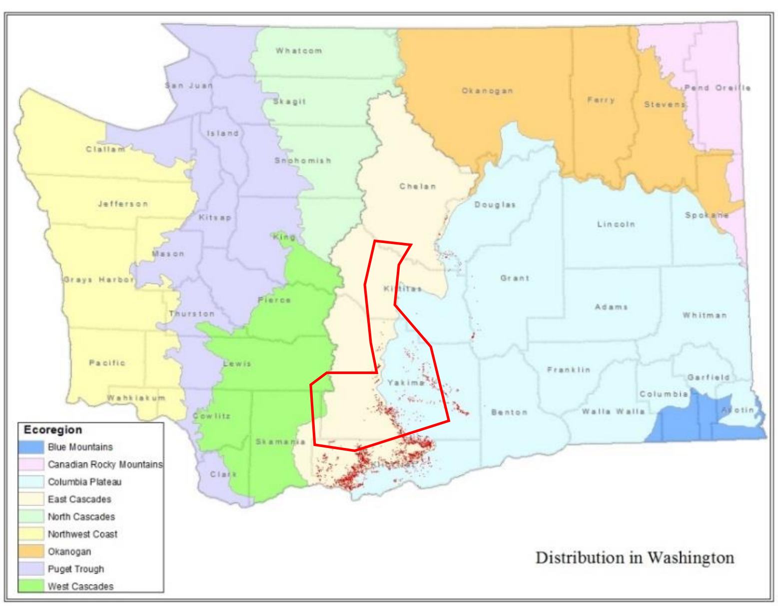
Description Author: Rex Crawford, NatureServe Western Ecology Team

EAST CASCADES OAK-PONDEROSA PINE FOREST AND WOODLAND

Concept: Forests and woodlands dominated by a mix of *Quercus garryana* and *Pinus ponderosa* or *Pseudotsuga menziesii* at or near lower treeline in the foothills of the Eastern Cascades and eastern Columbia River Gorge.

Conservation Status: Critically Imperiled (S1S2). The system has a limited distribution in Washington and has been subjected to changes in ecological integrity resulting from grazing and fire suppression. Within the drier portions of the system, a cycle of overgrazing and increased fire results in oak sprouting and a subsequent increase in overall canopy density thereby reducing or even eliminating understory species. Within the mesic portions of the system, fire suppression results in an increase in conifer density. Increased fire frequency can result in an increased abundance of exotic grasses.

Distribution: This narrowly restricted matrix ecological system appears at or near lower treeline in foothills of the eastern Cascades in Washington and Oregon within 65 km (40 miles) of the Columbia River Gorge. The map below is based on NatureServe's Ecological System map (Sayre et al. 2009). However, that map models the systems' distribution beyond the area within which it actually occurs (i.e. red polygon) in Washington. Disjunct occurrences in Klamath and Siskiyou counties, Oregon, have more sagebrush and bitterbrush in the understory, along with other shrubs. In the Columbia River Gorge, this system appears as small to large patches in transitional areas in the Little White Salmon and White Salmon river drainages in Washington and Hood River, Rock Creek, Mosier Creek, Mill Creek, Three-mile Creek, Fifteen Mile Creek, and White River drainages in Oregon.



DRY FORESTS & WOODLANDS

Environment: This system dominates in areas between shrub steppe at lower elevations and conifer-dominated woodlands or forests at higher elevations. The system occurs on slopes ranging from steep, lower slopes to more moderate slopes on dry benches. Substrates are usually very gravelly, stony coarse loams derived from basalt colluvium. Elevations range from 460 to 1920 m.

Vegetation: Most occurrences of this system are dominated by a mix of *Quercus garryana* and *Pinus ponderosa* or *Pseudotsuga menziesii*. Scattered *Pinus ponderosa* or *Pseudotsuga menziesii* can comprise the upper canopy over *Quercus garryana* trees but these only occur in favorable microsites and do not regenerate well. Clonal *Quercus garryana* can create dense patches across a grassy landscape or can dominate open woodlands or savannas. The understory may include dense stands of shrubs or, more often, be dominated by grasses, sedges or forbs. Shrub-steppe shrubs including *Purshia tridentata*, *Artemisia tridentata*, *Artemisia nova* (the latter is not in Washington), and *Chrysothamnus viscidiflorus* may be prominent in some stands and create a distinct tree / shrub / sparse grassland habitat. Understories are generally dominated by herbaceous species, especially graminoids. Mesic sites have an open to closed sodgrass dominated by *Calamagrostis rubescens, Carex geyeri, Carex rossii, Carex inops*, or *Elymus glaucus*. Drier savanna and woodland understories typically contain bunchgrass steppe species such as *Festuca idahoensis* or *Pseudoroegneria spicata*. Common exotic grasses that often appear in high abundance are *Bromus tectorum, Cynosurus echinata* and *Poa bulbosa*. *Quercus garryana* can create dense patches often associated with grassland or shrubland balds within a closed *Pseudotsuga menziesii* forest landscape. Commonly the understory is shrubby and composed of *Ceanothus integerrimus*, *Holodiscus discolor, Symphoricarpos albus*, and *Toxicodendron diversilobum* and is similar to the North Pacific Oak Woodland ecological system.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system:

G206 Cascadian Oregon White Oak - Conifer Forest & Woodland Group	Global/ State Rank	NatureServe/ WNHP Code
Pinus ponderosa - Quercus garryana / Carex geyeri Woodland	G2G3/S2S3	CEGL000882
Pinus ponderosa - Quercus garryana / Purshia tridentata Woodland	G3/S2	CEGL000883
Pinus ponderosa - Quercus garryana / Symphoricarpos albus Woodland	G2G3/S2S3	CEGL000884
Quercus garryana / Carex geyeri Woodland	G1G2/S1S2	CEGL000549
Quercus garryana / Festuca idahoensis Woodland	G1?/S1	CEGL000551
Quercus garryana / Pseudoroegneria spicata Woodland	G1G2/S1S2	CEGL000552

Ecological Processes: Fire plays an important role in creating vegetation structure and composition in this ecological system. In the past, most of the habitat experienced frequent, low-severity fires (5-30 year return interval) that maintained woodland or savanna conditions. The mean fire-return interval is 20 years, although it is variable. Decades of fire suppression have led to invasion by *Pinus ponderosa* along lower treeline and invasion by *Pseudotsuga menziesii* in the Columbia River Gorge and other oak patches on xeric sites in the East Cascade foothills. Soil drought also plays a role, maintaining an open tree canopy in part of this dry woodland habitat. Fire severity increases with density of understory shrubs and canopy trees. Increasing timber harvest or altered fire regime can result in lower densities of large live trees and increasing dominance of smaller size classes and sprouting oak clumps resulting in denser stands. In Klickitat County, dense stands of stunted oak indicate effects of fire exclusion in this community type (M. Vander Haegen, WDFW; pers. comm. 9/2/2010 as cited in Evans 2010). Where this system occurs on river terraces and other more mesic sites, fuel loads are increased and a mixed severity fire regime prevails, with return intervals of 50-60 years. Thus, canopy cover can both increase or decrease outside the historical range of variability due to altered fire regime, timber harvest, and grazing.

Threats: With fire suppression, many oak-pine woodlands have been invaded by a greater density and cover of oak and conifer trees. Fire suppression has also increased shrub cover in many oak woodlands leading to the development of fuel ladders. Some areas have been lost to urban or agriculture development. Conifer encroachment can occur in wetter sites, such as the White Salmon River drainage, but for the most part is not a significant stressor in this system. Improper grazing can result in the replacement of native bunchgrasses with nonnative species such as *Bromus tectorum, Poa bulbosa,* or *Cynosurus echinatus*. Some stands have been harvested for firewood and fenceposts. Logging and grazing have created scrub-like stands of oak, which are more susceptible to stand-replacement fires.

Classification Comments: The presence of *Quercus garryana* generally mixed with *Pinus ponderosa* or *Pseudotsuga menziesii* distinguishes this ecological system type. The Little White Salmon drainage near Augspurger Mountain is the transition area between North Pacific Oak Woodland and this system (Dog Mountain is the westernmost occurrence of this system in Washington). East Cascades oak-pine differ from Westside oak in that easterly sites respond more positively (in terms of growth) to minimum temperatures in the spring and in the fall than other Oregon white oaks west of the Cascade Mountains. (Maertens 2008). Eastside oak have a positive growth response to previous year spring and summer precipitation whereas many Westside stands have the opposite relationship (Maertens 2008). Oak types associated with wetlands or riparian areas are not included here. They are associated with the North Pacific Lower Riparian Forest and Shrubland or Columbia Basin Foothill Riparian Woodland and Shrubland ecological systems.

Related Concepts: This ecological system falls within the Ponderosa Pine Forest and Woodland habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the East Cascades Oak-Ponderosa Pine Forest and Woodland as one of their standard mapping units.

References

Evans, J. 2010. Transitional Woodland Viability Assessment. Arid Lands Initiative Conservation Action Plan. The Nature Conservancy, Wenatchee, WA.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Maertens, T.B. 2008. The Growth-Climate Relationship of Oregon White Oak (Quercus garryana). M.S. Thesis, University of Guelph. Guelph, Ontario.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Description Author: Rex Crawford, Gwen Kittel, Chris Chappell, and Marion Reid

DRY FORESTS & WOODLANDS

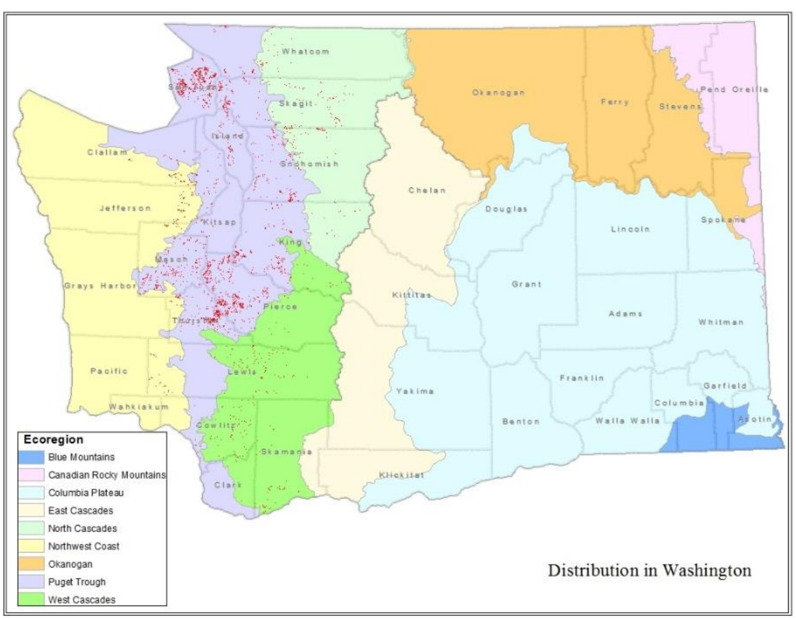
NORTH PACIFIC DRY DOUGLAS-FIR FOREST AND WOODLAND

Concept: Forests or woodlands primarily dominated by *Pseudotsuga menziesii* on dry soils within relatively dry to mesic climatic west of the Cascade crest. *Arbutus menziesii*, *Pinus contorta*, and *Abies grandis* cam be co-dominant..

Conservation Status: Imperiled (S2). Most of this system's range is within the Puget lowlands where the majority of the state's population lives and where land conversion rates are high.

Distribution: The North Pacific Dry Douglas-fir Forest and Woodland is a large and small patch system. In Washington, it occurs in the Puget lowlands, west slope of the Cascades and lee side of the Olympic Mountains.

Environment: The system occurs on dry soils within relatively dry to mesic climatic areas west of the Cascades. The vast majority of precipitation comes as rain during winter months and summer drought is the norm. Historically, this system was either a part of larger forested landscapes (mostly with the North Pacific Maritime Dry-Mesic Douglas-fir Western Hemlock Forest system) or occupied sheltered topographic positions in prairie-dominated landscapes (along with the North Pacific Oak Woodland and/or Willamette Valley Upland Prairie and Savanna system). The North Pacific Dry Douglas-fir Forest and Woodland system now also occurs on some sites that formerly supported prairies or tall shrublands (*Corylus cornuta*) with scattered trees.



Vegetation: This is a forest or woodland system primarily dominated by *Pseudotsuga menziesii*. A discontinuous emergent layer of old *Pseudotsuga menziesii* often appears above a more continuous canopy layer of trees in moderately open stands that survived for several centuries in the presence of repeated fires

(Chappell and Giglio 1999). *Arbutus menziesii*, *Pinus contorta* var. *contorta*, *Acer macrophyllum*, and *Abies grandis* are local dominant or co-dominant species. *Abies grandis* can be an important subcanopy or sapling tree. The understory consists of one or more dry-site shrub species such as *Holodiscus discolor, Corylus cornuta* var. *californica*, *Symphoricarpos albus*, or *Mahonia nervosa*, and the graminoid species *Festuca occidentalis* (Chappell 2004).

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Groups and Associations that are associated with this ecological system:

G205 Vancouverian Dry Coastal & Lowland Beach Pine Forest & Woodland	**Global/ State Rank**	**NatureServe/ WNHP Code**
Pinus contorta var. contorta - Pseudotsuga menziesii / Cladina spp. Forest	G2/S1?	CEGL003375
Pinus contorta var. contorta / Gaultheria shallon Forest	G1G2/S1	CEGL000150
G800 Southern Vancouverian Dry Douglas-fir - Madrone Woodland Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Arbutus menziesii - Pinus contorta / Gaultheria shallon Forest	GNRQ/SNR	CEGL000132
Arbutus menziesii / Arctostaphylos columbiana Woodland	G2/S1	CTWA003374
Pseudotsuga menziesii - Abies grandis / Symphoricarpos albus / Melica subulata Forest	G1?/S1	CEGL003350
Pseudotsuga menziesii - Arbutus menziesii / Gaultheria shallon Forest	G3/S2	CEGL000421
Pseudotsuga menziesii - Arbutus menziesii / Vicia americana Forest	G1G2Q/S1S2	CEGL000422
Pseudotsuga menziesii / Corylus cornuta / Polystichum munitum Forest	G1/S1	CEGL002616
Pseudotsuga menziesii / Gaultheria shallon - Holodiscus discolor Forest	G2G3/S2	CEGL000436
Pseudotsuga menziesii / Rosa gymnocarpa - Holodiscus discolor Forest	G2G3/S2	CEGL000456
Pseudotsuga menziesii / Symphoricarpos albus - Holodiscus discolor Forest	G1/S1	CEGL000460

Ecological Processes: Historically, this system experienced moderately frequent, low to mixed-severity fires that resulted in multiple cohort stands, with both even-aged and uneven-aged stands and a diversity of biological legacies (Chappell and Giglio 1999; Van Pelt 2007). LANDFIRE(2007) modeled this as a fire regime III system with 75% in late-seral structure (45% open), 20% mid-seral and 5% early seral in pre-settlement condition. In the Puget Trough, post-fire age classes are commonly 50–70, 110–140 and 250 or more years (Chappell and Giglio 1999). In the Elwha drainage of the Olympic Mountains the mean fire return interval is reported to be 99 years (Wendel and Zabowski 2010). Sites are too dry and warm or have been too frequently and extensively burned for anything more than small amounts of *Tsuga heterophylla* or *Thuja plicata* to be present. *Arbutus menziesii* dominance is favored by high-severity fires, and *Pseudotsuga menziesii* can be locally eliminated by logging and hot fire or repeated high-severity fires. Catastrophic winds, laminated root rot, Douglas-fir bark beetle, and other pathogens create gaps in the canopy creating heterogeneous stand structure.

Threats: Since European settlement, development, timber harvest, road building, fire suppression, tree plantations and introduced diseases have all impacted natural disturbance regimes, forest structure, composition, landscape patch diversity, and tree regeneration. Development has fragmented the landscape changing fire regime and connectivity of this small patch system particularly in lowlands. Timber harvest operations change canopy structural complexity and abundance of large woody debris of individual stands and has altered whole landscape patch pattern, age and structural complexity (Van Pelt 2007). Plantation

forestry has changed local tree gene pools, horizontal arrangement of trees and homogenized the diversity of tree sizes. Fire exclusion has likely increased tree density, increased *Tsuga heterophylla* or *Thuja plicata* importance, and created environments favoring deciduous shrubs rather than a grassy understory. Other effects include loss of early seral shrub species, advanced stand development, increased stand density, and increased tree mortality. Older logged areas can support dense, stagnating second growth with root rot (Arno 2000). Moderate to heavy grazing or other significant ground disturbance leads to increases in non-native invasive species, many of which are now abundant in stands with grassy or formerly grassy understories. Exotic herbaceous invaders include *Agrostis capillaris*, *Holcus lanatus*, *Poa pratensis*, *Arrhenatherum elatius*, *Bromus rigidus*, *Dactylis glomerata*, *Cynosurus echinatus*, *Festuca arundinacea*, and *Hypericum perforatum*.

Classification Comments: This system is characterized by having an overstory of *Pseudotsuga menziesii*, *Arbutus menziesii*, and/or *Pinus contorta* along with an understory consisting of dry indicator shrub species. *Tsuga heterophylla* and *Thuja plicata* are absent or inconspicuous.

Related Concepts: This ecological system falls within the Westside Oak and Dry Douglas-fir Forest and Woodlands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the North Pacific Dry Douglas-fir-(Madrone) Forest and Woodland as one of their standard mapping units.

References

Chappell, C.B. 2004. Upland Plant Associations of the Puget Trough Ecoregion, Washington. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. Online: http://www1.dnr.wa.gov/nhp/refdesk/communities/index.html

Chappell, C. B., and D. F. Giglio. 1999. Pacific madrone forests of the Puget Trough, Washington. Pages 2-11 in Adams, A. B., and C. W. Hamilton, eds. The decline of Pacific madrone (Arbutus menziesii Pursh): current theory and research directions. Center for Urban Horticulture, Univ. of Wash., Save Magnolia's Madrones, and Ecosystems Database Development and Research, Seattle, Washington. 146 pp.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

LANDFIRE. 2007. Biophysical Setting Model 0110350: North Pacific Dry Douglas-fir Forest. Rapid Assessment Biophysical Settings Model Descriptions.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Wendel, R., and D. Zabowski. 2010. Fire History within the lower Elwha Watershed, Olympic national Park. Northwest Science 84(1):88-97.

Van Pelt, R. 2007. Identifying Old trees and Forests in Eastern Washington. WA. Dept. Natural Resources, Olympia WA. 169p.

Description Author: Rex Crawford and Chris Chappell

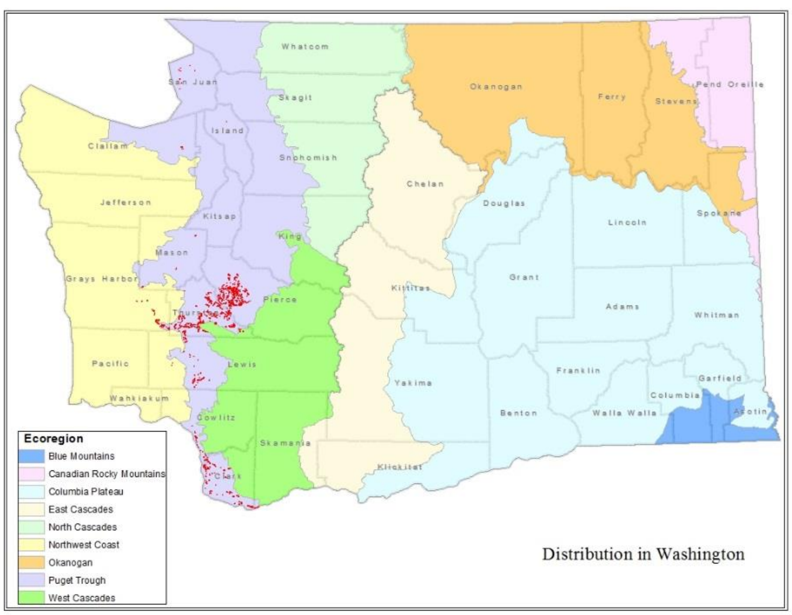
DRY FORESTS & WOODLANDS

NORTH PACIFIC OAK WOODLAND

Concept: *Quercus garryana* dominated to co-dominated forests and woodlands associated with dry, predominantly low-elevation sites and/or sites that experienced frequent presettlement fires. Oak types associated with wetlands and riparian areas are part of the North Pacific Lowland Riparian Forest and Shrubland ecological system.

Conservation Status: Critically Imperiled (S1). These oak woodlands are relatively limited in area and are currently declining in extent and condition. Most loss of ecological integrity occurred over the past 100 years Exotic grasses and shrubs have altered composition rangewide, and conifers have invaded and suppressed oaks due to fire suppression. Fires suppression has also resulted in increased stem density of oaks at many sites. Urbanization has occurred in and around occurrences.

Distribution: This is a large and small patch system which occurs primarily in the Puget Trough and Willamette Valley. In Washington, this oak woodland is most abundant on gravelly outwash plains in Thurston and Pierce counties but is found on dry sites that experienced frequent presettlement fires in other parts of the Puget Trough, especially within the rain shadow of the Olympic Mountains. The distribution map is based on Chappell et al. (2001) and pixels are exaggerated in size to make them more visible.



Environment: In Washington, this oak woodland is most abundant on gravelly outwash plains in Thurston and Pierce counties but is found on dry sites that experienced frequent presettlement fires in other part of the Puget Trough. In the northern portion of the Puget lowlands, this system is generally restricted to areas strongly affected by the Olympic Mountains rain shadow.

In the Willamette Valley, soils are mesic yet well-drained, and the type is clearly large patch in nature. It occurs on various soils in the interior valleys of the Klamath Mountains, and on shallow soils of "bald hills" toward the coast.

Vegetation: The vegetation ranges from woodland to forest dominated to co-dominated by *Quercus garryana*. Codominance by the evergreen conifer *Pseudotsuga menziesii* is common, and *Pinus ponderosa* is important in some stands. *Acer macrophyllum*, *Cornus nuttallii*, and *Fraxinus latifolia* are common associates in moister sites while *Arbutus menziesii*, *Pinus ponderosa*, and occasionally *P. contorta* are common in more xeric sites. In Washington, *Pinus ponderosa* is rare but important in some Pierce County stands. Understory species are diverse and today include many non-native and native increaser species (i.e. native species that respond favorably due anthropogenic disturbances). Native shrubs such as *Symphoricarpos albus*, *Holodiscus discolor*, *Rosa* spp., *Mahonia aquifolium, Amelanchier alnifolia*, *Oemleria cerasiformis*, and the nonnative shrub *Cytisus scoparius* are common. Under natural fire regimes, some sites (moist or otherwise protected sites) have naturally high relative cover of shrubs (up to 60%) while other sites typically have less than 10% cover of shrubs (LANDFIRE 2007). Native grass species such as *Festuca roemeri*, *Carex inops* ssp. *inops*, *Bromus carinatus*, *Danthonia californica*, and *Elymus glaucus* and nonnative species such as *Arrhenatherum elatius, Dactylis glomerata, Holcus lanata*, and *Poa pratensis*, are common components to oak woodlands. Native forbs such as *Camassia quamash, Vicia americana*, *Galium aparine*, *Fragaria vesca*, *Lomatium utriculatum* and nonnative forbs such as *Hypericum perforatum, Hypochaeris radicata*, and *Plantago lanceolata* are also conspicuous components to these oak woodlands. Oak woodlands also support distinctive epiphytic species as compared to other habitats throughout its range. In the Willamette Valley, over 100 species of epiphytic and terrestrial lichen and bryophytes have been documented in Oregon white oak forests (Pike 1973).

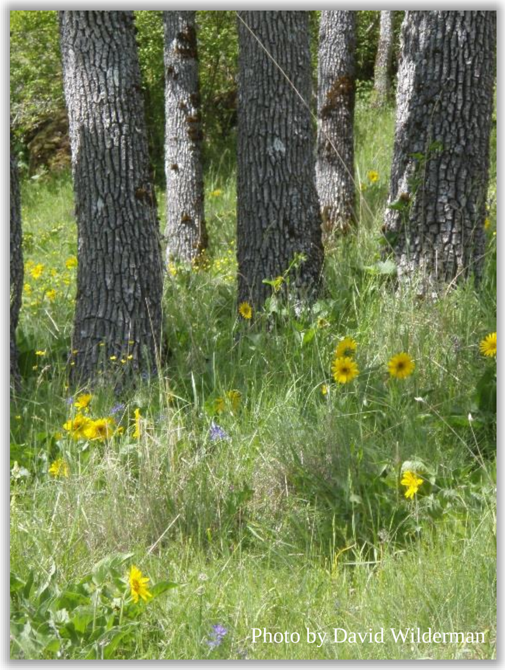
USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system:

G206 Cascadian Oregon White Oak - Conifer Forest & Woodland Group	Global/ State Rank	NatureServe/ WNHP Code
Pseudotsuga menziesii - Quercus garryana / Melica subulata Forest	G1G2/S1	CEGL003355
Pseudotsuga menziesii - Quercus garryana / Symphoricarpos albus Woodland	G2G3/S2S3	CEGL000929
Pseudotsuga menziesii - Quercus garryana / Toxicodendron diversilobum Woodland	G3/S2?	CEGL000928
Quercus garryana / Carex inops - Camassia quamash Woodland	G1/S1	CEGL000548
Quercus garryana / Symphoricarpos albus / Carex inops Woodland	G2/S1	CEGL003358
Quercus garryana / Toxicodendron diversilobum / Elymus glaucus Woodland	G2/S1	CEGL000932
Quercus garryana / Viburnum ellipticum - Toxicodendron diversilobum Woodland	G1/S1	CEGL003354
Quercus garryana Forest [Placeholder]	G2Q/S1	CEGL000547

Ecological Processes: Even where more environmentally limited, the system is strongly associated with a pre-European settlement (~1850), low-severity fire regime. Succession in the absence of fire tends to favor increased shrub dominance in the understory, increased tree density, and increased importance of conifers, with the end result being conversion to a conifer forest. Dissemination of acorns by squirrels and chipmunks is thought to be the most important long-distance dispersal mechanism.

Threats: This habitat is relatively limited in area and is currently declining in extent and condition. With the cessation of regular burning 100-130 years ago, many oak woodlands have been invaded by a greater density of trees and thus converted to a different habitat. Fire suppression has also increased shrub cover in many oak woodlands. Some areas have been lost to urban or agriculture development. Ongoing threats include residential development, increase and spread of exotic species, and fire suppression effects (the latter especially in oak-dominated stands). Moderate to heavy grazing can lead to an increase in non-native species, many of which are now abundant. Removal of *Quercus garryana* trees for firewood, fence posts, and other lumber products has and continues to occur in some areas. Selective logging of *Pseudotsuga menziesii* in oak stands can prevent long-term loss of *Quercus garryana* dominance. Oaks typically resprout after logging. *Cytisus scoparius* is invasive and persistent in many oak woodlands. Nonnative shrubs sweet cherry *Prunus avium* and *Crataegus monogyna* have invaded and now dominate the subcanopy in Willamette Valley oak woodlands. *Poa pratensis* is a major nonnative dominant in the understory. Other herbaceous invasive species include *Agrostis capillaris*, *Holcus lanatus*, *Arrhenatherum elatius*, *Anthoxanthum odoratum*, *Phleum pratense*, *Bromus rigidus*, *Dactylis glomerata*, *Cirsium arvense*, *Plantago lanceolata*, *Rumex acetosella*, *Cynosurus echinatus*, *Festuca arundinacea*, and *Hypericum perforatum*.

Classification Comments: The presence of *Quercus garryana* in pure stands or codominant with conifers characterizes these woodlands. Oak types associated with wetlands or riparian areas in western Washington are associated with the North Pacific Lowland Riparian Forest and Shrubland ecological system. Oak woodlands east of the Cascade Crest are included in a different ecological system (i.e., East Cascades Oak-Ponderosa Pine Forest and Woodland). The North Pacific Oak Woodland system generally occurs west of White Salmon, with transition types between this and East Cascades Oak-Ponderosa Pine Forest and Woodland system occurring in the Little White Salmon and White Salmon river drainages. In the southern portion of its range, the North Pacific Oak Woodland system merges into the Mediterranean California Mixed Oak Woodland (CES206.909) and on sites that support more conifers it merges into the Mediterranean California Lower Montane Black Oak-Conifer Forest and Woodland (CES206.923) system.



Related Concepts: This ecological system falls within the Westside Oak and Dry Douglas-fir Forest habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the North Pacific Oak Woodland as one of their standard mapping units.

References

Chappell, C. B., M.S. Mohn Gee, B. Stephens, R. Crawford, and S. Farone. 2001. Distribution and decline of native grasslands and oak woodlands in the Puget Lowland and Willamette Valley ecoregions, Washington. Pages 124-139 *in* Reichard, S.H., P.W. Dunwiddie, J.G. Gamon, A.R. Kruckeberg, and D.L. Salstrom, eds. Conservation of Washington's Rare Plants and Ecosystems. Washington Native Plant Society, Seattle, WA. 223 pp.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

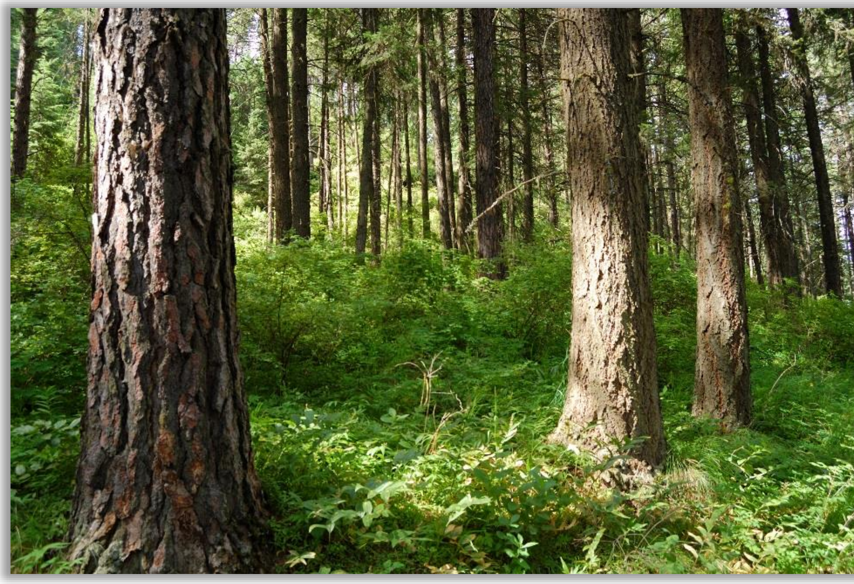
LANDFIRE. 2007. Biophysical Setting Model 0110080: North Pacific Oak Woodland. Rapid Assessment Biophysical Settings Model Descriptions.

Pike, L.H. 1973. Lichens and bryophytes of a Willamette Valley oak forest. Northwest Science, Vol. 47(3), pp. 149-158

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Description Author: Chris Chappell, Joe Rocchio, Gwen Kittel, and Marion Reid.

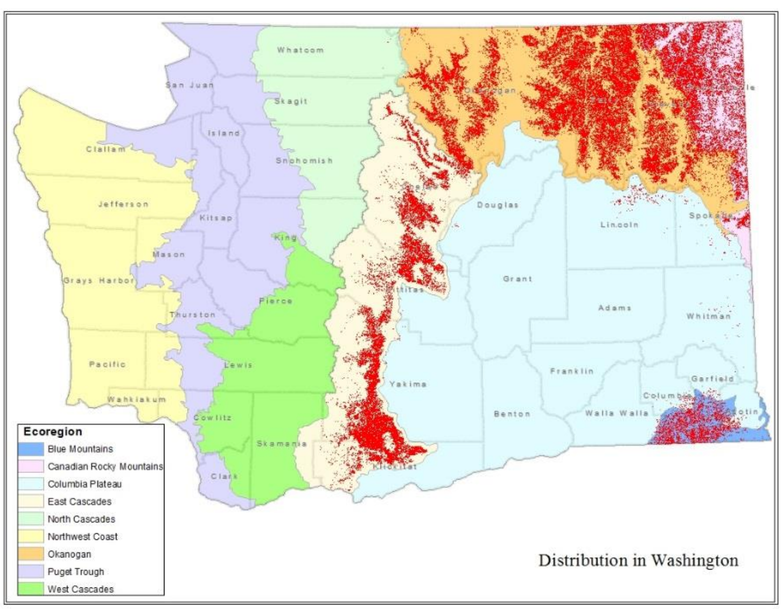
NORTHERN ROCKY MOUNTAIN DRY-MESIC MONTANE MIXED CONIFER FOREST



Concept: These are highly variable montane coniferous forests found along the east slope of the Cascades, Okanogan Highlands, Northern Rocky Mountains, and Blue Mountains. Most occurrences are dominated by a mix of *Pseudotsuga menziesii* and *Pinus ponderosa* (but there can be one without the other) and other typically seral species, including *Pinus contorta* var. *latifolia*, *Pinus monticola*, and *Larix occidentalis*.

Conservation Status: <u>Vulnerable (S3S4)</u>. This system is widespread. However, logging (especially high-grading or taking the largest trees), grazing and fire suppression have lowered overall ecological integrity of many occurrences.

Distribution: This matrix system found in the interior Pacific Northwest, from southernmost interior British Columbia, eastern Washington, eastern Oregon, northern Idaho, western and north-central Montana, and south along the east slope of the Cascades in Washington and Oregon. Within Washington it is a common component to montane forests of the East Cascades, Okanogan Highlands, Northern Rocky Mountains, and Blue Mountains.



Distribution in Washington

Environment: This system is associated with a submesic climate regime with annual precipitation ranging from 50 to 100 cm (~19 to 39 inches), with a maximum in winter or late spring. Winter snowpack typically melts off in early spring at lower elevations. Elevations range from 460 to 1920 m (1,500 to 6,330 feet).

Vegetation: Most occurrences of this system are dominated by a mix of *Pseudotsuga menziesii* and *Pinus ponderosa* (but there can be one without the other) and other typically seral species, including *Pinus contorta* var. *latifolia*, *Pinus* *monticola*, and *Larix occidentalis*. Low severity fires supported open, widely spaced, clusters of large *Pinus ponderosa* and *Pseudotsuga menziesii*. The understory varied depending on the fire interval and soil moisture. In dry sites, frequent fires results in an understory dominated by *Calamagrostis rubescens*, *Carex geyeri*, *Pseudoroegneria spicata*, *Carex rossii*, or *Arctostaphylos uva-ursi*. Moister sites or sites which may have missed a fire or two, such as north slopes, have a higher cover of shrubs such as *Acer glabrum*, *Juniperus communis*, *Physocarpus malvaceus*, *Symphoricarpos albus*, *Spiraea betulifolia*, or *Vaccinium membranaceum*. Lack of wildfire results in an increase of *Pinus ponderosa*, *Pseudotsuga menziesii* and *Abies grandis* in the understory. *Larix occidentalis* can be locally important. Understories are dominated by graminoids such as *Pseudoroegneria spicata*, *Calamagrostis rubescens*, *Carex geyeri*, and *Carex rossii*. Shrubs, such as *Acer glabrum*, *Juniperus communis*, *Physocarpus malvaceus*, *Symphoricarpos albus*, *Spiraea betulifolia*, or *Vaccinium membranaceum* may be present on mesic sites.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Groups and Associations that are associated with this ecological system:

G206 Cascadian Oregon White Oak - Conifer Forest & Woodland Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Pseudotsuga menziesii / Symphoricarpos albus / Hieracium cynoglossoides Forest	G2/SNR	CEGL000458
G210 Central Rocky Mountain Douglas-fir - Pine Forest Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Pinus ponderosa - Pseudotsuga menziesii / Calamagrostis rubescens Woodland	G2Q/S2	CEGL000210
Pinus ponderosa - Pseudotsuga menziesii / Penstemon fruticosus Woodland	G2G3/S2S3	CEGL000212
Pinus ponderosa - Pseudotsuga menziesii / Physocarpus malvaceus Forest	GNRQ/S2	CEGL000213
Pinus ponderosa - Pseudotsuga menziesii / Pseudoroegneria spicata ssp. inermis Woodland	G3Q/S3	CEGL000207
Pseudotsuga menziesii / Arctostaphylos uva-ursi - Purshia tridentata Forest	G3?/S3	CEGL000426
Pseudotsuga menziesii / Arctostaphylos uva-ursi Cascadian Forest	G3G4/S2	CEGL000425
Pseudotsuga menziesii / Calamagrostis rubescens Woodland	G5/S5	CEGL000429
Pseudotsuga menziesii / Carex geyeri Forest	G4?/S1	CEGL000430
Pseudotsuga menziesii / Festuca idahoensis Woodland	G4/S2	CEGL000900
Pseudotsuga menziesii / Festuca occidentalis Forest	G2/S1S2	CEGL000434
Pseudotsuga menziesii / Pseudoroegneria spicata Woodland	G4/S3	CEGL000908
G215 Middle Rocky Mountain Montane Douglas-fir Forest & Woodland Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Pseudotsuga menziesii / Holodiscus discolor / Carex geyeri Forest	G3/S2?	CEGL000437
Pseudotsuga menziesii / Physocarpus malvaceus Forest	G5/S4	CEGL000447
Pseudotsuga menziesii / Symphoricarpos albus Forest	G5/S4	CEGL000459
Pseudotsuga menziesii / Symphoricarpos oreophilus Forest	G5/S3	CEGL000462

Ecological Processes: Presettlement fire regimes may have been characterized by frequent, low-intensity ground fires that maintained relatively open stands of a mix of fire-resistant species (Fire regime I in LANDFIRE 2007). Much more infrequent mixed-severity and stand replacement wildfire occurred and tended to generate mosaics of older, larger tree patches and younger regeneration patches. Low and mixed severity fires favored relatively low tree density, clumped tree distribution, light and patchy fuel loads, simple canopy layering, and fire-tolerant tree and associated species compositions (Agee 2003; Hessburg et al. 2005). Regeneration of tree species occurs between fires but most of these seedlings and saplings are killed during the next fire. However, some tree individuals or sites escape a fire or two allowing individuals to reach an age where they are able to resist future fires resulting in the clustering of old trees and regeneration occurring across the landscape. This process of fire selection produces a forest with relatively low tree density (70-100 trees/ha), patchy distribution of young cohorts, and very little coarse woody debris and snags (Agee 2003). Many of the herbaceous and shrub species are sprouters or rhizomatous making them resilient to fire and able to quickly regrow following fire events. Stands of large mature trees become susceptible to bark beetle mortality and occasionally root disease. Along with natural fires, these disturbances create natural gaps where regeneration patches initiate. Collectively, fire, insect, and disease disturbance created a landscape mosaic of differing age classes and thereby spatially isolated patches where mixed or high severity would occur. Thus, snags and coarse woody debris were clustered across the landscape with their location shifting with beetle outbreaks and consumption by fire (Agee 2003). Under current conditions, the landscape mosaic is more homogenous with the predominant patch type being stands with a dense understory of shrubs and/or young trees. These stands are susceptible to mixed or high severity fires and thus have eliminated the historically patchy distribution of stands with low, mid, and high severity fire regimes. Endemic bark beetles produced patch mortality and rarely caused larger-scale overstory mortality thereby releasing understory trees. Defoliator outbreaks also cause fir mortality in some areas. Spruce budworm outbreaks are now more widespread than under historical conditions. Root diseases may play a significant role in late seral forests.

Threats: Since European settlement, fire suppression, timber harvest, livestock grazing, introduced diseases, road building, development, and plantation establishments have all impacted natural disturbance regimes, forest structure, composition, landscape patch diversity, and tree regeneration (Franklin et al. 2008). Timber harvesting has focused on the large shade-intolerant, fire-resistant species in mid- and late-seral forests thereby eliminating many old forest attributes from stands (Franklin et al. 2008). Fire suppression has allowed less fire-resistant, shade-tolerant trees to become established in the understory (and sometimes dominate the canopy) creating more dense and multi-layered forests than what historically occurred on the landscape. Overgrazing may have contributed to the contemporary dense stands by eliminating grasses in some areas thereby creating suitable spots for tree regeneration as well as reducing the abundance and distribution of flashy fuels that are important for carrying surface fires (Franklin et al. 2008; Hessburg et al. 2005). Road development has fragmented many forests creating fire breaks. Under present conditions the fire regime is mixed severity and more variable, with stand-replacing fires more common, and the forests are more homogeneous. With vigorous fire suppression, longer fire-return intervals are now the rule, and multi-layered stands of *Pseudotsuga menziesii*, *Pinus ponderosa*, and/or *Abies grandis* provide fuel "ladders," making these forests more susceptible to high-intensity, stand-replacing fires. The resultant stands at all seral stages tend to lack snags, have high tree density, and are composed of smaller and more shade-tolerant trees. Mid-seral forest structure is currently 70% more abundant than in historical, native systems. Late-seral forests of shade-intolerant species are now essentially absent. Early-seral forest abundance is similar to that found historically but lacks snags and other legacy features.

Classification Comments: This system is characterized as dry, mixed forests dominated by *Pseudotsuga menziesii* and *Pinus ponderosa* (but there can be one without the other) and other typically seral species but lacking the key mesic understory species listed for Northern Rocky Mountain Mesic Montane Mixed Conifer Forest.

Related Concepts: This ecological system falls within the Eastside (Interior) Mixed Conifer Forest habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the Northern Rocky Mountain Dry-Mesic Montane Conifer Forest as one of their standard mapping units.

References

Agee, J.K. 2003. Historical range of variability in eastern Cascades forests, Washington, USA. Landscape Ecology 18: 725-740.

Franklin, J.F. M.A. Hemstrom, R. Van Pelt, and J.B. Buchanan. 2008. The Case of Active Management of Dry Forest Types in Eastern Washington: Perpetuating and Creating Old Forest Structures and Functions. Washington Department of Natural Resources, Olympia, WA.

Hessburg, P.F., J.K. Agee, and J.F. Franklin. 2005. Dry forests and wildland fires of the inland Northwest USA: Contrasting the landscape ecology of the pre-settlement and modern eras. Forest Ecology and Management 211: 117-139

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

LANDFIRE. 2007. Biophysical Setting Model 1010451: Northern Rocky Mountain Dry- Mesic Montane Mixed-Conifer – Ponderosa pine-Douglas-fir. Biophysical Settings Model Descriptions.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Description Author: Rex Crawford, Chris Chappell, Joe Rocchio and Marion Reid.

DRY FORESTS & WOODLANDS

NORTHERN ROCKY MOUNTAIN FOOTHILL CONIFER WOODED STEPPE

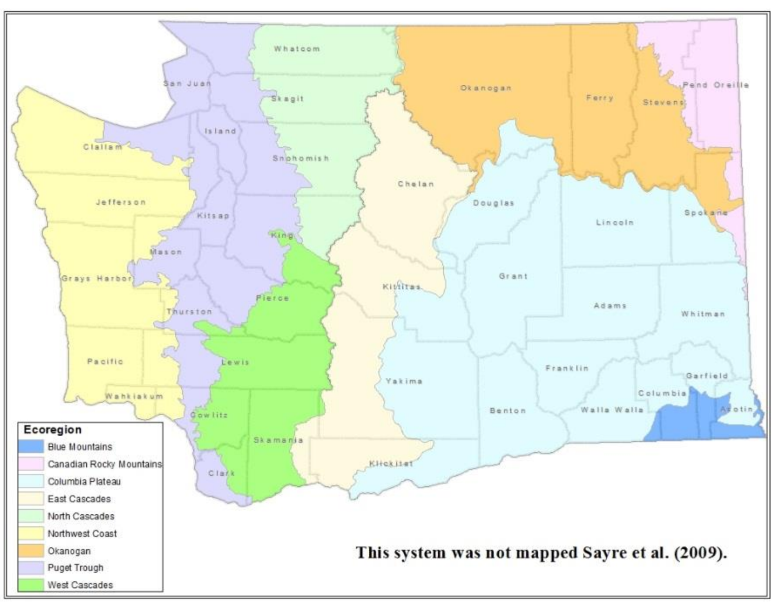

Photo by Rex Crawford

Concept: Wooded steppes which occur at the ecotone between lower treeline and grasslands or shrublands, typically on warm, dry, exposed sites too droughty to support a closed tree canopy. *Pinus ponderosa* and *Pseudotsuga menziesii* are the predominant conifers (not always together) and rarely with *Juniperus occidentalis* at lower or *Larix occidentalis* at higher elevations. In transition areas with big sagebrush steppe systems, *Purshia tridentata*, *Artemisia tridentata* ssp. *wyomingensis*, *Artemisia tridentata* ssp. *tridentata*, and *Artemisia tripartita* may be common in fire-protected sites such as rocky areas.

Conservation Status: Apparently Secure (S3S5). Since the system is not mapped it may be more rare than presumed. Some occurrences of this type may be mapped (Sayre et al. 2009) as ponderosa pine savanna although the wooded steppe physiognomy is frequently observable on imagery in adjacent non-forest.

Distribution: In Washington, this large patch system occurs in the foothills of the northern Rocky Mountains in the Columbia Plateau region and west along the foothills of the eastern Cascades.

Environment: This system is found on all slopes and aspects but most commonly on moderately steep to very steep slopes and ridgetops. Parent material varies although they have characteristic features of good aeration and drainage, coarse textures, an abundance of mineral material, rockiness, and periods of drought during the growing season. The system can occur on glacio-fluvial sand and gravel, basaltic rubble, colluvium, sand dunes, scablands, and pumice where edaphic conditions limit tree abundance.



Vegetation: In Washington, *Pinus ponderosa* and *Pseudotsuga menziesii* are the predominant conifers (not always together) and rarely with *Juniperus occidentalis* at lower or *Larix occidentalis* at higher elevations. In transition areas with big sagebrush steppe systems, *Purshia tridentata, Artemisia tridentata* ssp. *wyomingensis*, *Artemisia tridentata* ssp. *tridentata*, and *Artemisia tripartita* may be common. Deciduous shrubs, such as *Physocarpus malvaceus, Symphoricarpos albus*, or *Spiraea betulifolia*, can be abundant in more northerly sites or more moist climates. Important grass species include *Pseudoroegneria spicata, Poa secunda, Hesperostipa* spp., *Achnatherum* spp., *Elymus elymoides, Festuca idahoensis, or Festuca campestris* (NatureServe 2007). Tree growth is likely episodic, with regeneration episodes during years with available moisture.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Groups and Plant Associations that are associated with this ecological system:

G210 Central Rocky Mountain Douglas-fir - Pine Forest Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Pinus ponderosa - Pseudotsuga menziesii / Purshia tridentata Woodland	G3/S3	CEGL000214
G213 Central Rocky Mountain Ponderosa Pine Woodland & Savanna Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Pinus ponderosa / Hesperostipa comata Woodland	G1S1	CEGL000879
Pinus ponderosa / Pseudoroegneria spicata Woodland	G4/S1	CEGL000865
Pinus ponderosa / Purshia tridentata Woodland	G3G5/S3	CEGL000867

Ecological Processes: This is **not a fire-maintained savanna system**; its scattered tree or parkland character results from a climate-edaphic interaction that results in xeric soil conditions which limits tree establishment. The tree canopy rarely reaches woodland density even with long periods of no fires. This system burns occasionally, but the vegetation is sparse enough that fires are typically not carried through the stand or into canopies. This type usually has little surface fuel and replacement fires would be a function of extreme conditions. However, surface fuels can be dense enough to carry relatively frequent fire that is speculated to be 30-50 year return intervals representing fire regime III (LANDFIRE 2007).

Western pine beetle is a significant disturbance and especially affects larger trees. Mistletoe can cause tree mortality in young and small trees. Fires and insect outbreaks resulted in a landscape consisting of a mosaic of open forests of large trees (most abundant patch), small denser patches of trees, and openings (Franklin et al. 2008).

Threats: The primary land uses that alter the natural processes of this system are associated with livestock practices, tree removal, exotic species, fire regime alteration, direct soil surface disturbance, and fragmentation. Excessive grazing stresses the system through soil disturbance, opening the perennial layers to the establishment of native disturbance increasers and annual grasses. Persistent grazing will further diminish perennial cover, exposed bare ground, increase exotic annuals. Any soil and bunchgrass layer disturbances, such as vehicle tracks, chaining shrubs, will increase the probability alteration of vegetation structure and composition and response to fire. Harvesting of tree species alters the structural characteristics of this system and given the harsh environment typically reestablishment of the trees occurs very slowly. Road development has fragmented many forests creating fire breaks.

Classification Comments: This is not a fire-maintained system and the savanna character results from edaphic conditions as opposed to the Northern Rocky Mountain Ponderosa Pine Woodland and Savanna which is maintained by high-frequency / low-intensity fires.

Related Concepts: This ecological system falls within the Ponderosa Pine Forest and Woodlands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes Northern Rocky Mountain Foothill Conifer Wooded Steppe as one of their standard mapping units.

References

Franklin, J.F. M.A. Hemstrom, R. Van Pelt, and J.B. Buchanan. 2008. The Case of Active Management of Dry Forest Types in Eastern Washington: Perpetuating and Creating Old Forest Structures and Functions. Washington Department of Natural Resources, Olympia, WA.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

LANDFIRE. 2007. Biophysical Setting Model 1010451: Northern Rocky Mountain Dry- Mesic Montane Mixed-Conifer – Ponderosa pine-Douglas-fir. Biophysical Settings Model Descriptions.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Description Author: Marion Reid and Rex Crawford

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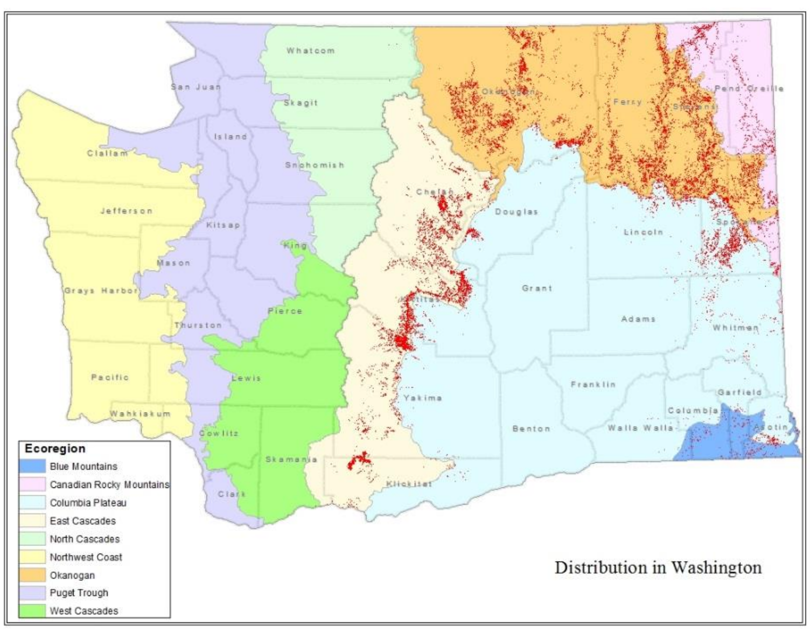
NORTHERN ROCKY MOUNTAIN PONDEROSA PINE WOODLAND AND SAVANNA

Concept: Woodland and savannas dominated by ponderosa pine found in the foothills along the eastern Cascades, the Blue Mountains, the Okanogan Highlands, and Northern Rocky Mountains of eastern Washington. This fire-maintained system occurs on the driest sites supporting conifers in the Pacific Northwest.

Conservation Status: Imperiled (S2). Most stands have been degraded due to fire suppression and grazing.

Distribution: This matrix system occurs in the foothills along the eastern Cascades, the Blue Mountains, the Okanogan Highlands, and in the Columbia Basin in northeastern Washington.

Environment: These woodlands occur on warm, dry, exposed sites on all slopes and aspects; however, moderately steep to very steep slopes or ridgetops are most common. They are generally found on glacial till, glacio-fluvial sand and gravel, dunes, basaltic rubble, colluvium, to deep loess or volcanic ash-derived soils, with characteristic features of good aeration and drainage, coarse textures, circumneutral to slightly acidic pH, an abundance of mineral material, rockiness, and periods of drought during the growing season. Precipitation varies from 36-76 cm (~14-30 in.) with most occurring as snowfall.



Distribution in Washington

Vegetation: Before 1900, this system was mostly open and park-like with relatively few understory trees. Currently, much of this system has a younger tree cohort, often more shade-tolerant species, resulting in a more closed, multilayered canopy. *Pinus ponderosa* is the predominant conifer; *Pseudotsuga menziesii* (primarily var. *glauca*) may be present in the tree canopy but is usually absent. *Populus tremuloides* may be present, but is generally <25% of tree canopy. The understory can be shrubby, with *Artemisia tridentata*, *Arctostaphylos uva-ursi*, *Ceanothus velutinus*, *Physocarpus malvaceus*, *Purshia tridentata*, *Symphoricarpos albus*, *Prunus virginiana*, *Amelanchier alnifolia*, and *Rosa* spp. being common. Understory vegetation in the true savanna occurrences is predominantly fire-resistant grasses and forbs that resprout following surface fires. Shrubs, understory trees and downed logs are uncommon in these areas. Open stands support grasses such as *Pseudoroegneria spicata*, *Hesperostipa* spp., *Achnatherum* spp., *Festuca idahoensis*, or *Festuca campestris*. The more mesic portions of this system may include *Calamagrostis rubescens* or *Carex geyeri*, species more typical of Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest. Most areas that may have been savanna in the past are now more nearly closed-canopy woodlands/forests. These "true, fire-maintained savannas" are included with this woodland system, rather than with the climatically-edaphically controlled Northern Rocky Mountain Foothill Conifer Wooded Steppe system. Hot, dry Douglas-fir types with grass understory are included here as well.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Groups and Associations that are associated with this ecological system:

G210 Central Rocky Mountain Douglas-fir - Pine Forest Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Pinus ponderosa - Pseudotsuga menziesii / Pseudoroegneria spicata ssp. inermis Woodland	G3Q/S3	CEGL000207
Pseudotsuga menziesii / Festuca idahoensis Woodland	G4/S2	CEGL000900
Pseudotsuga menziesii / Pseudoroegneria spicata Woodland	G4/S3	CEGL000908
G213 Central Rocky Mountain Ponderosa Pine Woodland & Savanna Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Pinus ponderosa / Calamagrostis rubescens Forest	G2Q/S1	CEGL000181
Pinus ponderosa / Festuca campestris Woodland	G3G4/S1	CEGL000185
Pinus ponderosa / Festuca idahoensis Woodland	G4/S2	CEGL000857
Pinus ponderosa / Hesperostipa comata Woodland	G1S1	CEGL000879
Pinus ponderosa / Physocarpus malvaceus Forest	G2/S1	CEGL000189
Pinus ponderosa / Pseudoroegneria spicata Woodland	G4/S1	CEGL000865
Pinus ponderosa / Purshia tridentata / Carex geyeri Woodland	G3/SNR	CEGL002606
Pinus ponderosa / Purshia tridentata / Festuca idahoensis Woodland	G3/S2	CEGL000195
Pinus ponderosa / Purshia tridentata / Pseudoroegneria spicata Woodland	G3/S2	CEGL000197
Pinus ponderosa / Symphoricarpos albus Forest	G4?/S2	CEGL000203

Ecological Processes: These woodlands and savannas are, or at least historically were, fire-maintained and occurring at the lower treeline/ecotone between grasslands or shrublands at lower elevations and more mesic coniferous forests at higher elevations. Summer drought and frequent, low-severity fires create woodlands composed of widely spaced, large trees with small scattered clumps of dense, even-aged stands which regenerated in forest gaps or were protected from fire due to higher soil moisture or topographic protection. Canopy coverage typically ranges from 10-60%. Closed canopy or dense stands were also part of the historical range of stand variability but was a minor component of that landscape. However, such structure is increasing in abundance due to fire suppression. Older stands typically include multiple size and age cohorts and are maintained by frequent surface and mixed-severity fires. Native Americans and lightning were sources of ignition during presettlement era. Historically, many of these woodlands and savannas lacked the shrub component as a result of low severity but high frequency fires (2 - to 10-year fire-return intervals). Some sites, because of low productivity, naturally lacked a dense shrub understory.

Mixed-severity fires had a return interval of 25-75 years while stand-replacing fire occurred at an interval of >100 year. The latter two intervals only occur on 20-25% of stands within the landscape while surface fires were the dominant fire regime on over 75% of stands (LANDFIRE 2007). Western pine beetle is another significant disturbance and especially affects larger trees. Mistletoe can cause tree mortality in young and small trees. Fires and insect outbreaks resulted in a landscape consisting of a mosaic of open forests of large trees (most abundant patch), small denser patches of trees, and openings (Franklin et al. 2008).

Threats: Since European settlement, fire suppression, timber harvest, livestock grazing, introduced diseases, road building, development, and plantation establishments have all impacted natural disturbance regimes, forest structure, composition, landscape patch diversity, and tree regeneration (Franklin et al. 2008). Timber harvesting has focused on the large, older trees in mid- and late-seral forests thereby eliminating many old forest attributes from stands (Franklin et al. 2008). Fire suppression has resulted in increased tree regeneration and thus a denser understory composed of young trees. Fire suppression has also allowed less fire-resistant, shade-tolerant trees to become established in the understory (and sometimes dominate the canopy) of moist or protected sites creating more dense and multi-layered forests than what historically occurred on the landscape. Overgrazing may have contributed to the contemporary dense stands by eliminating grasses in some areas thereby creating suitable spots for tree regeneration as well as reducing the abundance and distribution of flashy fuels that are important for carrying surface fires. (Franklin et al. 2008; Hessburg et al. 2005). Road development has fragmented many forests creating fire breaks. Under present conditions the fire regime is mixed severity and more variable, with stand-replacing fires more common, and the forests are more homogeneous. With vigorous fire suppression, longer fire-return intervals are now the rule, and multi-layered stands of *Pinus ponderosa* and/or *Pseudotsuga menziesii* provide fuel "ladders," making these forests more susceptible to high-intensity, stand-replacing fires. The resultant stands at all seral stages tend to lack snags, have high tree density, and are composed of smaller and more shade-tolerant trees. Mid-seral forest structure is currently 70% more abundant than in historical, native systems. Late-seral forests of shade-intolerant species are now essentially absent. Early-seral forest abundance is similar to that found historically but lacks snags and other legacy features.

Classification Comments: *Pinus ponderosa* is the dominant canopy component and inclusions of *Pseudotsuga menziesii* woodlands on cool aspects may be present. *Populus tremuloides* may be present, but is generally <25% of tree canopy. Most areas that may have been savanna in the past are now more nearly closed-canopy woodlands/forests. It is believed that these true savannas should be included with this woodland system, rather than with the climatically-edaphically controlled Northern Rocky Mountain Foothill Conifer Wooded Steppe system. Hence, the "true fire-maintained savanna" is included in this woodland system. Hot, dry *Pseudotsuga menziesii* types with grass are included here as well.

DRY FORESTS & WOODLANDS

Related Concepts: This ecological system falls within the Ponderosa Pine Forests and Woodlands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the Northern Rocky Mountain Ponderosa Pine Forest and Woodland as one of their standard mapping units.

References

Franklin, J.F. M.A. Hemstrom, R. Van Pelt, and J.B. Buchanan. 2008. The Case of Active Management of Dry Forest Types in Eastern Washington: Perpetuating and Creating Old Forest Structures and Functions. Washington Department of Natural Resources, Olympia, WA.

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Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

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Description Author: Marion Reid, Chris Chappell, and Rex Crawford.

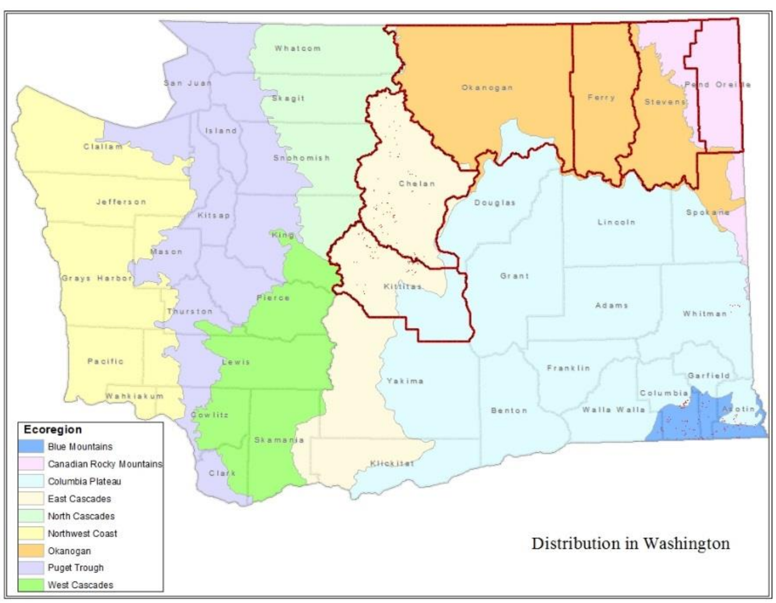
NORTHERN ROCKY MOUNTAIN WESTERN LARCH SAVANNA

Concept: These open-canopied "savannas" of the deciduous conifer *Larix occidentalis* appear in the Okanogan Highlands, East Cascades and possibly in the Blue Mountains of eastern Washington. These stands may have been initiated following stand-replacing crownfires of other conifer systems but are then maintained by a higher frequency, surface-fire regime.

Conservation Status: Critically Imperiled (S1). The open old-growth and woodland structure has been largely lost due to fire suppression and logging of big trees. Only two areas are globally known that have the original structure within a mix of closed forest. One of those stands occurs in Washington.

Distribution: This large patch system is restricted to the interior montane zone of the Pacific Northwest in northern Idaho and adjacent Montana, Washington, Oregon, and in southeastern interior British Columbia. In Washington, it appears in the Okanogan Highlands, East Cascades and possibly in the Blue Mountains. The sporadic distribution of this system limits visibility of mapped occurrences, thus the map also displays the counties in which the system is known to occur. Although not depicted on the map, there may be remnant stands in Yakima and Klickitat counties.

Environment: Elevations range from 680 to 2195 m (2230-7200 feet). Sites can be found in drier, lower montane settings of toe slopes and ash deposits. Winter snowpack typically melts off in early spring at lower elevations.



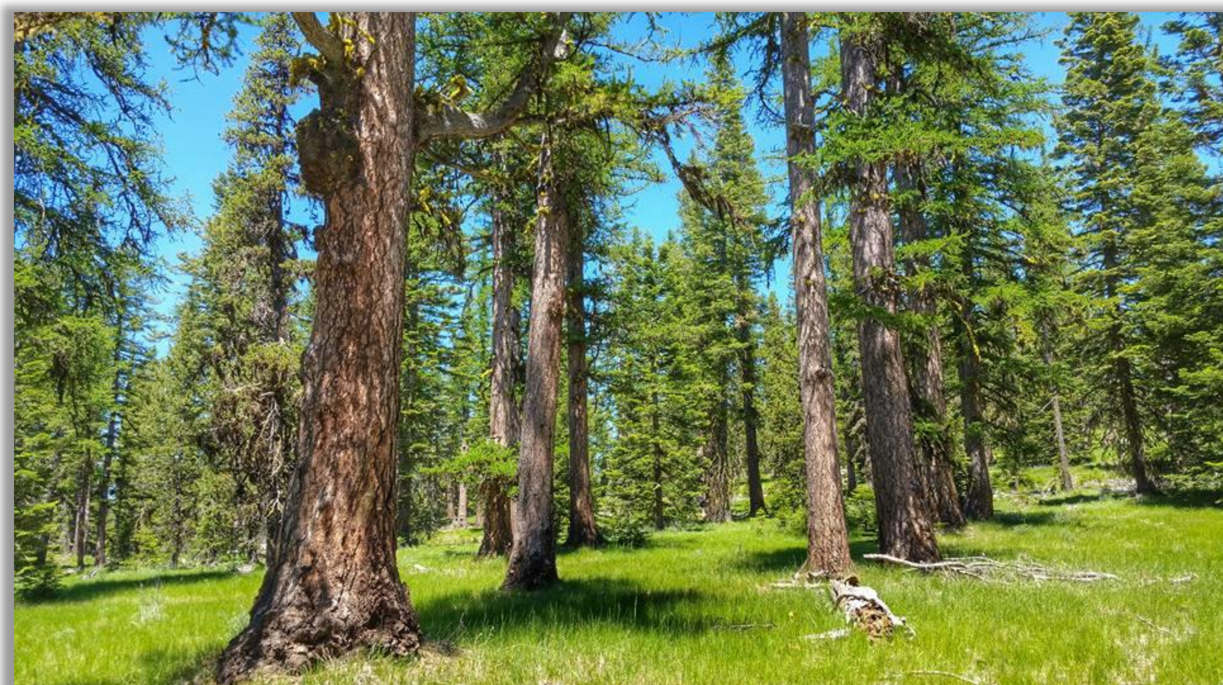
Distribution in Washington

Vegetation: *Larix occidentalis* dominates relatively open stands with canopy coverage typically ranging from 10-60%. Stands may be co-dominated by *Pseudotsuga menziesii* or *Pinus contorta* var. *latifolia.* The shade-tolerant, more fire sensitive trees *Abies lasiocarpa*, *Picea engelmannii*, or *Abies grandis* are slow to establish on these sites, grow slowly and, given the fire-return intervals, rarely gain canopy dominance but can be common in the sub-canopy. Undergrowth is dominated by low-growing *Arctostaphylos uva-ursi*, *Calamagrostis rubescens*, *Linnaea* *borealis*, *Spiraea betulifolia*, *Vaccinium caespitosum*, or *Xerophyllum tenax*. Less frequent fire allows mixed-dominant stands to develop often with shrubby undergrowth of *Acer glabrum*, *Ceanothus velutinus*, *Shepherdia canadensis*, *Physocarpus malvaceus*, *Rubus parviflorus*, or *Vaccinium membranaceum*. *Larix occidentalis* is a long-lived species (400-900 years old; Van Pelt 2008), and thus stands fitting this concept are themselves long-persisting. However, the *Larix*-dominated stands probably rarely exceed 250 years due to various mortality factors and competition by shade-tolerant species.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system:

G211 Central Rocky Mountain Mesic Grand Fir - Douglas-fir Forest Group	Global/ State Rank	NatureServe/ WNHP Code
Larix occidentalis / Clintonia uniflora Forest	GNR/SNR	CEGL005880
Larix occidentalis / Clintonia uniflora - Xerophyllum tenax Forest	GNR/SNR	CEGL005881
Larix occidentalis / Vaccinium caespitosum Forest	GNR/SNR	CEGL005882
Larix occidentalis / Vaccinium caespitosum / Clintonia uniflora Forest	GNR/SNR	CEGL005883

Ecological Processes: Occurrences of this ecological system are generated by stand-replacing fires, the fire-return interval for which is speculated to be on the order of 80 to 200 years. These sites may be maintained in a seral status for hundreds of years by low intensity, high frequency fires. The potential dominants *Abies lasiocarpa*, *Picea engelmannii*, or *Abies grandis* are slow to establish on these sites which suggests, given the fire-return intervals for this type, that the "climax" (long-term stable) condition is never realized. LANDFIRE (2007) describes this system as variant of the Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest system with a mixed severity fire regime (III), mean fire return interval of approximately 40 years, rare replacement fires, and occasional small, patchy surface fires. Older stands typically include multiple size and age cohorts and are maintained by frequent surface and mixed-severity fires. Closed canopy or dense stands were also minor part of the historical range of stand variability. However, such vertical structure is increasing in abundance due to fire suppression. Fire suppression has



created conditions that increase the likelihood of stand replacement fire as well mistletoe infestations of *Larix* stands. LANDFIRE (2007) estimated 30% of the system was open late-seral, 20% closed late-seral, 40% open and closed mid-seral and 10% early seral.

Threats: Since European settlement, fire suppression, tree harvesting, introduced diseases, road building, development, and plantation establishments have all impacted natural disturbance regimes, forest structure, composition, landscape patch diversity, and tree regeneration (Franklin et al. 2008). Timber harvesting has focused on the large, older trees in mid- and late-seral forests thereby eliminating many old forest attributes from stands (Franklin et al. 2008). Fire suppression has resulted in increased tree regeneration and thus a denser understory composed of young trees. Fire suppression has also allowed less fire-resistant, shade-tolerant trees to become established in the understory (and sometimes dominate the canopy) of moist or protected sites creating more dense and multi-layered forests than what historically occurred on the landscape. Road development has fragmented many forests creating fire breaks. Under present conditions the fire regime tends to be more high severity and variable, with stand-replacing fires more common, and the forests are more homogeneous. The resultant stands at all seral stages tend to lack snags, have high tree density, and are composed of smaller and more shade-tolerant trees. The introduced forest pest, larch casebearer (*Coleophora laricella)* defoliates trees and with heavy infestation and eventually kill trees.

Classification Comments: Many *Larix occidentalis* stands and mixed conifer stands with *Larix* are early to mid-seral components of the following mixed to high severity fire ecological systems: East Cascades Mesic Montane Mixed Conifer Forest, Northern Rocky Mountain Mesic Montane Mixed Conifer Forest and Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest. Those stands initiate following crown fires in areas with stand-replacing fire frequencies greater than 150 years. This contrasts with the high-frequency, mixed to low-severity fires that maintain the characteristic open-canopied savanna or woodland of the Northern Rocky Mountain Western Larch Savanna system. Open stands of *Larix occidentalis* and other conifers on talus or bedrock are included in Northern Rocky Mountain Foothill Conifer Wooded Steppe or Rocky Mountain Cliff, Canyon and Massive Bedrock ecological systems.

Related Concepts: This ecological system falls within the Eastside (Interior) Mixed Conifer Forest habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the Northern Rocky Mountain Western Larch Savanna as one of their standard mapping units.

References

Franklin, J.F. M.A. Hemstrom, R. Van Pelt, and J.B. Buchanan. 2008. The Case of Active Management of Dry Forest Types in Eastern Washington: Perpetuating and Creating Old Forest Structures and Functions. Washington Department of Natural Resources, Olympia, WA.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

LANDFIRE. 2007. Biophysical Setting Model 1010451: Northern Rocky Mountain Dry- Mesic Montane Mixed-Conifer – Ponderosa pine-Douglas-fir. Biophysical Settings Model Descriptions.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Van Pelt, R. 2008. Identifying Old trees and Forests in Eastern Washington. WA. Dept. Natural Resources, Olympia WA. 169p.

Description Author: Rex Crawford and Marion Reid.

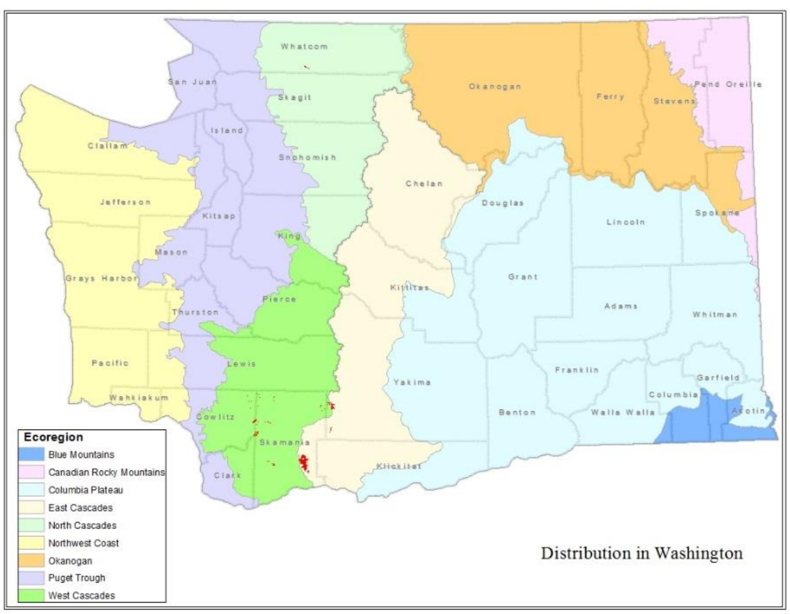
NORTH PACIFIC WOODED VOLCANIC FLOWAGE

Concept: Woodland to sparsely vegetated areas (generally >10% plant cover) on recent lava flows, excessively well-drained lahars, debris avalanches and pyroclastic flows. Examples occur on recent lava flows on the southwest side of Mount Saint Helens along Cold Creek (near Blue Lake), the north side of Mount Adams (andesite), and the big lava beds (basalt) south of Indian Heaven west of Mount Adams, Washington.

Conservation Status: Apparently Secure (S4).

Distribution: This is an uncommon, large patch system found in the east and west Cascades of Washington and Oregon, and may occur in small patches in northern California in the vicinity of Mount Lassen or Mount Shasta.

Environment: The system is supported by unique substrates resulting from recent lava flows or other flowage resulting from volcanic activity. Soil development is limited.



Vegetation: The characteristic feature of this system is an open to sparse nature of vegetation cover relative to the surrounding matrix closed forest due to environmentally limiting characteristics of the substrate. Characteristic species include *Pseudotsuga menziesii*, *Pinus contorta*, *Pinus monticola*, and *Abies lasiocarpa*. Tree cover can range from scattered (5%) up to 70% or occasionally even more. There may be scattered to dense shrubs present, such as *Acer circinatum*, *Vaccinium membranaceum*, *Arctostaphylos* *uva-ursi* (very characteristic), *Mahonia nervosa*, *Amelanchier alnifolia*, and *Xerophyllum tenax*. Mosses and lichens often cover the soil or rock surface.

USNVC Associated Types: Classification of vegetation patterns in this system is needed to identify component plant associations.

Ecological Processes: Volcanic activity resulting in lava flows, debris avalanches, or other flowage.

Threats: Forest management practices, such as clearcutting and plantations, have in many cases resulted in less diverse tree canopies, with an emphasis on Douglas-fir, reduced coarse woody debris, and truncated succession well before late-seral characteristics are expressed. Slash burning often has negative impacts on productivity and regeneration. However, the extent to which these threats have occurred in Washington occurrences is assumed to have been minimal.

Classification Comments: The substrates derived from lava or other volcanic flowage gives this system it unique character. This system represents mid-stages of primary succession. Early primary succession communities on these substrates which are classified as the North Pacific Volcanic Rock and Cinder Land. Later primary succession stages (increased soil development) are included in appropriate matrix forest systems.

Related Concepts: This ecological system falls within the Montane Mixed Conifer Forest habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the North Pacific Wooded Volcanic Flowage as one of their standard mapping units.

References

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Description Author: Rex Crawford.

LOWLAND & FOOTHILL MESIC FORESTS

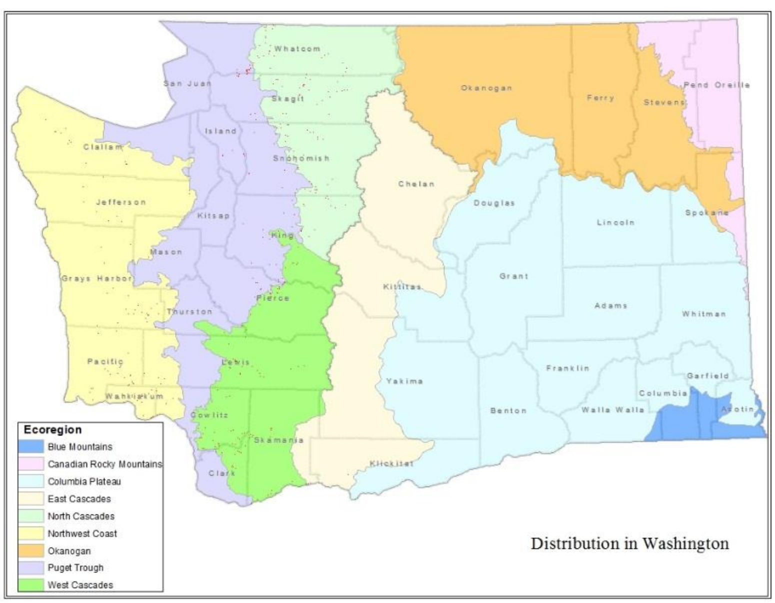
NORTH PACIFIC BROADLEAF LANDSLIDE FOREST AND SHRUBLAND

Concept: These forests and shrublands occur on steep slopes and bluffs that are subject to mass soil movements such as landslides and slumping on a periodic basis. They are found in patches of differing age associated with different landslide events.

Conservation Status: Imperiled (S2S3). This system is apparently a relatively rare, small patch type that experiences some threat to processes and stand structure. Only one rare association is part of this system along Puget Sound bluffs and banks.

Distribution: This is a large and small patch system found throughout the northern Pacific mountains and lowlands, becoming less prominent in the northern half of this region. The system occurs throughout western Washington within a matrix of North Pacific Maritime Dry-Mesic and Wet-Mesic Douglas-fir Western Hemlock Forest systems.

Environment: This system is associated with steep slopes (over 10%) and bluffs found in lowland areas and are characterized by slopes subjected to periodic landslides dominated by deciduous trees and shrubs (e.g. *Acer macrophyllum* and/or *Alnus rubra*). The system also occurs on the shorelines of Puget Sound and adjacent marine waters (Chappell 2004). Occurrences can be associated with deep-seated landslides or ancient landslides and with mid-slope benches, a common setting for a variety of landslide types (DOE no date). Parent materials likely include glacial till, advance glacial outwash, and glacial lake and marine sediments. Seeps are frequent on these slopes, resulting in local wetter microsites.



Distribution in Washington

Vegetation: In general, landslides increase the floristic and structural diversity of landscape and vegetation (Guariguata, M. 1990). Younger landslides have different vegetation on the slide than vegetation on the surrounding slopes. The vegetation consists of deciduous broadleaf forests, woodlands, or shrublands, sometimes with varying components of conifers that usually have less than 50% relative cover. *Alnus rubra* and *Acer macrophyllum* are the major tree species. *Rubus spectabilis, Rubus parviflorus, Ribes bracteosum*, and *Oplopanax horridus* are some of the major shrub species. Shrublands tend to be smaller in extent than woodlands or forests. Small patches of sparsely vegetated areas or herbaceous-dominated vegetation (especially *Petasites frigidus*) also often occur as part of this system. Vegetation on earthflows, once stable, may succeed to dominance by conifers. In coniferous forests, landslides typically are covered with deciduous trees for the first 100 years after the failure.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Association associated with this ecological system:

G237 North Pacific Red Alder - Bigleaf Maple - Douglas-fir Forest Group	Global/ State Rank	NatureServe/ WNHP Code
Acer macrophyllum - Alnus rubra / Polystichum munitum - Tellima grandiflora Forest	G2G3/S2	CEGL003334

Ecological Processes: Periodic mass soils movements such as landslides and slumping are the primary ecological driver. Conifers would be expected to increase in abundance without large slides and long-term substrate stability. Fire and wind also affect some of these forests.

Threats: Non-native English ivy (*Hedera helix*) and Himalayan blackberry (*Rubus armeniacus= discolor* are prolific invaders in this system. Many other non-native plants can occur. Development on land above the bluffs on which this system occurs can impact rates and types of mass movement processes. Actions that trigger landslide movement include erosion, poor construction practices, clear cutting timber on unstable slopes particularly when combined with heavy rainfall event, freezing and thawing, and earthquakes. Efforts to stabilize slopes such as draining excess water from slopes, adding material to buttress base of a slope and building retaining walls influence natural processes.

Classification Comments: This system is characterized by steep slopes subjected to periodic landslides dominated by deciduous trees and shrubs (e.g. *Acer macrophyllum* and/or *Alnus rubra*). Early-successional patches dominated by *Alnus* or *Acer* that are **not** associated with landslide disturbance are part of the sere vegetation of the matrix forest type. More stable shrub patches generally belong to North Pacific Montane Shrubland. Very wet sites such as seeps are part of the North Pacific Hardwood-Conifer Swamp system.

Related Concepts: This ecological system falls within the Westside Lowland Conifer-Hardwood habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the North Pacific Landslide Forest and Shrubland as one of their standard mapping units.

References

Chappell, C.B. 2004. Upland Plant Associations of the Puget Trough Ecoregion, Washington. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. Online: http://www1.dnr.wa.gov/nhp/refdesk/communities/index.html

Guariguata, M. 1990. Landslide disturbance and forest regeneration in the Upper Luquillo Mountains of Puerto Rico. Jour. Ecol. 78: 814-832.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

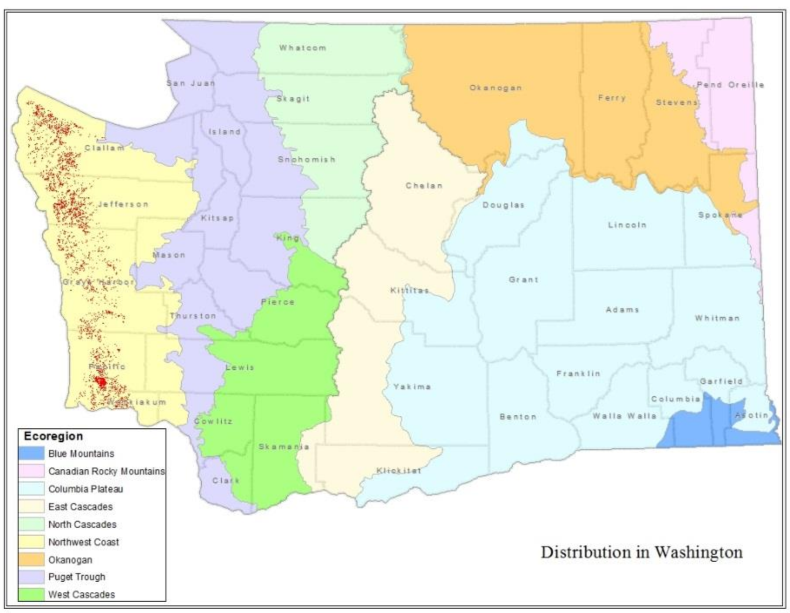
Washington Department of Ecology (DOE). Puget Sound Landslides. An online fact sheet. http://www.ecy.wa.gov/programs/sea/landslides/about/about.html

Description Author: Rex Crawford, Chris Chappell and Gwen Kittel

NORTH PACIFIC HYPERMARITIME WESTERN RED-CEDAR-WESTERN HEMLOCK FOREST

Concept: Open, scrubby, or closed forests located in the hypermaritime climatic areas along Washington's outer coast (never more than 20 km). These forests are dominated by *Thuja plicata* and *Tsuga heterophylla* The system is part of the coastal temperate rain forests of North America. Where these forests are best developed they occur in a mosaic with forested wetlands, peatlands, and Sitka spruce forests (the latter in riparian areas and on steep, more productive soils).

Conservation Status: Critically Imperiled (S1S2). Undisturbed conditions of this system are uncommon to rare. Many known stands are small remnants. Stands that have been high-graded (or have had large trees removed) will take centuries for large trees to recover, even without other disturbances.



Distribution: This is a matrix to large patch type restricted to the hypermaritime (*sensu* Klinka et al. 1989) climatic areas near the Pacific Coast centered in the northern coast of British Columbia into the southern half of southeastern Alaska and south into Washington. This is usually inland of the coastal fog zone and down slope of the rain-on-snow zone. The system occurs on low, gentle relief appearing mostly below 600 m (1970 ft.) elevation and usually within 25 km (15 miles) of the outer coast. In Washington, this system occurs along outer coastal areas, never more than 25 km from saltwater.

LOWLAND & FOOTHILL MESIC FORESTS

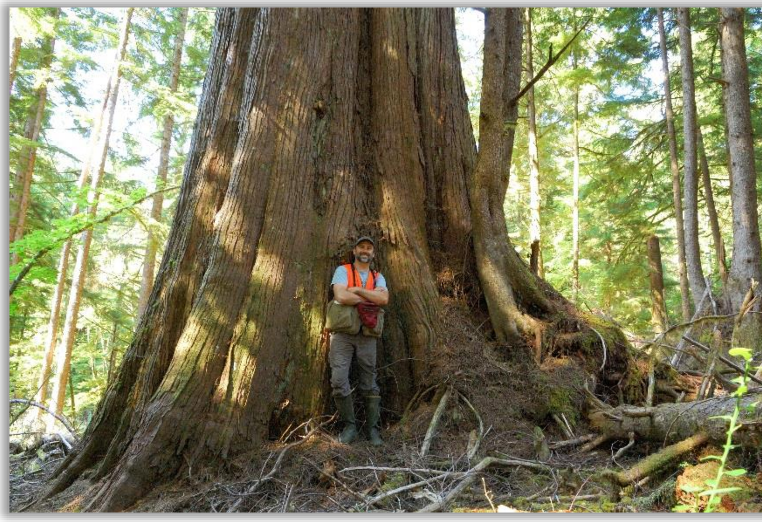
Environment: The system occurs on low, gentle relief appearing mostly below 600 m (1970 ft.) elevation and usually within 25 km (15 miles) of the outer coast. The associated hypermaritime climate has cool summers, fog, and very wet winters without a major snowpack. Annual precipitation is 100 to 150 inches, with the majority falling as rain, which can be heavy. Soils are often leached and nutrient-poor with much of the soil nutrients in the surface organic matter layers (McKinnon 2003). Soils typically have a distinct humus layer overlying mineral horizons or bedrock and are often poorly drained. These forests are best developed in a mosaic with forested wetlands, peatlands, and *Picea sitchensis* forests associated with valley bottoms soils.

Vegetation: The forests are often open and scrubby but can be closed. *Thuja plicata* and *Tsuga heterophylla* can individually dominate or codominate stands. *Pinus contorta* var. *contorta* or *Abies amabilis* can be part of the canopy. In Washington, nearly pure stands of *Tsuga heterophylla* are common and seem to be associated with microsites most exposed to intense windstorms. *Pseudotsuga menziesii* is rare in this system. *Picea sitchensis* can be present (less than 10% cover) but never common. The understory is rich with shade-tolerant species including shrubs *Gaultheria shallon*, and *Vaccinium ovalifolium*, forbs *Maianthemum dilatatum* and *Oxalis oregana*, and ferns *Polystichum munitum*, *Dryopteris* spp., and *Blechnum spicant* which can be abundant. A high diversity of mosses (commonly *Hylocomium splendens* and *Rhytidiadelphus loreus)* and lichens are abundant on logs, snags, trees, or the ground surface. *Rubus spectabilis* and *Acer circinatum* are common and persistent shrubs following disturbance. Plant species are similar among old growth and earlier stand developmental stages although some species are more common in old growth (McKinnon 2003).

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system:

G751 North Pacific Western Hemlock - Sitka Spruce - Western Red-cedar Seasonal Rainforest Group [Proposed]	Global/ State Rank	NatureServe/ WNHP Code
Pseudotsuga menziesii - Tsuga heterophylla / Polystichum munitum - Oxalis oregana Forest	GNR/S3	CEGL005568
Thuja plicata - Tsuga heterophylla / Vaccinium ovatum Forest	G3/SNR	CEGL000322
Tsuga heterophylla / Gaultheria shallon / Polystichum munitum - Blechnum spicant Forest	GNR/S3	CEGL000100
Tsuga heterophylla / Gaultheria shallon / Blechnum spicant Forest	G/S3	CTWA000013
Tsuga heterophylla / Polystichum munitum - Oxalis oregana Forest	GNR/S3?	CEGL005586

Ecological Processes: These forests very rarely burn and are more influenced by gap disturbance processes and intense windstorms than by fire. Pre-settlement forests were mostly old-growth (a British Columbia project found 98% of hypermaritime forest stand age classes were greater than 141 years, McKinnon 2003) with abundant large woody debris. Van Pelt (2007) mapped the presettlement distribution of 1,000 year and older *Thuja plicata* forest in Washington reflecting the extent of this system near the outer coast. Intense windstorms are occasional (average 20 years Henderson et al. 1989; 100-200 years LANDFIRE 2007) and



widespread. Wind disturbance in contrast to fire tends to topple taller trees and leave small trees, while the tallest trees are often the most wind-firm by surviving normal wind events and are left in major events (Van Pelt 2007). *Thuja plicata* often are over 1000 years old and with candelabra tops reflecting past wind breakage and other top kill events (Van Pelt 2007). Wind effects are in the range of 1-1000 of hectares (2.5-2500 acres); most are 10-100 ha (25-250 ac) (LANDFIRE 2007). Natural blowdown patches in Alaska hypermaritime forests are small (less than 50 acres) and scattered (Nowacki and Kramer 1998). Patches are concentrated on ridgetops and upper slopes and in some locations development beyond the stem exclusion stage is rare due to repeated blowdown. *Tsuga heterophylla* is the usual dominant in these blown down forests. Nowacki and Kramer (1998) cite that the 50 percent of the hypermaritime forest landscape on an Alaska Island was a mix of small- and large-scale disturbances.

Daniels and Gray (2006) summarize that mean fire return intervals are typically over 1000 years in the hypermaritime forests in British Columbia and LANDFIRE (2007) state that there is no evidence of fire in these forests. In general, the flammability ratings of the wet coastal temperate rain forest are low. Coarse woody debris accounts for the majority of persistent surface fuels that stays moist under moss and herbs and in the shade of multiple layers of trees and shrubs.

Threats: Since European settlement, development, timber harvest, road building, tree plantations and introduced diseases have all impacted natural disturbance regimes, forest structure, composition, landscape patch diversity, and tree regeneration. Timber harvest operations change canopy structural complexity and abundance of large woody debris of individual stands and has altered whole landscape patch pattern, age and structural complexity (Van Pelt 2007). Many historical occurrences of this system have become conifer plantations and logging of remaining intact stands remains a threat. Clearcut logging and plantation forestry have resulted in less diverse tree canopies, with reductions in coarse woody debris, a shortened stand initiation phase, and succession truncated well before late-seral characteristics are expressed (Nowacki and Kramer 1998). In the past century, stand-initiating fires, most were human-ignitions, have burned coastal forests but under unusual conditions in which logging created large fuel loads and microclimatic conditions that allowed the fuels to dry, making these sites conducive to burning (Daniels and Gray 2006).

Classification Comments: Like the North Pacific Seasonal Sitka Spruce Forest this system also occurs within 25 km (15.5 miles) of the outer coast but differs in that cover of *Picea sitchensis* is less than 10%. The abundance of *Thuja plicata* in relation to other conifers is one of the diagnostic characters of these forests; the other is the low abundance of *Pseudotsuga menziesii* and *Picea sitchensis*. Stands of *Thuja plicata* in the Olympic rain shadow (e.g., in the San Juan islands) are included in the North Pacific Maritime Mesic-Wet Douglas-fir Western Hemlock Ecological System due to lacking a hypermaritime climate. Those stands occur in areas of topographic moisture.

Related Concepts: This ecological system falls within the Westside Lowlands Conifer-Hardwood Forest habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management

Planning Tools Project (i.e. LANDFIRE) recognizes the North Pacific Hypermaritime Western Red-cedar-Western Hemlock Forest as one of their standard mapping units.

References

Daniels, L.D. and R.W. Gray. 2006. Disturbance regimes in coastal British Columbia. *BC* Journal of Ecosystems and Management 7(2):44–56.

Henderson, J.A., D.A. Peter, R. Lesher, and D.C. Shaw. 1989. Forested Plant Associations of the Olympic National Forest U.S.D.A. For. Serv. PNW Region. R6-ECOL-TP 001-88. 502 p.

Johnson, D.H. and T.A. O’Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Klinka, K., Krajina, V. J., Ceska, A., and Scagel, A. M.1989. Indicator plants of coastal British Columbia. UBC Press, Vancouver.

LANDFIRE. 2007. North Pacific Hypermaritime Sitka Spruce Forest. BPS 0110360. IN: Landfire Biophysical Setting Descriptions. http://www.landfire.gov/NationalProductDescriptions20.php

MacKinnon, A. 2003. West coast, temperate, old-growth forests. The Forestry Chronicle 79(3): 475-484.

Nowacki, G. J.; Kramer, M. G. 1998. The effects of wind disturbance on temperate rain forest structure and dynamics of southeast Alaska. Gen. Tech. Rep. PNW-GTR-421. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 25 p.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Van Pelt, R. 2007. Identifying Mature and Old Forests in Western Washington. WA. Dept. Natural Resources, Olympia WA. 104p.

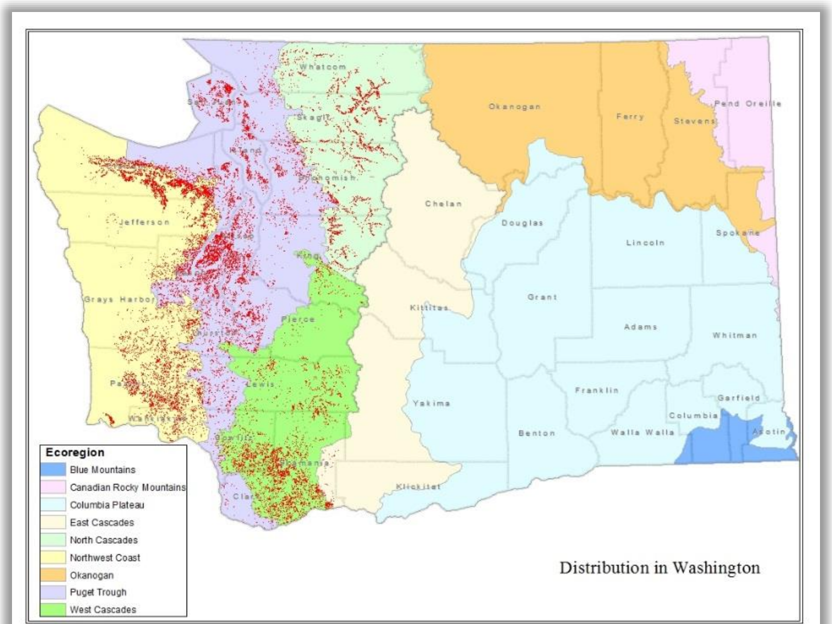
Description Author: Rex Crawford, Gwen Kittel and Chris Chappell.

NORTH PACIFIC MARITIME DRY-MESIC DOUGLAS-FIR WESTERN HEMLOCK FOREST

Concept: Western Washington, lowland forests characterized by *Pseudotsuga menziesii* forests with *Tsuga heterophylla* or *Thuja plicata* co-dominant or occasional in the understory. Understory species are generally dry site indicators and include *Gaultheria shallon*, *Mahonia nervosa*, *Rhododendron macrophyllum*, *Acer circinatum*, *Achlys triphylla*, *Vaccinium ovatum*, and *Linnaea borealis*. *Polystichum munitum* may also be present but less than 30-40% total cover.

Conservation Status: Imperiled (S2S3). Most stands have been logged and few old-growth stands remain. Most of this system's range is within the Puget lowlands where the majority of the state's population lives and where land conversion rates are high.

Distribution: These forests form the matrix vegetation in the lower montane, foothills and lowlands of western British Columbia, western Washington and much of western Oregon except in rainshadows. In Washington, the North Pacific Maritime Dry-Mesic Douglas-fir-Western Hemlock Forest appears as the forest matrix in a landscape mosaic with the North Pacific Maritime Mesic-Wet Douglas-fir-Western Hemlock Forest system that occurs in mesic-wet environments.



Distribution in Washington

Environment: These forests are best represented in areas with relatively winter high precipitation, long frost-free periods, and low to moderate fire frequencies. The associated climate is relatively mild and moist to wet. Mean annual precipitation is mostly 90-254 cm (35-100 inches) falling mostly as winter rain. Elevation ranges from sea level to 610 m (2000 feet). Snowfall is rare in lower elevations but occurs more regularly with increasing elevation but rarely establishes a snow pack. Topography ranges from relatively flat glacial till plains to steep mountainous terrain. Dry-Mesic forest soils are generally well-drained and are mesic to dry for much of the year.

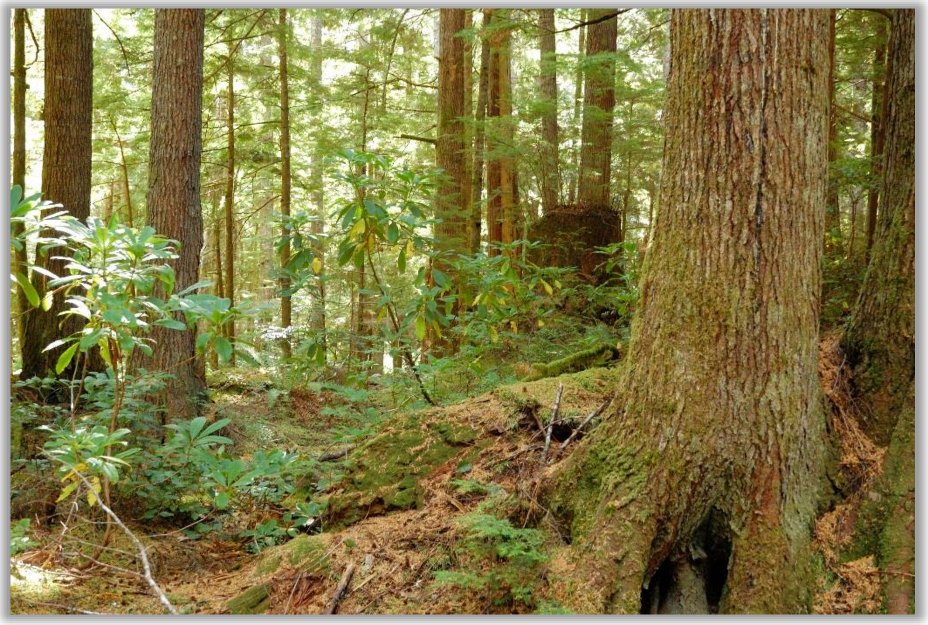
Vegetation: The Dry-Mesic system is characterized by giant *Pseudotsuga menziesii* forests with *Tsuga heterophylla* or *Thuja plicata* co-dominant or occasional in the understory. Other tree species such as *Abies grandis*, *Acer macrophyllum, Thuja plicata*, *Acer macrophyllum, Abies grandis,* and *Pinus monticola* appear less abundantly but sometimes can be significant canopy components. *Tsuga heterophylla* is generally the dominant regenerating tree species and is typically lacking from young stands, especially in the Puget Lowlands. Late seral stands typically have an abundance of large coniferous trees, a multi-layered canopy structure, biological legacies of large snags, and many large logs on the ground. Early seral stands typically have smaller trees, single-storied canopies, may be dominated by conifers, broadleaf trees, or both and most cases have biological legacies of previous stands. The understory may contain *Gaultheria shallon, Mahonia nervosa, Rhododendron macrophyllum, Acer circinatum, Achlys triphylla*, *Vaccinium ovatum*, and *Linnaea borealis. Polystichum munitum* may also be present but less than 30-40% total cover. Mosses are often a major ground cover. Lichens are abundant in the canopy of old stands.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system:

G240 North Pacific Maritime Douglas-fir - Western Hemlock Forest Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Pseudotsuga menziesii - (Tsuga heterophylla) / Holodiscus discolor / Polystichum munitum Forest	G3/SNR	PNWCOAST_187
Pseudotsuga menziesii - Tsuga heterophylla / Gaultheria shallon Forest	G3/S2	CEGL000084
Pseudotsuga menziesii - Tsuga heterophylla / Mahonia nervosa Forest	G2/S1	CEGL000083
Pseudotsuga menziesii - Tsuga heterophylla / Rhododendron macrophyllum - Vaccinium ovatum - Gaultheria shallon Forest	G2/S2	CEGL002615
Pseudotsuga menziesii - Tsuga heterophylla / Vaccinium ovatum Forest	G2/S2	CEGL002614
Pseudotsuga menziesii / Acer circinatum - Holodiscus discolor Forest	G3Q/S2	CEGL000109
Pseudotsuga menziesii / Gaultheria shallon Forest	G3G4/SNR	CEGL000435
Tsuga heterophylla / Rhododendron macrophyllum Forest	G4/S4	CEGL000112

Ecological Processes: Fire is the major natural disturbance, thus this system is less common to absent on the windward side of the Olympic Mountains and Willapa Hills, where fire is rare. Fire intervals vary from < 100 years in driest climatic areas to several hundred years in wetter climates. Generally characterized as large, stand-replacing fires, historical (pre-1880) fires were high-severity or, less commonly, moderate-severity, with natural return intervals of a few hundred to several hundred years. More frequent moderate-severity fires would generally not burn moister microsites. LANDFIRE (2007) modeled this system as a fire regime III system with 75% in late-seral structure, 20% mid-seral, and 5% early seral in pre-settlement condition. Approximately three-quarters of fire in this ecological are mixed severity with a fire interval of 100 to 150 years. The remaining fires are high severity every 300-500 years. Bark beetles and fungi are significant causes of mortality that typically operate on a small scale. Landslides occur in some areas.

Agee (1998) determined that over 385 sq. miles (10,000 ha) was the historical fire patch size in these forests. Pre-settlement patch structure as estimated by LANDFIRE (2007) consisted of 5% of the landscape in early



seral stage (cohort establishment of Franklin et al. (2002)) dominated by shrubs or rarely herbaceous plants. That stage typically develops into closed canopy forest stands with poor understory development (biomass accumulation/ competitive exclusion of Franklin et al. 2002)). Those patches occupied an estimated 15% of the landscape, typically with *Pseudotsuga menziesii* sometimes with *Tsuga heterophylla* as the dominant trees. Trees are less than 20 inches diameter-at-breast height, 12-inches on average. An estimated 20% has mature to old-growth structure (largest trees over 20 inches dbh) following mix-severity fire but with less *Tsuga heterophylla* or other shade-tolerant species in the upper canopy. An estimated 60% would be closed canopy mature to old-growth stands with high vertical structural diversity (Maturation to Pioneer loss stage of Franklin et al. 2002).

Threats: Many historical occurrences of this system have become conifer plantations and logging of remaining intact stands remains a threat. Clearcut logging and plantation forestry have resulted in less diverse tree canopies, and have focused mainly on Douglas-fir, with reductions in coarse woody debris, a shortened stand initiation phase, and succession truncated well before late-seral characteristics are expressed. Since European settlement, development, timber harvest, road building, fire suppression, tree plantations and introduced diseases have all impacted natural disturbance regimes, forest structure, composition, landscape patch diversity, and tree regeneration. Development has fragmented the landscape changing fire regime and connectivity of this small patch system particularly in lowlands. Timber harvest operations change canopy structural complexity and abundance of large woody debris of individual stands and has altered whole landscape patch pattern, age and structural complexity (Van Pelt 2007). Plantation forestry has changed local tree gene pools, horizontal arrangement of trees and homogenized the diversity of tree sizes. Other effects include loss of early seral shrub species, advanced stand development, increased stand density, and increased tree mortality. Older logged areas can support dense, stagnating second growth with root rot (Arno 2000). Ohlman and Waddel (2002) speculated that snag abundance more likely reflect recent disturbance and forest succession, whereas down wood amounts more are strongly reflect long-term stand history and site productivity.

Classification Comments: This system is characterized by *Tsuga heterophylla* or *Thuja plicata* comprising over 10% of the tree canopy and *Gaultheria shallon, Mahonia nervosa*, *Rhododendron macrophyllum,* or *Vaccinium ovatum* as understory dominants. Dominance (e.g. > 40% cover) of *Polystichum munitum* would indicate that the stand be classified as the closely related North Pacific Maritime Mesic-Wet Douglas-fir-Western Hemlock Forest. The latter occurs on sites where soils remain moist to subirrigated for much of the year and fires are less frequent.

LOWLAND & FOOTHILL MESIC FORESTS

Related Concepts: This ecological system falls within the Westside Lowlands Conifer-Hardwood Forest habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the North Pacific Maritime Dry-Mesic Douglas-fir Hemlock Forest as one of their standard mapping units.

References
Agee, J. 1998. Landscape ecology of western forest fire regimes. Northwest Sci.72:24-35.

Arno, S. (2000). Fire in western forest ecosystems (chapter 5). In: J.K Brown and J.K. Smith (eds), pp. 97-120, Wildland fire in ecosystems: effects of fire on flora. USDA Forest Service, General Technical Report RMRS-GTR-42-vol 2.

Franklin, J.F., T.A. Spies, R. Van Pelt, A.B. Carey, D.A. Thornburgh, D.R. Berg, D.B. Lindenmayer, M.E. Harmon, W.S. Keeton, D.C. Shaw, K. Bible and J. Chen. 2002. Disturbances and structural development of natural forest ecosystems with silvicultural implications, using Douglas-fir as an example. Forest Ecology and Management 155: 399–423.

LANDFIRE. 2007. Biophysical Setting Model 0110370: North Pacific Maritime Dry-Mesic Douglas-fir-Western Hemlock Forest. Rapid Assessment Biophysical Settings Model Descriptions.

Ohlman, J. and K. Waddell. 2002. Regional Patterns of Dead Wood in Forested Habitats of Oregon and Washington IN: Laudenslayer, William F., Jr.; Shea, Patrick J.; Valentine, Bradley E.; Weatherspoon, C. Phillip; Lisle, Thomas E., technical coordinators. Proceedings of the symposium on the ecology and management of dead wood in western forests. 1999 November 2-4; Reno, NV. Gen. Tech. Rep. PSW-GTR-181. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 949 p.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Thomson, J.L., C. Weller, and B. Severtsen. 2003. Cascades Crest Forests: Forest Loss, Habitat Fragmentation and Wildness. The Wilderness Society. 46p.

Van Pelt, R. 2007. Identifying Old trees and Forests in Eastern Washington. WA. Dept. Natural Resources, Olympia WA. 169p.

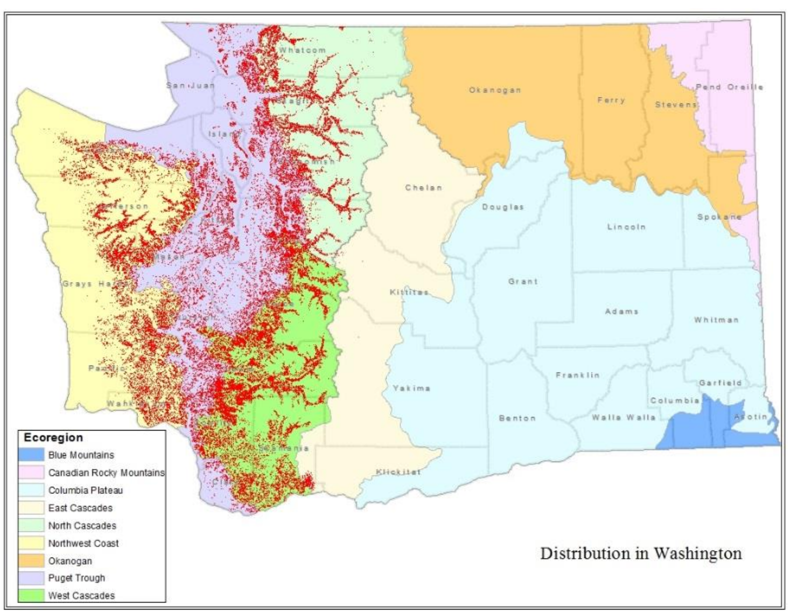
Description Author: Rex Crawford, Gwen Kittel and Chris Chappell.

NORTH PACIFIC MARITIME MESIC-WET DOUGLAS-FIR WESTERN HEMLOCK FOREST

Concept: Western Washington, lowland forests occurring in moist to very moist sites. Overstory canopy is dominated by *Pseudotsuga menziesii*, *Tsuga heterophylla*, and/or *Thuja plicata*. *Abies grandis* often can be codominant. *Acer macrophyllum* and *Alnus rubra* (the latter primarily where there has been historical logging disturbance) are commonly found as canopy or subcanopy codominants. *Polystichum munitum* (over 40% cover), *Oxalis oregana, Rubus spectabilis*, and *Oplopanax horridus* typify the poor to well-developed understory layers. *Gaultheria shallon, Mahonia nervosa, Rhododendron macrophyllum*, and *Vaccinium ovatum* are often present but are generally not as abundant as the aforementioned indicators.

Conservation Status: Vulnerable (S3S4).

Distribution: This ecological system occurs mostly as a large patch but occasional matrix system throughout lowlands of western Washington, northwestern Oregon, eastern Vancouver Island, and the southern Coast Ranges in British Columbia. In Washington, the North Pacific Maritime Mesic-Wet Douglas-fir-Western Hemlock Forest is a significant component of the lowland and low montane forests of western Washington, except on extremely dry sites and in the hypermaritime zone near the outer coast.



Environment: These forests are best represented on lower mountain slopes with high precipitation, long frost-free periods, and low fire frequencies. The associated climate is relatively mild and moist to wet. Mean annual precipitation is mostly 90-254 cm (35-100 inches) falling mostly as winter rain. Elevation ranges from sea level to 610 m (2000 feet). Snowfall is rare in lower elevations but occurs more regularly with increasing elevation but rarely establishes a snow pack. Topography ranges from relatively flat glacial till plains to steep mountainous terrain. Mesic-Wet forest soils are moist to somewhat wet (but not saturated) for much of the year and are well-drained to somewhat poorly drained. Typical soils for sites supporting a *Polystichum* understory would be deep, fine- to moderately coarse-textured, and for sites with an *Oplopanax* understory, soils typically have an impermeable layer at a moderate depth. Both types of soils are well-watered from upslope or hyporheic sources and seeps. However, these forests are not as wet as those found in the North Pacific Hardwood-Conifer Swamp system.

Vegetation: Overstory canopy is dominated by *Pseudotsuga menziesii*, *Tsuga heterophylla*, and/or *Thuja plicata*. *Abies grandis* often can be codominant. *Acer macrophyllum* and *Alnus rubra* (the latter primarily where there has been historical logging disturbance) are commonly found as canopy or subcanopy codominants, especially at lower elevations. In a natural landscape, small patches can be dominated by these same broadleaf trees for several decades after a severe fire. Late seral stands typically have an abundance of large coniferous trees, a multi-layered canopy structure, large snags, and many large logs on the ground. Early seral stands typically have smaller trees, single-storied canopies, and may be dominated by conifers, broadleaf trees, or both. Young stands may lack *Tsuga heterophylla* or *Thuja plicata*, especially in the Puget Lowland. *Tsuga heterophylla* is generally the dominant regenerating tree species. *Polystichum munitum* (over 40% cover), *Oxalis oregana*, *Rubus spectabilis*, and *Oplopanax horridus* typify the poor to well-developed understory layers. *Gaultheria shallon*, *Mahonia nervosa*, *Rhododendron macrophyllum*, and *Vaccinium ovatum* are often present but are generally not as abundant as the aforementioned indicators. *Acer circinatum* is a very common codominant as a tall shrub. Mosses are often a major ground cover. Lichens are abundant in the canopy of old stands.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Groups and Associations that are associated with this ecological system:

G212 East Cascades Mesic Grand Fir - Douglas-fir Forest Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Tsuga heterophylla / Tiarella trifoliata - Gymnocarpium dryopteris Forest	G3/S3	CEGL000116
G237 North Pacific Red Alder - Bigleaf Maple - Douglas-fir Forest Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Abies grandis - Acer macrophyllum / Symphoricarpos albus Forest	G3Q/SNA	CEGL000519
Acer macrophyllum - Pseudotsuga menziesii / Acer circinatum / Polystichum munitum Forest	G4/SNA	CEGL003394
Acer macrophyllum - Pseudotsuga menziesii / Corylus cornuta / Hydrophyllum tenuipes Forest	G3/SNA	CEGL000517
Acer macrophyllum / Acer circinatum Forest	G4G5/S4?	CEGL000560
Alnus rubra / Polystichum munitum Forest	G4/S4	CEGL000638
Betula papyrifera var. commutata - Alnus rubra / Polystichum munitum Forest	G1/S1	CEGL003352
G240 North Pacific Maritime Douglas-fir - Western Hemlock Forest Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Abies grandis - Tsuga heterophylla / Polystichum munitum Forest	G2/S2	CEGL000287
Pseudotsuga menziesii - (Abies grandis, Thuja plicata) / Mahonia nervosa - Gaultheria shallon Forest	G2/S1	CEGL002845
Pseudotsuga menziesii - Tsuga heterophylla / Polystichum munitum Forest	G3?/S2	CEGL000085

G240 North Pacific Maritime Douglas-fir - Western Hemlock Forest Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Pseudotsuga menziesii / Acer circinatum Forest	G5?/S4S5	CEGL000417
Pseudotsuga menziesii / Polystichum munitum Forest	G4G5Q/SNR	CEGL000450
Pseudotsuga menziesii-(Alnus rubra-Tsuga heterophylla)/Rubus spectabilis Forest	G4/SNR	CEGL000102
Pseudotsuga menziesii-Tsuga heterophylla/Gaultheria shallon/Polystichum munitum Forest	G4/SNR	CEGL000091
Tsuga heterophylla / Acer circinatum / Achlys triphylla Forest	G3G4/S2	CEGL000090
Tsuga heterophylla / Achlys triphylla Forest	G4/S4	CEGL000094
Tsuga heterophylla / Gaultheria shallon / Polystichum munitum Forest	G4/S4	CEGL000101
Tsuga heterophylla / Mahonia nervosa - Gaultheria shallon Forest	G4/S4	CEGL000096
Tsuga heterophylla / Mahonia nervosa Forest	G4/S4	CEGL000492
Tsuga heterophylla / Polystichum munitum - Blechnum spicant Forest	G4/S4	CEGL000108
G751 North Pacific Western Hemlock - Sitka Spruce - Western Red-cedar Seasonal Rainforest Group [Proposed]	**Global/ State Rank**	**NatureServe/ WNHP Code**
Thuja plicata - Abies grandis / Polystichum munitum Forest	G1G2/S1	CEGL000468
Thuja plicata - Acer macrophyllum - Abies grandis / (Oemleria cerasiformis) / Polystichum munitum Forest	GNR/SNR	CEGL002846
Thuja plicata - Pseudotsuga menziesii - Abies grandis / Mahonia nervosa / Polystichum munitum Forest	GNR/SNR	CEGL002848
Thuja plicata / Acer circinatum Forest	GNRQ/SNR	CEGL000469
Thuja plicata / Gaultheria shallon Forest	G1G2/S1S2	CEGL000475
Thuja plicata / Linnaea borealis Forest	G2/SNR	CEGL000089
Tsuga heterophylla - (Pseudotsuga menziesii) / Vaccinium alaskaense / Polystichum munitum Forest	GNR/S4	CEGL005573

Ecological Processes: Fire is the major natural disturbance, thus this system is less common to absent on the windward side of the Olympic Mountains and Willapa Hills, where fire is rare. Fire intervals vary from < 100 years in driest climatic areas to several hundred years in wetter climates. Generally characterized as large, stand-replacing fires, historical (pre-1880) fires were high-severity or, less commonly, moderate-severity, with natural return intervals of a few hundred to several hundred years. More frequent moderate-severity fires would generally not burn moister microsites. LANDFIRE (2007) modeled this system as a fire regime III system with 75% in late-seral structure, 20% mid-seral and 5% early seral in pre-settlement condition. Approximately three-quarters of fire in this ecological system are mixed severity with a fire interval of 100 to 150 years. The remaining fires are high severity every 300-500 years. Bark beetles and fungi are significant causes of mortality that typically operate on a small scale. Landslides occur in some areas. Wind may be an equally important natural disturbance as fire.

In a landscape analysis of the central Cascades in Washington, Thomson et al. (2003) concluded that the pre-settlement mean forest patch sizes are 1-5 square miles. Agee (1998) determined that over 385 sq. miles (10,000 ha) was the historical fire size in these systems. Pre-settlement patch structure as estimated by LANDFIRE (2007) consisted of 5% of the landscape in early seral stage (cohort establishment of Franklin et al. (2002)) dominated by shrubs or rarely herbaceous plants. That stage typically develops into closed canopy forest stands with poor understory development (biomass accumulation/ competitive exclusion of Franklin et al. 2002)). Those patches occupied an estimated 20% of the landscape, typically with *Pseudotsuga menziesii* sometimes with *Tsuga heterophylla* as the dominant trees. Trees are less than 20 inches diameter-at-breast height, 12-inches on average. Another 5% of the landscape consists of young, open canopy forest stands that have experienced or developed from mix-severity fire (usually conifer-dominated) or occur in more mesic to wet areas, areas with windthrow, root-rot or die. An estimated 70% of Mesic-Wet forest patches would be closed canopy mature to old-growth stands with high vertical structural diversity (Maturation to Pioneer loss stage of Franklin et al. 2002).

Threats: Many historical occurrences of this system have become conifer plantations and logging of remaining intact stands remains a threat. Clearcut logging and plantation forestry have resulted in less diverse tree canopies, and have focused mainly on Douglas-fir, with reductions in coarse woody debris, a shortened stand initiation phase, and succession truncated well before late-seral characteristics are expressed. Since European settlement, development, timber harvest, road building, fire suppression, tree plantations and introduced diseases have all impacted natural disturbance regimes, forest structure, composition, landscape patch diversity, and tree regeneration. Development has fragmented the landscape changing fire regime and connectivity of this small patch system particularly in lowlands. Timber harvest operations change canopy structural complexity and abundance of large woody debris of individual stands and has altered whole landscape patch pattern, age and structural complexity (Van Pelt 2007). Plantation forestry has changed local tree gene pools, horizontal arrangement of trees and homogenized the diversity of tree sizes. Other effects include loss of early seral shrub species, advanced stand development, increased stand density, and increased tree mortality. Older logged areas can support dense, stagnating second growth with root rot (Arno 2000). Ohlman and Waddel (2002) speculated that snag abundance more likely reflect recent disturbance and forest succession, whereas down wood amounts more are strongly reflect long-term stand history and site productivity.

Classification Comments: This system is characterized by *Tsuga heterophylla* or *Thuja plicata* comprising over 10% of the tree canopy and *Polystichum munitum* (> 40% cover), *Oxalis oregana*, *Rubus spectabilis*, and *Oplopanax horridus* as co-dominant to dominant (>10% cover) in the understory. Forested stands with abundant *Lysichiton americanus*, an indicator of seasonally flooded or saturated soils, would be classified as the North Pacific Hardwood-Conifer Swamp Ecological System. These forests differ from the North Pacific Maritime Dry-Mesic Douglas-fir-Western Hemlock Forest by occurring on moist to wet sites, mainly on lower slopes or valley landforms, having more hydrophilic understory species, higher abundance of shade- and moisture-tolerant canopy trees, and higher stand productivity, due to higher soil moisture and lower fire frequency.

Related Concepts: This ecological system falls within the Westside Lowlands Conifer-Hardwood Forest habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the North Pacific Maritime Dry-Mesic Douglas-fir Hemlock Forest as one of their standard mapping units.

References

Agee, J. 1998. Landscape ecology of western forest fire regimes. Northwest Sci.72:24-35.

Arno, S. (2000). Fire in western forest ecosystems (chapter 5). In: J.K Brown and J.K. Smith (eds), pp. 97-120, Wildland fire in ecosystems: effects of fire on flora. USDA Forest Service, General Technical Report RMRS-GTR-42-vol 2.

Franklin, J.F., T.A. Spies, R. Van Pelt, A.B. Carey, D.A. Thornburgh, D.R. Berg, D.B. Lindenmayer, M.E. Harmon, W.S. Keeton, D.C. Shaw, K. Bible and J. Chen. 2002. Disturbances and structural development of natural forest ecosystems with silvicultural implications, using Douglas-fir as an example. Forest Ecology and Management 155: 399–423.

LANDFIRE. 2007. Biophysical Setting Model 0110370: North Pacific Maritime Dry-Mesic Douglas-fir-Western Hemlock Forest. Rapid Assessment Biophysical Settings Model Descriptions.

Ohlman, J. and K. Waddell. 2002. Regional Patterns of Dead Wood in Forested Habitats of Oregon and Washington IN: Laudenslayer, William F., Jr.; Shea, Patrick J.; Valentine, Bradley E.; Weatherspoon, C. Phillip; Lisle, Thomas E., technical coordinators. Proceedings of the symposium on the ecology and management of dead wood in western forests. 1999 November 2-4; Reno, NV. Gen. Tech. Rep. PSW-GTR-181. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 949 p.

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Van Pelt, R. 2007. Identifying Old trees and Forests in Eastern Washington. WA. Dept. Natural Resources, Olympia WA. 169p.

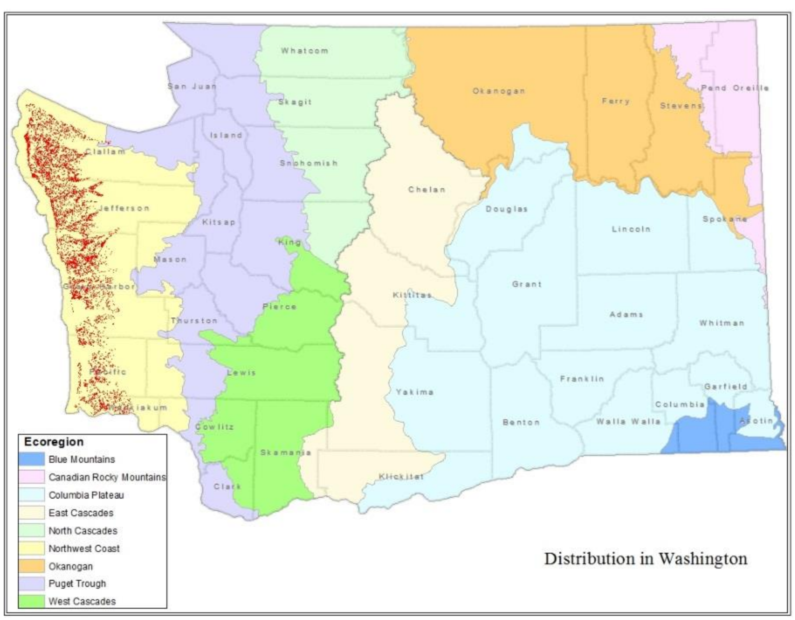
Description Author: Rex Crawford, Gwen Kittel and Chris Chappell.

NORTH PACIFIC SEASONAL SITKA SPRUCE FOREST

Concept: Sitka spruce dominated forests restricted to the hypermaritime climatic areas along the outermost coastal fringe where salt spray is prominent and on riparian terraces and valley bottoms near the coast where there is major fog accumulation. The system is part of the coastal temperate rain forests of North America.

Conservation Status: Critically Imperiled (S1S2). Occurrences of this system in an undisturbed condition are uncommon to rare. Many known stands are small remnants reflecting past management removal of trees, and burning or heavy site disturbance before planting off -site Douglas-fir. Most protected areas along the Pacific Coast were logged in the past.

Distribution: This ecological system is a matrix to large patch type restricted to the hypermaritime (*sensu* Klinka et al. 1989) climatic areas near the Pacific Coast, along a fog belt from Point Arena, California, north to the Kenai Peninsula, Alaska. The system is part of the coastal temperate rain forests of North America which contain the largest, most commercially valuable, and fastest-growing trees, the oldest and most fought-over forests (McKinnon 2003). Some of the system's associated forests are among the most productive in the world (Van Pelt 2007). The Washington Sitka spruce forests are found in the outermost coastal fringe where salt spray is prominent and on riparian terraces and valley bottoms near the coast where there is major fog accumulation.



Distribution in Washington

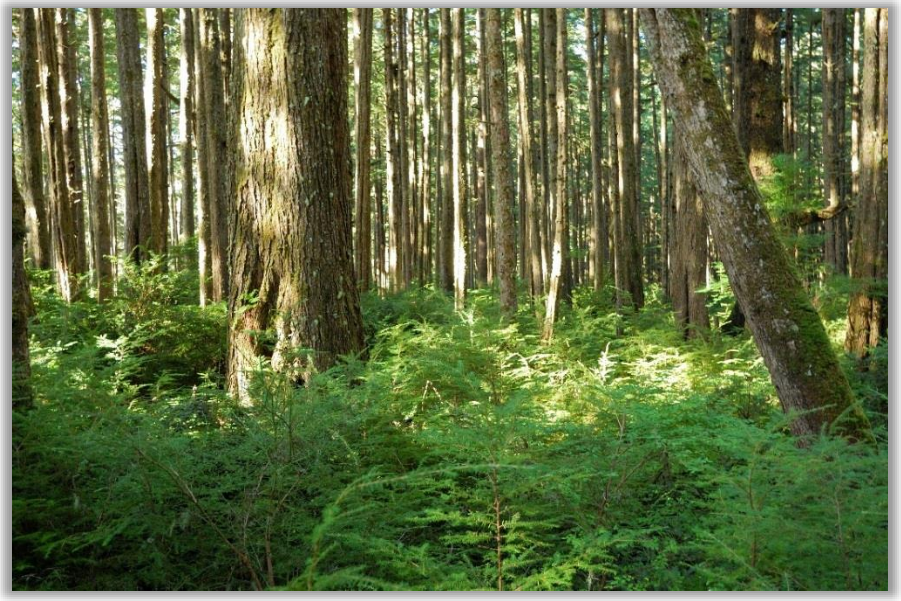
Environment: This system is found mostly below 300 m (985 ft.) elevation and within 25 km (15 miles) of the outer coast when not restricted to valley bottoms. The associated hypermaritime climate has cool summers, abundant fog, and very wet winters without a major snowpack. Summer fog is an important ecological driver as it ameliorates the effects of reduced summer precipitation. Annual precipitation averages 150 inches, with the majority falling as rain, which can be heavy. Soils are often leached and nutrient-poor with much of the soil nutrients in the surface organic matter layers (McKinnon 2003).

Vegetation: Stands are typically dominated or codominated by *Picea sitchensis* (over 10% cover) and often have a mixture of other conifers, such as *Tsuga heterophylla* (typically codominant or most abundant tree) and *Thuja plicata*. *Pseudotsuga menziesii* is part of this system south into Oregon but rare in Washington, except in the extreme southwest. The understory is rich with shade-tolerant species including evergreen shrubs *Gaultheria shallon*, and *Vaccinium ovatum*, forbs *Maianthemum dilatatum* and *Oxalis oregana*, and ferns *Polystichum munitum*, *Dryopteris* spp., and *Blechnum spicant*. A high diversity of mosses (commonly *Hylocomium splendens* and *Rhytidiadelphus loreus)* and lichens are abundant on logs, snags, trees, or the ground surface. *Rubus spectabilis* and *Acer circinatum* are common and persistent shrubs following disturbance. Plant species are similar among old growth and earlier stand developmental stages although some species are more common in old growth (McKinnon 2003).

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system:

G751 North Pacific Western Hemlock - Sitka Spruce - Western Red-cedar Seasonal Rainforest Group [Proposed]	**Global/ State Rank**	**NatureServe/ WNHP Code**
Picea sitchensis - Tsuga heterophylla / Polystichum munitum Forest	G3?/SNR	CEGL003787
Picea sitchensis / Calamagrostis nutkaensis Forest	G3G4/SNR	CEGL003266
Picea sitchensis / Gaultheria shallon - Rubus spectabilis Forest	G3/SNA	CEGL000402
Picea sitchensis / Gaultheria shallon Forest	G3/S3	CEGL000401
Picea sitchensis / Menziesia ferruginea - Vaccinium parvifolium Forest	G3/SNA	CEGL000056
Picea sitchensis / Oplopanax horridus Giant Forest	G4?/S2	CEGL000057
Picea sitchensis / Oxalis oregana Forest	G3/S3	CEGL000058
Picea sitchensis / Vaccinium ovatum Forest	G3/S2	CWWA000118

Ecological Processes: Pre-settlement forests were mostly old-growth (a British Columbia project found 98% of hypermaritime forest stand age classes were greater than 141 years, McKinnon 2003) with abundant large woody debris. *Picea sitchensis* is seral to *Tsuga heterophylla* and is retained in this system by canopy openings. Summer fog is an important ecological driver as it ameliorates the effects of less summer precipitation. The primary disturbance regime is mostly small-scale windthrow and other gap processes such as persistent salt-spray, slope movements and pathogens (Taylor 1990). There are occasional (average 20 years Henderson et al. 1989; 100-200 years LANDFIRE 2007) widespread intense windstorms and very few fires. Wind disturbance in contrast to fire tends to topple taller trees and leave small trees; although, the tallest trees are often the most wind-firm by surviving normal wind events and are left in major events (Van Pelt 2007). Taylor (1990) reported canopy gaps aged between 11 and 105 years, occupy 14 to 30% of in *Picea sitchensis-Tsuga heterophylla* hypermaritime forests in northern Oregon. Natural blowdown patches in Alaska hypermaritime forests are small (less than 50 acres) and scattered (Nowacki and Kramer 1998). Patches are concentrated on ridgetops and upper slopes. Forest turnover is estimated to be between 206 and 422 years (Taylor 1990). Nowacki and Kramer (1998) cite that the 50 percent of the hypermaritime forest landscape on an Alaska Island was a mix of small- and large-scale disturbances. Harcombe and others (2005) concluded that Sitka spruce forests are composed of large multi-aged disturbance patches often reflecting topography. In some topographic locations, forests may be have truncated developmental stages due to frequency of wind events, that is, never develop beyond stem exclusion stage.



Daniels and Gray (2006) summarize that mean fire return intervals are typically over 1000 years in the hypermaritime forests in British Columbia. Fire is more important in southern coastal forest (Harcombe et al. 2005). In general, the flammability ratings of the wet coastal temperate rain forest are low. Coarse woody debris accounts for the majority of persistent surface fuels that stays moist under moss and herbs and in the shade of multiple layers of trees and shrubs. Biomass is relatively stable with similar total amounts in old-growth and second-growth stands (Harcombe et al. 2005). Schreiner and others (1996) show that elk herbivory is an important part of the relationship between patch type and tree fall in the pattern of old growth *Picea sitchensis* forest on the Olympic Peninsula.

Threats: Since European settlement, development, timber harvest, road building, tree plantations and introduced diseases have all impacted natural disturbance regimes, forest structure, composition, landscape patch diversity, and tree regeneration. Timber harvest operations change canopy structural complexity and abundance of large woody debris of individual stands and has altered whole landscape patch pattern, age and structural complexity (Van Pelt 2007). Many historical occurrences of this system have become conifer plantations and logging of remaining intact stands remains a threat. Clearcut logging and plantation forestry have resulted in less diverse tree canopies, with reductions in coarse woody debris, a shortened stand initiation phase, and succession truncated well before late-seral characteristics are expressed (Nowacki and Kramer 1998). In the past century, stand-initiating fires, most were human-ignitions, have burned coastal forests but under unusual conditions in which logging created large fuel loads and microclimatic conditions that allowed the fuels to dry, making these sites conducive to burning (Daniels and Gray 2006). Non-native species are also a potential threat to the persistence and ecological integrity of this ecological system.

Classification Comments: This system is characterized by having over 10% cover of *Picea sitchensis*, occurring within 25 miles of the outer coast, and is not a swamp. Mild, wet climate with abundant summer fog are also characteristic.

Related Concepts: This ecological system falls within the Westside Lowlands Conifer-Hardwood Forest habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the North Pacific Hypermaritime Sitka Spruce Forest as one of their standard mapping units.

References

Daniels, L.D. and R.W. Gray. 2006. Disturbance regimes in coastal British Columbia. *BC* Journal of Ecosystems and Management 7(2):44–56.

Harcombe, P.A., S.E. Greene, M.G. Kramer, S.A. Acker, T.A. Spies, T. Valentine. 2004. The influence of fire and windthrow dynamics on a coastal spruce-hemlock forest in Oregon, USA, based on aerial photographs spanning 40 years. Forest Ecology and Management, 194(1-3): 71-82.

Henderson, J.A., D.A. Peter, R. Lesher, and D.C. Shaw. 1989. Forested Plant Associations of the Olympic National Forest U.S.D.A. For. Serv. PNW Region. R6-ECOL-TP 001-88. 502 p.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Klinka, K., Krajina, V. J., Ceska, A., and Scagel, A. M.1989. Indicator plants of coastal British Columbia. UBC Press, Vancouver.

LANDFIRE. 2007. North Pacific Hypermaritime Sitka Spruce Forest. BPS 0110360. IN: Landfire Biophysical Setting Descriptions. http://www.landfire.gov/NationalProductDescriptions20.php

MacKinnon, A. 2003. West coast, temperate, old-growth forests. The Forestry Chronicle 79(3): 475-484.

Nowacki, G. J.; Kramer, M. G. 1998. The effects of wind disturbance on temperate rain forest structure and dynamics of southeast Alaska. Gen. Tech. Rep. PNW-GTR-421. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 25 p.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Schreiner, E.G., Krueger, K.A. Happe, P.J. and D.B. Houston. 1996. Understory Patch Dynamics and Ungulate Herbivory in Old-Growth Forest of the Olympic National Park, Washington. Can. J. For. Res. 26: 255-265.

Taylor, A.H. 1990. Disturbance and Persistence of Sitka Spruce (Picea sitchensis (Bong) Carr.) in Coastal Forest of the Pacific Northwest, North America. Jour. Biogeo. 17(1):

Van Pelt, R. 2007. Identifying Mature and Old Forests in Western Washington. WA. Dept. Natural Resources, Olympia WA. 104p.

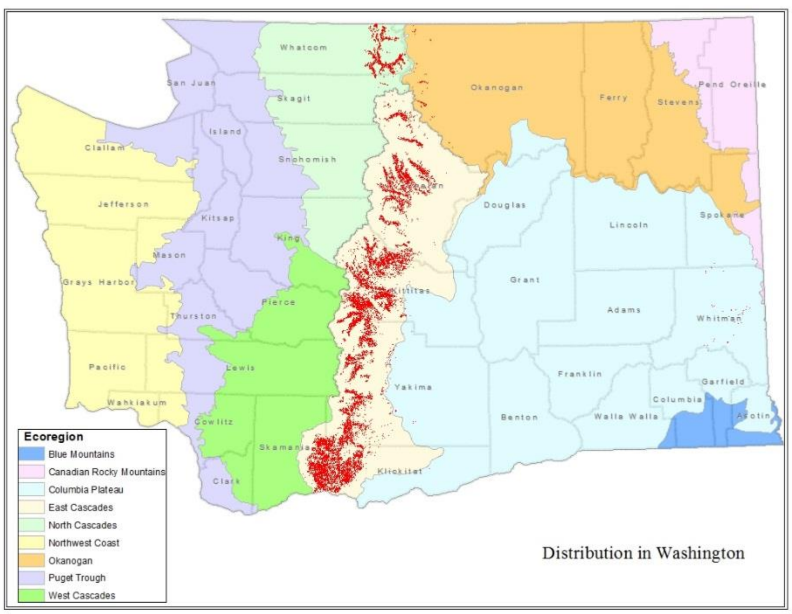
Description Author: Rex Crawford, Gwen Kittel, Pat Comer, Dick Vanderschaaf, Chris Chappell, Todd Keeler-Wolf, Marion Reid.

EAST CASCADES MESIC MONTANE MIXED-CONIFER FOREST AND WOODLAND

Concept: Mixed conifer forests in montane areas historically protected from fires, such as valley bottoms and mesic-coves. Stands are dominated by a mix of *Pseudotsuga menziesii* with *Abies grandis, Thuja plicata* and/or *Tsuga heterophylla.*

Conservation Status: Vulnerable (S3S4). This system has a restricted range limited to a more maritime climate along the eastern slopes of the Cascades. It is vulnerable to landscape level disturbances, defoliator insects, fire and roads.

Distribution: This large patch to matrix system is typically found on the upper east slopes of the Cascade Range in Washington south to Mt. Hood, OR. It occurs below the *Abies amabilis* forests east of the Cascade crest in Chelan, Kittitas, Yakima, and Klickitat counties in Washington and in adjacent Oregon. This system lies between and interfingers with the higher elevation North Pacific Mountain Hemlock Forest, North Pacific Mesic Western Hemlock-Silver Fir Forest or Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland and the lower elevation Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest. Westward in the Columbia River Gorge, this system merges with North Pacific Maritime Dry-Mesic Douglas-fir-Western Hemlock Forest. Elevations range from 610 to 1220 m (2000-4000 feet).



Distribution in Washington

Environment: The system is associated with a mesic climatic regime with annual precipitation ranging from 100 to 200 cm (40-80 inches) and winter snowpack that typically melts off in early spring at lower elevations. Elevations range from 610 to 1220 m (2000-4000 feet).

Vegetation: Dominant canopy trees include a mix of *Pseudotsuga menziesii* with *Abies grandis, Thuja plicata* and/or *Tsuga heterophylla.* Several other conifers can dominate or codominate, including *Pinus contorta, Pinus monticola, Pinus ponderosa* and *Larix occidentalis*. Common shrubs include *Mahonia nervosa, Linnaea borealis, Paxistima myrsinites, Acer circinatum, Spiraea betulifolia, Symphoricarpos hesperius, Cornus nuttallii, Rubus parviflorus,* and *Vaccinium membranaceum*.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system:

G212 East Cascades Mesic Grand Fir - Douglas-fir Forest Group	Global/ State Rank	NatureServe/ WNHP Code
Abies grandis - Pseudotsuga menziesii / Trientalis borealis ssp. latifolia Forest	G3/S2	CEGL000040
Abies grandis - Thuja plicata / Achlys triphylla Forest	G2/S2	CEGL002669
Abies grandis / Acer circinatum Forest	G4/S3	CEGL000266
Abies grandis / Achlys triphylla Forest	G3/S3	CEGL000268
Abies grandis / Arctostaphylos nevadensis Woodland	G2G3/S3	CEGL000915
Abies grandis / Cornus nuttallii - Acer glabrum Forest	G1/S1	CEGL001104
Abies grandis / Holodiscus discolor Forest	G2G3/S2	CEGL000274
Abies grandis / Mahonia nervosa Forest	G1/S1	CEGL000271
Abies grandis / Orthilia secunda Forest	G3/SNA	CEGL000279
Abies grandis / Vaccinium membranaceum - Achlys triphylla Forest	G2G3/S2S3	CEGL000291
Abies grandis / Vaccinium membranaceum Forest	G3G4/S3	CEGL000290
Tsuga heterophylla / Arctostaphylos nevadensis Woodland	G3/S3	CEGL000913
Tsuga heterophylla / Linnaea borealis Forest	G3/S3	CEGL000104
Tsuga heterophylla / Tiarella trifoliata - Gymnocarpium dryopteris Forest	G3/S3	CEGL000116

Ecological Processes: Stand-replacement, fire-return intervals are typically 150-500 years, with moderate-severity fire intervals of 50-100 years (Fire Regime Group III or IV, LANDFIRE 2007). Wright and Agee (2004) calculated a mean fire return interval of 23.9 years for the “wet grand fir” plant association group in the Teanaway Drainage. Hessburg and others (2007) found that mixed severity fires occurred on 53% of the cool/moist forest landscape of the East Cascades and the rest were low (21%) and high severity (26%) fires. Timing of mixed severity fires is irregular and fires are often overlapping (Brown et al. 2000). These mixed fire regimes and varied topography result in varied stand development and composition. Noss and others (2006) concluded that knowledge of the mixed-severity fire regime and its influence on stand structure and development is lacking and that assuming fire exclusion results in high tree density or shade-tolerant trees abundance may be incorrect. This complexity results in five general seral or developmental types recognizable in the similar Northern Rocky Mountain Mesic Mixed Conifer system. Some of these patch types are included in this ecological system and differ from the similar patches in the Northern Rocky Mountain Mesic Mixed Conifer system by having more distinct Vancouverian floristic elements, such as *Acer circinatum*, *Acer macrophyllum* and *Mahonia nervosa*. (Shiplett and Neuenschwander 1994):

SUBALPINE-MONTANE MESIC FORESTS

1) *Tsuga heterophylla – Thuja plicata* stands that initiate following disturbance
2) Mixed conifer stands that initiate from various disturbances
3) Shrubfields that develop from multiple burns
4) Scattered large *Larix occidentalis* surviving fires, and
5) *Pinus contorta* on less productive sites and relatively frequent burns.

This system is primarily composed of the first two types. Shrubfields (type 3 above) composed of *Acer circinatum* and *A. glabrum, Amelanchier alnifolia, Ceanothus* spp., *Salix scouleriana, Ribes* spp., and/or *Vaccinium membranaceum* typically develop following stand-replacing fire. Tree regeneration usually accompanies shrubs and these shrubfields become young forests within a few decades and are included in this system. (Shrubfields where trees are persistently absent to rare are better included in the Northern Rocky Mountain Lower Montane and Foothill Deciduous Shrubland system.) Following fire, most stands retain some trees and other biological legacies from the previous forest stand. Tree individuals or whole sites that escape a fire or two allow trees to reach sizes more resistant to fire and results in the clustering of old trees and stands across the landscape. Thus, old growth forests (type 1 above) develop in fire refugia such as headwalls and in riparian stringers and along benches (Camp et al. 1997). The less fire resistant and shade tolerant *Abies grandis*, *Taxus brevifolia*, *Thuja plicata*, and *Tsuga heterophylla* are more common in older forests. The mid-seral, mixed conifer (100-200 year old) stands (type 2 above) are usually canopies composed of *Pseudotsuga menziesii* , *Picea engelmannii*, *Pinus monticola*, and *Larix occidentalis* with *Abies grandis* and maybe *Thuja plicata* on moist, cool sites (Lillybridge et al 1995). Type 4 (above) is recognized as a separate small to large patch within the Northern Rocky Mountain Western Larch Savanna ecological system and type 5 is the Rocky Mountain Lodgepole Pine ecological system.


Photo by NPS – NCCN- Vegetation Inventory Monitoring Program

Less productive sites may be susceptible to insects or disease. Douglas-fir bark beetle will affect *Pseudotsuga menziesii* and *Abies grandis*. Root rots, butt rots, and stem decay can affect *Abies grandis, Thuja plicata*, whereas *Tsuga heterophylla* is less susceptible. *Pinus monticola* has been impacted by white pine blister rust and its abundance reduced in affected stands. Park and others (2005) concluded that due to climate, limited settlement history, low seed source and closed canopy forest the mountain ecoregions of the Northwest have fewer non-native invasive plants than other regions of the United States. Quigley and others (1997) estimate that late-seral forest structure (stands with upper canopy of primarily shade-intolerant trees) historically occupied about one-third of the landscape, mid-seral forest occupied 40% of the landscape, and early-seral forest occupied 20% of the landscape. Landfire (2007) modeled 65% of this system (BpS) as late seral, 25% mid-seral and 10% early seral.

Threats: Since European settlement, fire suppression, timber harvest, introduced diseases, road building, development, and plantation establishments have all impacted natural disturbance regimes, forest structure, composition, landscape patch diversity, and tree regeneration (Franklin et al. 2008). Timber harvesting has focused on the large shade-intolerant, fire-resistant species in mid- and late-seral forests thereby eliminating many old forest attributes from stands (Franklin et al. 2008). Fire suppression has allowed less fire-resistant, shade-tolerant trees to become established in the understory (and sometimes dominate the canopy) creating more dense and multi-layered forests than what historically occurred on the landscape. Road development has fragmented many forests creating fire breaks. Under present conditions the fire regime is mixed severity and more variable, with stand-replacing fires more common, and the forests are more homogeneous. With vigorous fire suppression, fire-return intervals are longer, and multi-layered stands provide fuel "ladders," making these forests more susceptible to high-intensity, stand-replacing fires. Quigley and others (1997) estimate that mid-seral forest structure is currently over 40% more abundant than historically, late-seral forests are diminished by 90% and early-seral forest abundance is 20% less than historically lacking snags and other legacy features.

Classification Comments: This ecological system has at least 10% cover of *Tsuga heterophylla*, *Thuja plicata,* or *Abies grandis* (with *Pseudotsuga menziesii* often dominant or co-dominant). This forest is similar to the Northern Rocky Mountain Mesic Montane Mixed Conifer Forest system except with distinct Vancouverian floristic elements, such as *Acer circinatum*, *Acer macrophyllum* and *Mahonia nervosa*. Herbaceous species the reflects local climate and degree of canopy closure and include species restricted to the Cascades, for example, *Achlys triphylla, Anemone deltoidea*, and *Vancouveria hexandra*. This system lies between and interfingers with the higher North Pacific Mountain Hemlock Forest, North Pacific Mesic Western Hemlock-Silver Fir Forest or Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland and the lower Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest. Westward in the Columbia River Gorge, this system merges with North Pacific Maritime Dry-Mesic Douglas-fir-Western Hemlock Forest.

Related Concepts: This ecological system falls within the Eastside (Interior) Mixed Conifer Forest habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the East Cascades Mesic Montane Mixed-Conifer Forest and Woodland as one of their standard mapping units.

References

Brown, J. K. and J.K. Smith, eds. Wildland fire in ecosystems: effects of fire on flora. Gen. Tech. Rep. RMRS-GTR-42-vol. 2. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 257 p.

Camp, A., C. Oliver, P. Hessburg and R. Everett. Predicting late-successional fire refugia pre-dating European settlement in the Wenatchee Mountains. For. Ecol. Manage. 95: 63-77.

Franklin, J.F. M.A. Hemstrom, R. Van Pelt, and J.B. Buchanan. 2008. The Case of Active Management of Dry Forest Types in Eastern Washington: Perpetuating and Creating Old Forest Structures and Functions. Washington Department of Natural Resources, Olympia, WA.

Hessburg, P.F., R.B. Salter, K.M. James. Re-examining fire-severity relations in pre-management era mixed conifer forest: inferences from landscape patterns of forest structure. Landscape Ecology.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

LANDFIRE. 2007. Biophysical Setting Model 0110180: East Cascades Mesic Montane Mixed-Conifer. Rapid Assessment Biophysical Settings Model Descriptions.

Noss, R.F., Franklin J.F., Baker W.L., *et al*. 2006. Ecology and management of fire-prone forests of the western United States. Society for Conservation Biology, North American Section. www.conbio.org/sections/namerica/napolicy.cfm.

Quigley, T. M. and S.J. Arbelbide (technical editors). 1997. An Assessment of Ecosystem Components in the Interior Columbia Basin and Portions of the Klamath and Great Basins: Volume 2. Gen. Tech. Rep. PNW-GTR-405. Portland, OR. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 4 Volumes. (Quigley, T.M., technical editor; The Interior Columbia Basin Ecosystem Management Project: Scientific Assessment).

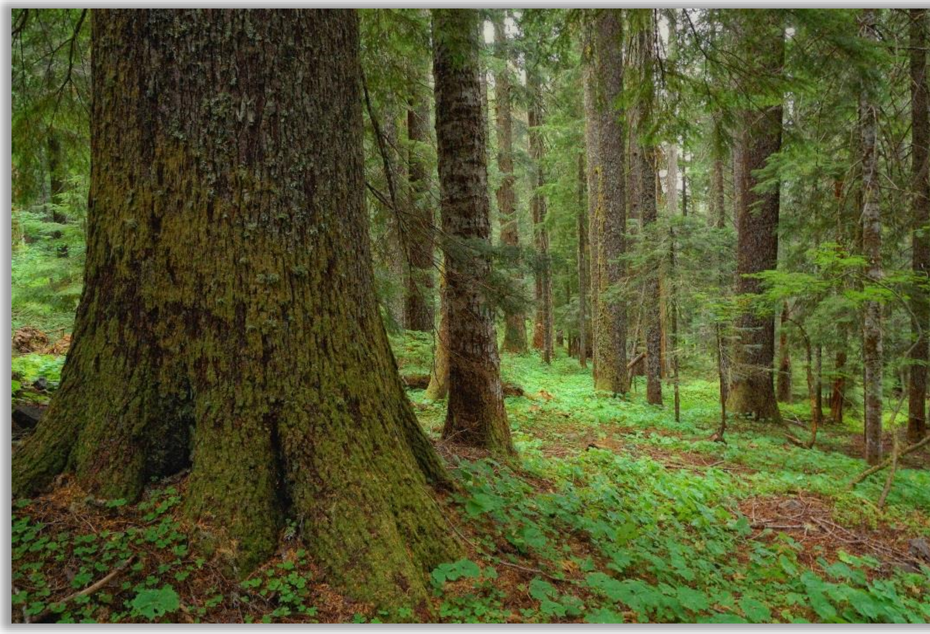
Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Shiplett, B.; Neuenschwander, L. F. 1994. Fire ecology of the cedar hemlock zone in Idaho. In: Baumgartner, D. M.; Lotan, J. E.; Tonn, J. R., ed. Interior cedar-hemlock-white pine forests: ecology and management symposium proceedings; 1993 March 2-4; Spokane, WA. Pullman, WA: Washington State University, Cooperative Extension: 41-52.

Wright, C.S. and J.K. Agee. 2004. Fire and Vegetation History in the eastern Cascade Mountains, Washington. Ecological Application. 14(2):443-459.

Description Author: Rex Crawford, Gwen Kittel, Chris Chappell, and Marion Reid

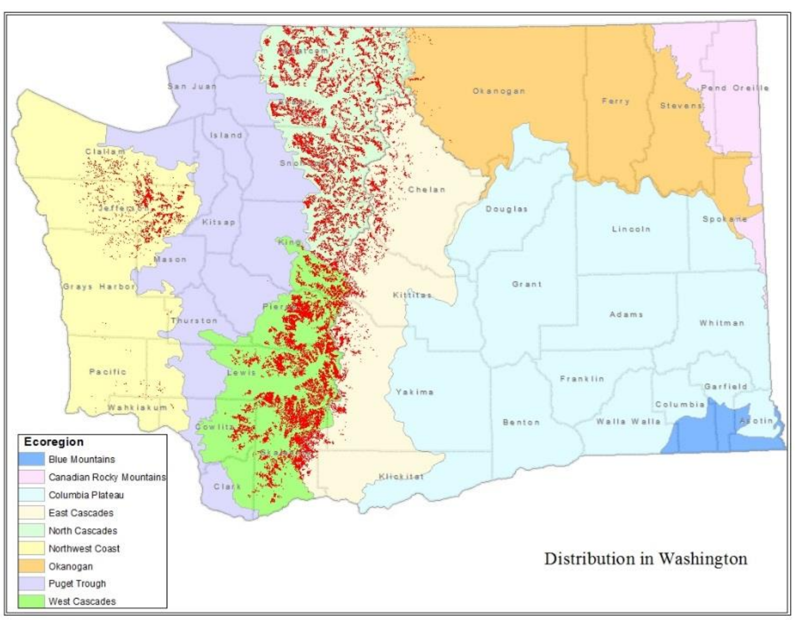
NORTH PACIFIC DRY-MESIC SILVER FIR-WESTERN HEMLOCK-DOUGLAS-FIR FOREST



Concept: Matrix forest in the mid-montane zones of the Cascade and Olympic Mountains and very sporadically in the Willapa Hills. Forest canopies are characterized by having an overstory of *Abies amabilis* and/or *Abies procera* over 10% tree cover often with *Tsuga heterophylla* codominant and usually containing *Pseudotsuga menziesii*.

Conservation Status: Secure (S5). This is a widespread system with little anthropogenic stressors affecting it. Although, past logging has occurred in some areas which may warrant a rank of higher conservation significance.

Distribution: This ecological system forms the matrix forest in the mid-montane zones of western British Columbia, western Washington and much of western Oregon. In British Columbia and in the Olympic Mountains, it occurs only on the leeward side of the mountains. In the Washington Cascades, it occurs on both windward and leeward sides of the Cascades mountains. In Washington, this forested system dominates mid-montane zones of the Cascade and Olympic Mountains and very sporadically in the Willapa Hills. It generally occurs in an elevational band between *Pseudotsuga menziesii* - *Tsuga heterophylla* forests and *Tsuga mertensiana* forests.



Environment: This system has a characteristically variable winter snowpack that typically lasts for 2 to 6 months and is sometimes referred to as the "rain-on-snow" zone because of the common occurrence of major winter rainfall on an established snowpack. Snowpack varies between 1 and 3.5

m (4-10 ft.) and fog drip adds inches to yearly total precipitation (Henderson et al. 1989).

Vegetation: This system is characterized by having an overstory of *Abies amabilis* and/or *Abies procera* over 10% tree cover often with *Tsuga heterophylla* codominant and usually containing *Pseudotsuga menziesii*. *Tsuga heterophylla* and/or *Abies amabilis* dominate the canopy of late-seral stands, though *Pseudotsuga menziesii* and *Chamaecyparis nootkatensis* (especially at higher elevations) can be codominant. *Abies procera* forests (usually mixed with *Abies amabilis*) are included in this system and occur in the Cascades from central Washington to central Oregon. *Pseudotsuga menziesii* is a common species that regenerates after fires and therefore is frequent as a codominant, except at higher elevations. *Abies lasiocarpa* sometimes occurs as a codominant, along with other conifers such as *Abies grandis* and *Picea engelmannii* on the east side of the Cascades. Understory species that tend to be more common include *Achlys triphylla, Mahonia nervosa*, *Xerophyllum tenax*, *Vaccinium membranaceum, Rhododendron macrophyllum*, and *Rhododendron albiflorum*. *Vaccinium alaskense* is occasional and only dominates on more moist sites.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system:

G241 North Pacific Maritime Silver Fir - Western Hemlock Forest Group	Global/ State Rank	NatureServe/ WNHP Code
Abies amabilis / Gaultheria shallon / Blechnum spicant Forest	G3/S3	CEGL000221
Abies amabilis / Gaultheria shallon Forest	G4/S4	CEGL000220
Abies amabilis / Mahonia nervosa Forest	G4/S4	CEGL000217
Abies amabilis / Rhododendron macrophyllum - Mahonia nervosa Forest	G4/SNA	CEGL000218
Abies amabilis / Rhododendron macrophyllum Forest	G5/S5	CEGL000225
Abies amabilis / Tiarella trifoliata Forest	G4/S4	CEGL000007
Abies amabilis / Vaccinium membranaceum / Xerophyllum tenax Forest	G4/S4	CEGL000239
Abies amabilis / Vaccinium ovalifolium - Gaultheria shallon Forest	G4/S4	CEGL002626
Abies amabilis / Vaccinium ovalifolium / Erythronium montanum Forest	G3/S3	CEGL000234
Abies amabilis / Vaccinium ovalifolium / Mahonia nervosa Forest	G4/S4	CEGL000232
Abies amabilis / Vaccinium ovalifolium / Tiarella trifoliata Forest	G4/S3	CEGL000009

Ecological Processes: Overall, infrequent mixed severity fire regimes occurring at greater than 100 years characterize this system (LANDFIRE 2007). Variable sized patches results from such a fire regime. Stand-replacement fires occur with mean return intervals of about 200-500 years, consequently where old-growth exist it is mostly "young old-growth" 200-500 years in age. Natural-origin stands less than 200 years old are also common. Fire frequency tends to decrease with increasing elevation and continentality but still remains within this typical range. Avalanches and wind events are also common disturbances in this type. LANDFIRE (2007) modeled this as a fire regime III system with 60% in late-seral structure (50% closed), 25% mid-seral (20% closed), and 15% early seral in pre-settlement condition.

In a landscape analysis of the central Cascades in Washington, Thomson, Weller and Severtsen (2003) concluded that the pre-settlement mean forest patch sizes are 1-5 square. Mixed-severity fires that are often stand-replacing events occur on the scale of 1000's of acres (LANDFIRE 2007). Pre-settlement landscape patch structure, as estimated by LANDFIRE (2007), consisted of 15% early seral stage (cohort establishment of Franklin et al. 2002) dominated by shrubs and tree seedlings. That stage typically develops

into closed canopy forest stands with poor understory development (biomass accumulation/ competitive exclusion of Franklin et al. 2002). Those patches occupied an estimated 20% of the landscape, typically with *Pseudotsuga menziesii* sometimes with *Abies amabilis* or *Abies procera* as the dominant trees. Trees are less than 20 inches diameter-at-breast height. Another 5% of the landscape consists of young, open canopy *Pseudotsuga menziesii* maybe with *Pinus monticola* stands developed from mix-severity fire. An estimate 10% of the forests is in the similar structural condition of larger trees following mix-severity fires but with *Abies amabilis*. An estimated 50% of forest patches would be closed canopy mature to old-growth stands with high vertical structural diversity (Maturation to Pioneer loss stage of Franklin et al. 2002).

Threats: Since European settlement, timber harvest, road building, fire suppression, tree plantations and introduced diseases have all impacted natural disturbance regimes, forest structure, composition, landscape patch diversity, and tree regeneration. Timber harvest operations change canopy structural complexity and abundance of large woody debris of individual stands and has altered whole landscape patch pattern, age and structural complexity (Van Pelt 2007). Forest management practices have in many cases resulted in less diverse tree canopies (with an emphasis on Douglas-fir), reduced coarse woody debris, and truncated succession well before late-seral characteristics are expressed. Plantation forestry has changed local tree gene pools, horizontal arrangement of trees and homogenized the diversity of tree sizes. *Abies procera* and *Pseudotsuga menziesii* are planted at higher densities than under natural regimes. Other effects include loss of early seral species, advanced stand development, increased stand density, and increased tree mortality. Older logged areas can support dense, stagnating second growth with root rot (Arno 2000). Ohlman and Waddel (2002) speculated that snag abundance more likely reflect recent disturbance and forest succession, whereas down wood amounts more are strongly reflect long-term stand history and site productivity. Post-harvest regeneration of trees has been a perpetual problem for forest managers in much of this habitat. Slash burning often has negative impacts on productivity and regeneration. Noble fir plantations are now fairly common in managed landscapes, even outside the natural range of the species.

Classification Comments: This system is characterized by having an overstory of silver fir and/or noble fir over 10% tree cover often with *Tsuga heterophylla* codominant and contains *Pseudotsuga menziesii*. The prevalence of *Pseudotsuga menziesii* is an important indicator in relation to the related climatically wetter North Pacific Mesic Western Hemlock-Silver Fir Forest where *Pseudotsuga menziesii* is not found. In addition, this system supports numerous dry understory species that tend to be more common or unique in this type compared to the wetter North Pacific Mesic Western Hemlock-Silver Fir Forest including *Achlys triphylla*, *Mahonia nervosa*, *Xerophyllum tenax*, *Vaccinium membranaceum*, *Rhododendron macrophyllum*, and *Rhododendron albiflorum*. *Vaccinium ovalifolium*, while still common, only dominates on more moist sites within this type, unlike in the related type where it is nearly ubiquitous. The North

Pacific Mesic Western Hemlock-Silver Fir Forest does not have stand replacing fires whereas such fires are the dominant natural process in this system.

Related Concepts: This ecological system falls within the Montane Mixed-Conifer Forest habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the North Pacific Dry-Mesic Silver Fir-Western Hemlock-Douglas-fir Forest as one of their standard mapping units. .

References

Arno, S. (2000). Fire in western forest ecosystems (chapter 5). In: J.K Brown and J.K. Smith (eds), pp. 97-120, Wildland fire in ecosystems: effects of fire on flora. USDA Forest Service, General Technical Report RMRS-GTR-42-vol 2.

Franklin, J.F., T.A. Spies, R. Van Pelt, A.B. Carey, D.A. Thornburgh, D.R. Berg, D.B. Lindenmayer, M.E. Harmon, W.S. Keeton, D.C. Shaw, K. Bible and J. Chen. 2002. Disturbances and structural development of natural forest ecosystems with silvicultural implications, using Douglas-fir as an example. Forest Ecology and Management 155: 399–423.

Henderson, J.A., D.A. Peter, R. Lesher, and D.C. Shaw. 1989. Forested Plant Associations of the Olympic National Forest U.S.D.A. For. Serv. PNW Region. R6-ECOL-TP 001-88. 502 p.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

LANDFIRE. 2007. North Pacific Dry-Mesic Silver fir – Western hemlock – Douglas-fir. BPS 0111740 IN: Landfire Biophysical Setting Descriptions. http://www.landfire.gov/NationalProductDescriptions20.php

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Thomson, J.L., C. Weller, and B. Severtsen. 2003. Cascades Crest Forests: Forest Loss, Habitat Fragmentation and Wildness. The Wilderness Society. 46p.

Van Pelt, R. 2007. Identifying Old trees and Forests in Western Washington. WA. Dept. Natural Resources, Olympia WA. 169p.

Description Author: Rex Crawford, Chris Chappell

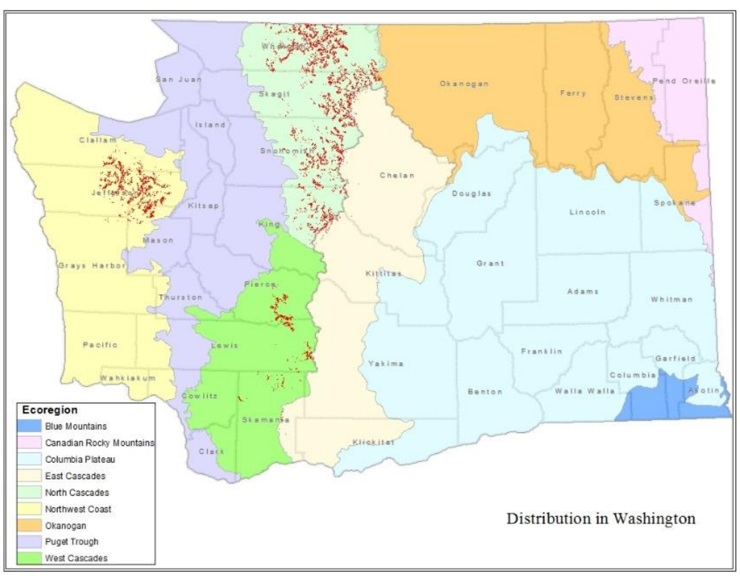
NORTH PACIFIC MARITIME MESIC SUBALPINE PARKLAND

Concept: Clumps of trees to small patches of forest interspersed with low shrublands and meadows form a mosaic of "tree islands" among generally larger patches of meadows and shrublands. This system is found throughout the Olympic and Cascade Mountains at the forest/alpine transition zone.

Conservation Status: Apparently Secure (S4). Almost all occurrences are relatively intact and have little threats.

Distribution: Large patch system which occurs throughout the mountains of the Pacific Northwest, from the southern Cascades of Oregon to the mountains of south-central Alaska. In Washington, the system is found throughout the Olympic and Cascade Mountains at the forest/alpine transition zone.

Environment: The climate is generally characterized by short, cool summers, rainy autumns and long, cool, wet winters with heavy snow cover for 5-9 months. Summer drought is also thought to be a primary ecological factor in drier areas. Very deep, long-lasting snowpack limits tree regeneration to favorable microsites (mostly adjacent to existing trees) or during drought years with low snowpack.



Distribution in Washington

Vegetation: This system is composed of tree islands surrounded by meadows or shrublands, where they form "parkland" habitats before transitioning into treeless alpine habitats. Plant associations include woodlands, forested and subalpine meadow types. Tree islands range in size from a few trees to 0.1 hectares or more. Tree islands often occur on ridges, slight hummocks or other areas with convex topography (Franklin and Dyrness 1988). Major tree species are *Tsuga mertensiana*, *Abies amabilis*, *Chamaecyparis nootkatensis*, and *Abies lasiocarpa*. *Abies amabilis* is common in mesic and lower elevation tree islands while *Abies lasiocarpa* is typical of warmer, drier sites and is more common in the alpine krummholz examples of this system (Franklin and Dyrness 1988). Dominant dwarf-shrubs include *Phyllodoce empetriformis, Cassiope mertensiana*, and *Vaccinium deliciosum*. Dominant herbaceous species include *Lupinus arcticus ssp. subalpinus, Valeriana sitchensis, Carex spectabilis*, and *Polygonum bistortoides*.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Groups and Associations that are associated with this ecological system:

G245 North Pacific Mountain Hemlock - Silver Fir Forest & Tree Island Group	Global/ State Rank	NatureServe/ WNHP Code
Chamaecyparis nootkatensis Subalpine Parkland Woodland	G3/SNA	CEGL000350
Tsuga mertensiana - Abies amabilis / Phyllodoce empetriformis - Vaccinium deliciosum Woodland	G4/S4	CEGL000914
G271 Rocky Mountain Subalpine-Montane Mesic Herbaceous Meadow Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Festuca viridula - Eucephalus ledophyllus Herbaceous Vegetation	G4/S4	CEGL001632
Valeriana sitchensis - Carex spectabilis Herbaceous Vegetation	G4/S4	CEGL001996
Valeriana sitchensis - Ligusticum grayi Herbaceous Vegetation	G3G4Q/S3S4	CEGL001997
Valeriana sitchensis - Veratrum viride Herbaceous Vegetation	G4/S4	CEGL001998
G317 North Pacific Alpine-Subalpine Dwarf-Shrubland & Heath Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Cassiope mertensiana Dwarf-shrubland	G3G4/S3S4	CEGL001395
Cassiope mertensiana - Phyllodoce empetriformis Dwarf-shrubland	G3G4/S3S4	CEGL001408
Phyllodoce empetriformis Parkland Dwarf-shrubland	G5/SNA	CEGL001404
Phyllodoce empetriformis / Lupinus arcticus ssp. subalpinus Dwarf-Shrubland	G4?/S4	CEGL001406
Phyllodoce empetriformis / Vaccinium deliciosum Dwarf-shrubland	G4/S4	CEGL001407
Vaccinium deliciosum Parkland Dwarf-shrubland	G4G5/S4S5	CEGL001427
Vaccinium membranaceum - Vaccinium deliciosum Dwarf-shrubland	G4?Q/S4?	CEGL001428
G320 North Pacific Alpine-Subalpine Turf & Herbaceous Meadow Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Carex spectabilis Herbaceous Vegetation	G5/S4S5	CEGL001827
Carex spectabilis - Polygonum bistortoides Herbaceous Vegetation	G4/S4	CEGL001828
Carex spectabilis - Potentilla flabellifolia Herbaceous Vegetation	G4Q/S4	CEGL001829
Luetkea pectinata - Saxifraga tolmiei Herbaceous Vegetation	G5/S4	CEGL001918
Lupinus arcticus ssp. subalpinus - Carex spectabilis Herbaceous Vegetation	G4/S4	CEGL001973

Ecological Processes: A shifting mosaic between tree islands and adjacent meadows is gradual and occurs over long-term periods (Franklin and Dyrness 1988). However, some areas have experienced rapid tree invasion. Mechanism for changes is complex and variable but includes drought, length of growing season, and good seed production (Franklin and Dryness 1988). Some researchers believe fire is an important factor in creation and maintenance of subalpine meadows, especially in climatically drier areas. However, other historical and environmental factors likely play a more significant role, especially in more mesic areas such as this North Pacific Maritime Mesic Subalpine Parkland. Development of the tree islands is presumed to

occur after a hardy subalpine tree species (*Abies lasiocarpa* in drier habitats and *Tsuga mertensiana* or *Abies amabilis* in more mesic habitats) establishes. As these initial trees grow larger they provide a suitable microenvironment (i.e. earlier snowmelt) for additional tree establishment by seed germination or layering of branches (Franklin and Dyrness 1988).

Threats: Livestock use and heavy horse or foot traffic can lead to trampling and soil compaction. Slow growth prevents rapid recovery from such disturbances.

Classification Comments: This system is distinguished from the interior dry parkland (Northern Rocky Mountain Subalpine Woodland and Parkland) primarily by the presence of *Tsuga mertensiana* or *Abies amabilis* and absence or paucity of *Pinus albicaulis* and *Larix lyallii*.

Related Concepts: This ecological system falls within the Subalpine Parkland habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the North Pacific Maritime Mesic Subalpine Parkland as one of their standard mapping units.

References

Franklin, J. F. and C.T. Dyrness. 1988. Natural Vegetation of Oregon and Washington. Oregon State University Press. Corvallis, Oregon.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Description Author: Gwen Kittel and Chris Chappell.

SUBALPINE-MONTANE MESIC FORESTS

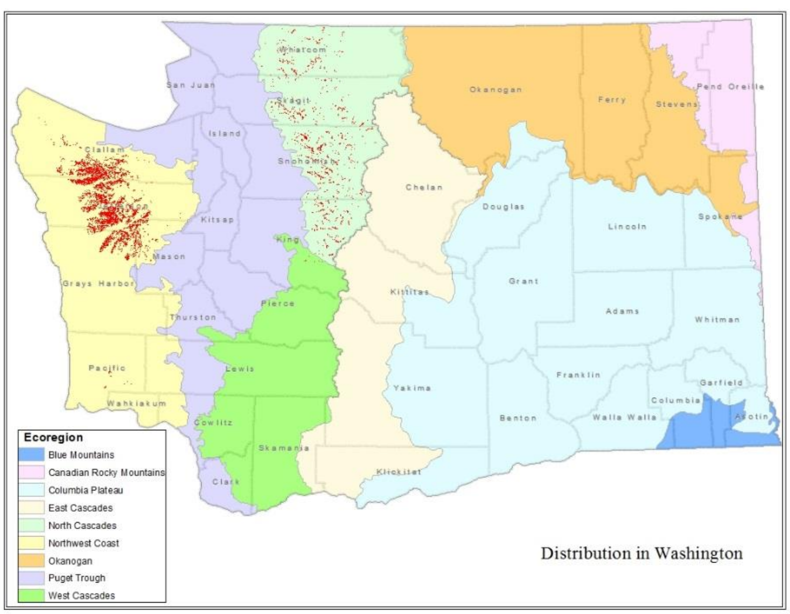
NORTH PACIFIC MESIC WESTERN HEMLOCK-SILVER FIR FOREST

Concept: *Tsuga heterophylla* and/or *Abies amabilis* dominate the canopy *and Chamaecyparis nootkatensis* can be codominant, especially at higher elevations, of this forested system. It dominates mid-montane maritime climatic zones on the Olympic Peninsula, and wettest portions of the North Cascades in Washington (north of Snoqualmie River). Major understory dominant species include *Vaccinium ovalifolium* and mesic to wet understory species such as *Oxalis oregana*, *Blechnum spicant*, and *Rubus pedatus* also occur.

Conservation Status: <u>Secure (S5).</u>

Distribution: This is a matrix system which occurs only in the Pacific Northwest mountains and entirely west of the Cascade crest from coastal British Columbia to Washington. It generally occurs in an elevational band between *Pseudotsuga menziesii* - *Tsuga heterophylla* forests and *Tsuga mertensiana* forests.

Environment: This system has a characteristically variable winter snowpack that typically lasts for 2 to 6 months and is sometimes referred to as the "rain-on-snow" zone because of the common occurrence of major winter rainfall on an established snowpack. Snowpack varies between 1 and 3.5 m (4-10 ft.) and fog drip adds inches to yearly total precipitation (Henderson et al. 1989).



Vegetation: *Tsuga heterophylla* and/or *Abies amabilis* dominate the canopy of late-seral stands, *and Chamaecyparis nootkatensis* can be codominant, especially at higher elevations. *Pseudotsuga menziesii* is relatively rare to absent in this system, as opposed to the similar but drier North Pacific Dry-Mesic Silver Fir-Western Hemlock-Douglas-fir Forest. The major understory dominant species is *Vaccinium ovalifolium* and mesic to wet understory species such as *Oxalis oregana*, *Blechnum spicant*, and *Rubus pedatus* also occur.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system:

G241 North Pacific Maritime Silver Fir - Western Hemlock Forest Group	Global/ State Rank	NatureServe/ WNHP Code
Abies amabilis / Menziesia ferruginea Forest	G4/S4	CEGL000224
Abies amabilis / Polystichum munitum Forest	G4/S4	CEGL000006
Abies amabilis / Rhododendron macrophyllum - Vaccinium ovalifolium Forest	G4/S3	CEGL000226
Abies amabilis / Rhododendron macrophyllum / Xerophyllum tenax Forest	G4/S3	CEGL000227
Abies amabilis / Vaccinium membranaceum - Vaccinium ovalifolium Forest	G4G5/S4S5	CEGL002610
Abies amabilis / Vaccinium membranaceum / Clintonia uniflora Forest	G4/S4	CEGL002625
Abies amabilis / Vaccinium membranaceum / Rubus lasiococcus Forest	G4/S3S4	CEGL000236
Abies amabilis / Vaccinium membranaceum Forest	G4/S4	CEGL000235
Abies amabilis / Vaccinium ovalifolium / Clintonia uniflora Forest	G5/S5	CEGL000233
Abies amabilis / Vaccinium ovalifolium / Xerophyllum tenax Forest	G4/S3	CEGL002609
Abies amabilis / Vaccinium ovalifolium Forest	G4G5/S4S5	CEGL000231
Abies procera / Oxalis oregana Forest	G1/SX	CEGL003444
Tsuga heterophylla - Abies amabilis / Oxalis oregana - Blechnum spicant Forest	G4/S4	CEGL000005

Ecological Processes: Windthrow is a common small-scale disturbance in this system, and gap creation and succession are important processes. Stand-replacement fires are relatively infrequent to absent, with return intervals of several hundred years.

Threats: Clearcutting and plantations have in many cases resulted in less diverse tree canopies (with an emphasis on Douglas-fir), reduced coarse woody debris, and truncated succession well before late-seral characteristics are expressed. Slash burning often has negative impacts on productivity and regeneration.

Classification Comments: The absence of *Pseudotsuga menziesii* is an important indicator in relation to the related climatically drier North Pacific Dry-Mesic Silver Fir-Western Hemlock-Douglas-fir Forest where *Pseudotsuga menziesii* is more abundant. It has been suggested that a threshold of 90 inches mean precipitation at sea level (with modification for topographic moisture) is useful for distinguishing this system from the drier North Pacific Dry-Mesic Silver Fir-Western Hemlock-Douglas-fir Forest.

Related Concepts: This ecological system falls within the Montane Mixed-Conifer Forest habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the North Pacific Mesic Western Hemlock-Silver Fir Forest as one of their standard mapping units.

References

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

SUBALPINE-MONTANE MESIC FORESTS

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

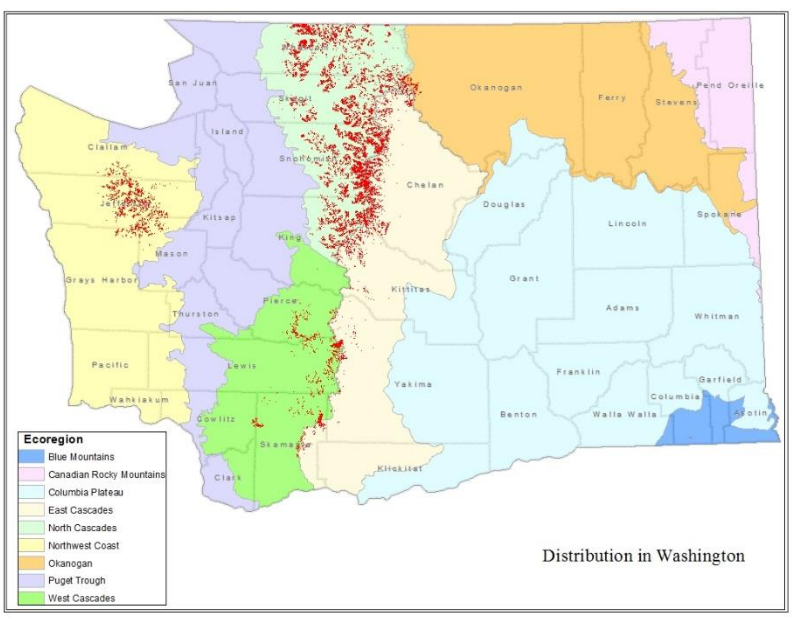
Description Author: Gwen Kittel and Chris Chappell.

NORTH PACIFIC MOUNTAIN HEMLOCK FOREST

Concept: These *Tsuga mertensiana* dominated forests form the matrix in the subalpine zones of windward and less so on the leeward sides of the Cascades Mountains in cold snowy environments.

Conservation Status: Apparently Secure (S4S5). If not for potential climate change impacts, conservation status would be secure (S5).

Distribution: This ecological system forms the matrix forest in the subalpine zones of southeast Alaska to the southern Cascades in Oregon. In the Washington Cascades, it occurs on both windward and less so on the leeward sides of the Cascades Mountains in cold snowy environments. Within the Olympic Mountains, it occurs only on the leeward side. Elevationally, it occurs between *Abies amabilis* - *Tsuga heterophylla* forests and North Pacific Maritime Mesic Subalpine Parklands and is the predominant forest of subalpine elevations in the coastal mountains of British Columbia, southeastern Alaska, western Washington and western Oregon. Eastward, that is climatically drier, this ecological system grades into Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodlands. The lower and upper elevational limits decrease from south to north and from east to west.



Environment: The climate is generally characterized by short, cool summers, rainy autumns and long, cool, wet winters with heavy snow cover for 5-9 months. Snowpack is typically over 3m (10 ft.) and drip from cloud condensation adds inches to yearly total precipitation (Henderson et al. 1989). The heavy snowpack is ubiquitous, but a summer drought can be experienced in the eastern Cascades. These forests often attain great age due to low fire frequency, but tree stature is strongly affected by local environmental conditions. Substrates are moderately deep soils derived from colluvium, glacial outwash and volcanic ash, which overlie gneiss or schist. Soils are acidic, coarse-textured, and often subirrigated with a substantial organic component, owing to persistently high moisture and low temperatures. Sites are cold and moist, and found on mid to lower slopes, benches and bottoms with typically western and northern aspects.

Vegetation: Stands are typically old-growth with multi-layered canopies and abundant woody debris. *Tsuga mertensiana* (over 5% cover) and *Abies amabilis* are the characteristic dominant tree species over most of the range. *Chamaecyparis nootkatensis* may be present at higher elevations and *Tsuga heterophylla* often occurs at lower elevations in this system but is much less abundant than *Tsuga mertensiana*. *Abies lasiocarpa* is a common associated east of the Cascade Crest where *Picea engelmannii, Larix lyallii, Larix occidentalis, Pinus albicaulis*, or *Pinus monticola* can occur in the canopy. Extensive areas on the leeward side of the mountains generally have more open, diverse tree canopies reflecting different climatic and fire regimes than that on the windward side. Dry sites where *Abies lasiocarpa* and *Pinus contorta* can be the first forests to develop after stand-replacing fire would be classified as Rocky Mountain Lodgepole Pine Forest unless *Tsuga mertensiana* has significant cover. Deciduous trees are rare in this system.

The undergrowth is often somewhat depauperate because of poor light penetration at the forest floor, but may include a moderately sparse shrub layer composed of *Elliottia pyroliflorus, Rhododendron albiflorum, Menziesia ferruginea, Vaccinium membranaceum*, and *Vaccinium ovalifolium*. Ground covering vines *Rubus lasiococcus* and *Rubus pedatus* are present to common. Shade-tolerant forbs and ferns include, *Clintonia uniflora, Cornus canadensis, Erythronium montanum, Orthilia secunda, Pteridium aquilinum, Streptopus lanceolatus* var. *curvipes (= Streptopus roseus), Valeriana sitchensis*, and *Tiarella trifoliata var. unifoliata*. Colder sites have ericaceous shrubs including *Vaccinium membranaceum, Vaccinium scoparium, Menziesia ferruginea*, and *Rhododendron albiflorum*. Herbaceous species include *Carex* spp., *Luzula glabrata*, and *Chimaphila umbellata*.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system:

G245 North Pacific Mountain Hemlock - Silver Fir Forest & Tree Island Group	Global/ State Rank	NatureServe/ WNHP Code
Abies lasiocarpa - (Pinus contorta) / Lupinus arcticus ssp. subalpinus Woodland	G2/S2	CEGL000316
Abies lasiocarpa / Phyllodoce empetriformis Woodland	G4Q/S4	CEGL000920
Abies lasiocarpa / Vaccinium membranaceum / Valeriana sitchensis Forest	G4/S4	CEGL002612
Abies lasiocarpa / Valeriana sitchensis Forest	G3/S3	CEGL000345
Chamaecyparis nootkatensis / Vaccinium ovalifolium Forest	G4Q/S4	CEGL000351
Tsuga mertensiana - Abies amabilis / Elliottia pyroliflorus Woodland	G3/G4/S2	CEGL000503
Tsuga mertensiana - Abies amabilis / Rhododendron albiflorum Forest	G5/S5	CEGL002632
Tsuga mertensiana - Abies amabilis / Rubus lasiococcus Forest	G3/S3	CEGL000509
Tsuga mertensiana - Abies amabilis / Tiarella trifoliata var. unifoliata - Streptopus lanceolatus Forest	G3G4/S3S4	CEGL000125
Tsuga mertensiana - Abies amabilis / Vaccinium membranaceum - Vaccinium ovalifolium Forest	G4G5/S4S5	CEGL002620
Tsuga mertensiana - Abies amabilis / Vaccinium membranaceum - Valeriana sitchensis Forest	G4/S4	CEGL002619
Tsuga mertensiana - Abies amabilis / Vaccinium membranaceum - Xerophyllum tenax Forest	G4/S4	CEGL000515
Tsuga mertensiana - Abies amabilis / Vaccinium membranaceum Forest	G4?/S3	CEGL002618

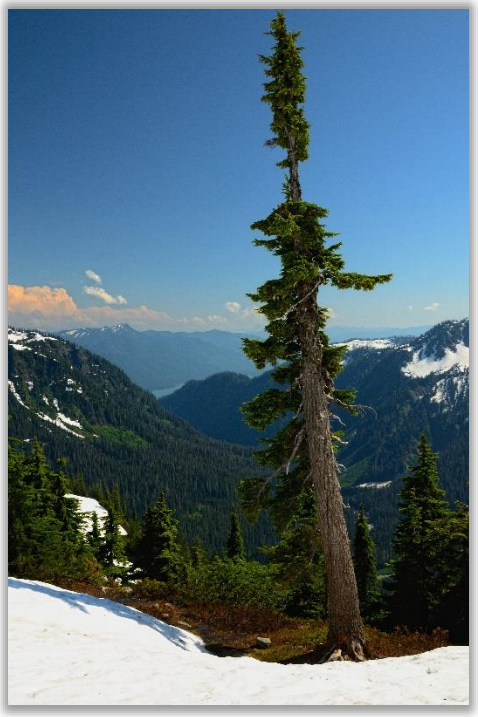
G245 North Pacific Mountain Hemlock - Silver Fir Forest & Tree Island Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Tsuga mertensiana - Abies amabilis / Vaccinium ovalifolium - Clintonia uniflora Forest	G4G5/S4	CEGL000512
Tsuga mertensiana - Abies amabilis / Vaccinium ovalifolium - Erythronium montanum Forest	G3G4/S3	CEGL000513
Tsuga mertensiana - Abies amabilis / Vaccinium ovalifolium - Maianthemum dilatatum Forest	G3G4/S3S4	CEGL002617
Tsuga mertensiana - Abies amabilis / Xerophyllum tenax Forest	G3/S3	CEGL000500
Tsuga mertensiana / Luzula glabrata var. hitchcockii Forest	G5/S3	CEGL000505
Tsuga mertensiana / Vaccinium scoparium Forest	G4/SNA	CEGL000126

Ecological Processes: Across the majority of the system's distribution, fire very rarely or never occurs while the more summer-dry climatic areas (east Cascades) have occasional high-severity fires with return intervals of 400-600 years. Consequently, old-growth is the most common stand condition. Overall, infrequent mixed severity fire regimes occurring at greater than 5000 years and stand-replacement fires occur with mean return intervals of about 10,000 years characterize most of this system (fire regime V, LANDFIRE 2007). In east Cascades areas, mean return intervals are 400 to over 1500 yrs. (fire regime V LANDFIRE 2007). Root rot (*Phellinus weirii)*, bark beetles, and other insects can be locally important disturbances in these higher elevation drier sites (LANDFIRE 2007). Wind can be a significant factor in portions of the system's range (Henderson et al. 1989). Avalanches are also common disturbances in this type.

Pre-settlement landscape patch structure as estimated by LANDFIRE (2007) consisted of 1% early seral stage (cohort establishment of Franklin et al. 2002) dominated by shrubs and *Tsuga mertensiana* and *Abies amabilis* tree seedlings. That early stage typically develops into closed canopy forest stands with poor understory development (biomass accumulation/ competitive exclusion of Franklin et al. 2002) and occupied an estimated 5% of the landscape. *Tsuga mertensiana* and *Abies amabilis* trees are less than 21 inches diameter-at-breast height. Another 5% of the landscape consists of young, open canopy of the same trees species developed from mix-severity fire or other standing thinning event (wind, avalanche, pathogens). An estimated 5% of the forests is similar and composed of trees with dbh of 21 inches or more. An estimated 85% of forest patches would be closed canopy mature to old-growth stands with high vertical structural diversity (Maturation to Pioneer loss stage of Franklin et al. (2002) (LANDFIRE 2007).

Threats: Since European settlement, timber harvest, road building, and tree plantations have all impacted natural disturbance regimes, forest structure, composition, landscape patch diversity, and tree regeneration. Timber harvest operations change canopy structural complexity and abundance of large woody debris of individual stands and has altered whole landscape patch pattern, age and structural complexity (Van Pelt 2007). They reduce coarse woody debris compared to natural levels, and truncate succession well before late-seral characteristics are expressed. Plantation forestry has changed local tree gene pools, horizontal arrangement of trees and homogenized the diversity of tree sizes. Older logged areas can support dense, stagnating second growth with root rot (Arno 2000). Ohlman and Waddel (2002) speculated that snag abundance more likely reflect recent disturbance and forest succession, whereas down wood amounts more strongly reflect long-term stand history and site productivity.

Classification Comments: This system has > 5% cover of *Tsuga mertensiana*, which is also the dominant to codominant tree. *Larix lyallii, Larix occidentalis, Pinus albicaulis*, or *Pinus monticola* have <5% cover. This system differs from the North Pacific Western Hemlock-Silver Fir types in that *Abies amabilis* has > 5% cover and *Tsuga mertensiana* has < 5% cover in that system. Early-seral stages, with *Pinus contorta* dominant in the upper canopy, could be classified and mapped as Rocky Mountain Lodgepole Pine Forest but should be considered part of this system if other tree species listed above are present. Tree islands within parklands (open woodlands or sparse trees with dwarf-shrub or herbaceous vegetation), even if dominated by *Tsuga mertensiana*, are part of the North Pacific Maritime Mesic Subalpine Parkland system.



Related Concepts: This ecological system falls within the Montane Mixed-Conifer Forest habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the North Pacific Mountain Hemlock Forest as one of their standard mapping units.

References

Arno, S. (2000). Fire in western forest ecosystems (chapter 5). In: J.K Brown and J.K. Smith (eds), pp. 97-120, Wildland fire in ecosystems: effects of fire on flora. USDA Forest Service, General Technical Report RMRS-GTR-42-vol 2.

Henderson, J.A., D.A. Peter, R. Lesher, and D.C. Shaw. 1989. Forested Plant Associations of the Olympic National Forest U.S.D.A. For. Serv. PNW Region. R6-ECOL-TP 001-88. 502 p.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

LANDIRE. 2007. Landfire Biophysical Setting Descriptions. http://www.landfire.gov/NationalProductDescriptions20.php

Ohlman, J. and K. Waddell. 2002. Regional Patterns of Dead Wood in Forested Habitats of Oregon and Washington IN: Laudenslayer, W. F., Jr.; Shea, P. J.; Valentine, Bradley E.; Weatherspoon, Phillip, C.; Lisle, T. E., technical coordinators. Proceedings of the symposium on the ecology and management of dead wood in western forests. 1999 November 2-4; Reno, NV. Gen. Tech. Rep. PSW-GTR-181. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 949 p.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Van Pelt, R. 2007. Identifying Old trees and Forests in Western Washington. WA. Dept. Natural Resources, Olympia WA. 169p.

Description Author: Rex Crawford, Gwen Kittel, Chris Chappell, and Marion Reid.

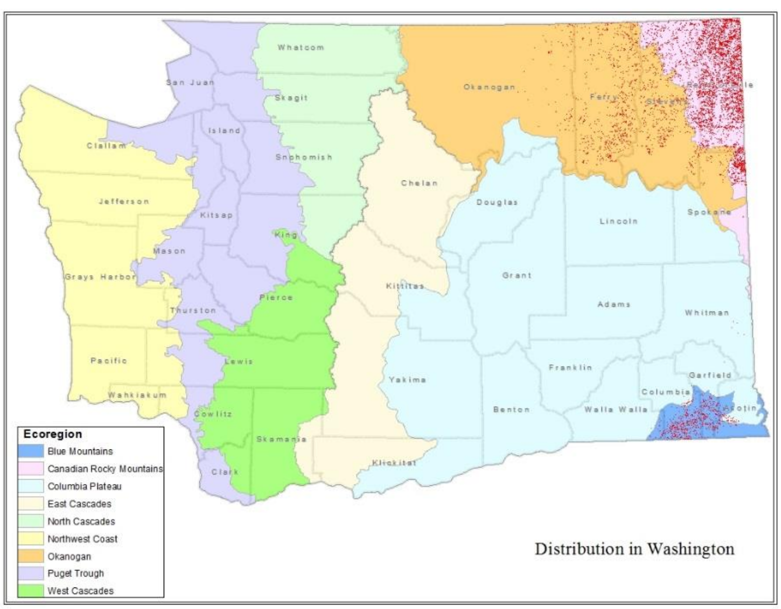
NORTHERN ROCKY MOUNTAIN MESIC MONTANE MIXED CONIFER FOREST

Concept: These montane forests are primarily dominated by *Tsuga heterophylla* and *Thuja plicata* and found in inland areas influenced by incursions of mild, wet, Pacific maritime air masses. These forests are locally referred to as cedar-hemlock.

Conservation Status: Vulnerable (S3S4).

Distribution: This ecological system is composed of the highly variable montane coniferous forests in the Rocky Mountains in southeastern British Columbia, eastern Washington, northern Idaho, western Montana, and northeastern Oregon.

Environment: This system, locally referred to as cedar-hemlock, is associated with a submesic climate regime in areas influenced by incursions of mild, wet, Pacific maritime air masses producing an annual precipitation ranging from 30 to 60 in (75-150 cm), with a maximum in winter or late spring. Elevations range from 2500-6000 ft. (759 to 1800 m). Winter snowpack typically melt off in early spring at lower elevations. Much of the annual precipitation occurs as rain, but where snow does occur, it can generally be melted by rain during warm winter storms. Occurrences generally are found on all slopes and aspects but grow best on sites with high soil moisture, such as toe slopes and bottomlands. At the periphery of its distribution (such as Washington), this system is confined to moist canyons and



cooler, moister aspects. These are moist upland sites that are not saturated yearlong.

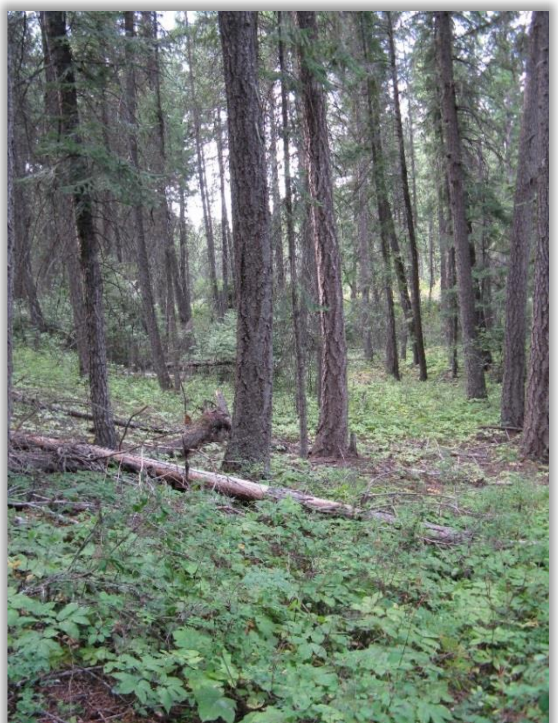
Vegetation: Forest canopies are typically closed although higher elevation or colder sites may be open. In the northeast and southeast corners of Washington, *Tsuga heterophylla*, *Thuja plicata* and /or *Abies grandis* commonly share the tree canopy with *Pseudotsuga menziesii* var. *glauca* although the former species can be sole canopy dominants. *Picea engelmannii*, *Pinus monticola*, *Pinus contorta*, *Taxus brevifolia* and *Larix occidentalis* are major canopy associates. Mesic *Abies grandis* associations are included in this system, and *Abies grandis* is often the dominant in these situations where *Tsuga heterophylla* and *Thuja plicata* can both be absent. *Abies lasiocarpa* may be present but only on the colder sites. *Linnaea borealis, Paxistima myrsinites, Alnus incana, Acer glabrum, Spiraea betulifolia, Cornus canadensis, Rubus parviflorus, Menziesia ferruginea*, and *Vaccinium membranaceum* are common shrub or sub-shrub species. The composition of the herbaceous layer reflects local climate and degree of canopy closure but is typically very diverse in all but closed-canopy conditions. Important mesic-site forbs and ferns include *Actaea rubra, Adiantum pedatum, Anemone piperi, Aralia nudicaulis, Asarum caudatum, Clintonia uniflora, Gymnocarpium dryopteris, Polystichum munitum, Rubus pedatus, Thalictrum occidentale, Tiarella trifoliata, Trientalis borealis, Trillium ovatum, Viola glabella* and *Xerophyllum tenax*.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Groups and Associations that are associated with this ecological system:

G211 Central Rocky Mountain Mesic Grand Fir - Douglas-fir Forest Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Abies grandis / Acer glabrum Forest	G3/S2	CEGL000267
Abies grandis / Calamagrostis rubescens Woodland	G4?/S4	CEGL000916
Abies grandis / Carex geyeri Woodland	G3/S3	CEGL000917
Abies grandis / Clintonia uniflora Forest	G5/S3	CEGL000272
Abies grandis / Linnaea borealis Forest	G3/S3	CEGL000275
Abies grandis / Physocarpus malvaceus Forest	G3/S2	CEGL000277
Abies grandis / Spiraea betulifolia Forest	G2/S2?	CEGL000281
Abies grandis / Symphoricarpos albus Forest	G3?/SNA	CEGL000282
Abies grandis / Taxus brevifolia Forest	G3/S1	CEGL000283
Abies grandis / Trautvetteria caroliniensis Forest	G3/S1S2	CEGL000285
Abies grandis / Vaccinium caespitosum Forest	G2/SNR	CEGL000288
Pinus contorta / Vaccinium membranaceum Forest	G4?/S4/	CEGL000170
Pinus contorta / Vaccinium membranaceum Rocky Mountain Forest	G3G4/SNR	CEGL000169
Pinus monticola / Clintonia uniflora Forest	G1Q/S1	CEGL000176
Pseudotsuga menziesii / Physocarpus malvaceus - Linnaea borealis Forest	G4/S4	CEGL000448
Pseudotsuga menziesii / Vaccinium caespitosum Forest	G5/S3	CEGL000465
Pseudotsuga menziesii / Vaccinium membranaceum Forest	G5?/S3	CEGL000466
Pseudotsuga menziesii / Vaccinium spp. Forest	G4Q/S3S4	CEGL000464
G217 Central Rocky Mountain Interior Western Red-cedar - Western Hemlock Forest Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Thuja plicata / Aralia nudicaulis Forest	G2/S2	CEGL000471
Thuja plicata / Asarum caudatum Forest	G5/SNR	CEGL000472
Thuja plicata / Clintonia uniflora - Xerophyllum tenax Forest	G4?/SNR	CEGL005930

G217 Central Rocky Mountain Interior Western Red-cedar - Western Hemlock Forest Group	Global/ State Rank	NatureServe/ WNHP Code
Thuja plicata / Clintonia uniflora Forest	G4/S3	CEGL000474
Thuja plicata / Vaccinium membranaceum Forest	G3G4/SNR	CEGL000487
Tsuga heterophylla / Aralia nudicaulis Forest	G3/SNR	CEGL000488
Tsuga heterophylla / Asarum caudatum Forest	G4/SNR	CEGL000490
Tsuga heterophylla / Athyrium filix-femina Forest	G2Q/SNR	CEGL000491
Tsuga heterophylla / Clintonia uniflora Forest	G4/S4	CEGL000493
Tsuga heterophylla / Menziesia ferruginea Forest	G2/S2	CEGL000496
Tsuga heterophylla / Rubus pedatus Forest	G2/S2	CEGL000113
Tsuga heterophylla / Xerophyllum tenax Forest	G2/S2	CEGL000499

Ecological Processes: In the northeast and southeast corners of Washington, this system is associated with the highest lightning strike area in the state (Van Pelt 2008). Stand-replacement, fire-return intervals are typically 150-500 years, with moderate-severity fire intervals of 50-100 years (Williams et al 1995) and within Fire Regime Group III or V (LANDFIRE 2007). Most forest areas composing this system are limited more by light competition than water (McDonald and others 2000). Transitional areas between this system and the more water-limited Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest system are influenced by *Armillaria* root diseases and defoliators. These forests are within a mixed severity fire regime that experience little to no underburning and produce a landscape composed of small patches (200-2000 ha) (Brown et al. 2000; McDonald et al 2000). The more moist portions of the system (higher precipitation and valley bottoms) are more likely to experience high severity fires that result in larger, older patches (500-50,000 ha) (McDonald et al. 2000). Timing of fires is irregular and fires are often overlapping (Brown et al. 2000). These mixed fire regimes and diverse topography results in a varied landscape of stand development and composition. This complexity results in five general seral or developmental types some of which are included in this ecological system. However, some of these patches are included in different ecological systems (Shiplett and Neuenschwander 1994):



1) *Tsuga heterophylla – Thuja plicata* stands that initiate following disturbance
2) Mixed conifer stands that initiate from various disturbances
3) Shrubfields that develop from multiple burns
4) Scattered large *Larix occidentalis* surviving fires, and
5) *Pinus contorta* on less productive sites and relatively frequent burns.

As with the East Cascades Mesic Montane Mixed-Conifer Forest and Woodland this system is primarily composed of the first two types except with Rocky Mountain floristic elements in the understory. Shrubfields (type 3 above) composed of *Acer glabrum, Amelanchier alnifolia, Ceanothus* spp., *Salix scouleriana, Shepherdia canadensis,* and/or *Vaccinium membranaceum* typically develop following stand-replacing fire. Tree regeneration usually accompanies shrubs and the shrubfields become young forests within a few decades and are included in this system.

(Shrubfields where trees are persistently absent to rare are better included in the Northern Rocky Mountain Lower Montane and Foothill Deciduous Shrubland system.) Most stands following fire retain some trees and other biological legacies from the previous forest stand. Tree individuals or whole sites that escape a fire or two allow trees to reach more resistant fire sizes that results in the clustering of old trees and stands across the landscape. Thus, old growth forests (type 1 above) develop in less fire prone areas, such as in riparian stringers and along benches in lower precipitation areas and in higher precipitation landscapes can increase on to drier landforms (Williams et al 1995). The old growth version of this system occupied 20-50% of the pre-settlement landscape (Lesica 1996). The less fire resistant and shade tolerant *Abies grandis*, *Taxus brevifolia*, *Thuja plicata*, and *Tsuga heterophylla* are more common in older forests. The mid-seral, mixed conifer (100-200 year old) stands (type 2 above) are usually canopies composed of *Pseudotsuga menziesii, Picea engelmannii, Pinus monticola,* and *Larix occidentalis* with *Abies grandis* and maybe *Thuja plicata* on moist, cool sites (Williams et al 1995). Type 4 is recognized as a separate small to large patch ecological system (Western Larch Savanna and Woodland) and type 5 is the Rocky Mountain Lodgepole Pine ecological system. Part of the natural range of variability of this and related system is currently rare to absent – *Pinus monticola* stands. McDonald and other (2000) recognize it as a keystone species prior to introduction of western white pine blister rust. *Pinus monticola* forests likely are an extirpated ecological system that is now represented as stands or by individuals in the variation of the current Northern Rocky Mountain Mesic Montane Mixed Conifer Forest system. Quigley and others (1997) estimate that late-seral forest structure (stands with an upper canopy of comprised of more shade-intolerant than shade tolerant trees) historically occupied around one-third of the landscape, mid-seral forest occupied 40-50% of the landscape, and early-seral forest occupied 20-30% of the landscape. LANDFIRE (2007) modeled 45-50% of this system (BpS) as late seral, 35-45% mid-seral and 10-15% early seral.

Threats: Since European settlement, fire suppression, timber harvest, introduced diseases, road building, development, and plantation establishments have all impacted natural disturbance regimes, forest structure, composition, landscape patch diversity, and tree regeneration (Franklin et al. 2008). These very productive forests have been priorities for timber production. Timber harvesting has focused on the large shade-intolerant, fire-resistant species in mid- and late-seral forests thereby eliminating many old forest attributes from stands (Franklin et al. 2008). Fire suppression has allowed less fire-resistant, shade-tolerant trees to become established in the understory (and sometimes dominate the canopy) creating more dense and multi-layered forests than what historically occurred on the landscape. Road development has fragmented many forests creating fire breaks. Under present conditions the fire regime is mixed severity and more variable, with stand-replacing fires more common, and the forests are more homogeneous. With vigorous fire suppression, fire-return intervals are longer, and multi-layered stands provide fuel "ladders," making these forests more susceptible to high-intensity, stand-replacing fires. Quigley and others (1997) estimate that mid-seral forest structure is currently over 40% more abundant than historically, late-seral forests are diminished by 90% and early-seral forest abundance is 20% less than historically and lacks snags and other legacy features. Park and others (2005) concluded that due to climate, limited settlement history, low seed source and closed canopy forest the mountain ecoregions of the Northwest have fewer non-native invasive plants than other regions of the United States.

Classification Comments: These mesic forests are dominated by *Abies grandis*, *Pseudotsuga menziesii*, *Tsuga heterophylla*, *Thuja plicata*, and *Picea engelmannii* along with key mesic understory species listed above. This system differs from the similar East Cascades Mesic Montane Mixed-Conifer Forest and Woodland system by lacking Vancouverian floristic elements, such as *Acer circinatum*, *Acer macrophyllum* and *Mahonia nervosa*.

Related Concepts: This ecological system falls within the Eastside (Interior) Mixed Conifer Forest habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the Northern Rocky Mountain Mesic Montane Conifer Forest as one of their standard mapping units.

References

Brown, James K., Smith, Jane Kapler, eds. 2000. Wildland fire in ecosystems: effects of fire on flora. Gen.Tech. Rep. RMRS-GTR-42-vol. 2. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 257 p.

Franklin, J.F. M.A. Hemstrom, R. Van Pelt, and J.B. Buchanan. 2008. The Case of Active Management of Dry Forest Types in Eastern Washington: Perpetuating and Creating Old Forest Structures and Functions. Washington Department of Natural Resources, Olympia, WA.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

LANDFIRE 2007. Northern Rocky Mountain Mesic Montane Mixed Conifer Forest (BpS 1010471) and Cedar Groves (BpS 1010472). Rapid Assessment Biophysical Settings Model Descriptions.

Lesica, P. 1996. Using fire history models to estimate proportions of old-growth forest in northwest Montana, USA. Biological Conservation 77: 33-39.

McDonald, G.I., Harvey, A.E. and Tonn, J.R. (2000) Fire, competition and forest pests: landscape treatment to sustain ecosystem function. *Crossing the Millennium: Integrating Spatial Technologies and Ecological Principles for a New Age in Fire Management. Proceedings from the Joint Fire Conference and Workshop, 2* (ed. by L. F. Neuenschwander and K. C. Ryan), pp. 195 – 211. University of Idaho and the International Association of Wildland Fire, Moscow, Idaho.

Parks, Catherine G., S. R. Radosevich, B. A. Endress, B. J. Naylor, D. Anzinger, L. J. Rew, B. D. Maxwell, K. A. Dwire. 2005. Natural and land-use history of the Northwest mountain ecoregions (USA) in relation to patterns of plant invasions. Perspectives in Plant Ecology, Evolution and Systematics 7 (2005) 137–158

Quigley, T. M. and S.J. Arbelbide (technical editors). 1997. An Assessment of Ecosystem Components in the Interior Columbia Basin and Portions of the Klamath and Great Basins: Volume 2. Gen. Tech. Rep. PNW-GTR-405. Portland, OR. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 4 Volumes. (Quigley, T.M., technical editor; The Interior Columbia Basin Ecosystem Management Project: Scientific Assessment).

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Shiplett, B.; Neuenschwander, L. F. 1994. Fire ecology of the cedar hemlock zone in Idaho. In: Baumgartner, D. M.; Lotan, J. E.; Tonn, J. R., ed. Interior cedar-hemlock-white pine forests: ecology and management symposium proceedings; 1993 March 2-4; Spokane, WA. Pullman, WA: Washington State University, Cooperative Extension: 41-52.

Van Pelt, R. 2008. Identifying Old trees and Forests in Eastern Washington. WA. Dept. Natural Resources, Olympia, WA. 169p.

Williams, C. K., B.F. Kelly, B.G. Smith and T.R. Lillybridge. 1995. Forested plant associations of the Colville National Forest. Gen. Tech. Rep. PNW-GTR-360. Portland, OR. U.S.D.A. PNW Res. Sta. 375 p.

Description Author: Rex Crawford, Marion Reid.

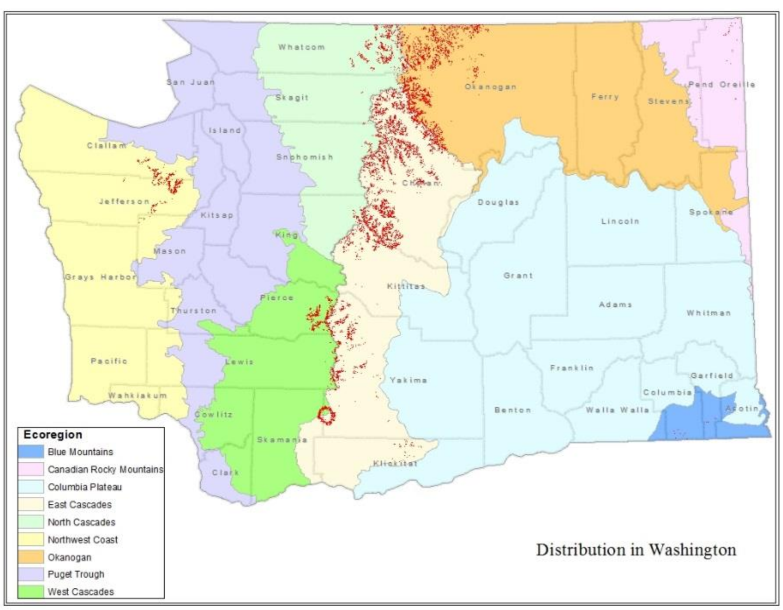
SUBALPINE-MONTANE MESIC FORESTS

NORTHERN ROCKY MOUNTAIN SUBALPINE WOODLAND AND PARKLAND

Concept: High-elevation mosaic of stunted tree clumps, open woodlands, and herb- or dwarf-shrub-dominated openings. Stands can be dominated by *Pinus albicaulis*, *Abies lasiocarpa*, and/or *Larix lyallii* occasionally with *Picea engelmannii*.

Conservation Status: Apparently Secure (S4). There is some uncertainty about the degree of impacts as threats are mostly on USFS land and above most land uses. Other than recreation, livestock grazing may be the most common stressor.

Distribution: The Northern Rocky Mountain Subalpine Woodland and Parkland system consists of a high-elevation mosaic of stunted tree clumps, open woodlands, and herb- or dwarf-shrub-dominated openings. It appears between closed subalpine forest ecosystems and alpine communities. This large patch system occurs in the northern Rocky Mountains, west into the Cascade Mountains and northeastern Olympic Mountains, and east into the mountain "islands" of central Montana. In Washington, it occurs primarily in the East Cascades, the eastern portion of the North Cascades, northeastern Olympic Mountains, and in the Northern Rocky Mountains. It is typically either a woodland of scattered trees or a landscape of open areas with clumps of trees. Stands can be dominated by *Pinus albicaulis*, *Abies lasiocarpa*, and/or *Larix lyallii* occasionally with *Picea engelmannii*.



Environment: This system occurs in a climate that is typically very cold in winter and dry in summer.

SUBALPINE-MONTANE MESIC FORESTS

In the Cascades and Olympic Mountains, the climate is more maritime, not as extreme, with heavier snow and wind desiccation. Landforms include ridgetops, mountain slopes, glacial trough walls and moraines, talus slopes, landslides and rockslides, and cirque headwalls and basins. Some sites have little snow accumulation because of high winds and sublimation. *Larix lyallii* stands generally occur at or near upper treeline on north-facing cirques or slopes where snowfields persist until June or July. *Pinus albicaulis* typically occurs on drier sites.

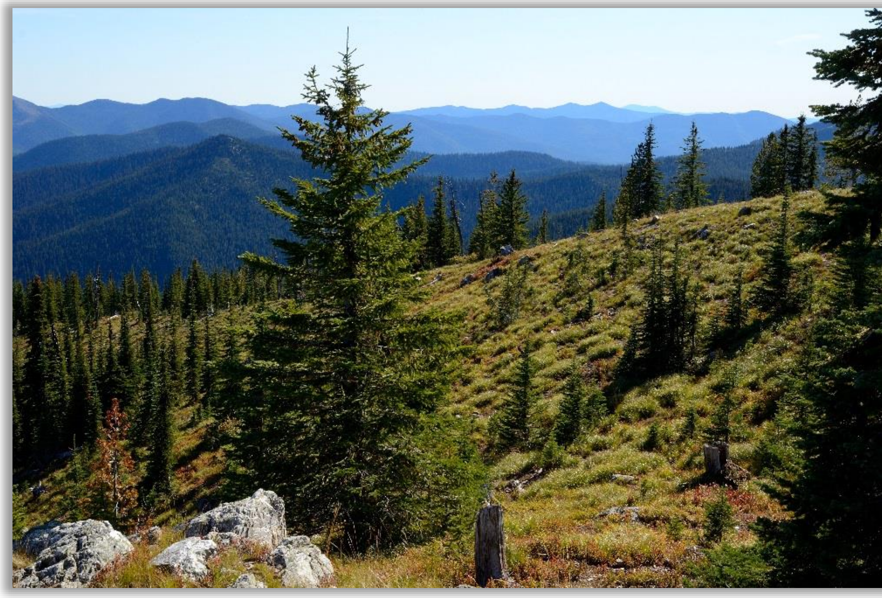
Vegetation: On the eastside of the Cascade Mountains and northeastern Olympic Mountains, the tree clump landscape pattern is a common feature, although woodlands with an open canopy are frequent. Woodlands without the tree clump pattern is more common in the Northern Rockies. Trees are often stunted and flagged from damage associated with wind and blowing snow and ice crystals, especially at the upper elevations of the type. Woodlands are common with *Pinus albicaulis* and *Larix lyallii*. In the Cascades and Olympics, *Abies lasiocarpa* sometimes dominates the tree layer without *Pinus albicaulis* and without more mesic site trees *Tsuga mertensiana* and *Abies amabilis*. As with most subalpine habitats, plant diversity is more related to site differences than with successional development. The undergrowth can be somewhat depauperate on harsh sites while some stands support a dense sward of heath plants, such as *Phyllodoce glanduliflora*, *Phyllodoce empetriformis*, *Empetrum nigrum*, and *Cassiope mertensiana*. Stands can include a slightly taller more open shrub layer of *Vaccinium myrtillus* or *Vaccinium scoparium;* either may be present to dominant. The herbaceous layer is sparse under dense shrub canopies but may be dense where the shrub canopy is open or absent. *Festuca viridula*, *Vahlodea atropurpurea*, *Luzula glabrata* var. *hitchcockii*, and *Juncus parryi* are the most commonly associated graminoids. The lowest elevation dry sites in Washington support *Pinus albicaulis* with a grass ground cover of *Calamagrostis rubescens* and *Carex geyeri* with occasional *Paxistima myrsinites* and *Vaccinium myrtillus*, or *Vaccinium scoparium* short shrub layer. These sites are the some of the highest species richness parts of the system (Lilybridge et al 1995).

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system:

G223 Northern Rocky Mountain Whitebark Pine - Subalpine Larch Woodland Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Abies lasiocarpa - Pinus albicaulis / Arctostaphylos uva-ursi Woodland	G2/S2	CEGL000751
Abies lasiocarpa - Pinus albicaulis / Vaccinium scoparium Woodland	G5?/SNA	CEGL000752
Larix lyallii / Vaccinium deliciosum Woodland	G3/S3	CEGL000952
Larix lyallii / Vaccinium membranaceum / Luzula glabrata var. hitchcockii Woodland	G2G3/SNR	CEGL005884
Larix lyallii / Vaccinium scoparium / Luzula glabrata var. hitchcockii Woodland	G2G3/S2S3	CEGL000951
Larix lyallii Woodland	G3Q/S3	CEGL000623
Pinus albicaulis / Calamagrostis rubescens Woodland	G2/S2	CEGL000753
Pinus albicaulis / Luzula glabrata var. hitchcockii Woodland	G3/S2	CEGL000758

Ecological Processes: This woodland and parkland system exists on harsh sites were component trees are not in competition during stand development. Major disturbances are windthrow and snow avalanches. The system also exists were fire plays a role in removing competing trees and keeping stands in open stage of stand development. The fire regime is highly variable and difficult to document. Lightning strikes are common on the ridges but discontinuous fuels created by rocky terrain effect fire spread that result in high variability in fire severity (LANDFIRE 2007). Ignitions may be common but typically do not spread beyond the initial patch. Infrequent severe crown fires in adjacent spruce-fir forests can spread into this system (LANDFIRE 2007). A 300 year replacement interval is estimated although most fires are mixed severity with an 80 return interval (Fire regime III, LANDFIRE 2007). Fire suppression has contributed to change in habitat structure and functions. Blister rust (*Cornartium ribicola*), an introduced pathogen, is increasing *Pinus albicaulis* mortality in these woodlands (Kendall and Keane 2001) and changing fire regime and successional relationship that accelerates changes in this system.

Mean patch size for this system historically is estimated to be 43.5 ha (107 ac) and currently is 30 ha (74 ac) (Morgan and Murray 2001). Logging can have prolonged effects because of slow invasion rates of trees and other high elevation species on the disturbed sites. This is particularly important on drier sites and in *Larix lyallii* stands. During wet cycles, fire suppression can lead to tree islands coalescing and the conversion of parklands into a more closed forest habitat. Parkland conditions can displace alpine conditions through tree invasions. Livestock use and heavy horse or foot traffic can lead to trampling and soil compaction. Slow growth in this habitat prevents rapid recovery.



Threats: The primary land uses that alter the natural processes of the Northern Rocky Mountain Subalpine Woodland and Parkland system are associated with exotic species, direct soil surface disturbance, timber management, livestock practices, and fragmentation. The introduced pathogen blister rust (*Cornartium ribicola*) increases *Pinus albicaulis* mortality in these woodlands (Kendall and Keane 2001) and changes fire regime, mountain pine beetle effects and successional relationships. Exotic species threatening this ecological system through invasion and potential replacement of native species include *Poa pratensis.* Excessive grazing stresses the system through soil disturbance and perennial layers to the establishment of native disturbance increasers (*Lupinus* spp., *Juncus parryi*, *Achillea millifolium*) in similar Northern Rocky systems (Johnson 2004). Persistent grazing will further diminish native perennial cover; expose bare ground, and increase erosion and exotics (Johnson and Swanson 2005). Grazing effects are usually concentrated in less steep slopes although grazing does create contour trail networks that can lead to addition slope failures. Cattle and heavy use by elk can reduce fescue cover and lead to erosion during summer storms (Johnson and Swanson 2005). Introduction of exotic ungulates can have noticeable impacts (e.g., mountain goats in the Olympic Mountains and domestic sheep grazing in the bunchgrass habitats east of the Cascades.) historical domestic sheep grazing may have occurred in these systems but its cumulative effects are unknown (LANDFIRE 2007). Locally trampling and associated recreational impact can affect sites for decades or longer (Lilybridge et al 1995). Sites are natural low in timber productivity and in stocking rate such that remove of trees can have very long-lasting influence on ecological processes (Lilybridge et al 1995).

Classification Comments: Tree clumps dominated by *Pinus albicaulis*, woodlands of *Pinus albicaulis* or *Larix lyallii* are typical and *Abies lasiocarpa* may also be present. There is a proposal to either split the dry, subalpine *Pinus albicaulis* woodlands of the Blue Mountains (Oregon) and northern Nevada into a different system; or else to include them in Rocky Mountain Subalpine-Montane Limber-Bristlecone Pine Woodland. For LANDFIRE, these *Pinus albicaulis* woodlands were included in this subalpine parkland system, but ecologically and floristically they are more similar to Rocky Mountain dry subalpine woodlands.

Related Concepts: This ecological system falls within the Subalpine Parkland habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the Northern Rocky Mountain Subalpine Woodland and Parkland as one of their standard mapping units.

References

Arno, S.F. 2001. Chapter 4. Community Types and Natural Disturbance Processes. Tomack, D. F., S.F. Arno, and R. E. Keane eds. Island Press. 74-88 pp.

Johnson, C.G. 2004. Alpine and subalpine vegetation of the Wallowa, Seven Devils, and Blue Mountains. USDA Forest Service R6-NR-ECOL-TP-03-04. 612 pp. + appendices.

Kendall, K.C. and R.E. Keane. 2001. Chapter 11. Whitebark Pine Decline: Infection, Mortality and Population Trends. IN: Whitebark Pine Communities. Tomack, D. F., S.F. Arno, and R. E. Keane eds. Island Press. 221-242 pp.

FRCC. 2008. Interagency Fire Regime Condition Class (FRCC) Guidebook *Version 1.3.0.* www.landfire.gov.

FRCC. 2010. FRCC Software Application User's Guide (version 3.0.3.0). www.frcc.gov.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

LANDFIRE. 2007. North Pacific Shrubland. BPS 0110460. IN: Landfire Biophysical Setting Descriptions. http://www.landfire.gov/NationalProductDescriptions20.php

Lillybridge T.R., B.L. Kovalchik., C.K. Williams, and B.G. Smith. 1995. Field guide for forested plant associations of the Wenatchee National Forest. USDA Forest Service Pacific Northwest Research Station General Technical Report PNW-GTR-359.

Montana Field Guide. 2011. Rocky Mountain Subalpine Woodland and Parkland — Northern Rocky Mountain Subalpine Woodland and Parkland. Retrieved on January 4, 2011, from http://FieldGuide.mt.gov/displayES_Detail.aspx?ES=4233

Morgan P., and M.P. Murray. 2001. Chapter 14. Landscape Ecology and Isolation: Implications for Conservation of Whitebark Pine. IN: Whitebark Pine Communities. Tomack, D. F., S.F. Arno, and R. E. Keane eds. Island Press. 289-309 pp.

Morgan P., and S.C. Bunting. 1990. Fire effects in whitebark pine forests. 166-170. In: Schmidt W.C. and K.J. McDonald (eds.) Proceedings: Symposium on whitebark pine ecosystems: Ecology and management of a high-mountain resources. USDA Forest Service General Technical Report INT-270.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Napper, C., S. Howes, and D. Page-Dumroese. 2009. The soil disturbance field guide. U.S. For. Serv. 0819 1815-SDTC. 112p.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

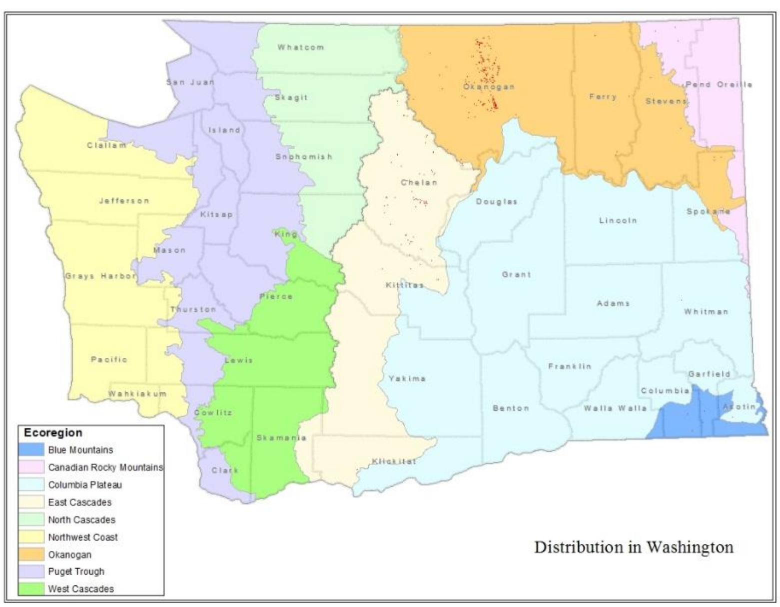
Description Author: Rex Crawford, Chris Chappell, Gwen Kittel, and Marion Reid.

ROCKY MOUNTAIN ASPEN FOREST AND WOODLAND

Concept: *Populus tremuloides* upland forests and woodlands found east of the Cascades. These forests and woodlands are most common along the east side of the North Cascades and in the Okanogan Highlands.

Conservation Status: Imperiled (S2). Naturally uncommon in Washington and appears to declining due to fire suppression effects of conifer invasion and aging of clones. Elk and livestock have minimal impact of aspen although associated flora changes with invasion of *Poa pratensis*, knapweeds etc. Aspen stands are thought to be considerably less common today than historically largely because of existing land uses (Hadfield and Magelssen 2004, 2006).

Distribution: The Rocky Mountain Aspen Forest and Woodland system is a widespread, large patch system found throughout much of the western U.S. and Canada. It is most common in the southern and central Rocky Mountains. In Washington, *Populus tremuloides* forests and woodlands are a minor, small patch type found east of the Cascades, most common in the north and in the Okanogan Highlands. *Populus tremuloides* probably makes up less than one percent of the trees on the Okanogan and Wenatchee National Forests (Hadfield and Magelssen 2004). Rockfalls, talus, or stony north slopes are often typical sites and the aspen system may occur in Intermountain Basin big sagebrush landscapes on such moist microsites. *Populus tremuloides* stands are small patches in Washington with more than half of surveyed stands cover less than two acres (Hadfield and Magelssen 2004, 2006).



Environment: Well-drained mountain slopes or canyon walls that have some moisture. Rockfalls, talus, or stony north slopes are often typical sites and the system may occur in steppe on moist microsites.

SUBALPINE-MONTANE MESIC FORESTS

Vegetation: This system is characterized by dominance of *Populus tremuloides* in forests or woodlands with less than 25% total tree canopy cover by conifers. The tree canopy is typically closed and essentially all *Populus tremuloides* regeneration results from asexual vegetative production of sprouts from roots following disturbances (Hadfield and Magelssen 2004, 2006). *Populus tremuloides* is the sole dominant in many stands although scattered *Abies grandis*, *Pinus ponderosa*, *Pinus contorta* or *Pseudotsuga menziesii* trees are common in Washington stands (Hadfield and Magelssen 2004, 2006). *Symphoricarpos oreophilus* and *S. albus* are the most common dominant shrubs. Tall shrubs, such as *Acer glabrum*, *Salix scouleriana* and *Amelanchier alnifolia* may be abundant. In some stands, *Calamagrostis rubescens* may dominate the ground cover without shrubs. Other common grasses are *Festuca idahoensis*, *Bromus carinatus*, or *Elymus glaucus*. Characteristic tall forbs include *Agastache* spp., *Aster* spp., *Senecio* spp., *Rudbeckia* spp. Low forbs include *Thalictrum* spp., *Galium* spp., *Osmorhiza* spp., and *Lupinus* spp.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system:

G222 Rocky Mountain Subalpine & Montane Aspen Forest & Woodland Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Betula papyrifera Forest	G4Q/S2?	CEGL000520
Populus tremuloides / Calamagrostis rubescens Forest	G5?/S2	CEGL000575
Populus tremuloides / Symphoricarpos oreophilus Forest	G5/SNR	CEGL000610

Ecological Processes: Occurrences of this system originate and are maintained by stand-replacing disturbances such as crown fire, insect outbreak, disease and windthrow within the matrix of conifer forests. Fire plays an important role in maintenance of this habitat. *Populus tremuloides* will colonize sites after fire or other stand disturbances through root sprouting. The stems of these thin-barked, clonal trees are easily killed by ground fires, but they can quickly and vigorously resprout in densities of up to 30,000 stems per hectare (CNHP 2005). With adequate disturbance a clone may live many centuries or millennia. The stems are relatively short-lived (100-150 years), and stands will succeed to longer-lived conifer forest if left undisturbed. Natural fire return interval may be as frequent as 7-10 years although LANDFIRE Modeling (2007) cites 35-100 year frequency of mixed severity fires as fire regime III (LANDFIRE modeling of this system in the central Rockies assumes fire regime I). Ungulate browsing plays a variable role in aspen habitat by slowing tree regeneration by eating *Populus tremuloides* sprouts on some sites. Wolf predation plays a role in reducing elk browse effects and thus structure of *Populus tremuloides* stands in Yellowstone (Halofsky et al 2008). Although *Populus tremuloides* produces abundant seeds, seedling survival is rare because the long moist conditions required to establish them are rare in these habitats (Romme et al. 1997). Grazing reduces the fine fuels thereby reducing the risk of fires spreading into the stands and killing aspen stems and small conifers (Hadfield and Magelssen 2004, 2006).

Threats: Heavy livestock browsing can adversely impact *Populus tremuloides* growth and regeneration. Cattle and elk commonly graze on grasses and forbs in *Populus tremuloides* stands allowing conifers to become established (Hadfield and Magelssen 2004, 2006). With fire suppression and alteration of fine fuels, fire rejuvenation of aspen habitat has been greatly reduced since about 1900. Conifers now dominate many seral *Populus tremuloides* stands and extensive stands of young *Populus tremuloides* are uncommon. Many stands surveyed on the Okanogan and Wenatchee National Forests are successional to conifers and shrinking in size. Hadfield and Magelssen (2004, 2006) conclude that *Populus tremuloides* occupied a considerably larger area in Washington in the past than now. Major factors contributing to this condition are browsing by wild and domestic ungulates and exclusion of fires. Grazing also increases invasion by exotics species, such as, *Poa pratensis* and *Cirsium* spp.

Classification Comments: This system is characterized by being dominated by a broadleaf forest or woodland dominated by *Populus tremuloides* with less than 25% total tree canopy cover by conifers. Although *Populus tremuloides* can be associated with streams, ponds, or wetlands, the Rocky Mountain Aspen Forests and Woodland system consists of upland aspen stands found from low to moderate elevation as patches or stands primarily within Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest systems.

Related Concepts: This ecological system falls within the Upland Aspen Forest habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the Rocky Mountain Aspen Forest and Woodland as one of their standard mapping units.

References

Agee, J.K. 2003. Historical range of variability in eastern Cascades forests, Washington, USA. Landscape Ecology 18: 725-740.

Colorado Natural Heritage Program (CNHP). 2005. Rocky Mountain Aspen Forest and Woodland. Colorado State University. Fort Collins, Colorado. http://www.cnhp.colostate.edu/download/reports.asp

Hadfield, J. and R. Magelssen. 2004. Assessment of the Condition of Aspen on the Okanogan and Wenatchee National Forests. USDA Okanogan and Wenatchee National Forests report. 26 p.

Hadfield, J. and R. Magelssen. 2006. Assessment of the Condition of Aspen on the Colville National Forest. USDA Colville National Forests report. 23 p.

Hadfield, J.S. 2003. Little Pend Oreille National Wildlife Refuge aspen condition assessment survey. U.S. D.A. Forest Ser., Forestry Sciences Lab, Wenatchee, WA. 11 p.

Halofsky J.F., Ripple W.J. and Beschta, R. L. 2008. Recoupling fire and aspen recruitment after wolf reintroduction in Yellowstone National Park, USA. Forest Ecology and Management 256: 1004–1008.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

LANDFIRE. 2007. Biophysical Setting Model 0110110: Rocky Mountain Aspen Forest and Woodland.

Napper, C., S. Howes, and D. Page-Dumroese. 2009. *The soil disturbance field guide.* U.S. For. Serv. 0819 1815-SDTC. 112p.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Romme, W.H.; Turner, M.G.; Gardner, R.H.; Hargrove, W.W.; Tuskan, G.A.; Despain, D.G.; Renkin, R.A. 1997. A rare episode of sexual reproduction in aspen (*Populus tremuloides* Michx.) following the 1988 Yellowstone fires. Natural Areas Journal 17: 17-25.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Description Author: Rex Crawford, Marion Reid and Gwen Kittel.

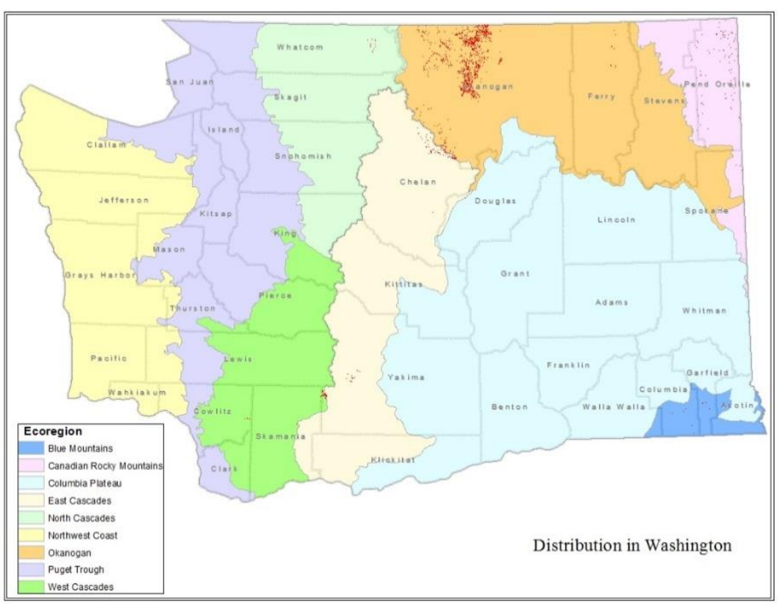
ROCKY MOUNTAIN LODGEPOLE PINE FOREST


Photo by David Wilderman

Concept: *Pinus contorta* (primarily var. *latifolia*) dominated upper montane and subalpine forests that are related to fire history, not to topo-edaphic conditions. Other montane conifers that may be present include *Abies grandis*, *Larix occidentalis*, *Pinus monticola*, *P. ponderosa*, and *Pseudotsuga menziesii*. Tall deciduous shrubs include *Acer glabrum*, *Amelanchier alnifolia*, *Holodiscus discolor*, or *Salix scouleriana*.

Conservation Status: Vulnerable (S3S4). Likely closer to an S3 than S4 because of beetles and forest health treatments.

Distribution: This ecological system is composed of subalpine and upper montane forests with *Pinus contorta* (primarily var. *latifolia*) dominance that is related to fire history, not to topo-edaphic conditions. This type is a widespread, large patch to matrix-forming system in upper montane to subalpine elevations of the Rocky Mountains, Intermountain West region, north into the Canadian Rockies, east into mountain "islands" of north-central Montana and into the northeast Cascades in Washington. *Pinus contorta* stands south in the Cascades in Oregon are either Rocky Mountain Poor-Site Lodgepole Pine Forest (pumice zone) or Sierra Nevada Subalpine Lodgepole Pine Forest and Woodland (*Pinus contorta* var. *murrayana*). As described here, the Rocky Mountain Lodgepole Pine Forest system includes fire-maintained *Pinus contorta* forests in the subalpine spruce-fir and Montane spruce zones in Washington (Meidinger and Pojar 1991).



Distribution in Washington

Environment: This ecological system is found mostly at mid- to higher elevations in typically cold and relatively dry areas, usually with a persistent winter snowpack. Most stands occur as early- to mid-successional forests which developed following fires associated with the Dry-Mesic Subalpine Spruce Fir and Mesic-Wet Subalpine

SUBALPINE-MONTANE MESIC FORESTS

Spruce Fir ecological systems. Soils supporting these forests are typically well-drained, gravelly, coarse-textured, acidic, and rarely formed from calcareous parent materials.

Vegetation: *Pinus contorta* possesses cone serotiny which is an important factor in its regeneration after fire. It typically has nonserotinous (open) cones until 20 to 30 years old and afterwards trees produce more serotinous (closed) cones (Smith and Fischer 1997). The serotinous cones on older trees open after exposure to heat during forest fire and allow it to regeneration quickly (Smith and Fischer 1997). Typically, *Pinus contorta* establishes within 10-20 years after fire and then declines after 100-200 years (Lilybridge et al. 1995). While these forests usually persistent for over 100 years, they may eventually succeed to mixed montane coniferous forests. Potential for high severity fires are in the dense regeneration phases and overmature late seral stage when fuels accumulate (Smith and Fischer 1997). Without fire and insects, stands become more closed-canopy forest with sparse undergrowth and prone to stagnation, snow breakage, and windthrow. Because *Pinus contorta* rarely reproduces under a canopy, old unburned stands are replaced by shade-tolerant conifers. Vertical structure is typically a single tree layer; however, reproduction of other more shade-tolerant conifers can be abundant in the undergrowth. Several distinct undergrowth types develop under the tree layer: 1) evergreen or deciduous medium-tall shrubs, 2) evergreen low shrub, or 3) graminoids with few shrubs. The tree layer is dominated by *Pinus contorta* var. *latifolia* and may be associated with other montane conifers (*Abies grandis*, *Larix occidentalis*, *Pinus monticola*, *P. ponderosa*, *Pseudotsuga menziesii*). Tall deciduous shrubs include *Acer glabrum*, *Amelanchier alnifolia*, *Holodiscus discolor*, or *Salix scouleriana*. These tall shrubs often occur over a layer of mid-height deciduous shrubs such as *Rosa gymnocarpa*, *Shepherdia canadensis*, *Spiraea betulifolia*, and *Symphoricarpos albus*. At higher elevations, *Vaccinium membranaceum* can be locally important, particularly following fire. Mid-tall evergreen shrubs can be abundant in some stands, for example, *Mahonia repens*, *Ceanothus velutinus*, and *Paxistima myrsinites*. Colder and drier sites support low-growing evergreen shrubs, such as *Arctostaphylos uva-ursi* or *A. nevadensis*. *Vaccinium scoparium* and *Xerophyllum tenax* are consistent evergreen low shrub dominants in the subalpine part of this habitat. Some undergrowth is dominated by graminoids with few shrubs. *Calamagrostis rubescens* and/or *Carex geyeri* can appear with *Vaccinium scoparium* in the subalpine zone. The forb component of this habitat is diverse and varies with environmental conditions.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system:

G220 Rocky Mountain Lodgepole Pine Forest & Woodland Group	Global/ State Rank	NatureServe/ WNHP Code
Pinus contorta / Arctostaphylos uva-ursi Forest	G5/S3	CEGL000134
Pinus contorta / Calamagrostis rubescens Forest	G5/S3	CEGL000139
Pinus contorta / Clintonia uniflora - Xerophyllum tenax Woodland	G4G5/SNR	CEGL005921
Pinus contorta / Clintonia uniflora Forest	G5/SNR	CEGL005916
Pinus contorta / Menziesia ferruginea / Clintonia uniflora Forest	G4G5/SNR	CEGL005922
Pinus contorta / Shepherdia canadensis Forest	G3G4/S3?	CEGL000163
Pinus contorta / Vaccinium caespitosum / Clintonia uniflora Forest	G4?/SNR	CEGL005923
Pinus contorta / Vaccinium membranaceum / Xerophyllum tenax Forest	G4G5/SNR	CEGL005913
Pinus contorta / Vaccinium membranaceum Forest	G4?/S4?	CEGL000170
Pinus contorta / Vaccinium scoparium / Calamagrostis rubescens Forest	G3Q/SNR	CEGL000174
Pinus contorta / Vaccinium scoparium / Xerophyllum tenax Forest	G3G4/SNR	CEGL005924
Pinus contorta / Vaccinium scoparium Forest	G5/S4	CEGL000172

Ecological Processes: In general, fire-free intervals less than the life span of *Pinus contorta* favor its dominance while longer intervals and the loss of standing dead trees with closed cones, favor dominance by other trees (Smith and Fischer 1997). Mean fire interval of replacement fires (80% of all fires) is 115 years and described as 35-100+ year frequency, replacement severity fires (Fire regime IV, LANDFIRE 2007). Summer drought areas generally have low to medium-intensity ground fires occurring at intervals of 25-50 years, whereas areas with more moisture have sparse undergrowth and slow fuel build-up that results in less frequent, more intense fire. Woody fuels accumulate on the forest floor from insect (*Dendroctonus ponderosae* mountain pine beetle) and disease outbreaks and residual wood from past fires. High-severity crown fires are likely in young stands, when the tree crowns are near deadwood on the ground. The historical range of variability of these system is relatively straight forward. Because of fire sensitivity of both *Pinus contorta* and most invading conifers seedlings during stand development (*Abies lasiocarpa* and *Picea engelmannii*) the majority of trees are killed. LANDFIRE (2007) modeled 25% of the Lodgepole Pine Forest system were early, closed canopy seedling stages, 45% in midseral closed canopy tree less than 10 inches dbh and the remaining 30% closed canopy *Pinus contorta* trees 10-21 inches dbh under natural fire regime.

Threats: Fire suppression has left many single-canopy *Pinus contorta* sites unburned resulting in more multilayered stands. Mountain pine beetle can infest and kill *Pinus contorta* trees when they reach large trunk sizes and at low levels of infestation can create openings and *Pinus contorta* seed and reestablish with other conifers. As most tree reach large sizes with phloem thick enough to support large beetle populations pine beetle (over 10 inches dbh) epidemics can occur and kill many trees and fuel increasing future fire severity (Smith and Fischer 1997). These forests have been fragmented by roads, timber harvest, and influenced by periodic livestock grazing and altered fire regimes. Grasses compete with *Pinus contorta* seedlings, and use of non-native species causes long-term changes in community composition (Smith and Fischer 1997). *Poa pratensis* and *Elymus elymoides* can be locally abundant where livestock grazing has persisted. Increases in cattle use results in increases in trampling damage to regenerating *Pinus contorta* seedlings (Pitt et al. 1998).

Classification Comments: Early to mid-seral forests on productive soils where the dominance of *Pinus contorta* (>2/3 total tree canopy) is related to fire history. The similar Rocky Mountain Poor-Site Lodgepole Pine Forest differs in that they are related to topo-edaphic conditions and nutrient-poor soils, such as excessively well-drained pumice deposits, glacial till and alluvium on valley floors where there is cold-air accumulation, warm and droughty shallow soils over fractured quartzite bedrock, and shallow moisture-deficient soils with a significant component of volcanic ash. The Rocky Mountain Poor-Site Lodgepole Pine Forest is not thought to occur in Washington.

Related Concepts: This ecological system falls within the Lodgepole Pine Forest and Woodlands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning

Tools Project (i.e. LANDFIRE) recognizes the Rocky Mountain Lodgepole Pine Forest as one of their standard mapping units.

References

Agee, J.K., 1993. Fire Ecology of Pacific Northwest Forests. Island Press, Washington.

FRCC. 2008. Interagency Fire Regime Condition Class (FRCC) Guidebook, version 1.3.0.

FRCC. 2010. FRCC Software Application User's Guide (version 3.0.3.0). www.frcc.gov.

Green, P. J. Joy, D. Sirucek, W. Hann, A. Zack, and B. Naumann. 1994. Old Growth Forest Types of the Northern Region. R-1 SES 4/92; USDA Forest Service, Northern Region, Missoula, MT http://www.fs.fed.us/rl/projects/forest-rangeland/green_etal.pdf

Jenkins, M.J., Hebertson, E., Page, W., Jorgensen, A.A., 2008. Bark beetles, fuels, fires and implications for forest management in the Intermountain West. Forest. Ecol. Manage. 254, 16–34.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

LANDFIRE. 2007. Rocky Mountain Lodgepole Pine Forest and Woodland. Biophysical Setting Model BpS 0110500. http://www.landfire.gov/NationalProductDescriptions24.php

Meidinger, D., and J. Pojar, editors. 1991. Ecosystems of British Columbia. British Columbia Ministry of Forests Special Report Series No. 6. 330 pp.

Napper, C., S. Howes, and D. Page-Dumroese. 2009. The soil disturbance field guide. U.S. For. Serv. 0819 1815-SDTC. 112p.

Pitt, M. D., R. F. Newman, P.L. Youwe, B.M. Wikeem, and D.A. Quinton. 1998. Using a grazing pressure index to predict cattle damage of regenerating tree seedlings. J. Range Management. 51: Abstract.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Smith, J. K. and W.C. Fischer. 1997. Fire ecology of the forest habitat types of northern Idaho. Gen. Tech. Rep. INT-GTR-363. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 142 p.

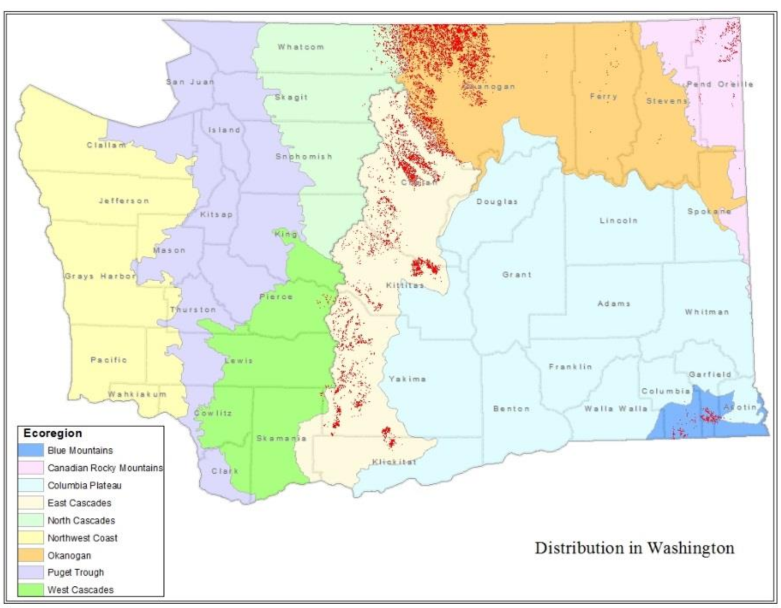
Description Author: Rex Crawford, Marion Reid and Gwen Kittel.

ROCKY MOUNTAIN SUBALPINE DRY-MESIC SPRUCE-FIR FOREST AND WOODLAND

Concept: *Picea engelmannii* and *Abies lasiocarpa (*primarily *bifolia)* dominated subalpine forest and woodlands in relatively dry environments in the Northern Rocky Mountains, East Cascades, Blue Mountains and in the high elevation, rain shadow areas of Mount Baker and Mount Rainier. Understory species include *Vaccinium scoparium, Shepherdia canadensis*, *Amelanchier alnifolia, Juniperus communis, Linnaea borealis*, *Mahonia repens* and herbaceous species *Arnica cordifolia*, *Calamagrostis canadensis* and *Carex geyeri*.

Conservation Status: Apparently Secure (S3S5). More information about wooly aphid effects and logging is needed to assign a more specific rank.

Distribution: The spruce – fir (*Picea engelmannii* - *Abies lasiocarpa* subalpine forest and woodlands of the Rocky Mountains and in northeast Cascade Mountains are composed of two ecological systems recognized at high-elevations. The Dry-Mesic Subalpine Spruce Fir and the Mesic-Wet Spruce Fir Forest and Woodland ecological systems usually co-occur on the landscape separated by aspect and topographic position. The Mesic-Wet system extends to lower elevations in cold air drainages or frost pockets and is more common in wetter, deeper snowpack climates. In Washington, these systems generally appear at mid-elevation to near upper treeline (4000 and 6500 feet) in northeastern Washington, east Cascades, Blue Mountains and in the high rain shadow in the northeast Olympic Mountains, Mount Baker and Mount Rainier in western Washington.



Environment: These are in cold, moist environments with a snow-dominated, continental climate. Winters are long and cold creating a short growing season. Sites cold year-round, and precipitation is predominantly in the form of snow, which may persist until late summer.

SUBALPINE-MONTANE MESIC FORESTS

Snowpack is deep and late-lying, and summers are cool. Frost is possible almost all summer and may be common in restricted topographic basins and benches. Snowpack depth (2-12 feet), late snow melting, and spring moisture are important to success of tree regeneration.

Vegetation: Forests are closed to open and usually dominated by *Picea engelmannii* and/or *Abies lasiocarpa*. *Pinus contorta* is a common canopy member in Rocky Mountain and northeast Cascades occurrences. Large *Pinus contorta* var. *latifolia* stands are recognized as the Rocky Mountain Lodgepole Pine Forest system. *Pseudotsuga menziesii*, *Pinus contorta,* or *Larix occidentalis* may persist in occurrences of the Dry-Mesic system for long periods without regeneration. Mixed conifer/*Populus tremuloides* stands may be encountered in the Dry-Mesic Subalpine Spruce Fir system.

Upper elevation examples may have more woodland physiognomy and *Pinus albicaulis* can be a seral component. The understory is variable where shrubs can be absent to dominant. The highest elevation sites that are in transition to subalpine parkland or woodland systems typically contain the short shrubs *Phyllodoce empetriformis* and *Empetrum nigrum* and the herbaceous species *Luzula glabrata* var. *hitchcockii* or *Lupinus arcticus* ssp. *subalpinus.* Understory species include *Vaccinium scoparium, Shepherdia canadensis, Amelanchier alnifolia, Juniperus communis, Linnaea borealis, Mahonia repens* and herbaceous species *Arnica cordifolia*, *Calamagrostis canadensis* and *Carex geyeri*. More mesic shrub species, such as *Menziesia ferruginea, Rhododendron albiflorum*, and *Vaccinium membranaceum* may be present as short stature less abundant members of the understory.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system:

G219 Rocky Mountain Subalpine Dry-Mesic Spruce - Fir Forest & Woodland Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Abies lasiocarpa - Picea engelmannii / Calamagrostis rubescens Forest	G4G5/S4	CEGL000301
Abies lasiocarpa - Picea engelmannii / Carex geyeri Forest	G5/SNA	CEGL000304
Abies lasiocarpa / Paxistima myrsinites Woodland	G4/S4	CEGL000324
Abies lasiocarpa - Picea engelmannii / Vaccinium scoparium Forest	G5/S4	CEGL000344
Abies lasiocarpa - Picea engelmannii / Juniperus communis Woodland	G4G5/S3	CEGL000919

Ecological Processes: A high-severity/low frequency fire regime typically characterizes spruce-fir forests (Agee, 1993). The relatively cold and moist subalpine environment limits fire occurrences to only a few weeks in late summer (Jenkins et al 2008). Consequently, fire frequency in spruce-fir forests is low. Trees with dense crowns and low branches are often covered with lichens and typically have a sparse understory with compact litter. This reduces low-intensity surface fires and creates conditions for crown fire (Jenkins et al 2008). LANDFIRE (2007) lists fire regime III for both Wet-Mesic and Dry-Mesic subalpine spruce-fir systems that include 35-100+ year frequency of mixed severity and 35-400+ year frequency of high severity fires. Lightning strikes are frequent, but will often result in small, patchy spot fires. Other natural disturbances include occasional windthrow and insect outbreaks (30-50 years) that create canopy gaps. Actions of defoliator and bark beetles can influence stand development, species composition and stand density. Large scale insect infestations may create large patches of early seral conditions and/or create conditions that lead to large, stand-replacement fires.

The historical range of variability of these system is highly variable. Because of fire sensitivity of both *Picea engelmannii* and *Abies lasiocarpa* fire return interval is important in initial stand conditions. In general, infrequent fires often lead to dominance of *Picea engelmannii* and/or *Abies lasiocarpa* with little or no *Pinus contorta, Larix occidentalis,* or *Pseudotsuga menziesii*. When very severe fires occur, shrubland or grassland areas can persist for long periods. Persistent treeless areas may better be classified

the Northern Rocky Mountain Subalpine Deciduous Shrubland or Northern Rocky Mountain Subalpine-Upper Montane Grassland systems. Tree establishment is slow and stands remain open even into old-growth (Agee 1989). These aging mixed conifer stands become more susceptible to spruce beetle, to root diseases (*Phellinus, Armillaria*), and to windthrow with time. Stands with over 65% *Picea engelmannii* over 15 in (40 cm) dbh are most susceptible to spruce beetle attack. The patchy nature of these forests is similar to forests with a mixed severity fire regime although the stands are primarily uneven age. This system typically has mixed conifer forests with more fire-adapted tree species, *Pinus contorta, Larix occidentalis* or *Pseudotsuga menziesii* with *Picea engelmannii* and/or *Abies lasiocarpa* present than in the Mesic-Wet system. These may include small even-aged stands of a single species. Bark beetle infestations of *Pinus contorta* can create gaps and move these stands to high severity regimes dominated by *Picea engelmannii* and/or *Abies lasiocarpa.* Quigley and others (1997) estimate that, historically, late-seral patches occupied approximately 25%, mid-seral 52%, and early-seral 23% in the east Cascades of Washington. LANDFIRE (2007) modeled 30-35% of these systems as late seral, 50-60% mid-seral and 5-20% early seral.

Threats: Since European settlement, timber harvest, introduced diseases, such as balsam woolly adelgids (*Adelges piceae*) on subalpine fir, road building, development, and tree plantations have all impacted natural disturbance regimes, forest structure, composition, landscape patch diversity, and tree regeneration. Fire exclusion generally has had little to no effect on fuels or forest structure in forests characterized by high-severity fire regimes (Noss et al 2006). Road development has fragmented many forests creating fire breaks. Quigley and others (1997) estimate that mid-seral forest structure is currently 10% more abundant than historically, late-seral forests are diminished by 75% and early-seral forest abundance is 57% more than historically in the east Cascades of Washington.

Classification Comments: This system typically has mixed conifer forests with more fire-adapted tree species, *Pinus contorta, Larix occidentalis* or *Pseudotsuga menziesii* with *Picea engelmannii* and/or *Abies lasiocarpa* present than in the Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland system. The Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland also is characteristic of relatively mesic local environments such as north toe slopes, and has an abundance of mesic understory species whereas this system occurs as a matrix to large patch system across much of the subalpine zone. However, in Washington this pattern varies due to the fact that Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland often occurs as a matrix type.

Related Concepts: This ecological system falls within the Montane Mixed Conifer Forest habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools

Project (i.e. LANDFIRE) recognizes the Rocky Mountain Dry-Mesic Spruce-Fir Forest and Woodland as one of their standard mapping units.

References

Agee, J.K., 1993. Fire Ecology of Pacific Northwest Forests. Island Press, Washington,

FRCC. 2010. FRCC Software Application User's Guide (version 3.0.3.0). www.frcc.gov.

Green, P. J. Joy, D. Sirucek, W. Hann, A. Zack, and B. Naumann. 1994. Old Growth Forest Types of the Northern Region. R-1 SES 4/92; USDA Forest Service, Northern Region, Missoula, MT http://www.fs.fed.us/rl/projects/forest-rangeland/green_etal.pdf

Jenkins, M.J., Hebertson, E., Page, W., Jorgensen, A.A., 2008. Bark beetles, fuels, fires and implications for forest management in the Intermountain West. Forest. Ecol. Manage. 254, 16–34.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

LANDFIRE. 2007. Rocky Mountain Subalpine Dry-Mesic Spruce-fir Forest and Woodland. Biophysical Setting Model. http://www.landfire.gov/NationalProductDescriptions24.php

LANDFIRE. 2007. Rocky Mountain Subalpine Mesic-Wet Spruce-fir Forest and Woodland. Biophysical Setting Model. http://www.landfire.gov/NationalProductDescriptions24.php

Napper, C., S. Howes, and D. Page-Dumroese. 2009. *The soil disturbance field guide.* U.S. For. Serv. 0819 1815-SDTC. 112p.

Noss R.F., J.F. Franklin, W.L. Baker. 2006. Ecology and management of fire-prone forests of the western United States. Society for Conservation Biology, North American Section. www.conbio.org/sections/namerica/napolicy.cfm.

Quigley, T. M. and S.J. Arbelbide (technical editors). 1997. An Assessment of Ecosystem Components in the Interior Columbia Basin and Portions of the Klamath and Great Basins: Volume 2. Gen. Tech. Rep. PNW-GTR-405. Portland, OR. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 4 Volumes. (Quigley, T.M., technical editor; The Interior Columbia Basin Ecosystem Management Project: Scientific Assessment).

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Wong, C., and K. Iverson. 2004. Range of natural variability: Applying the concept to forest management in central British Columbia. Ext. Note British Columbia Journal of Ecosystems and Management 4(1). http://www.forrex.org/jem/2004/vol4/no1/art3.pdf

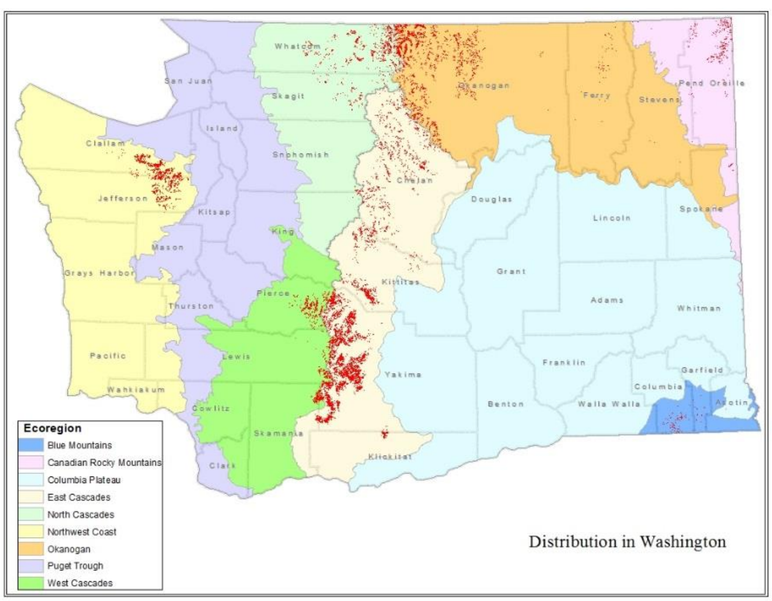
Description Author: Rex Crawford, Chris Chappell, Marion Reid and Gwen Kittel.

ROCKY MOUNTAIN SUBALPINE MESIC-WET SPRUCE-FIR FOREST AND WOODLAND

Concept: *Picea engelmannii* and *Abies lasiocarpa (*primarily *bifolia)* dominated subalpine forest and woodlands of relatively mesic local environments, such as north toe slopes, of the northeastern Olympic Mountains, Okanogan Highlands, northern Rockies, and Blue Mountains. This system co-occurs with and is differentiated from the Rocky Mountain Dry-Mesic Spruce Fir Forest and Woodland ecological system by having an abundance of mesic understory species such as *Menziesia ferruginea*, *Vaccinium membranaceum*, *Rhododendron albiflorum*, *Rubus parviflorus*, *Rubus pedatus Ledum glandulosum* and herbaceous species *Actaea rubra*, *Clintonia uniflora*, *Cornus canadensis*, *Gymnocarpium dryopteris*, *Tiarella trifoliata*, and *Valeriana sitchensis*.

Conservation Status: Secure (S5). More information about wooly aphid effects is needed.

Distribution: The spruce – fir (*Picea engelmannii* **-** *Abies lasiocarpa* subalpine forest and woodlands of the Rocky Mountains and in northeast Cascade Mountains are composed of two ecological systems recognized at high-elevations. The Dry-Mesic Subalpine Spruce Fir and the Mesic-Wet Spruce Fir Forest and Woodland ecological systems usually co-occur on the landscape separated by aspect and topographic position. The Mesic-Wet system extends to lower elevations in cold air drainages or frost pockets and is more common in wetter, deeper snowpack climates. In Washington, the Mesic-Wet system is more common than the Dry-Mesic system. In Washington, these systems generally appear at mid-elevation to near upper treeline (4000 and 6500 feet) in northeastern Washington, east Cascades, Blue Mountains and in the high rain shadow in the northeast Olympic Mountains, Mount Baker and Mount Rainier in western Washington.



Environment: This system is found in mesic to wet locations with cold-air drainage, or where snowpack or available soil moisture lingers late into the summer, such as north-facing slopes and high-elevation ravines. This system can also extend below the subalpine zone in places where cold-air ponding occurs and northerly and easterly aspects predominate. It is found on gentle to very steep mountain slopes, high-elevation ridgetops and upper slopes, plateau-like surfaces, basins, alluvial terraces, toe-slopes, and inactive stream terraces. Winters are long and cold creating a short growing season. Precipitation is predominantly in the form of snow, which may persist until late summer. Snowpack is deep and late-lying, and summers are cool. Frost is possible almost all summer and may be common in restricted topographic basins and benches. Snowpack depth (2-12 feet), late snow melting, and spring moisture are important to success of tree regeneration. Climate in the Olympics and Cascades mountains is more maritime than typical for this system, but due to lower snowfall in these rainshadow areas, summer drought may be more significant than snowpack in limiting tree regeneration in burned areas. *Picea engelmannii* is rare in these areas.

Vegetation: These forests are closed to open and usually dominated by *Picea engelmannii* and/or *Abies lasiocarpa*. *Pinus contorta* is a common canopy member in Rocky Mountain and northeast Cascade occurrences. However, large *Pinus contorta* var. *latifolia* stands are recognized as the Rocky Mountain Lodgepole Pine Forest system. A portion of this ecological system includes *Tsuga mertensiana* in the Northern Rockies and in the drier portions of the Cascades (areas typically without *Abies amabilis* or *Cupressus nootkatensis)*. This system is usually associated with Northern Rocky Mountain or East Cascades Montane Mesic systems.

Upper elevation examples may have more woodland physiognomy and *Pinus albicaulis* can be a seral component. The understory is variable and shrubs can be absent to dominant. The highest elevation sites that are in transition to subalpine parkland or woodland systems typically contain the short shrubs *Phyllodoce empetriformis* and *Empetrum nigrum* and the herbaceous species *Luzula glabrata* var. *hitchcockii* or *Lupinus arcticus* ssp. *subalpinus*. Understory species in this system include taller shrubs such as *Menziesia ferruginea, Vaccinium membranaceum, Rhododendron albiflorum, Rubus parviflorus, Rubus pedatus Ledum glandulosum.* Herbaceous species include *Actaea rubra, Maianthemum stellatum, Cornus canadensis, Erigeron eximius, Gymnocarpium dryopteris, Rubus pedatus, Saxifraga bronchialis, Tiarella* spp., *Lupinus arcticus ssp. subalpinus, Valeriana sitchensis*, and graminoids *Luzula glabrata var. hitchcockii* or *Calamagrostis canadensis*.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system:

G218 Rocky Mountain Subalpine Moist Spruce - Fir Forest & Woodland Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Abies lasiocarpa - Picea engelmannii / Clintonia uniflora - Xerophyllum tenax Forest	G4G5/SNR	CEGL005892
Abies lasiocarpa - Picea engelmannii / Clintonia uniflora Forest	G5/S3	CEGL005912
Abies lasiocarpa - Picea engelmannii / Linnaea borealis Forest	G5/S4	CEGL000315
Abies lasiocarpa - Picea engelmannii / Luzula glabrata var. hitchcockii Woodland	G5/S2	CEGL000317
Abies lasiocarpa - Picea engelmannii / Menziesia ferruginea - Vaccinium scoparium Forest	G2G4/SNR	CEGL005894
Abies lasiocarpa - Picea engelmannii / Menziesia ferruginea / Clintonia uniflora Forest	G4G5/SNR	CEGL005893
Abies lasiocarpa - Picea engelmannii / Menziesia ferruginea / Luzula glabrata var. hitchcockii Woodland	G4?/SNR	CEGL005896
Abies lasiocarpa - Picea engelmannii / Menziesia ferruginea / Streptopus amplexifolius Woodland	G3G4/SNR	CEGL005897
Abies lasiocarpa - Picea engelmannii / Menziesia ferruginea / Xerophyllum tenax Forest	G4G5/SNR	CEGL005895

G218 Rocky Mountain Subalpine Moist Spruce - Fir Forest & Woodland Group	Global/ State Rank	NatureServe/ WNHP Code
Abies lasiocarpa - Picea engelmannii / Menziesia ferruginea Forest	G5/SNA	CEGL000319
Abies lasiocarpa - Picea engelmannii / Vaccinium caespitosum Forest	G5/S3?	CEGL000340
Abies lasiocarpa - Picea engelmannii / Vaccinium membranaceum Rocky Mountain Forest	G5/SNA	CEGL000341
Abies lasiocarpa - Picea engelmannii / Xerophyllum tenax - Luzula glabrata var. hitchcockii Woodland	G4G5/SNR	CEGL005898
Abies lasiocarpa / Cornus canadensis Forest	G3G4/S3S4	CEGL000309
Abies lasiocarpa / Rhododendron albiflorum Woodland	G4/S4	CEGL000330
Abies lasiocarpa / Vaccinium membranaceum Forest	G4/S4	CEGL000342
Abies lasiocarpa / Xerophyllum tenax Forest	G5/S3	CEGL000346
Picea engelmannii / Maianthemum stellatum Forest	G4?/SNR	CEGL000415
Tsuga mertensiana / Rhododendron albiflorum Forest	GNR/SNA	CEGL000508

Ecological Processes: A high-severity/low frequency fire regime typically characterizes spruce-fir forests (Agee, 1993). The relatively cold and moist subalpine environment limits fire occurrences to only a few weeks in late summer (Jenkins et al 2008). Fire frequency in spruce-fir forests consequently is low. Trees with dense crowns and low branches are often covered with lichens and typically have a sparse understory with compact litter. This reduces low-intensity surface fires and creates conditions for crown fire (Jenkins et al 2008). LANDFIRE (2007) lists fire regime III for both Wet-Mesic and Dry-Mesic subalpine spruce-fir systems that include 35-100+ year frequency of mixed severity and 35-400+ year frequency of high severity fires. Lightning strikes are frequent, but will often result in small, patchy spot fires. Other natural disturbances include occasional windthrow and insect outbreaks (30-50 years) that create canopy gaps. Actions of defoliator and bark beetles can influence stand development, species composition and stand density. Large scale insect infestations may create large patches of early seral conditions and/or create conditions that lead to large, stand-replacement fires.

The historical range of variability of these system is highly variable. Because of fire sensitivity of both *Picea engelmannii* and *Abies lasiocarpa*, the fire return interval is important in determining initial stand conditions. In general, infrequent fires often lead to dominance of *Picea engelmannii* and/or *Abies lasiocarpa* with little or no *Pinus contorta*, *Larix occidentalis*, or *Pseudotsuga menziesii* because of severe site conditions. When very severe fires occur, shrubland or grassland areas can persist for long periods. Persistent treeless areas may better be classified the Northern Rocky Mountain Subalpine Deciduous Shrubland or Northern Rocky Mountain Subalpine-Upper Montane Grassland systems. Tree establishment is slow and stands remain open even into old-growth (Agee 1989). These aging mixed conifer stands become more susceptible to spruce beetle, to root diseases (*Phellinus*, *Armillaria*), and to windthrow with time. Stands with over 65% *Picea engelmannii* over 15 in (40 cm) dbh are most susceptible to spruce beetle attack. The patchy nature of these forests is similar to forests with a mixed severity fire regime although the stands are primarily uneven age. The Dry-Mesic Subalpine Spruce Fir system typically has mixed conifer forests with more fire-adapted tree species, *Pinus contorta*, *Larix occidentalis* or *Pseudotsuga menziesii* with *Picea engelmannii* and/or *Abies lasiocarpa* present than in the Mesic-Wet system. These may include small even-aged stands of a single species. Bark beetle infestations of *Pinus contorta* can create gaps and move these stands to high severity regimes dominated by *Picea engelmannii* and/or *Abies lasiocarpa*. Quigley and others (1997) estimate that, historically, late-seral patches occupied approximately 25%, mid-seral 52%, and early-seral 23% in the east Cascades of Washington. Landfire (2007) modeled 30-35% of these systems (BpS) as late seral (25% open), 50-60% mid-seral (40% closed) and 5-20% early seral.

Threats: Since European settlement, timber harvest, introduced diseases, such as balsam woolly adelgids (*Adelges piceae*) on subalpine fir, road building, development, and tree plantations have all impacted natural disturbance regimes, forest structure, composition, landscape patch diversity, and tree regeneration. Fire exclusion generally has had little to no effect on fuels or forest structure in forests characterized by high-severity fire regimes (Noss et al 2006). Road development has fragmented many forests creating fire breaks. Quigley and others (1997) estimate that mid-seral forest structure is currently 10% more abundant than historically, late-seral forests are diminished by 75% and early-seral forest abundance is 57% more than historically in the east Cascades of Washington.

Classification Comments: This system differs from the Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland by its occurrence on mesic to wet sites and abundance of mesic understory species in the understory. The subalpine fir-dominated forests of the northeastern Olympic Mountains and the northeastern side of Mount Rainier are included here as they are floristically more similar to subalpine fir forests on the eastern slopes of the Cascades than they are to mountain hemlock forests.

Related Concepts: This ecological system falls within the Montane Mixed Conifer Forest habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the Rocky Mountain Mesic-Wet Spruce-Fir Forest and Woodland as one of their standard mapping units.

References

Agee, J.K., 1993. Fire Ecology of Pacific Northwest Forests. Island Press, Washington,

FRCC. 2010. FRCC Software Application User's Guide (version 3.0.3.0). www.frcc.gov.

Green, P. J. Joy, D. Sirucek, W. Hann, A. Zack, and B. Naumann. 1994. Old Growth Forest Types of the Northern Region. R-1 SES 4/92; USDA Forest Service, Northern Region, Missoula, MT http://www.fs.fed.us/rl/projects/forest-rangeland/green_etal.pdf

Jenkins, M.J., Hebertson, E., Page, W., Jorgensen, A.A., 2008. Bark beetles, fuels, fires and implications for forest management in the Intermountain West. Forest. Ecol. Manage. 254, 16–34.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

LANDFIRE. 2007. Rocky Mountain Subalpine Dry-Mesic Spruce-fir Forest and Woodland. Biophysical Setting Model. http://www.landfire.gov/NationalProductDescriptions24.php

LANDFIRE. 2007. Rocky Mountain Subalpine Mesic-Wet Spruce-fir Forest and Woodland. Biophysical Setting Model. http://www.landfire.gov/NationalProductDescriptions24.php

Napper, C., S. Howes, and D. Page-Dumroese. 2009. *The soil disturbance field guide.* U.S. For. Serv. 0819 1815-SDTC. 112p.

Noss R.F., J.F. Franklin, W.L. Baker. 2006. Ecology and management of fire-prone forests of the western United States. Society for Conservation Biology, North American Section. www.conbio.org/sections/namerica/napolicy.cfm.

Quigley, T. M. and S.J. Arbelbide (technical editors). 1997. An Assessment of Ecosystem Components in the Interior Columbia Basin and Portions of the Klamath and Great Basins: Volume 2. Gen. Tech. Rep. PNW-GTR-405. Portland, OR. U.S. Department of Agriculture, Forest Service, Pacific Northwest

Research Station. 4 Volumes. (Quigley, T.M., technical editor; The Interior Columbia Basin Ecosystem Management Project: Scientific Assessment).

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Wong, C., and K. Iverson. 2004. Range of natural variability: Applying the concept to forest management in central British Columbia. Ext. Note British Columbia Journal of Ecosystems and Management 4(1). http://www.forrex.org/jem/2004/vol4/no1/art3.pdf

Description Author: Rex Crawford, Chris Chappell, Marion Reid and Gwen Kittel.

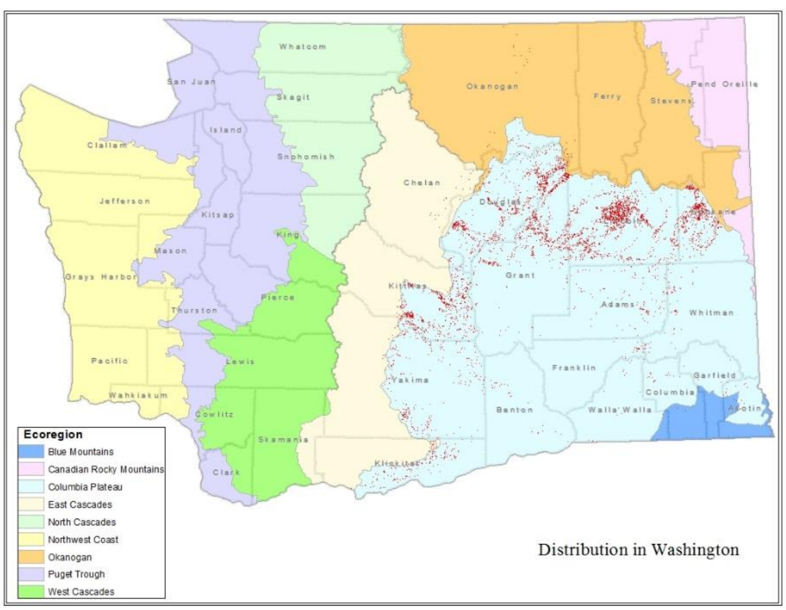
UPLAND SHRUBLANDS

COLUMBIA PLATEAU SCABLAND SHRUBLAND

Concept: Xeric, low (e.g. < 0.5 m tall) open shrublands dominated by *Artemisia rigida* along with or only by other dwarf-shrub species, particularly shrubby *Eriogonum* species (*compositum*, *douglasii*, *sphaerocephalum*, *strictum* or *thymoides*) located on sites with little soil development and extensive areas of exposed rock, gravel, or compacted soil. Some sites can be dominated by grasses and semi-woody forbs. . Low cover of perennial short bunchgrasses, primarily *Poa secunda* with scattered forbs, including species of *Allium*, *Antennaria*, *Balsamorhiza*, *Lomatium*, *Phlox*, and *Sedum*, characterize scabland sites.

Conservation Status: Secure (S5). Land uses in this system are few due to rocky soils and stressors to natural processes are confined to livestock use, exotic species invasion and direct use of sites. This system provides little forage and consequently is used only as a final resort by livestock.

Distribution: This large to small patch ecological system occurs on the Columbia Plateau in eastern Washington, eastern Oregon, southern Idaho, and extreme northern Nevada.



Distribution in Washington

Environment: These shrublands are found across a wide range of elevations from 500 to 5,000 ft. and is characteristically associated with flats, plateaus, and gentle to steep slopes with rock. This system occurs on sites with little soil development and extensive areas of exposed rock, gravel, or compacted soil. Bare ground and rock usually account for greater than 60% of the ground cover. Shallow (4-9 inches) lithic soil typically occurs over fractured basalt or rarely deep gravel that has limited water-holding capacity and is a major environmental driver. Due to poor drainage through basalt, winter precipitation can saturate soils from fall to spring but typically dry out completely to bedrock by spring to midsummer. Precipitation ranges from 8 to 16 inches.

Vegetation: Total vegetation cover is typically low, generally less than 50% and often much less. The open dwarf-shrub canopy is usually dominated by *Artemisia rigida* along with or only by other dwarf-shrub species, particularly shrubby *Eriogonum* species (*compositum, douglasii, sphaerocephalum, strictum* or *thymoides*). Some sites can be dominated by grasses and semi-woody forbs, such as *Stenotus stenophyllus*. More than a presence of other *Artemisia* species besides *Artemisia rigida* indicates a different ecological system. Low cover of perennial short bunchgrasses, primarily *Poa secunda* with scattered forbs, including species of *Allium, Antennaria, Balsamorhiza, Lomatium, Phlox,* and *Sedum*, characterize scabland sites. Other short bunchgrasses, *Danthonia unispicata*, *Elymus elymoides* can occur. Annual species may be seasonally abundant, and cover of moss and lichen is often high (e.g. 1-60% cover). Biological soil crust cover in Columbia Plateau Scabland Shrublands is considered to be high (Belnap et al 2001).

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system:

G273 Central Rocky Mountain Lower Montane, Foothill & Valley Grassland Group	Global/ State Rank	NatureServe/ WNHP Code
(Balsamorhiza serrata) - Poa secunda Herbaceous Vegetation	G2/SNA	CEGL001782
Lomatium cous - Poa secunda Herbaceous Vegetation	G4/SNA	CEGL001790
G307 Columbia Plateau Scabland Shrubland Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Artemisia rigida / Poa secunda Shrub Herbaceous Vegetation	G4/S3S4	CEGL001528
Artemisia rigida / Pseudoroegneria spicata Shrub Herbaceous Vegetation	G3/S2	CEGL001529
Eriogonum compositum / Poa secunda Dwarf-shrub Herbaceous Vegetation	G2/S2	CEGL001784
Eriogonum douglasii / Poa secunda Dwarf-shrub Herbaceous Vegetation	G4/S2	CEGL001785
Eriogonum microthecum - Physaria oregona Dwarf-shrubland	G2/S1	CEGL001737
Eriogonum niveum / Poa secunda Dwarf-shrub Herbaceous Vegetation	G3/S3	CEGL001786
Eriogonum sphaerocephalum / Poa secunda Dwarf-shrub Herbaceous Vegetation	G3/S2	CEGL001448
Eriogonum strictum / Poa secunda Dwarf-shrub Herbaceous Vegetation	G3/SNA	CEGL001788
Eriogonum thymoides / Poa secunda Dwarf-shrub Herbaceous Vegetation	G3/S3	CEGL001449
Salvia dorrii / Pseudoroegneria spicata Dwarf-shrubland	G4/SNA	CEGL001453

Ecological Processes: Hardman (2007) concluded from a study in the Blue Mountains that *Artemisia rigida* steppe and thin soil grasslands are sensitive habitats greatly impacted by soil disturbance and that they host rare lichen and bryophyte species such as *Grimmia ovalis* and *Dermatocarpon bachmannii* and the lichen *Cladonia imbricarica*. Johnson and Swanson (2005) indicated little difference in biological soil crust cover in grazed areas although they stated overgrazing will destroy crusts. Freezing of saturated soils results in "frost-heaving" that churns the soil and is a major disturbance factor in determining vegetation patterns. Native ungulates utilize this ecological system in early spring and also contribute to churning of the soil surface. Severely grazed *Artemisia rigida* bushes are browsed to "compact mats" (Johnson and Swanson 2005). Vegetation cover is too low to carry fires and scablands rarely burn (Agee 1994).

UPLAND SHRUBLANDS

Threats: Land uses in this system are few and stressors to natural processes are confined to livestock use, exotic species invasion and direct use of sites. This system provides little forage and consequently is used only as a final resort by livestock. However, heavy use by livestock or vehicles, particularly after the sites have dried, disrupts the moss/lichen layer and increases exposed rock and bare ground increasing the potential for invasion by non-native plants. Grazing also reduces the cover of bunchgrasses and increases the abundance of many forbs such as *Achillea millefolium*, *Phlox* sp., *Trifolium macrocephalum*, *Balsamorhiza serrata*, *Sitanion hystrix*, and annual bromes. All dwarf-shrub species are intolerant of fire and do not sprout. Consequently, redevelopment of dwarf shrub-steppe habitat is slow following fire or any disturbance that removes shrubs. Wind farms and industrial solar panel “farms” have been developed on scabland sites and represent conversion and fragmentation of scabland occurrences.

Classification Comments: Low shrubs (e.g. < 0.5 m), typically *Artemisia rigida* and woody *Eriogonum* spp., are diagnostic of this ecological system. Sites with co-dominance of *Artemisia rigida* and *Artemisia tridentata* or *Purshia tridentata* are included as part of the matrix Inter-Mountain Basins Big Sagebrush Steppe system. The latter are sites with fine texture soils and high proportion of rocks and have intermediate characteristics of scablands and shrub-steppe.

Related Concepts: This ecological system falls within the Dwarf Shrub-steppe habitat type as identified in Johnson and O’Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the Columbia Plateau Scabland Shrubland as one of their standard mapping units. This is included as part of all the lithosol habitat types noted in Daubenmire (1970).

References

Agee, James K. 1994. Fire and weather disturbances in terrestrial ecosystems of the eastern Cascades. Gen. Tech. Rep. PNW-GTR-320. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 52 p.

Belnap, J., J. Kaltenecker, R. Rosentreter, J. Williams, S. Leonard, and D. Eldridge. 2001. Biological Soil Crusts: Ecology and Management. Technical Report 1730-2, United States Department of the Interior. 110 pp.

Daubenmire. R. 1970. Steppe Vegetation of Washington. Washington Agricultural Experiment Station, College of Agriculture, Washington State University. Technical Bulletin 62. Pullman, Washington.

Hardman, A. 2007. Terrestrial Lichen and Bryophyte Communities of the Blue Mountains in Northeast Oregon. M.S. Oregon State Univ.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Johnson, C.G. and D.K. Swanson. 2005 Bunchgrass Communities of the Blue and Ochoco Mountains: A Guide for Managers. U.S.D.A. For. Ser. PNW-GTR-641.

Tyler, K.J. 2006. Biological Crusts: Analysis of Monitoring Techniques at the Yakima Training Center, Washington. M.S. Thesis Central Washington University, Ellensberg, WA. 117p.

Description Author: Rex Crawford, Marion Reid.

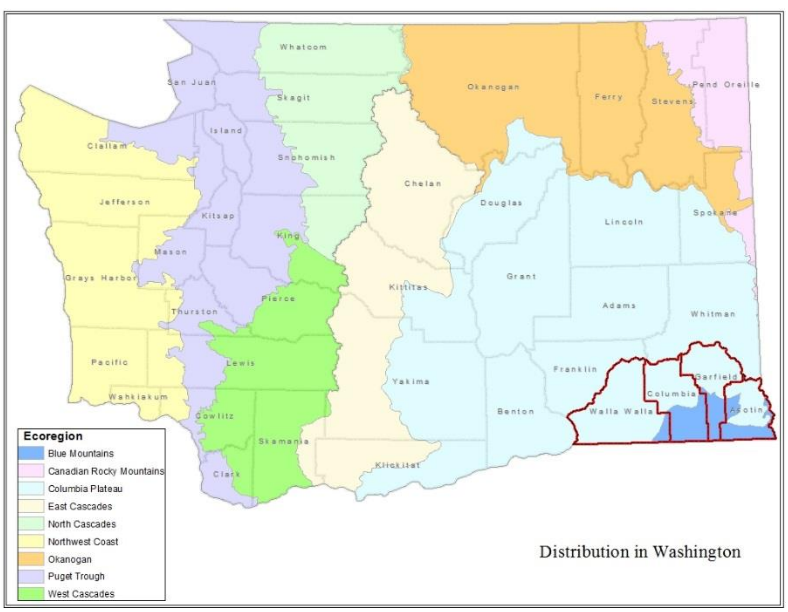
UPLAND SHRUBLANDS

INTER-MOUNTAIN BASINS CURL-LEAF MOUNTAIN-MAHOGANY WOODLAND AND SHRUBLAND

Concept: Woodlands and shrublands dominated by *Cercocarpus ledifolius*. *Artemisia tridentata* ssp. *vaseyana*, *Purshia tridentata*, with species of *Arctostaphylos*, *Ribes*, or *Symphoricarpos* are often present. Within Washington, this system is limited to the extreme southeast corner of the state within the foothills of the Blue Mountains.

Conservation Status: Critically Imperiled (S1). This system has a very restricted range in Washington.

Distribution: This ecological system occurs in hills and mountain ranges of the Intermountain West basins from the eastern foothills of the Sierra Nevada northeast to the foothills of the Bighorn Mountains. Within Washington, it occurs in the extreme southeast corner of the state within the foothills of the Blue Mountains.



Environment: This system typically occurs from 600 m to over 2650 m in elevation on rocky outcrops or escarpments and forms small- to large-patch stands in forested areas. Most stands occur as shrublands on ridges and steep rimrock slopes, but they may be composed of small trees in steppe areas. In Washington, it occurs on dry slopes in the foothills to mid-elevation areas of the Blue Mountains.

Vegetation: This system includes both woodlands and shrublands dominated by *Cercocarpus ledifolius*. *Artemisia tridentata* ssp. *vaseyana*, *Purshia tridentata*, with species of *Arctostaphylos, Ribes*, or *Symphoricarpos* are often present. Scattered junipers or pines may also occur. Undergrowth is often very sparse and dominated by bunchgrasses, usually *Pseudoroegneria spicata* and *Festuca idahoensis*.

USNVC Associated Types: The equivalent USNVC Group is “G249 Intermountain Basins Curl-leaf Mountain-mahogany Scrub & Woodland”. Additional inventory is needed to identify which USNVC plant associations occur in Washington.

Ecological Processes: *Cercocarpus ledifolius* is a slow-growing, drought-tolerant species that generally does not resprout after burning and needs the protection from fire that rocky sites provide.

Threats: Frequent fire could eliminate the system from the landscape.

Classification Comments: No other system is dominated by *Cercocarpus ledifolius*.

Related Concepts: This ecological system falls within the Western Juniper and Mountain Mahogany Woodlands habitat type as identified in Johnson and O’Neil (2001). .

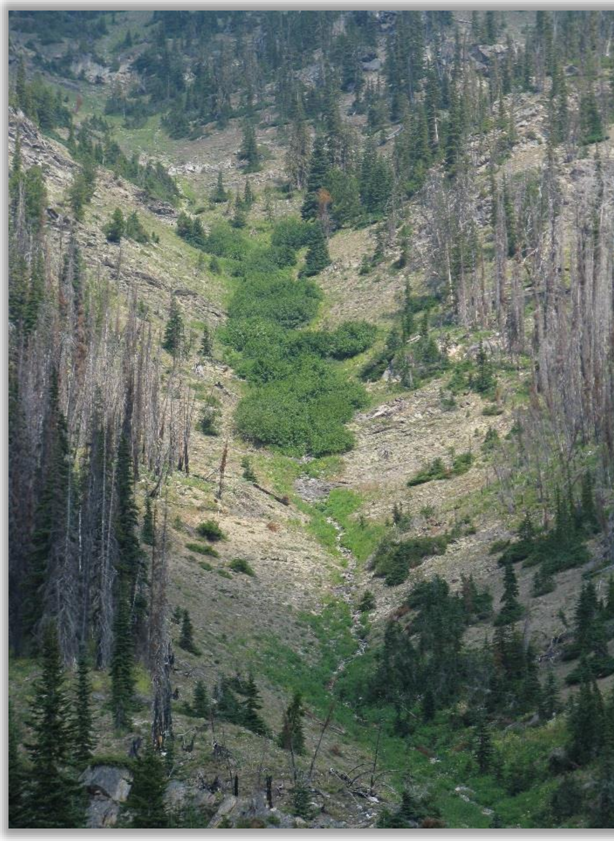
References

Johnson, D.H. and T.A. O’Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Description Author: Marion Reid and Gwen Kittel.

NORTH PACIFIC AVALANCHE CHUTE SHRUBLAND



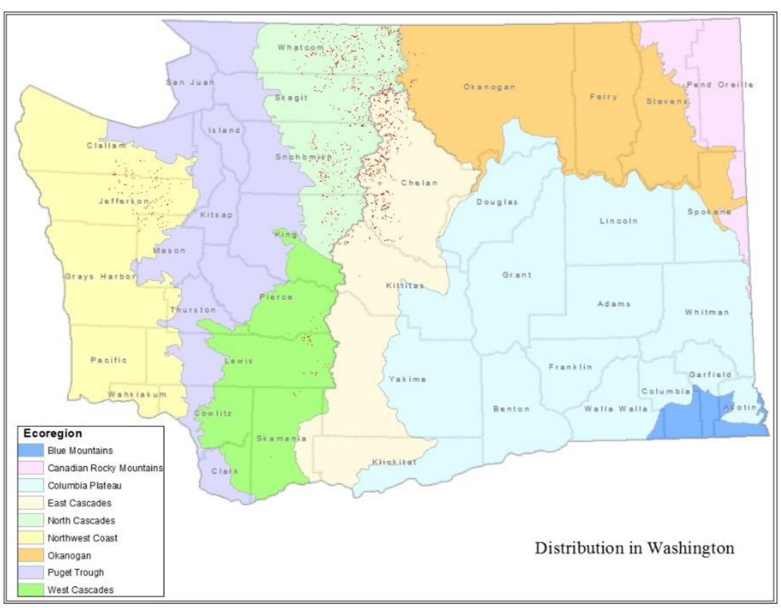
Concept: Tall shrublands occurring on mountain sideslopes or colluvium in the Cascades and Olympic Mountains but is most common in the North Cascades region.

Conservation Status: Apparently Secure (S4).

Distribution: This is a large patch system which occurs throughout mountainous regions of the Pacific Northwest, from the southern Cascades and Coast Ranges north to south-central Alaska.

Environment: These shrublands occur on sites ranging from moderately xeric to wet and occur within snow avalanche chutes at montane elevations. Avalanche chutes can be quite long, extending from the subalpine into the montane and foothill zones. In the mountains, talus sites and snow avalanche chutes often spatially coincide. In the North Cascades, avalanches often occur in "sheets" along steep slopes as opposed to being restricted to a geomorphically defined "chute"

Vegetation: On the west side of the Cascades, the major dominant species are *Acer circinatum, Alnus viridis ssp. sinuata, Rubus parviflorus*, and small trees, especially *Chamaecyparis nootkatensis*. Forbs, grasses, or other shrubs can also be locally dominant. *Prunus virginiana, Amelanchier alnifolia, Vaccinium membranaceum* or *Vaccinium scoparium*, and *Fragaria* spp. are common species on drier avalanche tracks on the east side of the Cascades.



USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system:

G322 Vancouverian Wet Shrubland Group	Global/ State Rank	NatureServe/ WNHP Code
Alnus viridis ssp. sinuata / Acer circinatum Shrubland	G4G5/S4S5	CEGL001155
Alnus viridis ssp. sinuata / Mesic Forbs Shrubland	G3G4/S3S4	CEGL002633
Alnus viridis ssp. sinuata / Oplopanax horridus Shrubland	G4G5/S4	CEGL001157
Alnus viridis ssp. sinuata Shrubland [Placeholder]	GNRQ/S4S5	CEGL001154
Chamaecyparis nootkatensis / Oplopanax horridus Forest	G3/S3?	CEGL000349

Ecological Processes: Periodic avalanches maintain shrublands in these environments.

Threats: Due to the very steep environment of this system, human activity is limited within this ecological system.

Classification Comments: This system differs from the closely related Northern Rocky Mountain Avalanche Chute Shrubland due to occurring in a more maritime climate than the latter. This climatic difference results in more Vancouverian species occurring in this system. Avalanche slopes in the Cascades and mountains of southern British Columbia are probably drier than those found further north in Alaska, where precipitation regime does not have a seasonal, dry component to it. Hence, these have been split into two different systems. Exactly where they transition from one to another is yet to be determine.

Related Concepts: This ecological system falls within Westside Riparian-Wetlands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the Northern Rocky Mountain Avalanche Chute Shrubland as one of their standard mapping units.

References

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Description Author: Keith Boggs, Gwen Kittel, and Chris Chappell.

UPLAND SHRUBLANDS

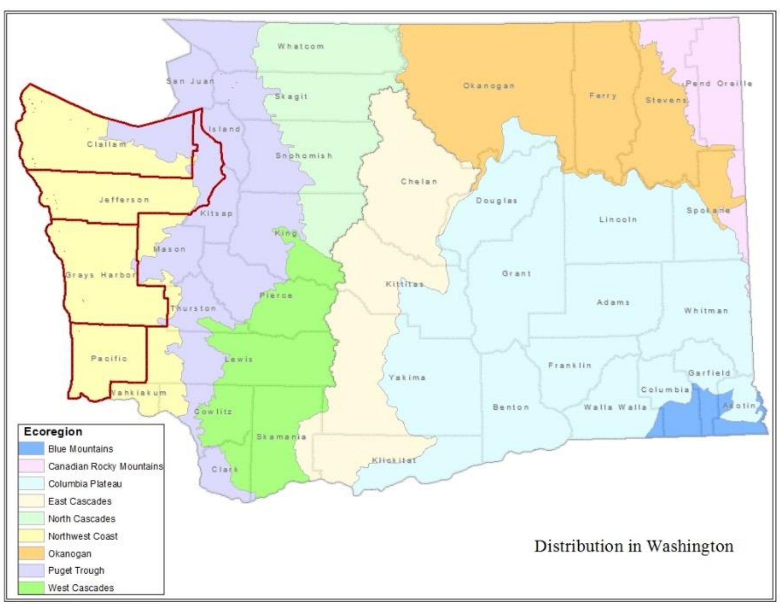
NORTH PACIFIC HYPERMARITIME SHRUB AND HERBACEOUS HEADLAND

Concept: Herbaceous- and shrub-dominated areas directly adjacent to the outer Pacific Coast, typically with persistent salt spray and high winds. The system typically occurs on steep slopes associated with coastal bluffs, headlands, or small islands, though sometimes it occurs on relatively level tops of headlands or islands.

Conservation Status: Vulnerable (S3S4).

Distribution: This system occurs directly adjacent to the outer Pacific Coast in areas exposed to persistent salt spray and high winds. It is a small patch system associated with coastal temperate rain forests along the outer Pacific Coast from central Oregon north to Vancouver Island. Within Washington, this system is found along outer coastal areas in the counties outlined in red on the map.

Environment: The system typically occurs on steep slopes associated with coastal bluffs, headlands, or small islands, though sometimes it occurs on relatively level tops of headlands or islands. Soils can be shallow and of bedrock or of glacial or marine sediment origin. Climate is under the dominant influence of the Pacific Ocean (hypermaritime continentality *sensu* Klinka et al. 1989) and is very wet, relatively warm in winter where snow is rare, and cool and foggy. There are no prolonged dry periods although summers are drier than winter. Seasonal conditions are milder and less extreme than continental climates at similar latitudes.



Vegetation: Vegetation is dominated by perennial bunch grasses and/or shrubs. Shrubland areas are dominated by evergreen shrubs *Gaultheria shallon* and *Vaccinium ovatum*, and deciduous shrubs *Lonicera involucrata*, *Rubus spectabilis*, *Rubus parviflorus*, *Vaccinium alaskaense*, *Vaccinium ovalifolium* or the dwarf shrub, *Empetrum nigrum*. Scattered stunted trees, especially *Picea sitchensis* but occasionally *Tsuga heterophylla*, *Pseudotsuga menziesii*, or *Alnus rubra* are often present. Native dominant grasses are *Festuca rubra* or *Calamagrostis nutkaensis*. *Elymus glaucus*, *Danthonia californica*, and *Bromus sitchensis* can also be important. A diversity of forbs occurs, with some of the most prominent being *Solidago canadensis*, *Lomatium martindalei*, *Vicia gigantea*, *Equisetum telmateia*, and *Artemisia suksdorfii*. Fern such as *Pteridium aquilinum* or *Blechnum spicant* can be common. Relative prevalence of grasslands versus shrublands increases to the south into Oregon.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system:

G554 North Pacific Coastal Scrub & Herb Cliff & Bluff Group	Global/ State Rank	NatureServe/ WNHP Code
Calamagrostis nutkaensis - Elymus glaucus Herbaceous Vegetation	G2/S2	CEGL001564
Calamagrostis nutkaensis / Baccharis pilularis Herbaceous Vegetation	G2/SNR	CEGL003377
Festuca rubra Coastal Headland Herbaceous Vegetation	G2/S1	CEGL001567
Gaultheria shallon - Vaccinium ovatum / Pteridium aquilinum Shrubland	G3/S2S3	CEGL000972

Ecological Processes: Along with slope failures, wind and salt spray combine to limit tree growth and are dominant ecological processes on these sites.

Threats: Road construction or timber harvesting can accelerate slope movements. Building and associated development can introduce exotic species and alter drainage and slope stability. Large patch grasslands within this system can be grazed by livestock that can result in decreasing importance of native grasses, especially bunchgrasses, and increasing importance of exotic species. Sweet vernalgrass (*Anthoxanthum odoratum*), common velvetgrass (*Holcus lanatus*), and orchardgrass (*Dactylis glomerata*) are major exotic grass species that dominate significant areas. Gorse (*Ulex europaeus*) is also found in this system. Recreational impacts such as tramping and trail proliferation can be local sources of stress.

Classification Comments: This system occurs directly along the coast and differs from the closely related North Pacific Herbaceous Bald and Bluff system by having a distinct flora resulting from persistent salt spray and high winds in a hypermaritime climate. Balds and bluffs adjacent to ocean waters in the San Juan Islands are included North Pacific Herbaceous Bald and Bluff system due to them having less exposure to persistent salt spray and high winds.

Related Concepts: This ecological system falls within the Coastal Headlands and Islets habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize the North Pacific Hypermaritime Shrub and Herbaceous Headland as a unique mapping unit and did not aggregate it into another mapping unit.

References

Alverson, E. 2009. Vascular Plants of the Prairies and associated habitats of the Willamette Valley-Puget Trough-Georgia Basin ecoregion. Excel Spreadsheet which includes fidelity values. The Nature Conservancy, Eugene, Oregon.

Chappell, C. 2000. Herbaceous Balds and Bluffs. Appendix 11 Willamette Valley – Puget Trough – Georgia Basin Ecoregion Terrestrial Ecological System EO Specs and EO Rank Specs. *In* Floberg, J., M. Goering, G. Wilhere, C. MacDonald, C. Chappell, C. Rumsey, Z. Ferdana, A. Holt, P. Skidmore, T. Horsman, E. Alverson, C. Tanner, M. Bryer, P. Iachetti, A. Harcombe, B. McDonald, T. Cook, M. Summers, D. Rolph.

2004. Willamette Valley-Puget Trough-Georgia Basin Ecoregional Assessment, Volume One: Report. Prepared by The Nature Conservancy with support from the Nature Conservancy of Canada, Washington Department of Fish and Wildlife, Washington Department of Natural Resources (Natural Heritage and Nearshore Habitat programs), Oregon State Natural Heritage Information Center and the British Columbia Conservation Data Centre.

Chappell, C.B. 2006. Plant Associations of Balds and Bluffs of western Washington. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. Online: http://www1.dnr.wa.gov/nhp/refdesk/communities/index.html

Crawford, R. C., C. B. Chappell, C. C. Thompson, and F. J. Rocchio. 2009. Vegetation Classification of Mount Rainier, North Cascades, and Olympic National Parks. Natural Resource Technical Report NPS/NCCN/NRTR—2009/D-586. National Park Service, Fort Collins, Colorado.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

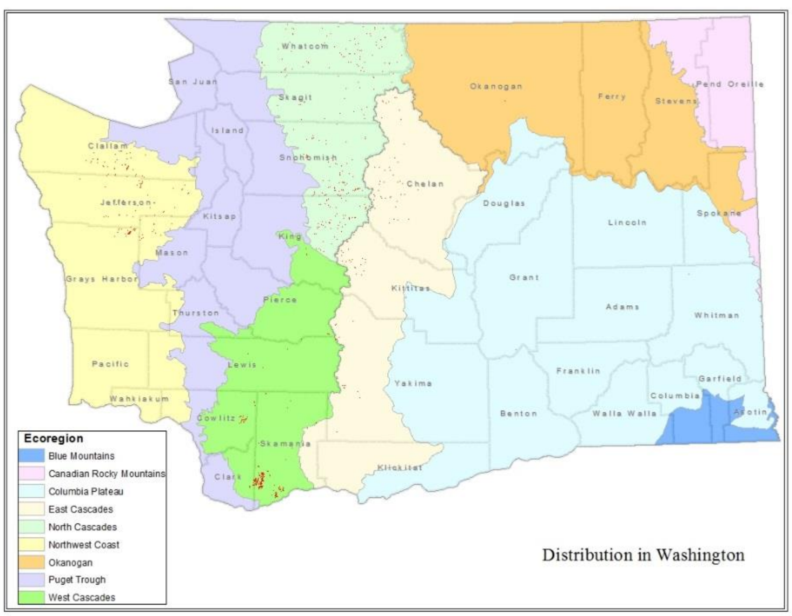
Description Author: Rex Crawford, Chris Chappell, Keith Boggs, and Marion Reid.

NORTH PACIFIC MONTANE SHRUBLAND

Concept: Long-lived, typically deciduous, broadleaf, seral shrublands that persist for several decades or more after major wildfires, or smaller patches of shrubs that periodically burn on dry sites that are marginal for tree growth. Species composition is highly variable; however, some of the most common species include *Acer circinatum, Acer glabrum, Holodiscus discolor, Sorbus* spp., *Rubus parviflorus* and *Vaccinium membranaceum.* This system can also be dominated by evergreen shrubs *Arctostaphylos nevadensis,* and *Ceanothus velutinus.*

Conservation Status: Vulnerable (S3S4). Other than factors influencing berry production, no inventory of ecological condition of shrubfields has been conducted. Decline is mostly cited in more anthropogenic huckleberry fields due to forest invasion. Very little is known about other (i.e., non-huckleberry) mid-montane shrublands.

Distribution: This ecological system occurs on upland sites within the zone of continuous forest (not associated with avalanche chutes and sheets) at montane into subalpine elevations below subalpine parklands. In Washington, they occur in the Cascades and Olympic Mountains and into adjacent western Oregon and north into British Columbia. These shrublands or shrubfields are typically seral to coniferous forest and their persistence depends on periodic fires or other periodic disturbance that limits tree growth. It is less common to absent on the windward sides of the coastal mountains where fires are rare due to very wet climates.



UPLAND SHRUBLANDS

Environment: This system consists of long-lived, typically deciduous, broadleaf, seral shrublands that persist for several decades or more after major wildfires, or smaller patches of shrubs that periodically burn on dry sites that are marginal for tree growth. The system can occur in small to large patches on ridgetops and upper to lower mountain slopes, especially on sunny southern aspects. Elevation ranges from about 152 m (500 feet) up to the lower limits of subalpine parkland.

Vegetation: These shrublands appear as large and small patches surrounded by conifer trees but lack significant tall tree cover within them. Shrublands vary in height from less than 3 feet (1m) in higher, drier environments to over 10 ft. (3m) in mild moist areas and often are vigorous sprouting species. These shrublands are composed mostly of deciduous broadleaf shrubs and sometimes contain a mix of shrub-statured trees or sparse cover of conifer trees. Species composition is highly variable; however, some of the most common species include *Acer circinatum, Acer glabrum, Holodiscus discolor, Sorbus* spp., *Rubus parviflorus* and *Vaccinium membranaceum.* This system can also be dominated by evergreen shrubs *Arctostaphylos nevadensis,* and *Ceanothus velutinus.* Herbaceous cover is often low as well as litter accumulation (Smith and Fisher 1997). The evergreen, woody-based "forb" *Xerophyllum tenax* can be dominant in some areas often with *Vaccinium membranaceum*. Important forbs include *Chamerion angustifolium, Heracleum maximum* and *Pteridium aquilinum*.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system:

G305 Central Rocky Mountain High Montane Mesic Shrubland Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Rubus parviflorus / Chamerion angustifolium - Heracleum maximum Shrubland	G4/S4	CEGL001127
Vaccinium membranaceum / Xerophyllum tenax Shrubland	G3?/SNR	CEGL005891

Ecological Processes: The shrubfields occur on all aspects and soils although they are more prevalent on south and west-facing slopes that have periodically burned (Smith and Fisher 1997). They are generally associated with well-drained sites. Soils tend to be moist to wet and can be too rocky to support forest cover. These shrublands are maintained by recurring disturbances, including fire and downslope movement of soil, water, snow and rock. *Vaccinium membranaceum* is an important member of this ecological systems as it is an important cultural resource for native peoples. Fire was used by native people to expand or rejuvenate shrubfields for berries and/or beargrass (Richards and Alexander 2006, Boyd 1999, Fisher 1996) so shrubfields are sometimes anthropogenic in extent.

Threats: Maintenance and expansion of seral shrubfields have been reduced due to fire exclusion and fuel management may have reduced their reburning (Wellner 1970). In response to fire suppression, trees may invade these shrublands. With heavy livestock grazing, shrubs are browsed, broken, and trampled, which eventually creates a more open shrubland with a more abundant herbaceous layer. Fisher (1996) states that some berry gathering areas were historically cleared and farmed by Euro- Americans, or grazed, especially by sheep. Minore (1979) concluded that sheep grazing did not damage huckleberry production in a controlled experiment. Invasive species are generally not as problematic at higher elevations and in closed forests as lower elevation disturbed forests and riparian areas. There is some concern about invasive species threatening subalpine and alpine environments (Parks *et al.* 2005).

Classification Comments: This system is characterized by dry site shrublands that are supported by periodic fire and xeric soil conditions which preclude the establishment of trees. This system is floristically similar to North Pacific Avalanche Chute Shrubland, but the avalanche chutes originate from very different processes. Avalanche sheets that cover wide swaths of slopes are difficult to distinguish from, and often overlap with, this ecological system. Avalanche shrublands tend to be more diverse within stands, and are often wetter, being driven ecologically by snow-loading and concomitant snowmelt. Seral shrubfields of comparable composition that will develop into a forest (i.e., stand development stage with trees (over 10% cover within 50 years)) are excluded from this ecological system and are included in their appropriate forest system. This system overlaps with the Northern Rocky Mountain Subalpine Deciduous Shrubland System at higher elevations in the Cascades and is distinguished at lower elevation by species more associated with North Pacific flora such as *Acer circinatum*, *Gaultheria shallon* and *Vaccinium ovatum.* This system occurs below subalpine parklands and lacks heathers (*Cassiope* and *Phyllodoce*) and associated species. Small shrub patches below approximately 500 feet elevation maybe included within North Pacific Herbaceous Bald and Bluff or North Pacific Hypermaritime Shrub and Herbaceous Headland systems.

Related Concepts: This ecological system falls within Montane Mixed Conifer Forest and Westside Lowland Conifer-Hardwood Forest habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the North Pacific Montane Shrubland as one of their standard mapping units.

References

Boyd, R., ed. 1999. Indians. Fire, and the Land in the Pacific Northwest. Corvallis: Oregon State University Press.

Fisher, Andrew H. 1996. The 1932 Handshake Agreement: Cultural persistence and Accommodation in the Pacific Northwest. Arizona State University.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

LANDFIRE. 2007. North Pacific Shrubland. BPS 0110840. IN: Landfire Biophysical Setting Descriptions. http://www.landfire.gov/NationalProductDescriptions20.php

Minore, D., Smart, A. W. and Dubrasich, M. B. 1979. Huckleberry and ecology management research in the Pacific Northwest. Gen. Tech. Rep. PNW-GTR-093. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 60 p.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Parks, C.G., S.R. Radosevich, B. A. Endress, B. J. Naylor, D. Anzinger, L.J. Rew, B.D. Maxwell, and K.A. Dwire. 2005. Natural and land-use history of the Northwest mountain ecoregions (USA) in relation to patterns of plant invasions. Perspectives in Plant Ecology, Evolution and Systematics 7 (2005) 137-158.

Richards, R. T. and Alexander, S. J. 2006. A social history of wild huckleberry harvesting in the Pacific Northwest. Gen. Tech. Rep. PNWGTR- 657. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 113 p.

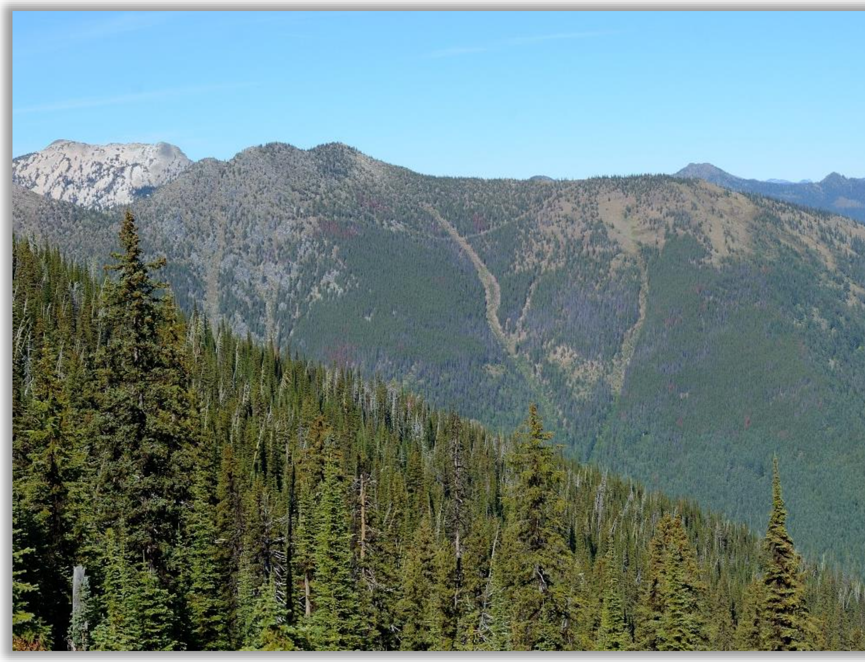
Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Smith, J. and Fisher, R. 1997. Fire Ecology of the Forest Habitat Types of Northern Idaho. USDA Forest Service General Technical Report INT-GTR-363, 142 p.

Wellner, Charles A. 1970. Fire history in the Northern Rocky Mountains. In: Symposium, the role of fire in the Intermountain West. October 27-29; Missoula, MT. Missoula, MT: University of Montana, School of Forestry: 42-64.

Description Author: Rex Crawford, Chris Chappell, Gwen Kittel, and Marion Reid.

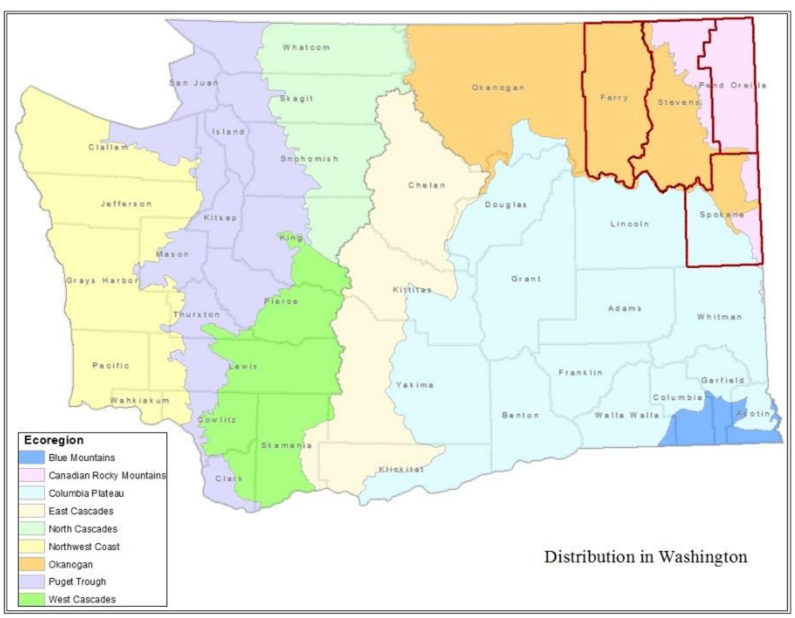
NORTHERN ROCKY MOUNTAIN AVALANCHE CHUTE SHRUBLAND



Concept: Moderately dense, shrublands characterized diverse mix of deciduous shrubs or trees, and conifers found on steep, frequently disturbed slopes in the mountains. Characteristic species include *Abies lasiocarpa*, *Acer glabrum*, *Alnus viridis ssp. sinuata* or *Alnus incana*, *Populus balsamifera ssp. trichocarpa*, *Populus tremuloides*, or *Cornus sericea*. Other common woody plants include *Paxistima myrsinites*, *Sorbus scopulina*, and *Sorbus sitchensis*. This system occurs in mountains of northeast Washington where considerable snow pack is accumulated.

Conservation Status: Critically Imperiled (S1). This is a very rare type in Washington.

Distribution: These small patch shrublands occurs throughout the Northern Rocky Mountains, from Wyoming north and west into British Columbia and Alberta. In Washington they are found in avalanche tracks in isolated peaks in higher mountain ranges from the Salmo-Priest Wilderness in Pend Oreille County south to Mt Spokane and east in Kettle Range.



Environment: These shrublands are found on steep (ranging from 15-60%), frequently disturbed slopes in the mountains, specifically the lower portions and runout zones of avalanche tracks. Aspects vary, but are more common where unstable or heavy snowpack conditions frequently occur. Sites are often mesic to wet because avalanche paths are often in stream gullies, and snow deposition can be heavy in the run-out zones.

Vegetation: This system consists of a moderately dense, shrublands characterized by dwarfed and damaged conifers and deciduous shrubs. Characteristic species include *Abies lasiocarpa, Acer glabrum, Alnus viridis ssp. sinuata* or *Alnus incana, Populus balsamifera ssp. trichocarpa, Populus tremuloides*, or *Cornus sericea*. Other common woody plants include *Paxistima myrsinites, Sorbus scopulina*, and *Sorbus sitchensis*. The moderately dense to dense ground cover is forb-rich with such species as *Senecio triangularis, Castilleja* spp., *Athyrium filix-femina, Thalictrum occidentale, Urtica dioica, Erythronium grandiflorum, Myosotis asiatica (= Myosotis alpestris), Veratrum viride, Heracleum maximum (= Heracleum lanatum)*, and *Xerophyllum tenax*. Mosses and ferns are often present.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Groups and Associations that are associated with this ecological system:

G506 Rocky Mountain & Great Basin Montane Riparian Forest	**Global/ State Rank**	**NatureServe/ WNHP Code**
Populus tremuloides / Cornus sericea Forest	G4/S1S2	CEGL000582
G527 Western Montane-Subalpine Riparian & Seep Shrubland	**Global/ State Rank**	**NatureServe/ WNHP Code**
Alnus viridis ssp. sinuata / Athyrium filix-femina - Cinna latifolia Shrubland	G4/S3	CEGL001156
Alnus viridis ssp. sinuata / Mesic Forbs Shrubland	G3G4/S3S4	CEGL002633

Ecological Processes: Periodic avalanches maintain shrublands in these environments.

Threats: Due to the very steep environment of this system, human activity is limited within this ecological system. However, nearby populations of non-native species could become established in this system, thus limiting activities which could allow for non-native species establishment in adjacent areas would help minimize this potential.

Classification Comments: This system is found on steep slopes where avalanches periodically occur resulting in distinct vegetation from the surrounding landscape. This system differs from the closely related North Pacific Avalanche Chute Shrubland due to occurring in a more continental climate and consequently supporting a more characteristic of Rocky Mountain flora.

Related Concepts: This ecological system best fits into the Eastside (Interior) Riparian Wetlands habitat type in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the Northern Rocky Mountain Avalanche Chute Shrubland as one of their standard mapping units.

References

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

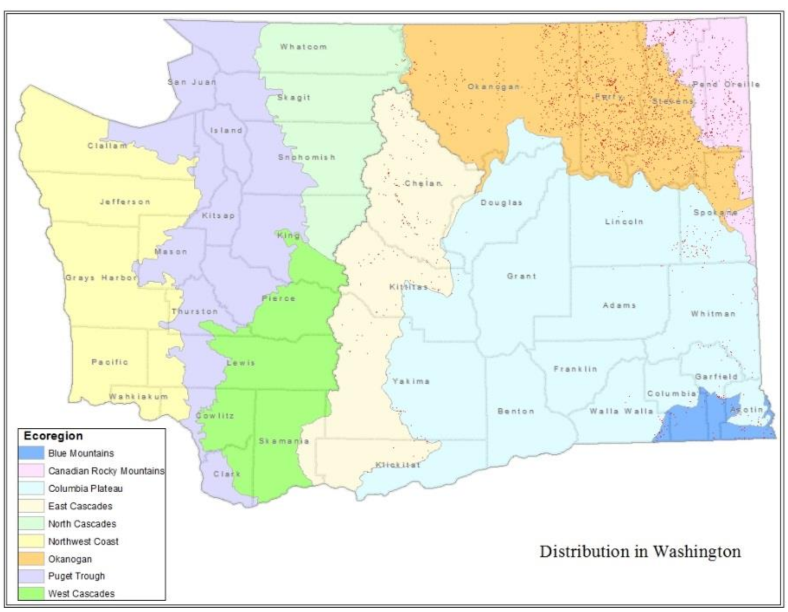
Description Author: Rex Crawford and NatureServe Western Ecology Team.

NORTHERN ROCKY MOUNTAIN MONTANE-FOOTHILL DECIDUOUS SHRUBLAND

Concept: Deciduous shrublands which occur in the lower montane and foothill regions around the Columbia Basin. *Physocarpus malvaceus*, *Prunus emarginata*, *Prunus virginiana*, *Rosa* spp., *Rhus glabra*, *Acer glabrum*, *Amelanchier alnifolia*, *Symphoricarpos albus*, *Symphoricarpos oreophilus*, and *Holodiscus discolor* are the most common dominant shrubs, occurring alone or in any combination. The shrublands develop near talus slopes as garlands, at the heads of dry drainages, and toe slopes in the moist shrub-steppe and steppe zones.

Conservation Status: Apparently Secure (S4?). This system is widespread but limited to relatively small patches around the Columbia Basin. Many examples are not in good ecological condition due to effects from livestock grazing and nonnative species.

Distribution: This small to large patch ecological system is found in the lower montane and foothill regions around the Columbia Basin and into the Northern Rocky Mountains. These shrublands typically occur at and below lower treeline, within the matrix of surrounding low-elevation grasslands and sagebrush steppe. They also occur in the ponderosa pine and Douglas-fir zones, but rarely up into the subalpine zone (on dry sites).



Environment: These shrublands are usually found on steep slopes of canyons and in areas with some soil development, either loess deposits or volcanic clays and they occur on all aspects. This system develops near talus slopes as garlands, at the heads of dry drainages, and toe slopes in the moist shrub-steppe and steppe zones.

Vegetation: *Physocarpus malvaceus*, *Prunus emarginata*, *Prunus virginiana*, *Rosa* spp., *Rhus glabra*, *Acer glabrum*, *Amelanchier alnifolia*, *Symphoricarpos albus*, *Symphoricarpos oreophilus*, and *Holodiscus discolor* are the most common dominant shrubs, occurring alone or in any combination. *Rubus parviflorus*, *Ceanothus velutinus* and *Artemisia tridentata* var. *vaseyana* can be important shrubs, especially in montane occurrences. *Crataegus douglasii* may be common in lowland moist areas. *Festuca idahoensis*, *Festuca campestris*, *Calamagrostis rubescens*, *Carex geyeri*, *Koeleria macrantha*, *Pseudoroegneria spicata*, and *Poa secunda* are the most important grasses. *Achnatherum thurberianum* and *Leymus cinereus* can be locally important. *Poa pratensis* and *Phleum pratense* are common introduced perennial grasses. *Geum triflorum*, *Potentilla gracilis*, *Lomatium triternatum*, *Balsamorhiza sagittata*, and species of *Eriogonum*, *Phlox*, and *Erigeron* are important forbs. Shrubs *Shepherdia canadensis*, *Spiraea betulifolia* and *Vaccinium membranaceum,* can be abundant in some cases. These three shrub species also occur in the Northern Rocky Mountain Subalpine Deciduous Shrubland system in which *Vaccinium membranaceum* is a dominant indicator.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Groups and Associations that are associated with this ecological system:

G141 Northern Great Plains Mixedgrass Prairie Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Prunus virginiana - (Prunus americana) Shrubland	G4Q/S2?	CEGL001108
G272 Central Rocky Mountain Montane-Foothill Deciduous Shrubland Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Amelanchier alnifolia / Xerophyllum tenax Herbaceous Vegetation	GNRQ/SNR	CEGL001066
Celtis laevigata var. reticulata / Pseudoroegneria spicata Woodland	G2G3/S1	CEGL001085
Physocarpus malvaceus - Symphoricarpos albus Shrubland	G3/SNA	CEGL001171
Rhus glabra / Aristida purpurea var. longiseta Shrub Herbaceous Vegetation	G1/S1	CEGL001507
Rhus glabra / Pseudoroegneria spicata Shrub Herbaceous Vegetation	G2/S1	CEGL001122
Symphoricarpos albus - Rosa nutkana Shrubland	G3/S1	CEGL001130
G282 Western North American Montane Sclerophyll Scrub	**Global/ State Rank**	**NatureServe/ WNHP Code**
Ceanothus velutinus Shrubland	GNR/S3S5Q	CEGL002167

Ecological Processes: Fire is an important disturbance in this system. Most dominant species resprout after fire or regenerate from the buried seed and quickly re-establish (Williams et al. 1995). Although the precise fire frequency is unknown, fire return intervals in adjacent bunchgrass and woodlands likely defines shrub patches. LANDFIRE (2007) modeled the system as occurring with fire regime II. Defoliating insects, ungulate browsing, slope movement, and erosion are other disturbance factors. Soil creep on these steep slopes makes rapid slope movements possible, especially after fire.

Threats: The primary land uses that alter the natural processes of this system are associated with fire regime alteration, livestock practices, exotic species invasion, timber harvesting, and fragmentation. In response to fire suppression, shrub thickets on northerly aspects near and above lower treeline tend to increase in patch size and height and are invaded by tree species. Fire suppression increases tree (*Pinus ponderosa* or *Pseudotsuga menziesii*) invasion by allowing smaller trees that would be killed in fire to survive. Due to steepness of terrain, grazing effects are usually concentrated in less steep slopes although grazing does create contour trail networks that can lead to slope failures. With heavy livestock grazing, shrubs are browsed, broken, and trampled, which eventually creates a more open shrubland with a more abundant herbaceous layer often with invasive species. Invasive perennial exotics such as *Centaurea solstitialis*, *Hypericum perfoliatum*, *Poa pratensis*, and *Prunus cerasifera* are major stressors.

Classification Comments: These are shrub fields within lower montane forests (primarily associated with the Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest system) are maintained by factors that inhibit or slow tree invasion: fire intensity or increased frequency or site drought. Seral shrub fields with trees that could develop into a seral forest stage (within 50 years) are excluded from this shrub system and are included in an appropriate forest system. Shrublands dominated by *Vaccinium membranaceum* are included in the Northern Rocky Mountain Subalpine Deciduous Shrubland system. Shrub fields of comparable composition that typically develop into a seral stage with trees (within 50 years) are excluded from this system and are included in their appropriate forest system.

Related Concepts: This ecological system falls within Eastside (Interior) Canyon Shrublands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the Northern Rocky Mountain Montane-Foothill Deciduous Shrubland as one of their standard mapping units.

References

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

LANDFIRE. 2007. Northern Rocky Mountain Montane-Foothill Deciduous Shrubland. BPS:0111060. IN: Landfire Biophysical Setting Descriptions. http://www.landfire.gov/NationalProductDescriptions20.php

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Williams, C. K., B.F. Kelly, B.G. Smith and T.R. Lillybridge. 1995. Forested plant associations of the Colville National Forest. Gen. Tech. Rep. PNW-GTR-360. Portland, OR. U.S.D.A. PNW Res. Sta. 375 p.

Description Author: Rex Crawford, Jimmy Kagan, and Marion Reid.

UPLAND SHRUBLANDS

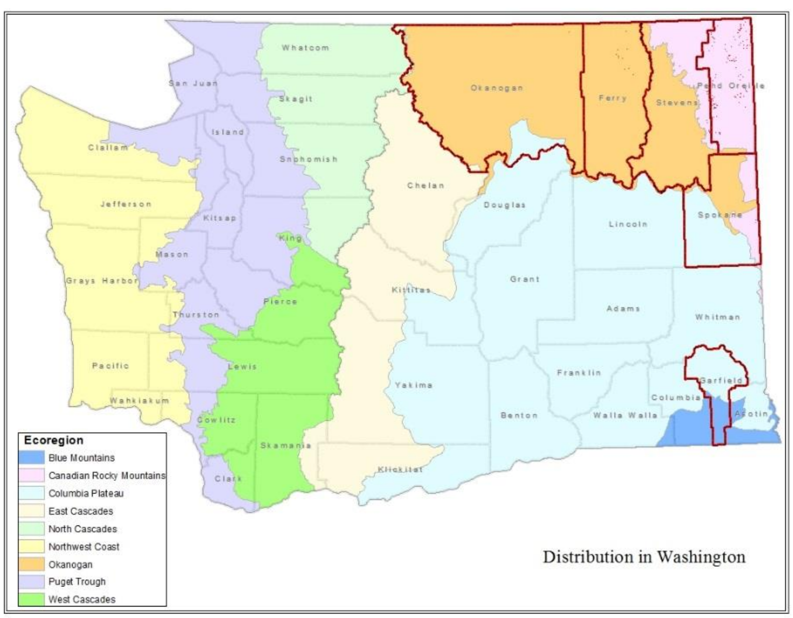
NORTHERN ROCKY MOUNTAIN SUBALPINE DECIDUOUS SHRUBLAND

Concept: Shrublands within the zone of continuous forest (not avalanche chutes) at upper montane into subalpine elevations in the Northern Rocky Mountains of northeastern Washington. These shrublands are typically seral to coniferous forest and their persistence depends on periodic fires. *Vaccinium membranaceum* is the most common member of this mixed deciduous shrubland vegetation.

Conservation Status: Apparently Secure (S4). This system is not common but there are few threats.

Distribution: This large and small patch ecological system occurs on upland sites within the zone of continuous forest (not avalanche chutes) at upper montane into subalpine elevations in the Northern Rocky Mountains of northeastern Washington, Idaho, western Montana, eastern Oregon and north into British Columbia’s Canadian Rockies.

Environment: The shrubfields occur on all aspects and soils although they are more prevalent on south and west-facing slopes that have periodically burned (Smith and Fisher 1997). They are generally associated with well-drained sites. Soils tend to be moist to wet.



Distribution in Washington

Vegetation: These shrublands appear as large and small patches surrounded by conifer trees but lacking significant tall tree cover within them. Shrublands vary in height from less than 1 foot (0.3m) higher, drier environments to over 10 ft. (3m) in mild moist areas. *Vaccinium membranaceum* is the most common member of this mixed deciduous shrubland vegetation. *Menziesia ferruginea*, *Rhamnus alnifolia*, *Ribes lacustre*, *Rubus parviflorus*, *Alnus viridis*, *Rhododendron albiflorum*, *Sorbus scopulina*, *Sorbus sitchensis*, *Vaccinium myrtillus*, and *Vaccinium scoparium* are the other common dominant shrubs that can occur alone or in various combinations. The evergreen shrub *Paxistima myrsinites* often occurs under dense tall shrubs. Other shrubs can include *Shepherdia canadensis* and *Ceanothus velutinus* which never occur as dominants in this system but occur more abundantly in the Northern Rocky Mountain Montane-Foothill Deciduous Shrubland ecological system. Herbaceous cover is often low as well as litter accumulation (Smith and Fisher 1997). The evergreen, woody-based "forb" *Xerophyllum tenax* can be dominant in some areas, often with *Vaccinium membranaceum*. Important forbs include *Chamerion angustifolium*, and *Pteridium aquilinum*, reflecting the mesic nature of many of these shrublands.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Association known to be associated with this ecological system. Additional inventory is needed to identify other USNVC plant associations that may occur in this ecological systems within Washington.

G305 Central Rocky Mountain High Montane Mesic Shrubland Group	Global/ State Rank	NatureServe/ WNHP Code
Vaccinium membranaceum / Xerophyllum tenax Shrubland	G3?/SNR	CEGL005891

Ecological Processes: This system is maintained by recurring disturbances, including fire and downslope movement of soil, water, snow and rock. Stands are typically initiated by fires and will persist on sites for long periods because of repeated burns and changes in the presence of volatile oils in the soil which impedes tree regeneration (LANDFIRE 2007). Fire frequencies in these shrubfields are relatively short intervals and are highly dependent on surrounding vegetation, but typically range from 50-75yrs (LANDFIRE 2007). Smith and Fisher (1997) note that reoccurring fires maintain these shrublands due to: 1) reducing conifer seed sources, 2) increasing soil temperature and soil drought, 3) increasing soil erosion, 3) reducing soil wood that limits nitrogen fixation, mycorrhizae inoculum, and microsites for tree establishment; and 4) potentially increasing soil pH. While fire impacts these shrubfields many can persist on sites for up to 500 years (Montana Field Guide 2010). By killing or weakening adjacent forests, insects and diseases often play an indirect but sometimes major role in the development or maintenance of these shrublands (Montana Field Guide 2010). Fire was used by native people to expand or rejuvenate shrubfields for berries and/or beargrass (Richards and Alexander 2006, Boyd 1999. Fisher 1996) so shrubfields are at least partially anthropogenic in extent.

Threats: Maintenance and expansion of seral shrubfields have been reduced due to fire exclusion and fuel management may have reduced their reburning (Wellner 1970). In response to fire suppression, trees may invade these shrublands. With heavy livestock grazing, shrubs are browsed, broken, and trampled, which eventually creates a more open shrubland with a more abundant herbaceous layer. Fisher (1996) states that some berry gathering areas were historically cleared and farmed by Euro- Americans, or grazed, especially by sheep. Minore (1979) concluded that sheep grazing did not damage huckleberry production in a controlled experiment. Invasive species are generally not as problematic at higher elevations and in closed forests as lower elevation disturbed forests and riparian areas. There is some concern about invasive species threatening subalpine and alpine environments (Parks *et al.* 2005).

Classification Comments: This system is floristically similar to Northern Rocky Mountain Avalanche Chute Shrubland, but the avalanche chutes originate from very different processes, tend to be more diverse within stands, and are wetter, being driven ecologically by snow-loading and subsequent snowmelt. Seral shrub fields of comparable composition that typically will develop into a seral stage with trees (over 10% tree cover within 50 years) are excluded from this shrub system and are included in their appropriate forest system.

Related Concepts: This ecological system does not explicitly fall within any habitat type as identified in Johnson and O'Neil (2001) and is included in multiple habitat types in that document. The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the Northern Rocky Mountain Montane-Foothill Deciduous Shrubland as one of their standard mapping units.

References

Boyd, R., ed. 1999. Indians, Fire, and the Land in the Pacific Northwest. Corvallis: Oregon State University Press.

Fisher, Andrew H. 1996. The 1932 Handshake Agreement: Cultural persistence and Accommodation in the Pacific Northwest. Arizona State University.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

LANDFIRE. 2007. Northern Rocky Mountain Subalpine Deciduous Shrubland. BPS 1011690. IN: Landfire Biophysical Setting Descriptions. http://www.landfire.gov/NationalProductDescriptions20.php

Minore, D., Smart, A. W. and Dubrasich, M. B. 1979. Huckleberry and ecology management research in the Pacific Northwest. Gen. Tech. Rep. PNW-GTR-093. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 60 p.

Montana Field Guide. 2010. Rocky Mountain Subalpine Deciduous Shrubland — Northern Rocky Mountain Subalpine Deciduous Shrubland. Retrieved on December 28, 2010. http://fieldguide.mt.gov/displayES_Detail.aspx?ES=5326

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Parks, C.G., S.R. Radosevich, B. A. Endress, B. J. Naylor, D. Anzinger, L.J. Rew, B.D. Maxwell, and K.A. Dwire. 2005. Natural and land-use history of the Northwest mountain ecoregions (USA) in relation to patterns of plant invasions. Perspectives in Plant Ecology, Evolution and Systematics 7 (2005) 137-158.

Richards, R. T. and Alexander, S. J. 2006. A social history of wild huckleberry harvesting in the Pacific Northwest. Gen. Tech. Rep. PNWGTR- 657. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 113 p.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Smith, J. and Fisher, R. 1997. Fire Ecology of the Forest Habitat Types of Northern Idaho. USDA Forest Service General Technical Report INT-GTR-363, 142 p.

Wellner, Charles A. 1970a. Fire history in the Northern Rocky Mountains. In: Symposium, the role of fire in the Intermountain West. October 27-29; Missoula, MT. Missoula, MT: University of Montana, School of Forestry: 42-64.

Description Author: Rex Crawford and Marion Reid.

COLUMBIA PLATEAU LOW SAGEBRUSH STEPPE

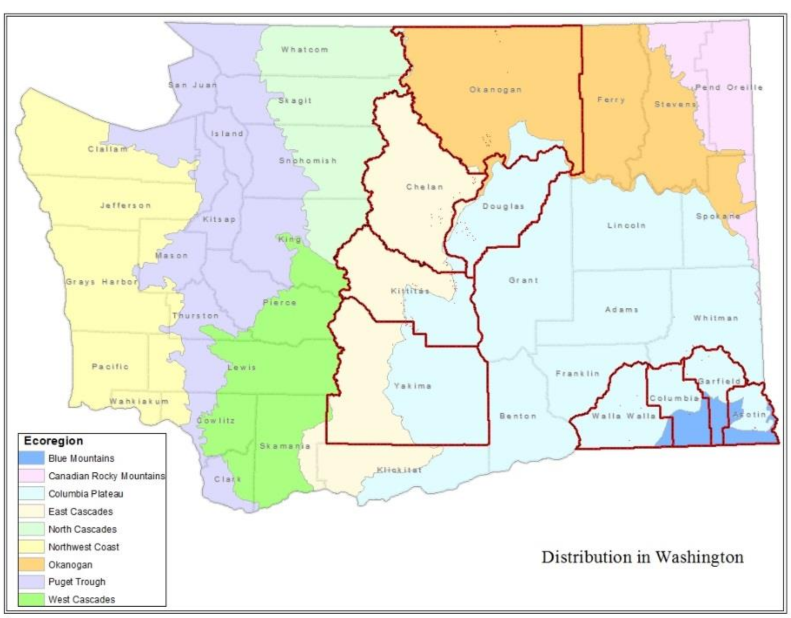
Concept: Dwarf sagebrush shrub-steppe dominated by *Artemisia arbuscula*. And typically found on mountain ridges and flanks and broad terraces.

Conservation Status: Critically Imperiled (S1S2). This is a rare type within Washington. Some occurrences are degraded from livestock grazing.

Distribution: This matrix or large patch ecological system occurs in a variety of shallow-soil habitats throughout eastern Oregon, northern Nevada, southern Idaho and eastern Washington. In Washington, it appears on isolated ridges near or above lower treeline in Chelan, Kittitas and Yakima counties.

Environment: In Washington, this system forms stands on mountain ridges and flanks and broad terraces, ranging from 3280-4500 feet (1000 to 1400 m) elevation surrounded by *Pseudotsuga menziesii* and *Pinus ponderosa* forests. Substrates are shallow, fine-textured soils, poorly drained clays and almost always very stony, characterized by recent rhyolite or basalt.

Vegetation: In Washington, this system is dominated by *Artemisia arbuscula*. Of the four subspecies of *A. arbuscula* only subspecies *arbuscula* is in Washington. *Artemisia rigida* and *Artemisia tridentata* ssp. *wyomingensis* or *vaseyana* can also be present with an understory of *Festuca idahoensis*, *Poa secunda*, *Pseudoroegneria spicata*, and *Koeleria macrantha*. Other shrubs and dwarf-shrubs present may include *Purshia tridentata* and *Eriogonum* spp. Many forbs also occur and may dominate the herbaceous vegetation, especially at the higher elevations. The space between vascular plants may support a biological crust that has low cover even without



Distribution in Washington

disturbance. Biological crust cover generally decreases with increasing disturbance of soil surface, vascular plant cover, elevation, loose surface rock, and coarseness of soil so that its presence and diversity indicate high integrity relative to anthropogenic disturbances. Johnson and Swanson (2005) indicate that bare ground even in least disturbed sites is 0-25% cover.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system:

G308 Intermountain Low & Black Sagebrush Shrubland & Steppe Group	Global/ State Rank	NatureServe/ WNHP Code
Artemisia arbuscula ssp. arbuscula / Festuca idahoensis Shrub Herbaceous Vegetation	G5/S1	CEGL001409
Artemisia arbuscula ssp. arbuscula / Pseudoroegneria spicata Shrub Herbaceous Vegetation	G5/S2	CEGL001412

Ecological Processes: Fire influences the density and distribution of shrubs. In general, fire increases the abundance of herbaceous perennials and decreases the abundance of woody plants. The fire interval for this system is 110 years (LANDFIRE 2007). Anecdotal observations indicate that these patches often are not burned during surrounding forest fires. Recovery of this system after fire may take 325–450 years (Baker 2006). Low sagebrush steppe in Washington can be confused remotely with the mountain sagebrush steppe and must be determined on-the-ground.

Threats: The primary land uses that alter the natural processes of this system are associated with livestock practices, annual exotic species invasion, fire regime alteration, direct soil surface disturbance, and fragmentation. *Artemisia arbuscula* is considered a valuable browse plant during the spring, fall, and winter months and often grazed by native ungulates (elk and mule deer) and domestic livestock. Domestic livestock grazing can result in decreased density of native bunchgrass species along with a concurrent increase in shrub density and cover of annual species. Repeated or intense disturbance, particularly on drier sites, leads to *Bromus tectorum* dominance and replacement of native bunchgrasses. Heavy use by livestock or vehicles can disrupt the moss/lichen layer and increase cover of bare ground increasing the potential for invasion by non-native plants as well as increased erosion. Fire suppression may also increase shrub density. The increased abundance of non-native species is displacing native bunchgrasses.

Classification Comments: *Artemisia arbuscula ssp. arbuscula* is the dominant sagebrush species.

Related Concepts: This ecological system falls within the Dwarf shrub-steppe habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e.

LANDFIRE) recognizes the Columbia Plateau Low Sagebrush Steppe as one of their standard mapping units.

References

Baker, W.L. 2006. Fire and Restoration of Sagebrush Ecosystems. Wildlife Soc. Bull. 34(1):177–185.

Belnap, J., J. Kaltenecker, R. Rosentreter, J. Williams, S. Leonard, and D. Eldridge. 2001. Biological Soil Crusts: Ecology and Management. Technical Report 1730-2, United States Department of the Interior. 110 pp.

Johnson, C.G. and D.K. Swanson. 2005 Bunchgrass Communities of the Blue and Ochoco Mountains: A Guide for Managers. U.S.D.A. For. Ser. PNW-GTR-641.

Eldridge, D. J. and R. Rosentreter 1999 Morphological groups: a framework for monitoring microphytic crusts in arid landscapes. Journal of Arid Environments, Volume 41(1):11-25.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Johnson, C.G. and D.K. Swanson. 2005. Bunchgrass Communities of the Blue and Ochoco Mountains: A Guide for Managers. U.S.D.A. For. Ser. PNW-GTR-641.

LANDFIRE. 2007. Biophysical Setting Model 0111240: Columbia Plateau Low Sagebrush Steppe.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

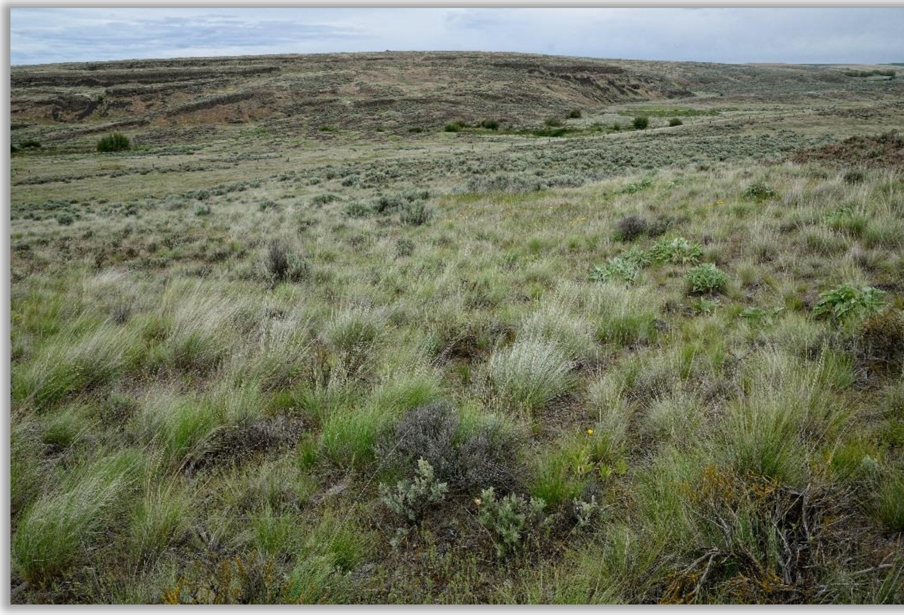
Pellant, M., P. Shaver, D.A. Pyke, and J.E. Herrick. 2005. Interpreting indicators of rangeland health, version 4. Technical Reference 1734-6. U.S. Department of the Interior, Bureau of Land Management, National Science and Technology Center, Denver, CO. BLM/WO/ST-00/001+1734/REV05. 122 pp.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Description Author: Rex Crawford and Jimmy Kagan.

SHRUB-STEPPE

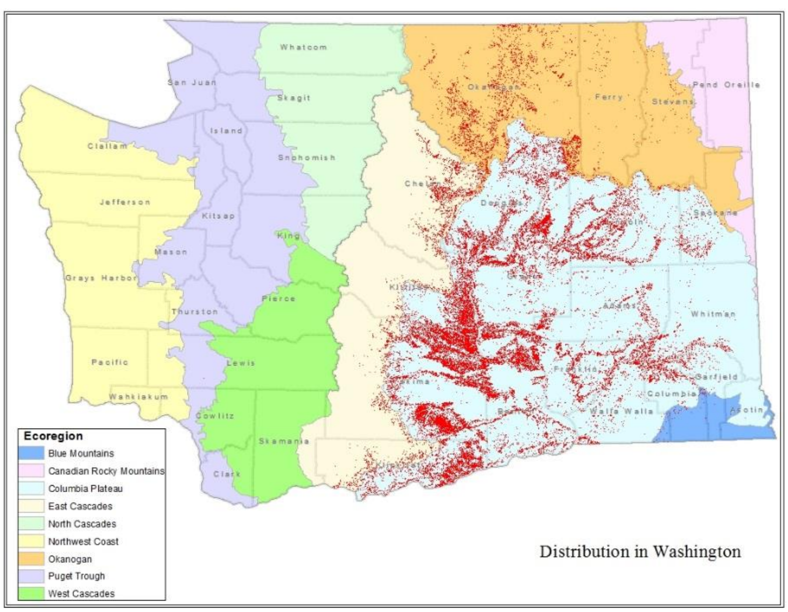
INTER-MOUNTAIN BASINS BIG SAGEBRUSH STEPPE



Concept: Shrub-steppe (grassland with shrubs) dominated by *Artemisia spp.*, and/or *Purshia tridentata* in an open to moderately dense (5-40% cover) shrub layer and with at least 25% total perennial herbaceous cover. The natural fire regime of this ecological system maintains a patchy distribution of shrubs, so the general aspect is that of grassland.

Conservation Status: Imperiled (S2). This system has a wide distribution but large areas are in poor to fair condition. Good to excellent condition areas are frequent in fescue dominated types along the northern Columbia Basin counties but rare in bluebunch wheatgrass and needlegrass types because of weed invasion. Conversion to agriculture is a serious threat.

Distribution: This widespread, matrix-forming ecological system occurs throughout much of the northern Intermountain West (West and Young 2000). Within Washington, the system occurs within the Columbia Basin and Okanogan valley. The system is bound by montane woodlands and the Palouse prairie (Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland system) and rings outer portion of the driest area of the Columbia Basin that supports the Inter-Mountain Basins Semi-Desert Shrub Steppe system. The distribution of shrub steppe varies in a landscape mosaic reflecting topography and/or soils texture and depth. Shallow soils (lithic or deep, gravel flood deposits) are concentrated in Pleistocene flood channels that fan across the Columbia Basin and support the Columbia Basin Scabland system. Deep canyons (Snake River) dissecting the southeastern corner of the basin support Columbia Basin Foothill and Canyon Dry Grasslands which are distinguished by having colluvial soils derived from basalt and loess and experience periodic slope failures and slumping.



Environment: Landforms that support shrub steppe are a mosaic of patch types or plant associations that reflect differences in site (soils/precipitation zone) and fire effects. Soils are deep (over 6 inches) to shallow and non-saline. The space between vascular plants usually supports a biological soil crust that can cover up to 90% or more without disturbance. Biological soil crust cover generally decreases with increasing vascular plant cover, elevation, soil disturbance, loose surface rock, and coarseness of soil. Greater biological crust cover occurs on north- and east-facing slopes at mid elevations with stable, silt-loam or calcareous soils where not disturbed (Tyler 2006) or where vascular cover and litter are not limiting.

Vegetation: This ecological system is dominated by perennial bunchgrasses and forbs (collectively >25% cover) with *Artemisia tridentata (*ssp. *tridentata*, *xericensis*, and *wyomingensis), Artemisia tripartita*, and/or *Purshia tridentata* shrubs in an open to moderately dense (5-30% cover) shrub layer. Shrubs can be represented only as seedlings. Associated graminoids can include *Pseudoroegneria spicata*, *Poa secunda*, *Poa cusickii*, *Koeleria macrantha Hesperostipa comata*, and *Achnatherum thurberiana*. *Pseudoroegneria spicata* is the dominant bunchgrass in the climatically drier zones as well as on south-facing slopes and edaphically dry sites throughout the Columbia Basin. Sites with deep and/or sandy soils are often dominated by *Artemisia tridentata* ssp. *tridentata*. Sandy sites are often co-dominated by *Hesperostipa comata*. *Purshia tridentata* can also dominate sandy and/or rocky sites. *Purshia tridentata* dominated shrub-steppe is sporadically distributed along the woodland/shrub-steppe transition zone along the foothills of the East Cascades. *Artemisia tripartita* ssp. *tripartita* is the dominant shrub in more moist climatic areas. These areas support closed to nearly closed grasslands with *Festuca idahoensis* or *F. washingtonica*, higher forb diversity, *Carex filifolia* (an important rhizomatous species), *Artemisia tridentata* ssp. *tridentata*, *Artemisia tridentata* ssp. *xericensis*, *Purshia tridentata*, and have fewer southern Great Basin characteristic species than on lower precipitation or shallow, more skeletal soil sites. The latter areas typically have more *Bromus tectorum* in all seres than the more moist versions of this system that are generally more resilient to vegetation disturbance. Perryman (2001) notes that depending upon site potential, when sagebrush cover reaches 5-7% herbaceous biomass production begins to decline and herbaceous density begins to decline when sagebrush cover is 12-15%.

SHRUB-STEPPE

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system:

G302 Intermountain Mesic Tall Sagebrush Shrubland & Steppe Group	Global/ State Rank	NatureServe/ WNHP Code
Artemisia tridentata (ssp. tridentata, ssp. xericensis) / Pseudoroegneria spicata Shrub Herbaceous Vegetation	G2G4/S1	CEGL001018
Artemisia tridentata / Festuca idahoensis Shrub Herbaceous Vegetation	G4Q/S3	CEGL001530
Artemisia tridentata ssp. tridentata / Hesperostipa comata Shrubland	G4?/S2	CEGL002966
Artemisia tridentata ssp. tridentata / Leymus cinereus Shrubland	G2/S1	CEGL001016
Artemisia tridentata ssp. wyomingensis / Hesperostipa comata Shrubland	G2/S1	CEGL001051
Artemisia tridentata ssp. wyomingensis / Poa secunda Shrubland	G4/S3	CEGL001049
Artemisia tridentata ssp. wyomingensis / Pseudoroegneria spicata Shrub Herbaceous Vegetation	G5?/S3	CEGL001535
Artemisia tridentata ssp. wyomingensis / Pseudoroegneria spicata Shrubland	G5?/SNR	CEGL001009
Artemisia tripartita ssp. tripartita / Festuca campestris Shrub Herbaceous Vegetation	G2?/S1S2	CEGL001537
Artemisia tripartita ssp. tripartita / Festuca idahoensis Shrub Herbaceous Vegetation	G3/S3	CEGL001536
Artemisia tripartita ssp. tripartita / Hesperostipa comata Shrub Herbaceous Vegetation	G1/S1	CEGL001539
Artemisia tripartita ssp. tripartita / Pseudoroegneria spicata Shrub Herbaceous Vegetation	G2G3/S1	CEGL001538
Purshia tridentata / Achnatherum hymenoides Shrubland	G1/S1	CEGL001058
Purshia tridentata / Festuca idahoensis Shrub Herbaceous Vegetation	G3G5/S3	CEGL002674
Purshia tridentata / Hesperostipa comata Shrub Herbaceous Vegetation	G2/S1	CEGL001498
Purshia tridentata / Pseudoroegneria spicata Shrub Herbaceous Vegetation	G3/S2	CEGL001495

Ecological Processes: The natural fire regime of this ecological system maintains a patchy distribution of shrubs, so the general aspect of the vegetation is that of grassland. Fire most obviously influences the density and distribution of shrubs. In general, fire increases abundance of herbaceous perennials and decreases woody plants. Fire return intervals have variable estimates. Miller and Eddlemen (2001) estimate that fire intervals for productive shrub steppe is 12-15 years (fire regime I) and 50-100 years (fire regime II) in less productive areas. Conversely, Baker (2006) concludes that *Artemisia tridentata* spp. *wyomingensis* steppe fire rotations are 100-240 years (fire regime V). Grassland or steppe fire intervals are 1-23 years (Perryman 2001). Where fire frequency has resulted in a shift to a native grassland maintained without significant shrub invasion over a 50 to 70 year interval, the area would be considered to be the Columbia Basin Steppe and Grassland system. Compared to sites on fine-textured soils, rocky sites have longer fire intervals and support higher shrub cover and lower absolute bunchgrass cover. Historically, the duration, seasonality and severity of grazing by large native ungulates in the Columbia Basin differed from that which occurred in the Great Plains grasslands (Mack and Thompson 1982, Burkhart 1996). In general, pre-settlement grazing in the Columbia Basin was dispersed and occurred during the winter and spring when forage was available. The growing season is typically around six-weeks (Burkhart 1996). Davies and others (2009) conclude that sites with heavy litter accumulation, (ungrazed *Artemisia tridentata* ssp. *wyomingensis/Festuca idahoensis – Achnatherum thurberiana* community) are more susceptible to exotic annual invasion following fire than those with less litter accumulation. The space between vascular plants usually supports a biological soil crust that can cover up to 90% or more without disturbance.

Threats: The primary land uses that alter the natural processes of this system are associated with livestock practices, annual exotic species, fire regime alteration, direct soil surface disturbance, and fragmentation. Excessive grazing stresses the system through soil disturbance, diminishing or eliminating the biological soil crust, altering the composition of perennial species, and increases the establishment of native disturbance increasers and annual grasses, particularly *Bromus tectorum* and other exotic annual bromes. Response to grazing can be variable depending on the type of grazer and the season in which grazing occurs. If soil moisture is present and sagebrush seeds are available, grazing can result in increased shrub density. There are strong links between foliose lichens and ecosystem health (Rosentreter and Eldridge 2002). Severe trampling breaks lichens into fragments too small to re-establish that eventually leads to foliose lichen elimination (Rosentreter and Eldridge 2002). Biological soil crust cover generally decreases with increasing vascular plant cover, elevation, increasing soil disturbance, loose surface rock, and coarseness of soil. Observations by the authors suggest that the integrity of the biological soil crust is often a predictor of the abundance of nonnative grasses such as *Bromus tectorum*. Even in high-quality shrub-steppe, *Bromus tectorum* often dominates areas where small or large mammal soil disturbances have disrupted the biological soil crust. Fire further stresses livestock-altered vegetation by increasing exposure of bare ground and consequently increases exotic annuals and decreases perennial bunchgrass and sagebrush abundance. Fire suppression, even in the absence of livestock grazing impacts, can increase shrub density that in turn reduces bunchgrass cover or results in increased grass litter and fire fuel. Both conditions increase the probability of fire and vegetation responses that increase annual grass abundance following fire (Davies et al. 2009). *Hesperostipa comata* can increase in abundance in response to either grazing or fire. Any soil and bunchgrass layer disturbances, such as vehicle tracks or chaining shrubs, will increase the probability of alteration of vegetation structure and composition and response to fire as discussed above. Loss of shrub density and degradation of the bunchgrass layer's native diversity, decreases obligate shrub steppe birds (Vander Haegen et al. 2000). Fragmentation of shrub steppe by agriculture increases cover of annual grass, total annual/biennial forbs, bare ground, decreases cover of perennial forbs and biological soil crusts, reduces obligate insects (Quinn 2004), obligate birds and small mammals (Vander Haegen et al. 2000).

Classification Comments: This system differs from the similar Inter-Mountain Basins Montane Sagebrush Steppe in that it occurs at lower elevations than the latter and is not dominated by *Artemisia tridentata* ssp. *vaseyana*. In the past the related Inter-Mountain Basins Sagebrush Shrubland system was thought to occur in Washington (Sayre et al. 2009). That system differs from the Inter-Mountain Basins Big Sagebrush Steppe by having < 25% cover of perennial species and a denser shrub layer. However, after much review and numerous field visits, DNR-Natural Heritage Program ecologists are of the opinion that areas matching the description of the Inter-Mountain Basins Sagebrush Shrubland in Washington are actually degraded areas or simply areas of dense cover of sagebrush within the Inter-Mountain Basins Big Sagebrush Steppe and Inter-Mountain Basins Semi-Desert Shrub-Steppe systems. Bunchgrass cover in Washington's portion of the Columbia Basin is almost always too high to match the definition of the Inter-Mountain Basins Sagebrush Shrubland.

Where fire frequency has resulted in a shift to a native grassland maintained without significant shrub invasion over a 50 to 70 year interval, the area would be considered to be the Columbia Basin Steppe and Grassland system. Deep canyons (Snake River) dissecting the southeastern corner of the basin support Dry Canyon grasslands distinguished by colluvial soils derived from basalt and loess and periodic slope failures and slumping. Shallow soils (lithic or deep, gravel flood deposits) are concentrated in Pleistocene flood channels that fan across the Basin and support the Columbia Basin Scabland. Although currently included in this system, there has been past consideration of including Daubenmire's *Artemisia tripartita – Festuca idahoensis* zone within the Northern Rocky Mountain Lower Montane, Foothill, and Valley Grassland system due to it having similar species composition, climate, and overlap in elevation.

SHRUB-STEPPE

Related Concepts: This ecological system falls within the Shrub-steppe habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the Inter-Mountain Basin Big Sagebrush Steppe as one of their standard mapping units. This system includes the *Artemisia tridentata – Agropyron spicatum*, *Artemisia tridentata – Festuca idahoensis*, *Artemisia tripartita – Festuca idahoensis*, and *Purshia tridentata – Festuca idahoensis* habitat types of Daubenmire (1970).

References

Baker, W.L. 2006. Fire and Restoration of Sagebrush Ecosystems. Wildlife Society Bulletin:34(1):177-185.

Burkhardt, J.W. 1996. Herbivory in the Intermountain West. An overview of evolutionary history, historical cultural impacts and lessons from the past. Station Bulletin 58. Idaho Forest, Wildlife and Range Experiment Station, University of Idaho, Moscow. 35 pp.

Daubenmire. R. 1970. Steppe Vegetation of Washington. Washington Agricultural Experiment Station, College of Agriculture, Washington State University. Technical Bulletin 62. Pullman, Washington.

Davies, K.W., T.J. Svejcar and J.D. Bates. 2009. Interaction of historical and nonhistorical disturbances maintains native plant communities. Ecological Applications, 19(6), pp. 1536–1545.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Mack, R.N. and J.N. Thompson. 1982. Evolution in steppe with few large, hoofed animals. American Naturalist 119: 757-773.

Miller, R.F., and L.L. Eddleman. 2001. Spatial and temporal changes of sage grouse habitat in the sagebrush biome. Oregon State Univ. Agric. Exp. Sta. Tech Bull. 151. 35pp.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Perryman, B. L., A. M. Maier, A. L. Hild and R. A. Olson. 2001. Demographic characteristics of 3 *Artemisia tridentata* Nutt. subspecies. Journal of Range Management 54: 166-170.

Quinn, M.A. 2004. Influence of habitat fragmentation and crop system on Columbia Basin Shrubsteppe communities. Ecological Applications 14: 1634-1655.

Rostentreter, R.A. and D.J. Eldridge. 2002. Monitoring Biodiversity And Ecosystem Function: Grasslands, Deserts, And Steppe. *in*: Monitoring with Lichens—Monitoring Lichens. Eds. Nimis, Scheidegger and Wolseley. Dordrect: Kluwer Academic Publishers.199-233 pp.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Tyler, K.J. 2006. Biological Soil Crusts: Analysis of Monitoring Techniques at the Yakima Training Center, Washington. M.S. Thesis Central Washington University. Ellensburg, WA. 109 p.

Vander Haegen, W. M., F. C. Dobler, and D. J. Pierce. 2000. Shrubsteppe bird response to habitat and landscape variables in eastern Washington, USA. Conservation Biology 14:1145-1160.

West, N.E. and J.A. Young. 2000. Chapter 2. Inter-Mountain Valleys and Lower Mountain Slopes. *in*: Barbour, M. G. and W. D. Billings. eds. North American terrestrial vegetation. Cambridge, UK: Cambridge University Press.2nd edition. p. 256-284.

Description Author: Rex Crawford, Joe Rocchio, Gwen Kittel, and Marion Reid.

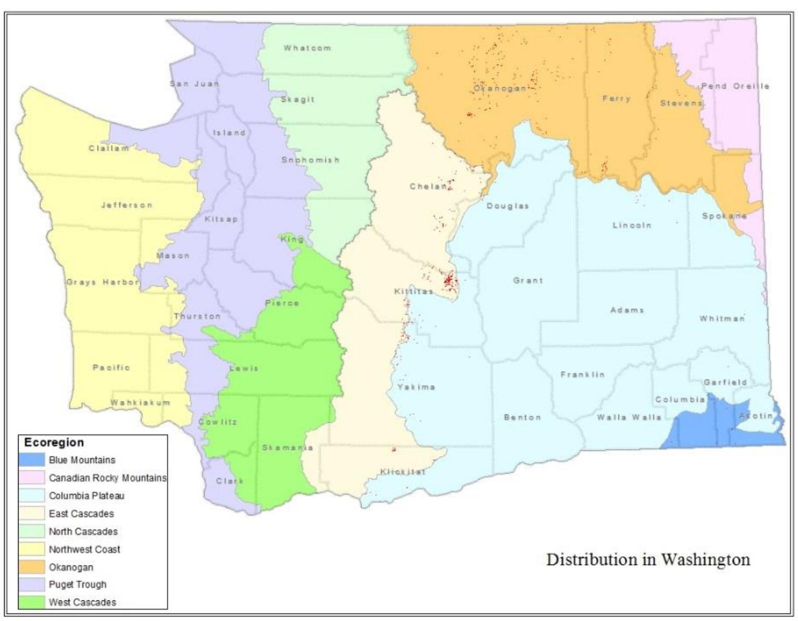
INTER-MOUNTAIN BASINS MONTANE SAGEBRUSH STEPPE

Concept: Subalpine to montane shrub-steppe dominated by *Artemisia tridentata* ssp. *vaseyana*, and related taxa such as *Artemisia tridentata* ssp. *spiciformis* (= *Artemisia spiciformis*). *Purshia tridentata* may co-dominate some stands. In Washington, this ecological system occurs within forest landscapes in the East Cascades and western Okanogan Highlands.

Conservation Status: Vulnerable (S3S4).

Distribution: The widespread large to small patch ecological system occurs throughout much of the northern Intermountain West. This system includes sagebrush communities occurring at foothill to subalpine elevations across the western U.S. It occurs from 3250 feet (1000 m) in eastern Oregon and Washington to over 10,000 feet (3000 m) in the southern Rockies (NatureServe 2007). In Washington, this ecological system occurs in montane and subalpine elevations typically in forest landscapes in the east Cascades and western Okanogan Highlands.

Environment: This system primarily occurs on deep-soiled to stony flats, ridges, nearly flat ridgetops, and mountain slopes. In general, this system shows an affinity for mild topography, fine soils with some source of subsurface moisture or more mesic sites, zones of higher precipitation and areas of snow accumulation (NatureServe 2007).



Vegetation: Across its range of distribution, this system is a compositionally diverse system. It is composed primarily of *Artemisia tridentata* ssp. *vaseyana*, and related taxa such as *Artemisia tridentata* ssp. *spiciformis* (= *Artemisia spiciformis*). *Purshia tridentata* may co-dominate some stands. Other common shrubs include *Symphoricarpos* spp., *Amelanchier* spp., *Ericameria nauseosa*, *Ribes cereum*, and *Chrysothamnus viscidiflorus*. Most stands have an abundant perennial herbaceous layer (over 25% cover, in many cases over 50% cover). Common graminoids include

Festuca idahoensis, *Hesperostipa comata*, *Poa fendleriana*, *Elymus trachycaulus*, *Bromus carinatus*, *Poa secunda*, *Calamagrostis rubescens*, and *Pseudoroegneria spicata*. Species of *Achnatherum* are common, including *Achnatherum nelsonii* ssp. *dorei*, *Achnatherum nelsonii* ssp. *nelsonii*, and *Achnatherum hymenoides*. In many areas, wildfires can create an open herbaceous-rich steppe condition, although at most sites, shrub cover can be over 40%, with moisture providing equally high grass and forb cover.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system:

G304 Intermountain Mountain Big Sagebrush Shrubland & Steppe Group	Global/ State Rank	NatureServe/ WNHP Code
Artemisia tridentata ssp. vaseyana / Festuca campestris Shrub Herbaceous Vegetation	G3Q/SNR	CEGL001531
Artemisia tridentata ssp. vaseyana / Festuca idahoensis Shrub Herbaceous Vegetation	G5/SNR	CEGL001533

Ecological Processes: The space between vascular plants may support a biological soil crust that has low cover even without disturbance. Biological soil crust cover generally decreases with increasing natural disturbance of soil surface, vascular plant cover, elevation, loose surface rock, and coarseness of soil. Johnson and Swanson (2005) indicate that bare ground even in least naturally disturbed sites has 3-25% cover. Fire most obviously influences the density and distribution of shrubs. In many areas, wildfires can maintain an open herbaceous-rich steppe condition, although at most sites, shrub cover can be unusually high for a steppe system (>40%), with moisture providing equally high grass and forb cover. In general, fire increases abundance of herbaceous perennials and decreases woody plants. Fire return interval is 40-75 years or fire regime II (LANDFIRE 2007) although the FRIS data base cites 15-20 years at lower treeline locations in Idaho. In stark contrast, Baker (2006) concluded that *Artemisia tridentata* spp. *vaseyana* steppe fire rotations are 325-450 years (fire regime V). Anecdotal observations suggest that these patches often are not burned during surrounding forest fires.

Threats: The primary land uses that alter the natural processes of this system are associated with livestock practices, exotic species, direct soil surface disturbance, and fragmentation. Healthy sagebrush shrublands are very productive and as such are often grazed by native ungulates and domestic livestock and can be strongly preferred sites during the growing season (Johnson and Swanson 2005). Prolonged livestock use can cause a decrease in the abundance of native bunch grasses and increase in the cover of shrubs and non-native grass species, such as *Poa pratensis*. Conversely, fire in the fall may decrease shrub abundance. *Artemisia tridentata* ssp. *vaseyana* are generally killed by fire and may take over ten years to recover.

Classification Comments: This system is found in the montane or subalpine zone while the similar Inter-Mountain Basins Big Sagebrush Steppe system occurs at lower elevations usually below lower treeline. The montane big sagebrush steppe can be confused remotely with the Northern Rocky Mountain Lower Montane, Foothill and Valley grassland. If *Purshia tridentata* is used as indicator, mountain sagebrush steppe also overlaps with *Artemisia tripartita* along foothills if the east Cascades. These determinations must be made on-the-ground.

Related Concepts: This ecological system falls within the Shrub-steppe habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the Inter-Mountain Basin Montane Sagebrush Steppe as one of their standard mapping units.

References

Baker, W.L. 2006. Fire and Restoration of Sagebrush Ecosystems. Wildlife Society Bulletin: 34(1):177-185.

Eldridge, D. J. and R. Rosentreter 1999 Morphological groups: a framework for monitoring microphytic crusts in arid landscapes. Journal of Arid Environments, Volume 41(1):11-25.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Johnson, C.G. and D.K. Swanson. 2005. Bunchgrass Communities of the Blue and Ochoco Mountains: A Guide for Managers. U.S.D.A. For. Ser. PNW-GTR-641.
Landfire. 2007. Inter-Mountain Basins Montane Shrub Steppe (BpS 0111260). Rapid Assessment Biophysical Settings Model Descriptions.

LANDFIRE. 2007. Biophysical Setting Model 0911260: Inter-Mountain Basins Montane Sagebrush Steppe.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Perryman, B. L., A. M. Maier, A. L. Hild and R. A. Olson. 2001. Demographic characteristics of three *Artemisia tridentata* Nutt. subspecies. Journal of Range Management 54: 166-170.

Pellant, M., P. Shaver, D.A. Pyke, and J.E. Herrick. 2005. Interpreting indicators of rangeland health, version 4. Technical Reference 1734-6. U.S. Department of the Interior, Bureau of Land Management, National Science and Technology Center, Denver, CO. BLM/WO/ST-00/001+1734/REV05. 122 pp.

Ponzetti, J., B. McCune, and D.A. Pyke. 2007. Biotic soil crusts in relation to topography, cheatgrass and fire in the Columbia Basin, Washington. The Bryologist 110(4):706-722.

Rostentreter, R.A. and D.J. Eldridge. 2002. Monitoring Biodiversity and Ecosystem Function: Grasslands, Deserts, And Steppe. *in*: Monitoring with Lichens—Monitoring Lichens. Eds. Nimis, Scheidegger and Wolseley. Dordrect: Kluwer Academic Publishers.199-233 pp.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Seefeldt, S.S., Germino, M., Dicristina, K. 2007. Prescribed fires in *Artemisia tridentata* ssp. *vaseyana* steppe have minor and transient effects on vegetation cover and composition. Applied Vegetation Science. 10:249-256.

Description Author: Rex Crawford and Marion Reid.

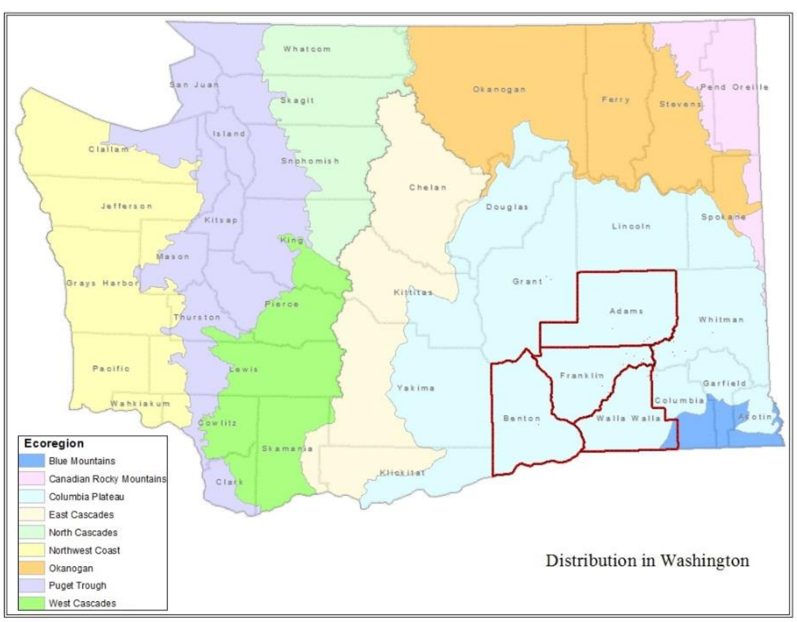
INTER-MOUNTAIN BASINS SEMI-DESERT SHRUB-STEPPE

Concept: This widespread matrix-forming ecological system occurs throughout much of the Intermountain West, most commonly in the southern portions. In Washington, it occurs as large to small patches in the hottest, driest (less than 8 inches (20 cm)/year) portions of the Columbia Basin (Pasco, Quincy, Umatilla, and lower Yakima basins). The woody layer is often a mixture of shrubs and dwarf-shrubs, although it may be dominated by a single shrub species. Characteristic species include *Grayia spinosa* or *Krascheninnikovia lanata* with *Ericameria nauseosa.*

Conservation Status: Critically Imperiled (S1). This system is uncommon and has a very limited range within Washington. Following fire or site disturbance, annuals replace perennials. There is a high potential of invasion from *Bromus tectorum*. The largest known occurrence is on Hanford Monument which burned and is now weed dominated (Evans and Lih 2005). Much of this system's likely historical range in Washington is in irrigation agriculture.

Distribution: The widespread matrix-forming ecological system occurs throughout much of the Intermountain West, most commonly in the southern portions. In Washington, it occurs as large to small patches in the hottest, driest (less than 8 inches (20 cm)/year) portions of the Columbia Basin (Pasco, Quincy, Umatilla, and lower Yakima basins). This was mapped very differently by NatureServe (Sayre et al. 2009) and by LANDFIRE and neither match known locations. What NatureServe mapped as Inter-Mountain Basins Mixed Salt Desert Scrub in Washington better fits Inter-Mountain Basin Semi-Desert Shrub-Steppe.

Environment: Soils are deep to shallow, well-drained, non-saline, often calcareous and typically with a biological soil crust. This system is apparently associated with the Ringold Formation on slopes. In Washington, this rare system is surrounded upslope by the Inter-Mountain Basins Big Sagebrush Shrub Steppe system (mostly Wyoming big sagebrush/bluebunch wheatgrass and related associations) on deeper soils and the Columbia Plateau Scabland Shrubland system on shallow soils (lithic or deep, gravel flood deposits). In valley bottoms this system can occur in a landscape pattern with Inter-Mountain Basins Greasewood Flat on wetter, alkaline to saline sites and Inter-Mountain Basins Active and Stabilized Dune systems.



Distribution in Washington

Vegetation: This semi-arid shrub-steppe is typically an open shrub to moderately dense woody layer and a strong graminoid layer (>25% cover but rarely closed). The woody layer is often a mixture of shrubs and dwarf-shrubs, although it may be dominated by a single shrub species. Characteristic species include *Grayia spinosa* or *Krascheninnikovia lanata* with *Ericameria nauseosa. Artemisia tridentata* may be present but typically does not dominate although it will increase with disturbance. On stonier sites, *Salvia dorrii* can be present to common. In Washington, the *Artemisia* *tridentata / Poa secunda* association can occur in this system when in association with semi-desert vegetation. Characteristic grasses include *Achnatherum hymenoides, A. thurberiana*, *Elymus elymoides*, *Poa secunda*, *Sporobolus airoides*, and *Hesperostipa comata*. The most widespread species are *Poa secunda* and *Pseudoroegneria spicata* (not dominant). Annual grasses, especially the exotics *Bromus tectorum*, may be present to abundant. Forbs are generally of low importance and are highly variable across the range but may be diverse in some occurrences for example; *Helianthus cusickii* and *Sphaeralcea munroana* can be abundant. The general aspect of occurrences may be either open shrubland with patchy grasses or patchy open herbaceous layers.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system:

G310 Intermountain Semi-Desert Shrubland & Steppe Group	Global/ State Rank	NatureServe/ WNHP Code
Krascheninnikovia lanata / Hesperostipa comata Dwarf-shrubland	G3/SNA	CEGL001327
Krascheninnikovia lanata / Poa secunda Dwarf-shrubland	G3/S1	CEGL001326

Ecological Processes: Disturbance may be important in maintaining the woody component. The natural fire regime of this ecological system is assumed to be similar to the Inter-Mountain Basins Big Sagebrush Steppe Ecological Systems although both *Grayia spinosa* and *Krascheninnikovia lanata* are capable of sprouting following fire. Fire maintains a patchy distribution of shrubs, so the general aspect of the vegetation is that of grassland. Where fire frequency has allowed for shifts to a native grassland condition, maintained without significant shrub invasion over a 50- to 70-year interval, the area would be considered Inter-Mountain Basins Semi-Desert Grassland, although the latter system is not thought to occur in Washington. Fire most obviously influences the density and distribution of shrubs. In general, fire increases the abundance of herbaceous perennials and decreases woody plants. Fire return interval for productive shrub steppe is 12-15 years and 50-100 years in less productive areas (Miller and Eddleman 2001). In general, grazing was dispersed and occurred during the winter and spring when forage was available. Growing season is typically around six-weeks (Burkhart 1996).

Threats: The primary land uses that alter the natural processes of this system are associated with livestock practices, annual exotic species invasion, fire regime alteration, direct soil surface disturbance, and fragmentation. Excessive grazing stresses the system through soil disturbance, diminishing or eliminating the biological soil crust, altering the composition of perennial species, and increases the establishment of native disturbance increasers and annual grasses, particularly *Bromus tectorum* and other exotic annual bromes. Persistent grazing will further diminish perennial grass cover, exposed bare ground, increase exotic annuals, and may lead to dense stands of *Artemisia tridentata.* Fire further stresses livestock-altered vegetation by increasing exposure of bare ground and consequent increases in exotic annuals and decrease in perennial bunchgrass and *Krascheninnikovia lanata*. Native communities dominated by *Krascheninnikovia lanata* produced little fine fuel. The introduction of *Bromus tectorum* into these communities has altered fuel loads and fuel distribution. Fire drastically alters the community composition because salt-desert shrubs are not adapted to periodic fire. Loss of shrub density and degradation of bunchgrass layer native diversity decreases obligate shrub steppe birds (Vander Haegen et al. 2000). Fragmentation of shrub steppe by agriculture increases cover of annual grass, annual/biennial forbs, bare ground, decreases cover of perennial forbs and biological soil crusts, and reduces obligate insects (Quinn 2004), obligate birds and small mammals (Vander Haegen et al. 2001).

Classification Comments: What NatureServe mapped as Inter- Mountain Basins Mixed Salt Desert Scrub in Washington better fits Inter-Mountain Basin Semi-Desert Shrub-Steppe.

Related Concepts: This ecological system falls within the Shrub-steppe habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the Inter-Mountain Basin Montane Sagebrush Steppe as one of their standard mapping units. This is included as part of the *Artemisia tridentata – Agropyron spicatum* zone and *Eurotia lanata - Poa secunda* edaphic habitat types of Daubenmire (1970).

References

Burkhardt, J.W. 1996. Herbivory in the Intermountain West. An overview of evolutionary history, historical cultural impacts and lessons from the past. Station Bulletin 58. Idaho Forest, Wildlife and Range Experiment Station, University of Idaho, Moscow. 35 pp.

Daubenmire. R. 1970. Steppe Vegetation of Washington. Washington Agricultural Experiment Station, College of Agriculture, Washington State University. Technical Bulletin 62. Pullman, Washington.

Evans, J.R., Lih, M.P. 2005. Recovery and Rehabilitation of Vegetation on the Fitzner-Eberhardt Arid Lands Ecology Reserve, Hanford Reach National Monument, Following the 24 Command Fire. Final Report: 2001 – 2004. Prepared by The Nature Conservancy of Washington for the U.S. Fish and Wildlife Service, Hanford Reach National Monument in partial fulfillment of Cooperative Agreement No. 13410.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Mack, R.N. and J.N. Thompson. 1982. Evolution in steppe with few large, hoofed animals. American Naturalist 119: 757-773.

Miller, R.F., and L.L. Eddleman. 2001. Spatial and temporal changes of sage grouse habitat in the sagebrush biome. Oregon State Univ. Agric. Exp. Sta. Tech Bull. 151. 35pp.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Quinn, M.A. 2004. Influence of habitat fragmentation and crop system on Columbia Basin Shrubsteppe communities. Ecological Applications 14: 1634-1655.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Vander Haegen, W. M., F. C. Dobler, and D. J. Pierce. 2000. Shrubsteppe bird response to habitat and landscape variables in eastern Washington, USA. Conservation Biology 14:1145-1160.

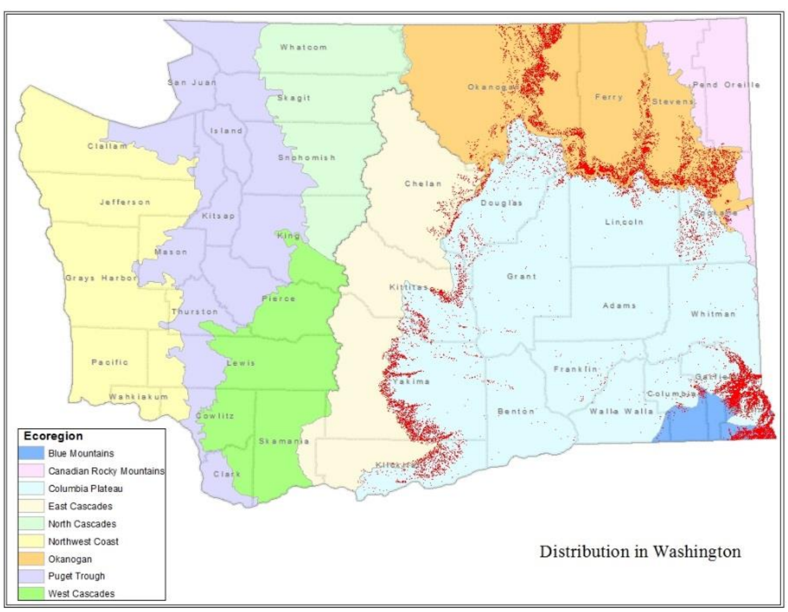
Vander Haegen, W.M, S.M. McCorquodale, C.R. Pearson, G.A.Green, and E.Yensen. 2001. Wildlife of Eastside Shrubland and Grassland Habitats. Chapter 11 IN: Johnson, D.H. and O'Neil T.A. Wildlife-Habitat Relationships in Oregon and Washington. OSU Press. Corvallis, OR. 317-341pp.

Description Author: Rex Crawford, Gwen Kittel, Marion Reid, and Keith Schulz.

COLUMBIA BASIN FOOTHILL AND CANYON DRY GRASSLAND

Concept: Perennial bunchgrasses and forbs (usually over 25% cover) dominated grasslands that occur on steep open slopes in the canyons and valleys of the Columbia Basin, particularly along the Snake River canyon and large tributaries. They can be floristically similar to the Columbia Basin Palouse Prairie but are distinguished by landform, soil, and process characteristics.

Conservation Status: Critically Imperiled (S1S2). This system has limited distribution in Washington. It is somewhat protected from conversion due to steepness of slopes and remote location. Degradation of ecological integrity of occurrences is the major reason the system is considered critically imperiled. Mid slopes always retain ecological integrity better than upper or lower slopes. South aspects tend to be dominated by *Bromus tectorum* and other annual bromes, *Poa bulbosa*, *Centaurea solstitialis*, and knapweeds are commonly seen on north aspects and terracettes are common. The current ecological integrity of these grasslands in the upper elevation range of this system (where is merges with lower montane grasslands) is not well known. The hot, dry canyons tend to be dominated by nonnative or weedy native species. Shrubs invade moister sites.



Distribution: This ecological system occur on steep open slopes in the canyons and valleys of the Columbia Basin, particularly along the Snake River canyon and large tributaries. The map (Sayre et al. 2009) overestimates the distribution of this type and appears to include many areas that are likely burned Inter-Mountain Basins Big Sagebrush Steppe occurrences on steep slopes and Northern Rocky Mountain Lower Montane, Foothill and Valley Grasslands.

Environment: Annual precipitation is 5- 10 inches (12-25 cm) and occurs mostly in the winter, primarily as rain. Landform settings of this grassland are primarily long, steep slopes of 100 m to well over 400 m in length, with colluvial soils derived from residuum and having patchy, thin, wind-blown surface deposits. Saturated soil layers over frozen soil are related to most soil slips (Tisdale 1986).

Vegetation: Perennial bunchgrasses and forbs (usually over 25% cover) dominate these grasslands. Bare ground, gravel and rock between bunches are common features due to soil movement and sun exposure. Biological soil crust cover is usually present but generally decreases with increasing vascular plant cover, elevation, loose surface rock, and coarseness of soil (Belnap et al. 2001). Dry occurrences of this grassland are open with spaces between mid-tall deep-rooted bunchgrass (*Pseudoroegneria spicata* or *Aristida purpurea* var. *longiseta*) along with *Poa secunda*, *Lupinus* spp., *Balsamorhiza sagittata*, *Phlox colubrina*, *Erigeron pumilus*, and *Opuntia polyacantha*. These species are joined by other mid-tall deep-rooted bunchgrasses (*Festuca idahoensis* and *Koeleria macrantha*) on more moist sites (north aspects or higher elevations) often with a heavy litter cover.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system:

G311 Intermountain Semi-Desert Grassland Group	Global/ State Rank	NatureServe/ WNHP Code
Aristida purpurea var. longiseta - Poa secunda Herbaceous Vegetation	G3/S1	CEGL001781
Aristida purpurea var. longiseta - Pseudoroegneria spicata - Sporobolus cryptandrus Herbaceous Vegetation	G2/S1	CEGL001589
Aristida purpurea var. longiseta - Sporobolus cryptandrus Herbaceous Vegetation	G1/S1	CEGL001515
Pseudoroegneria spicata - Balsamorhiza sagittata - Poa secunda Herbaceous Vegetation	G3/SNA	CEGL001662
Pseudoroegneria spicata - Festuca idahoensis Canyon Herbaceous Vegetation	G3/S2	CEGL001669
Pseudoroegneria spicata - Opuntia polyacantha - (Poa secunda) Herbaceous Vegetation	G3/S2?	CEGL001673
Pseudoroegneria spicata - Poa secunda Lithosolic Herbaceous Vegetation	G3/S3	CEGL001678
Sporobolus cryptandrus - Poa secunda Herbaceous Vegetation	G2/S1S2	CEGL001516

Ecological Processes: Slope failures and soil creep are common processes. Fire frequency is presumed to be less than 20 years; the return interval may have historically been as low as 5-10 years (LANDFIRE 2007). Elk, deer and bighorn sheep are native large grazers who used these grasslands particularly in winter and spring (Tisdale 1986). Burrowing animals and their predators likely played important roles in creating small-scale patch patterns.

Threats: The primary land uses that alter the natural processes of this system are associated with livestock practices, annual exotic species invasion, fire regime alteration, direct soil surface disturbance, and fragmentation. Excessive grazing stresses the system through soil disturbance, diminishing or eliminating the biological soil crust, altering the composition of perennial species, and increases the establishment of native disturbance increasers and annual grasses, particularly *Bromus tectorum* and other exotic annual bromes. There are strong links between foliose lichens and ecosystem health (Rosentreter and Eldridge 2002). Severe trampling breaks lichen into fragments too small to re-establish that eventually leads to foliose lichen elimination (Rosentreter and Eldridge 2002). Persistent grazing will further diminish perennial cover, expose bare ground, and increase exotic annuals. Darambazar (2007) cites Johnston (1962) that when bare ground is approximately 15%, reduced infiltration and increased runoff occur in fescue grassland ecosystems. Fire further stresses livestock-altered vegetation by increasing exposure of bare ground and consequent increases in exotic annuals and decrease in perennial bunchgrass. Due to steepness of terrain grazing effects are usually concentrated in less steep slopes, although grazing does create contour trail networks that can lead to addition slope failures.

In more mesic canyon grasslands, fire suppression leads to increase of deciduous shrubs (*Symphoricarpos* spp., *Physocarpus malvaceus*, *Holodiscus discolor*, and *Ribes* spp.) and in some areas trees (*Pinus ponderosa* or *Pseudotsuga menziesii*). Additional disturbances, such as vehicle tracks and chaining shrubs, will increase the probability of alteration of vegetation structure and composition and response to fire as discussed above. Invasive perennial exotics such as *Centaurea solstitialis, Hypericum perfoliatum, Poa pratensis,* and *Prunus cerasifera* are major site stressors. Davies and others (2009) conclude that sites with heavy litter accumulation (e.g., ungrazed *Artemisia tridentata* ssp. *wyomingensis/Festuca idahoensis – Achnatherum thurberiana* community) are more susceptible to exotic annual invasion following fire than those with less litter accumulation. They note that introduced species and changes in climate can change ecosystem response to natural disturbance regimes.

Tisdale (1986) notes that canyon grasslands are "highly stable, with boundaries that are unlikely to change without a sizeable shift in climate." And that "grassland community changes caused by heavy grazing do not appear to have altered their pattern of distribution."

Classification Comments: These grassland are floristically similar to the Columbia Basin Palouse Prairie but are distinguished by landform, soil, and process characteristics. Burned Inter-Mountain Basins Big Sagebrush Steppe occurrences on steep slopes where *Artemisia tridentata* or *Purshia tridentata* has been eliminated over whole landforms are included in the Columbia Basin Steppe and Grassland system rather than this canyon system. The Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland ecological system merges with this system and generally is associated with more moist areas, higher elevations near and above lower tree line, and more likely to be dominated by closed fescue-dominated grasslands. Droughty gravelly and sandy sites in valley bottoms and toe slopes within low precipitation areas are included in the Intermountain Basins Semi-desert Grassland ecological system.

Related Concepts: This ecological system falls within the Eastside (Interior) Grasslands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the Columbia Basin Foothill and Canyon Dry Grassland as one of their standard mapping units. This is part of the *Agropyron – Poa secunda* habitat type of Daubenmire (1970).

References

Belnap, J., J. Kaltenecker, R. Rosentreter, J. Williams, S. Leonard, and D. Eldridge. 2001. Biological Soil Crusts: Ecology and Management. Technical Report 1730-2, United States Department of the Interior. 110 pp.

Darambazar, E., T. DelCurto, D. Damiran, A. A. Clark, and R. V. Taylor. 2007. Species composition and diversity on northwestern bunchgrass prairie rangelands. *In:* Proceedings of Western Section, American Society of Animal Sciences 58:233-236.

Daubenmire. R. 1970. Steppe Vegetation of Washington. Washington Agricultural Experiment Station, College of Agriculture, Washington State University. Technical Bulletin 62. Pullman, Washington.

Davies, K.W., T.J. Svejcar and J.D. Bates. 2009. Interaction of historical and nonhistorical disturbances maintains native plant communities. Ecological Applications, 19(6), pp. 1536–1545.

Johnston, A. 1962. Effects of grazing intensity and cover on the water-intake rate of fescue grassland. J. Range Manage. 15:79-87.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

LANDFIRE. 2007. Biophysical Setting Model 0811340: Columbia Basin Foothill and Dry Canyon Grassland.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Rostentreter, R.A. and D.J. Eldridge. 2002. Monitoring Biodiversity and Ecosystem Function: Grasslands, Deserts, and Steppe. IN: Monitoring with Lichens—Monitoring Lichens. Edited by Nimis, Scheidegger and Wolseley. Dordrect: Kluwer Academic Publishers.199-233 pp.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Tisdale, E.W. 1986. Canyon grasslands and associated shrublands of west-central Idaho and adjacent areas. Bulletin No. 40. Forestry, Wildlife and Range Experiment Station, University of Idaho, Moscow.

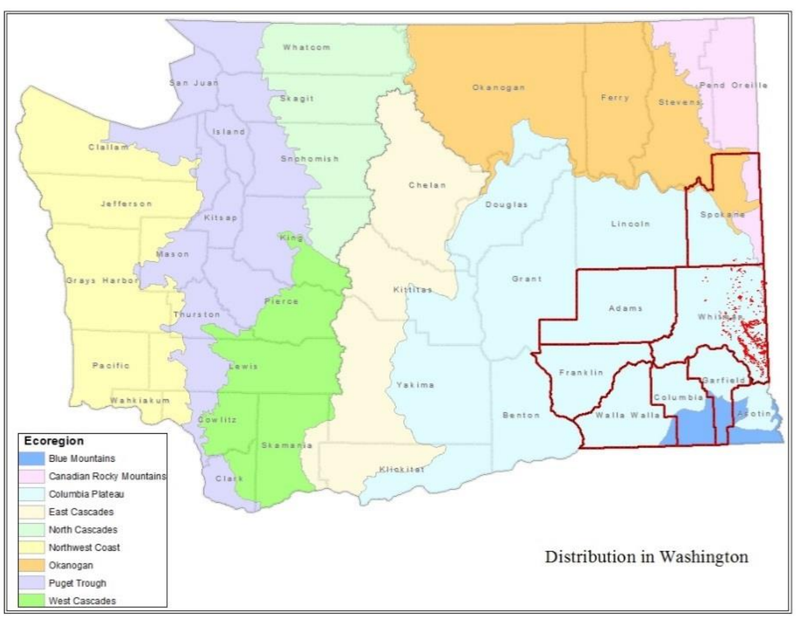
Description Author: Rex Crawford, Jimmy Kagan, and Marion Reid.

COLUMBIA BASIN PALOUSE PRAIRIE

Concept: The Columbia Basin Palouse Prairie was once an extensive grassland system in southeast Washington and adjacent Idaho and Oregon but is now reduced to small remnants. It is characterized by dense bunchgrass cover and a high density of forbs on a dune-like topography composed of loess hills and plains over basalt. The Palouse prairie can be spilt into "moist" and "dry" variants based on increasing precipitation from eastern Franklin County to the Idaho state line.

Conservation Status: Critically Imperiled (S1). Over 99% of this prairie has been converted to agricultural uses (Looney and Eigenbrode 2012). Remaining remnants are very small (< 2 ha) and subject to weed and native shrub invasion and other isolation impacts (Looney and Eigenbrode 2012). Many consider it to be functionally extirpated. Although highly fragmented remaining remnants support rare plant associations and rare plant species.

Distribution: This ecological system was once an extensive grassland system in southeast Washington and adjacent Idaho and Oregon. Most of the Palouse prairie was converted to agriculture in the late 1800's (Looney and Eigenbrode 2012). The Palouse Prairie system is part of the Pacific Northwest Bunchgrass (Tisdale 1983; Lichthardt and Moseley 1997) associated with deep soils on rolling loess hills with 10 to 100-foot long slopes centered on southeast Washington and adjacent Idaho and Oregon. Once a matrix system, today the Palouse prairie in Washington is a small to large patch system as result of landscape conversion to agriculture (Black and others 1998; Looney and Eigenbrode 2012). Remnant prairies are now typically associated with small, steep and rocky sites or small, isolated sites within an agricultural landscape (Looney and Eigenbrode 2012). The points on the map are based on Looney and Eigenbrode (2012) and is limited to showing the "moist" Palouse prairie remnants (i.e.



Daubenmire's (1970) *Festuca – Symphoricarpos and Festuca – Rosa* habitat types). The dry Palouse prairie (Daubenmire's (1970) *Agropyron – Festuca* habitat type) extends west into eastern Franklin County, southeastern Adams County, and the northern portions of Walla Walla, Columbia and Garfield counties.

Environment: The associated climate of the Palouse Prairie is generally warm to hot, dry summers and cool, wet winters. Annual precipitation is high relative to other areas of the Columbia Basin, 38-76 cm (15-30 inches), and mostly fall during winter. Eastern Franklin County, southeastern Adams County, and the northern portions of Walla Walla, Columbia and Garfield counties occur within the drier range of this system and are sometimes referred to as "dry" Palouse prairie. Further east, precipitation increases and support "moist" Palouse prairie. The soils are typically deep, well-developed, and old. Historically, this system was associated with deep soils on rolling loess hills with 10 to 100-foot long slopes. Remnant grasslands are now typically associated with steep and rocky sites or small and isolated sites within an agricultural landscape.

Vegetation: This system is characterized by dense cool season bunchgrass cover with a high diversity of forbs. Characteristic species are *Festuca idahoensis* and *Pseudoroegneria spicata* (typically ssp. *inerme)* with *Hesperostipa comata*, *Koeleria macrantha, Leymus cinereus,* or *Poa secunda*. Shrub and forb diversity varies between "dry" and "moist" Palouse prairie remnants with diversity and density of vegetation being much higher in the moist prairie. Dry Palouse prairie (e.g., *Agropyron – Festuca* habitat type of Daubenmire 1970) is dominated by *Festuca idahoensis* and *Pseudoroegneria spicata*. *Poa secunda* is also abundant. Sagebrush is generally absent, except in areas with past disturbance (Daubenmire 1970), which distinguishes these sites from Inter-Mountain Basins Big Sagebrush Steppe. *Symphoricarpos*, *Rosa* and *Artemisia tripartita* are also generally absent in the dry Palouse prairie which, along with low forb diversity (Daubenmire (1970) noted 16 forb species), distinguishes the dry from moist Palouse prairie (Daubenmire 1970). Moist Palouse prairie (e.g., *Festuca – Symphoricarpos and Festuca – Rosa* zones of Daubenmire 1970) is a closed grassland primarily dominated by *Festuca idahoensis*, *Pseudoroegneria spicata, and Koeleria cristata along* with a high diversity of forbs. Daubenmire (1970) noted 35 forb species. The ecotype of *Pseudoroegneria spicata* that occurs in the moist Palouse prairie is often rhizomatous (Daubenmire 1970). Another diagnostic characteristic is the occurrence of *Symphoricarpos* and *Rosa* as dwarf-shrubs dispersed among the grassland. Other shrubs include *Prunus virginiana*, *Eriogonum heracleoides*, *Amelanchier alnifolia*, and *Crataegus douglasii*. Past land use, excessive grazing, and invasion by introduced annual species have resulted in a broad conversion to agriculture or steppe with shrubs and annual grasslands dominated by *Artemisia* spp., *Ericameria nauseosa*, *Chrysothamnus viscidiflorus*, and *Bromus tectorum*, *Ventenata dubia*, *Poa bulbosa*.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system:

G273 Central Rocky Mountain Lower Montane, Foothill & Valley Grassland Group	Global/ State Rank	NatureServe/ WNHP Code
Festuca idahoensis - Koeleria macrantha Herbaceous Vegetation	G3Q/S1	CEGL001620
Festuca idahoensis - Symphoricarpos albus Herbaceous Vegetation	G1/S1	CEGL001509
Hesperostipa comata - Poa secunda Herbaceous Vegetation	G1/S1	CEGL001704
Pseudoroegneria spicata - Festuca idahoensis Palouse Herbaceous Vegetation	G1G2/S1	CEGL001670
Pseudoroegneria spicata - Poa secunda Herbaceous Vegetation	G4?/S2	CEGL001677
Rosa nutkana - Festuca idahoensis Herbaceous Vegetation	G1G2Q/S1	CEGL001626

Ecological Processes: A frequent (25-50 year) non-lethal fire regime (Morgan and other 1996), along with soil drought and herbivory, retards woody species invasion and can result in a patchy distribution of shrubs

and trees. The most droughty sites produce little and discontinuous fuel and likely have much longer fire regimes. Isolation of grassland patches by fragmentation may also limit seed dispersal of native shrubs leading to persistence of the grassland. Elk and deer are native large grazers used the Palouse, particularly in spring.

Threats: The primary land uses that alter the natural processes of this system are associated with agricultural and livestock practices, exotic species, fire regime alteration, direct soil surface disturbance, and fragmentation. Excessive grazing stresses the system through soil disturbance increasing the probability of establishment of native disturbance increasers and annual grasses, particularly exotic annual bromes (*Bromus commutatus*, *japonicus*, *mollis*, *tectorum*) and *Ventenata dubia* on more xeric sites and exotic perennial grasses *Arrhenatherum elatius*, *Bromus inermis*, *Phleum pratense*, and *Poa pratensis* on more mesic sites. Other exotic species threatening this ecological system through invasion and potential complete replacement of native species include *Hypericum perfoliatum*, *Potentilla recta*, *Euphorbia esula*, and knapweeds, especially *Centaurea biebersteinii (= Centaurea maculosa)*. Persistent grazing will further diminish native perennial cover, expose bare ground, and increase exotics (Johnson and Swanson 2005). Darambazar (2007) cites Johnston (1962) that when bare ground is approximately 15%, reduced infiltration and increased runoff occurs in *Festuca* grassland ecosystems. Fire further stresses livestock altered vegetation by increasing exposure of bare ground and consequent increases in exotic annuals and decrease in perennial bunchgrass. Grazing effects are usually concentrated in less steep slopes although grazing does create contour trail networks that can lead to addition slope failures. Fire suppression leads to deciduous shrubs, *Symphoricarpos* spp., *Physocarpus malvaceus*, *Holodiscus discolor*, and *Ribes* spp. and in some areas trees (*Pinus ponderosa* and *Pseudotsuga menziesii*) to increase. Johnson and Swanson (2005) note that *Festuca idahoensis* decreases following fire but following a flush of annuals sites regain pre-fire cover of *Festuca* after a few years.

Classification Comments: Floristically, these grasslands are similar to the Columbia Basin Foothill and Canyon Grassland system but are distinguished by landform, soil, and process characteristics. The system appears between the Columbia Plateau Steppe and Grassland and the Intermountain Basins Big Sagebrush Steppe systems to the east and the Northern Rocky Mountain Ponderosa Pine and Northern Rocky Mountain Dry-Mesic Forest ecological systems north and eastward. In the southern portion, the Palouse is dissected by the floristically similar Columbia Basin Canyon Dry Grasslands that is associated with steep, long slopes with soil derived from colluvial material and loess. The Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland system, also floristically similar, occurs at higher elevation at and within the lower forest zones on broad ridgetops, plateau or in wide valleys. Sagebrush is generally absent, except in areas with past disturbance (Daubenmire 1970), which distinguishes these sites from Inter-Mountain Basins Big Sagebrush Steppe.

Related Concepts: This ecological system falls within the Eastside (Interior) Grasslands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools

Project (i.e. LANDFIRE) recognizes the Columbia Basin Palouse Prairie as one of their standard mapping units. This system includes the *Festuca idahoensis – Symphoricarpos albus, Festuca idahoensis – Rosa nutkana*, and *Agropyron spicatum – Festuca idahoensis* habitat types of Daubenmire (1970).

References

Busacca, A.J. and McDonald, E.V., 1994. Regional sedimentation of late Quaternary loess of the Columbia Plateau: sediment source areas and loess distribution patterns. Bull. Washington Div. Geol. Earth Resources 80: 181-190.

Black, A.E., E. Strand, R. G. Wright, J. M. Scott, P. Morgan and C. Watson. 1998. Land use history at multiple scales: implications for conservation planning. Landscape and Urban Planning 43(1): 49-63.

Darambazar, E., T. DelCurto, D. Damiran, A. A. Clark, and R. V. Taylor. 2007. Species composition and diversity on northwestern bunchgrass prairie rangelands. *In:* Proceedings of Western Section, American Society of Animal Sciences 58:233-236.

Daubenmire. R. 1970. Steppe Vegetation of Washington. Washington Agricultural Experiment Station, College of Agriculture, Washington State University. Technical Bulletin 62. Pullman, Washington.

Johnston, A. 1962. Effects of grazing intensity and cover on the water-intake rate of fescue grassland. J. Range Manage. 15:79-87.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Johnson, C.G. and D.K. Swanson. 2005. Bunchgrass communities of the Blue and Ochoco Mountains: A guide for managers. Gen. Tech. Rep. PNW-GTR-641 Portland Oregon. 119p.

Lichthardt, J. and R.K. Moseley. 1997. Status and conservation of the Palouse grassland in Idaho. Conservation Data Center, Idaho Department of Fish and Game, Boise. 28 pp. plus appendices.

Looney, C. and S.D. Eigenbrode. 2012. Characteristics and Distribution of Palouse Prairie Remnants: Implications for Conservation Planning. Natural Areas Journal 32 (1): 75-85.

Morgan, P., S. Bunting, A.E. Black, T. Merrill, S. Barrett. 1998. Past and present fire regimes in the interior Columbia River basin. In: Fire management under fire (adapting to change); proc. of the 1994 Interior West Fire Council Meeting. International Association of Wildland Fire, Fairfield, WA: 77-82.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Tisdale, E.W. 1983. Grasslands of western North America: The Pacific Northwest Bunchgrass. Pages 223-245 *in* Grassland ecology and classification symposium proceedings, A.C. Nicholson, A. McLean, and T.E. Baker, editors, Ministry of Forest, Province of British Columbia, Victoria, BC.

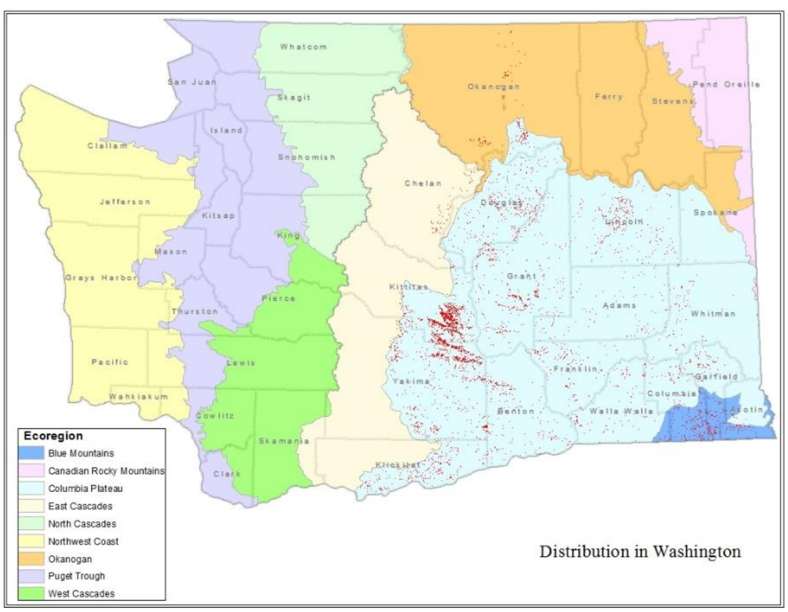
Description Author: Rex Crawford, Jimmy Kagan and Marion Reid.

COLUMBIA PLATEAU STEPPE AND GRASSLAND

Concept: Grasslands dominated by perennial bunch grasses and forbs (>25% cover) and sometimes with a sparse (<10% cover) shrub layer. *Artemisia tridentata*, *Artemisia tripartita* and *Purshia tridentata* are absent and are unlikely to re-establish due to lack of seed source. This grassland system occurs over large areas, occasionally entire landforms, and is an alternative state of the Inter-Mountain Basins Big Sagebrush Steppe ecological system type where frequent fire (< 20 years) or fire severity results in an absence or very low cover of deep-rooted, fire intolerant shrub.

Conservation Status: Imperiled (S2). Fire effects and site disturbances that promote annual grass invasion are major threats that can irreversibly alter the system.

Distribution: This large patch system occurs throughout much of the Columbia Plateau, from north-central Idaho, south and west into Washington, Oregon, southern Idaho, and northern Nevada. This grassland occurs over large areas, occasionally entire landforms, and is an alternative state of the Inter-Mountain Basins Big Sagebrush Steppe ecological system type where frequent fire (< 20 years) or fire severity results in an absence or very low cover of deep-rooted, fire intolerant shrubs (Laycock 1991). Geographically (climatically), this steppe system is associated with the Inter-Mountain Basins Big Sagebrush Steppe system, rings the driest portion of the Basin that supports the Inter-Mountain Basins Semi-desert Shrub Steppe system and is bounded by montane woodlands and the Palouse prairie. The map overestimates the distribution of this system. The system is primarily concentrated in southwest portions of the Columbia



Basin where frequent fires have maintained these grasslands. The isolated pixels elsewhere on the map are likely recent burns where short-term shrub recovery is probable.

Environment: Soils are variable, ranging from relatively deep, fine-textured to stony volcanic-derived clays that are non-saline and often with coarse fragments and a microphytic crust. Greater crust cover occurs on north- and east-facing slopes at mid elevations with stable, silt-loam soils where not disturbed (Tyler 2006) or where vascular cover and litter are not limiting.

Vegetation: These grasslands are dominated by perennial bunchgrasses and forbs (>25% cover), and can have very little exposed bare ground due to mosses and lichens carpeting the area between plants. Associated graminoids include *Achnatherum hymenoides, Elymus elymoides, Elymus lanceolatus* ssp. *lanceolatus*, *Hesperostipa comata*, *Festuca idahoensis*, *Koeleria macrantha*, *Poa secunda*, and *Pseudoroegneria spicata*. Common forbs are *Phlox hoodii, Arenaria* spp., and *Astragalus* spp. Areas with deeper soils are rare because of conversion to other land uses. Shrubs such as *Chrysothamnus viscidiflorus, Ericameria nauseosa,* or *Tetradymia* spp. may be present in burned or grazed stands. *Artemisia tridentata, Artemisia tripartita* and *Purshia tridentata* are absent due to frequent fire and are unlikely to re-establish due to lack of seed source.

USNVC Associated Types: Classification of these grasslands is needed to identify component plant associations.

Ecological Processes: Repeated fires that eliminate most shrub species so that shrub invasion is severely limited by lack of seed source is the diagnostic environmental feature of this system. These grasslands apparently lacked extensive herds of large grazing and browsing animals until the late 1800's, when domestic livestock were introduced. Burrowing animals and their predators likely played important roles in creating small-scale patch patterns. Biological soil crust is very important in this ecological system. Fire return interval for productive shrub steppe is 12-15 years (fire regime I) and 50-100 years (fire regime II) in less productive areas (Miller and Eddleman 2001) or alternatively Baker (2006) concludes that Wyoming sagebrush fire rotations are 100-240 years (fire regime V). Grassland or steppe fire intervals are 1-23 years (Perryman 2001). Fire intervals in this system are frequent enough to eliminate shrub invasion over a 50 to 70 year time frame. Nearby seed source of shrubs, along with fire, are predictors of shrub invasion. For example, Perryman et al. (2001) calculated a mean recruitment interval of 2.3 (±0.7) years for sagebrush stands in Wyoming. Shrubs produce large quantities of small seeds beginning at 3 to 4 years of age. The Fire Effects Information System (FEIS; http://www.feis-crs.org/beta/) notes that approximately 90% of big sagebrush seed is dispersed within 30 feet (9 m) of the parent and few seeds are carried more than 100 feet (30 m). Thus, it was concluded that 50 acres is a minimum persistent patch size for a site to be classified as this system. Large native ungulate grazing in the Columbia Basin differed from that in the Great Plains grasslands in terms of duration, seasonality, and

severity (Mack and Thompson 1982, Burkhart 1995). In general, grazing was dispersed and was during the winter and spring when forage was available.

Threats: The primary land uses that alter the natural processes of this system are associated with livestock practices, annual exotic species, fire regime alteration, direct soil surface disturbance, and fragmentation. Excessive grazing stresses the system through soil disturbance, trampling and displacing the biological soil crust, altering the composition of perennial species, and increasing the establishment of native disturbance increasers and exotic annual grasses, particularly *Bromus tectorum*. Persistent grazing will further diminish perennial cover, expose bare ground, and increase exotic annuals. Fire further stresses livestock-altered vegetation by increasing exposure of bare ground and consequent increases in exotic annuals and decrease in perennial bunchgrass. In more mesic steppe, fire is not as important in maintenance of perennial grasses and forbs. Any disturbances to soil and bunchgrass layers, such as vehicle tracks and chaining shrubs, will increase the probability of alteration of vegetation structure and composition and response to fire as discussed above. Johnson and Swanson (2005) note that *Festuca idahoensis* decreases following fire but following a flush of annuals these sites regain pre-fire cover after a few years.

Fragmentation of shrub steppe by agriculture increases cover of annual grass, total annual/biennial forbs, bare ground, decreases cover of perennial forbs and biological soil crusts, and reduces obligate insects (Quinn 2004), obligate birds and small mammals (Vander Haegen et al 2003). These fragmentation responses are similarly expected in steppe vegetation.

Classification Comments: These grasslands are floristically similar to the Inter-Mountain Basins Big Sagebrush Steppe ecological system type but differs by having a more frequent fire regime (< 20 years) resulting in an absence or low cover (< 20%) of shrubs over large areas, occasionally entire landforms. Notably *Artemisia tridentata, Artemisia tripartita* and *Purshia tridentata* are absent and are unlikely to re-establish due to lack of seed source. Distinguishing this steppe system from shrub less bunchgrass-dominated patches within the Inter-Mountain Basins Big Sagebrush Steppe or Inter-Mountain Basins Semi-Desert Shrub-Steppe ecological system occurrences is an on-the-ground determination based on the presence or absence of shrub-steppe indicator shrubs in relatively homogeneous areas typically well over 50 acres, often including whole landforms. Northern Rocky Mountain Foothill and Valley Grasslands are more productive, and typically associated with woodlands or forests. Deep canyons (Snake River) dissecting the southeastern corner of the basin, support the Columbia Plateau Foothill and Canyon Dry Grasslands ecological system that is distinguished by occurring primarily on colluvial soils derived from basalt and loess and by periodic slope failures and slumping. Shallow soils (lithic or deep, gravel flood deposits) occur in Pleistocene flood channels that fan across the basin and support the Columbia Plateau Scabland Shrubland ecological system.

Related Concepts: This ecological system falls within the Eastside (Interior) Grasslands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the Columbia Plateau Steppe and Grassland as one of their standard mapping units. This system is part of the *Artemisia tridentata – Agropyron spicatum*, *Artemisia tridentata – Festuca idahoensis*, *Artemisia tripartita – Festuca idahoensis*, and *Purshia tridentata – Festuca idahoensis* habitat types of Daubenmire (1970).

References

Baker, W.L. 2006. Fire and Restoration of Sagebrush Ecosystems. Wildlife Society Bulletin: 34(1):177-185.

Burkhardt, J.W. 1996. Herbivory in the Intermountain West. An overview of evolutionary history, historical cultural impacts and lessons from the past. Station Bulletin 58. Idaho Forest, Wildlife and Range Experiment Station, University of Idaho, Moscow. 35 pp.

Daubenmire. R. 1970. Steppe Vegetation of Washington. Washington Agricultural Experiment Station, College of Agriculture, Washington State University. Technical Bulletin 62. Pullman, Washington.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Johnson, C.G. and D.K. Swanson. 2005. Bunchgrass Communities of the Blue and Ochoco Mountains: A Guide for Managers. U.S.D.A. For. Ser. PNW-GTR-641.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Laycock, W. A. 1991. Stable states and thresholds of range condition on North American rangelands. J. Range Management 44(5): 427-433.

Miller, R.F., and L.L. Eddleman. 2001. Spatial and temporal changes of sage grouse habitat in the sagebrush biome. Oregon State Univ. Agric. Exp. Sta. Tech Bull. 151. 35pp.

Mack, R.N. and J.N. Thompson. 1982. Evolution in steppe with few large, hoofed animals. American Naturalist 119: 757-773.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Perryman, B. L., A. M. Maier, A. L. Hild and R. A. Olson. 2001. Demographic characteristics of 3 *Artemisia tridentata* Nutt. subspecies. Journal of Range Management 54: 166-170.

Quinn, M.A. 2004. Influence of habitat fragmentation and crop system on Columbia Basin Shrubsteppe communities. Ecological Applications 14: 1634-1655.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Tyler, K.J. 2006. Biological Crusts: Analysis of Monitoring Techniques at the Yakima Training Center, Washington. M.S. Thesis Central Washington University, Ellensburg, WA. 117p.

Vander Haegen, W.M, S.M. McCorquodale, C.R. Pearson, G.A.Green, and E.Yensen. 2003. Wildlife of Eastside Shrubland and Grassland Habitats. Chapter 11 *in*: Johnson, D.H. and O'Neil T.A. Wildlife-Habitat Relationships in Oregon and Washington. OSU Press. Corvallis, OR. 317-341pp.

Description Author: Rex Crawford and Marion Reid.

Upland Grasslands and Meadows

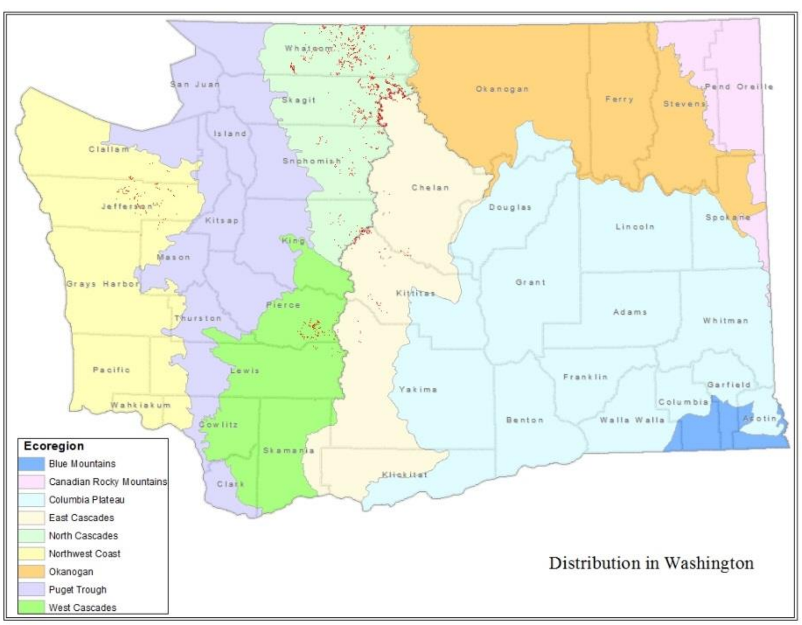
North Pacific Alpine and Subalpine Dry Grassland

Concept: Grasslands dominated by *Festuca viridula* and *F. roemeri* found at subalpine into alpine elevations in the mountains of western Oregon and Washington. These grasslands are found on dry sites, particularly south-facing slopes, which are typically embedded in or above subalpine forests and woodlands.

Conservation Status: Apparently Secure (S4). Potential climate change effects were not considered.

Distribution: This large patch ecological system is found at subalpine into alpine elevations in the mountains of western Oregon and Washington, north into adjacent the Canadian coast ranges and south into northern California. In Washington, this ecological system occurs along the crest of the Cascades and Olympic Mountains.

Environment: In Washington, this ecological system occurs between elevations 1370 and 2600 m elevation (4500-8500 ft.) and is found on dry sites, particularly south-facing slopes. These grasslands are typically embedded in or above subalpine forests and woodlands (Douglas and Bliss 1977). In general, soil textures are much finer, and soils are often deeper under grasslands than in the neighboring forests. Occurrences appear as small openings to large open ridges above or on sites too dry to support high-elevation conifer trees.



Vegetation: These grasslands can appear in transition zones with *Larix lyallii* and/or *Abies lasiocarpa* woodlands. These sites, although composed primarily of tussock-forming species, do exhibit a dense sod that makes root penetration difficult for tree species. Typically more subalpine dominant species include *Festuca idahoensis*, *Festuca viridula*, and *Festuca roemeri* (the latter species occurring only in the Olympic Mountains). *Eucephalus (=Aster) ledophyllus* is frequently present to sometimes co-dominant. *Lupinus (arcticus* ssp. *subalpinus, latifolius)* or *Ligusticum grayi* is often prominent to co-dominant. *Arnica parryi*, *Nothocalais (=Microseris) alpestris*, and *Penstemon confertus* are somewhat frequent in higher elevation sites. *Carex spectabilis*, *Luetkea pectinata*, and *Polygonum bistortoides* are often present to prominent. Other common species include *Potentilla flabellifolia*, *Antennaria lanata*, *Hieracium gracile*, *Juncus parryi*, *Ligusticum grayi*, and *Oreostemma alpigenum* (Crawford and others 2009). Alpine sites are characterized by xeric grasses and a "turf" of sod-forming sedges, dominated by one or more and often an intermixed combination of species. These grasslands often have one or two species having higher cover than the rest, but with usually at least three of the following species are present: *Carex breweri*, *Carex nardina*, *Carex scirpoidea ssp. pseudoscirpoidea, Carex phaeocephala, Festuca brachyphylla* (in the Cascades), *Festuca saximontana* (in the Olympics), and/or *Festuca roemeri (= Festuca idahoensis var. roemeri)*. A variety of other alpine herbaceous species are also typically present such as *Lupinus arcticus* ssp. *subalpinus, Lupinus latifolius, Lupinus sellulus* var. *lobbii*, *Minuartia obtusiloba (= Arenaria obtusiloba), Oreostemma alpigenum, Selaginella wallacei, Sibbaldia procumbens, Silene parryi, Smelowskia ovalis, Solidago multiradiata*, and *Trisetum spicatum alpigenum* (Crawford and others 2009).

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system:

G271 Rocky Mountain Subalpine-Montane Mesic Herbaceous Meadow Group	Global/ State Rank	NatureServe/ WNHP Code
Festuca roemeri - Delphinium glareosum Herbaceous Vegetation	G2/S2	CEGL001613
Festuca roemeri - Phlox diffusa ssp. longistylis Herbaceous Vegetation	G2/S2	CEGL001622
Festuca rubra Montane Herbaceous Vegetation	G2Q/S2?	CEGL001568
Festuca viridula - Carex hoodii Herbaceous Vegetation	G3/SNR	CEGL001596
Festuca viridula - Eucephalus ledophyllus Herbaceous Vegetation	G4/S4	CEGL001632
Festuca viridula - Festuca idahoensis Herbaceous Vegetation	G2?Q/SNR	CEGL001633
Festuca viridula - Lupinus argenteus var. laxiflorus Herbaceous Vegetation	G3Q/SNA	CEGL001634
Festuca viridula - Lupinus latifolius Herbaceous Vegetation	G4/S4	CEGL001635

Ecological Processes: High elevation climatic conditions, drought and site exposure are the primary factors limiting tree growth in this ecological system. Fire can also play a role in maintain these grasslands. However, late season fires may damage *Festuca viridula* plants (LANDFIRE 2007). It is possible that lack of fire has promoted invasion by *Abies lasiocarpa* (Johnson and Clausnitzer 1992). Average fire return interval is estimated to be over 500 years (LANDFIRE 2007) although this type lacks fire history data.

Threats: The primary land uses that alter the natural processes of this system are associated with livestock practices, exotic species, direct soil surface disturbance, and fragmentation. Trampling and associated recreational impacts (e.g., tent sites) are a major source of human disturbance. Introduction of exotic ungulates can have noticeable impacts (e.g., mountain goats in the Olympic Mountains and domestic sheep grazing in the bunchgrass habitats east of the Cascades). Historical domestic sheep grazing may have occurred in these systems but its cumulative effects are unknown (LANDFIRE 2007). Excessive grazing stresses the system through soil disturbance and perennial layers to the establishment of native disturbance increasers (*Lupinus* spp., *Achnatherum* spp., *Carex rossii, and Rudbeckia occidentalis*) in similar Northern Rocky grassland systems (Johnson 2004). Persistent grazing will further diminish native perennial cover;

expose bare ground, and increase erosion and exotics such as *Poa pratensis* (Johnson and Swanson 2005). Grazing effects are usually concentrated in less steep slopes although grazing does create contour trail networks that can lead to addition slope failures. Cattle and heavy use by elk can reduce fescue cover and lead to erosion during summer storms (Johnson and Swanson 2005). Over-grazing can cause soil erosion and an increase in forbs and other grass-like species such as *Lupinus* species, *Juncus parryi, Carex* species, *Achnatherum occidentale* and *Penstemon* species (LANDFIRE 2007). Schreiner (1994), in an Olympic Mountain goat study, considered *Achillea millefolium, Cirsium edule,* and *Phacelia hastata* disturbance increasers.

Classification Comments: This system is similar to the Northern Rocky Mountain Subalpine-Upper Montane Grassland, differing in that the North Pacific Grassland system includes dry alpine habitats, more Vancouverian floristic elements, greater snowpack, and higher overall precipitation. The North Pacific Alpine and Subalpine Dry Grassland is less mesic and includes few if any shrubs than the higher elevation North Pacific Dry and Mesic Alpine Dwarf-Shrubland, Fell-field and Meadow system.

Related Concepts: This ecological system falls within the Alpine Grasslands and Shrublands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the North Pacific Alpine and Subalpine Dry Grassland as one of their standard mapping units.

References

Crawford, R. C., C. B. Chappell, C. C. Thompson, and F. J. Rocchio. 2009. Vegetation Classification of Mount Rainier, North Cascades, and Olympic National Parks. Natural Resource Technical Report NPS/NCCN/NRTR—2009/D-586. National Park Service, Fort Collins, Colorado.

Douglas, G.W. and L. C. Bliss. 1977. Alpine and high subalpine plant communities of the North Cascades Range, Washington and British Columbia. Ecol. Monographs 47: 113-150.

Henderson, J. A. 1974. Composition, distribution and succession of subalpine meadows in Mount Rainier National Park, Washington. 150p. Ph.D. dissertation, Oregon St. Univ., Corvallis, OR.

Johnson, C.G. 2004. Alpine and Subalpine Vegetation of the Wallowa, Seven Devils and Blue Mountains. U.S.D.A. For. Ser. R6-NR-ECOL-TP-03-04.

LANDFIRE. 2007. North Pacific Alpine-Subalpine Dry Grassland. BPS 0111710. *in:* Landfire Biophysical Setting Descriptions. http://www.landfire.gov/NationalProductDescriptions20.php

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

LANDFIRE. 2007. Biophysical Setting Model: 0111710 North Pacific Alpine and Subalpine Dry Grassland. http://www.landfire.gov/NationalProductDescriptions24.php

Johnson, C.G. and D.K. Swanson. 2005. Bunchgrass Communities of the Blue and Ochoco Mountains: A Guide for Managers. U.S.D.A. For. Ser. PNW-GTR-641.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Schreiner, E.G. 1994. Appendix A1: Vegetation Sampling. IN: Houston, D.B., E.C. Schriener and B.B. Moorhead eds. 1994. Mountain Goats in Olympic National Park: Biology and Management of an Introduced Species. YUSDI Scientific Monograph PS/NROLYN/NRSM 94/25.

Description Author: Rex Crawford.

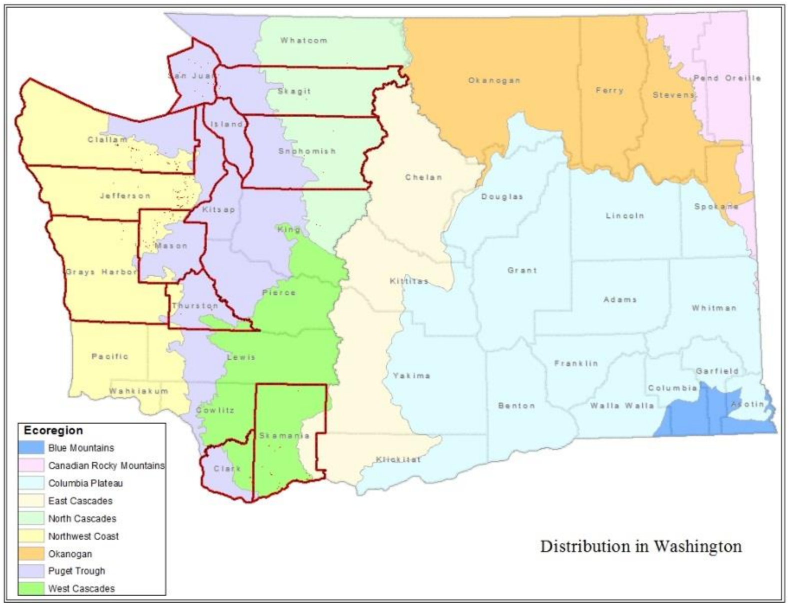
UPLAND GRASSLANDS AND MEADOWS

NORTH PACIFIC HERBACEOUS BALD AND BLUFF

Concept: Small grasslands or herbaceous-dominated patches that occur on steep, hilly terrain in the lowlands to mid-montane elevations in western Washington. These balds and bluffs occur on sites that are too dry or marginal for tree growth due to shallow soils, steep slopes, sunny aspect, and/or upper slope position. Dominant or codominant native grasses include *Festuca roemeri, Danthonia californica, Achnatherum lemmonii, Festuca rubra* (near saltwater), and *Koeleria macrantha*. Forb diversity can be high.

Conservation Status: Vulnerable (S3). This system is uncommon but widely distributed in western Washington. Most occurrences are small patches within forests and are susceptible to tree invasion. Exotic grasses and shrubs can be problematic particularly in developed or timber managed landscapes.

Distribution: This grassland / herbaceous-dominated, small patch system occurs on steep, hilly terrain in the lowlands to mid-montane elevations from eastern Vancouver Island and the Georgia Basin south to at least the southern end of the Willamette Valley and adjacent slopes of the Coast Ranges and western Cascades, excluding areas adjacent to the outer coastline (e.g., have hypermaritime climate). In Washington, balds and bluffs are found in the Olympic Mountains rain shadow, especially in the San Juan Islands, as well as in other edaphically dry sites in the South Puget Sound region.



Distribution in Washington

Environment: This system occurs on sites that are dry and marginal for tree establishment and growth (except in favorable microsites) due to shallow soils, steep slopes, sunny aspect, and/or upper slope position. The climate is relatively dry to wet (20 to 100 inches annual precipitation), always with a distinct dry summer season when these sites usually become droughty enough to limit tree growth and establishment. Most sites receive little snowfall, although sites in the *Abies amabilis* zone can have significant winter snowpack. Snowpack would be expected to melt off sooner on these sunny aspect sites than surrounding areas. Seeps are frequent features that result in vernally moist to wet areas. Small seeps would be included in this system but larger seep areas (>0.5 acre) would be included in the Temperate Pacific Freshwater Emergent Marsh system. Rock outcrops are a typical small-scale feature within balds and are considered part of this system (Chappell 2006).

Vegetation: Vegetation varies among and within individual balds with relative differences in soil moisture. Grasslands are the most prevalent vegetation cover, though forblands are also common especially in the mountains. Dwarf-shrublands commonly occur, especially in mountains or foothills, as very small patches, usually in a matrix of herbaceous vegetation. Balds with many favorable microsites can have a "savanna" type structure with a sparse tree layer of *Pseudotsuga menziesii* or, less commonly at lower elevations, *Arbutus menziesii* or *Quercus garryana*. Dominant or codominant native grasses include *Festuca roemeri*, *Danthonia californica*, *Achnatherum lemmonii*, *Festuca rubra* (near saltwater), and *Koeleria macrantha* (Chappell 2006). Forb diversity can be high and can include species such as *Camassia quamash*, *Camassia leichtlinii*, *Triteleia hyacinthina*, *Mimulus guttatus* (seeps), *Plectritis congesta*, *Lomatium martindalei*, *Allium cernuum*, and *Phlox diffusa* (can be considered a dwarf-shrub). Important dwarf-shrubs are *Arctostaphylos uva-ursi*, *Arctostaphylos nevadensis*, and *Juniperus communis*. Small patches and strips dominated by the shrub *Arctostaphylos columbiana* are a common feature associated with some herbaceous balds. Significant portions of balds, especially on rock outcrops, are dominated by bryophytes (mosses) and to a lesser degree lichens.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Groups and Associations that are associated with this ecological system:

G282 Western North American Montane Sclerophyll Scrub	**Global/ State Rank**	**NatureServe/ WNHP Code**
Arctostaphylos columbiana Herbaceous Vegetation	GNR/S3	TBD (Crawford et al. 2009)
G488 Southern Vancouverian Shrub & Herbaceous Bald, Bluff & Prairie Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Achnatherum lemmonii / Racomitrium canescens Herbaceous Vegetation	G1/S1	CEGL001800
Allium cernuum Herbaceous Vegetation	GNR?/S1	TBD (Chappell 2006)
Arctostaphylos (nevadensis, uva-ursi) - Juniperus communis Herbaceous Vegetation	GNR/S3S4	TBD (Chappell 2006)
Arctostaphylos uva-ursi - Fragaria virginiana - (Festuca roemeri) Herbaceous Vegetation	GNR/S3S4	TBD (Chappell 2006)
Balsamorhiza deltoidea Herbaceous Vegetation [Provisional]	GNR/S1Q	TBD (Chappell 2006)
Calamagrostis howellii Herbaceous Vegetation [Provisional]	GNR/S1Q	TBD (Chappell 2006)
Calamagrostis nutkaensis - Vicia nigricans ssp. gigantea - (Equisetum telmateia) Herbaceous Vegetation	GNR/S1	TBD (Chappell 2006)
Camassia quamash - Triteleia hyacinthina Herbaceous Vegetation	GNR/S1S2	TBD (Chappell 2006)
Carex inops - Eriophyllum lanatum Herbaceous Vegetation	GNR/S2	TBD (Chappell 2006)
Danthonia californica - Eriophyllum lanatum Herbaceous Vegetation	GNR/S1	TBD (Chappell 2006)
Festuca roemeri – (Cerastium arvense - Koeleria macrantha) Herbaceous Vegetation	G2/S2	CEGL003349
Festuca roemeri – Camassia leichtlinii Herbaceous Vegetation	GNR/S1	TBD (Chappell 2006)
Festuca roemeri – Camassia quamash - Cerastium arvense Herbaceous Vegetation	GNR/SH	TBD (Chappell 2004; Rocchio et al. 2012)
Festuca roemeri - Plectritis congesta Herbaceous Vegetation	GNR/S1	TBD (Chappell 2006)

UPLAND GRASSLANDS AND MEADOWS

G282 Western North American Montane Sclerophyll Scrub	Global/ State Rank	NatureServe/ WNHP Code
Festuca rubra - (Camassia leichtlinii, Grindelia stricta var. stricta) Herbaceous Vegetation	G1/S1	CEGL003347
Festuca rubra - Festuca roemeri - Aspidotis densa Herbaceous Vegetation	GNR/S1	TBD (Chappell 2006)
Juniperus communis - (Phlox diffusa) Herbaceous Vegetation	GNR/S3S4	TBD (Chappell 2006)
Koeleria macrantha - (Agrostis pallens) Herbaceous Vegetation	GNR/S1	TBD (Chappell 2006)
Lomatium martindalei Herbaceous Vegetation	G2/S2	TBD (Chappell 2006)
Mimulus guttatus - Triteleia hyacinthina Herbaceous Vegetation	GNR/S2	TBD (Chappell 2006)
Phlox diffusa - (Lomatium martindalei - Penstemon subserratus) Herbaceous Vegetation	GNR/S2S3	TBD (Chappell 2006)
Plectritis congesta Herbaceous Vegetation	GNR/S1Q	TBD (Chappell 2006)
Senecio integerrimus var. ochroleucus Herbaceous Vegetation [Provisional]	GNR/S1Q	TBD (Chappell 2006)
Triteleia hyacinthina Herbaceous Vegetation	GNR/S2	CWWA000243

Ecological Processes: Landslides are a significant disturbance on coastal bluffs without persistent salt spray and high winds, especially on bluffs composed of glacial deposits. Landslides can both destroy these herbaceous communities and create new habitat for them by creating barren surfaces. Fires, both lightning-ignited and those ignited by people, occasionally burn these sites. Lower elevation sites probably burned more frequently and in some cases intentionally. Due to shallow soils, steep slopes, sunny aspect, and/or upper slope position, these sites are dry and marginal for tree establishment and growth except in favorable microsites. Disturbance patches within that are part of the variation the matrix forest may appear similar to balds but have a preponderance of forest species, such as, *Gaultheria shallon* and *Mahonia nervosa*.

Threats: The exclusion of fire from most of this system over the last 100+ years has resulted in profound changes. Except on the very driest sites, encroachment by trees (such as *Pseudotsuga menziesii*) and shrubs, in the absence of fire, is a "natural" process that occurs eventually on the vast majority of balds. This encroachment leads to the conversion of herbaceous-dominance to shrublands or forests. Nonnative species such as *Cytisus scoparium*, *Hypericum perforatum*, *Hypochaeris radicata*, *Holcus lanatus*, *Chrysanthemum leucanthemum*, *Agrostis capillaris*, *Anthoxanthum odoratum*, *Poa pratensis*, *Arrhenatherum elatius*, *Taeniatherum caput-medusae*, *Festuca arundinacea*, *Hieracium pilosella*, *Potentilla recta*, *Centaurea* spp., and *Bromus mollis* are prominent in this habitat and generally increase after ground-disturbing activities like off-road vehicle use. Prescribed fire and other management tools have been used recently to control *Cytisus scoparium*, *Pseudotsuga menziesii* encroachment, and to attempt to mimic historical conditions in some areas. Recreation, as well as timber harvest activities and road-building, should avoid high-quality examples of this system due to the potential for spread of non-native species and relatively fragile soils.

Classification Comments: The closely related North Pacific Hypermaritime Shrub and Herbaceous Headland system is associated with persistent salt spray and high winds in a hypermaritime climate and also differs by having a distinct, often more shrubby flora (*Gaultheria shallon, Vaccinium ovatum;* grasses: *Calamagrostis nutkaensis, Festuca rubra*). Balds differ from the Willamette Valley Upland Prairie system in that balds: (1) occur on slopes, (2) are associated with relatively shallow soils and an underlying restrictive layer of bedrock, and (3) tend to be small patches in a forest matrix (Chappell 2006). Small seeps would be included in this system but larger seep areas (>0.5 acre) would be included in the Temperate Pacific Freshwater Emergent Marsh system. Rock outcrops are a typical small-scale feature within balds and are considered part of this system (Chappell 2006).

Related Concepts: This ecological system falls within the Westside Grasslands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize the North Pacific Herbaceous Bald and Bluff as a unique mapping unit and did not aggregate it into another mapping unit.

References

Chappell, C.B. 2004. Upland Plant Associations of the Puget Trough Ecoregion, Washington. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. Online: http://www1.dnr.wa.gov/nhp/refdesk/communities/index.html

Chappell, C.B. 2006. Plant Associations of Balds and Bluffs of western Washington. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. Online: http://www1.dnr.wa.gov/nhp/refdesk/communities/index.html

Crawford, R. C., C. B. Chappell, C. C. Thompson, and F. J. Rocchio. 2009. Vegetation Classification of Mount Rainier, North Cascades, and Olympic National Parks. Natural Resource Technical Report NPS/NCCN/NRTR—2009/D-586. National Park Service, Fort Collins, Colorado.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Rocchio, F. J., R. C. Crawford, and C. Copass. 2012. San Juan Island National historical Park vegetation classification and mapping project report. Natural Resource Report NPS/NCCN/NRR—2012/603. National Park Service, Fort Collins, Colorado.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Description Author: Rex Crawford, Chris Chappell and Marion Reid.

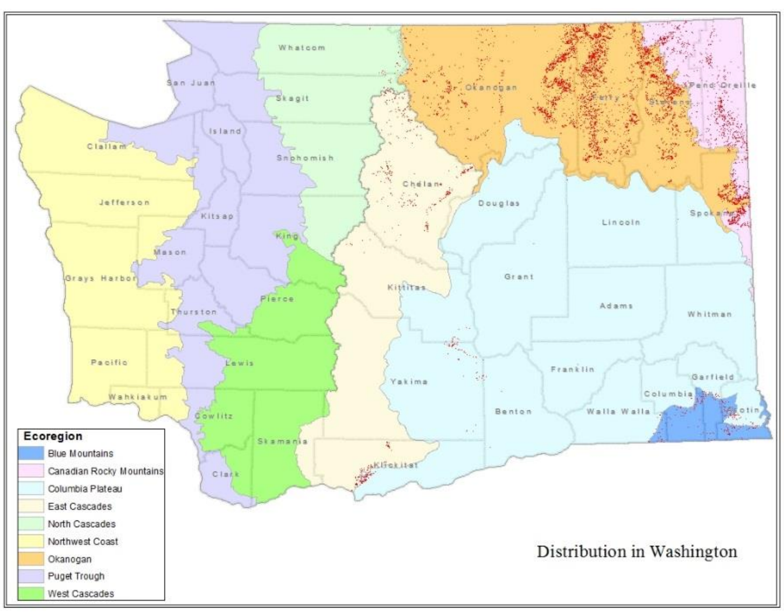
UPLAND GRASSLANDS AND MEADOWS

NORTHERN ROCKY MOUNTAIN LOWER MONTANE, FOOTHILL, AND VALLEY GRASSLAND

Concept: Grasslands dominated by mid-tall bunchgrasses, such as *Pseudoroegneria spicata*, *Festuca campestris*, *Festuca idahoensis* or *Koeleria macrantha*, on level to moderate slopes and on steep slopes not associated with canyons. These grasslands range from small meadows to open parks surrounded by conifers within lower montane forests in the mountains surrounding the Columbia Basin and as foothill and valley grasslands below the lower tree line.

Conservation Status: Vulnerable (S3S4).

Distribution: This large patch ecological system occurs at lower montane to foothill elevations in the mountains and large valleys of northeastern Wyoming and western Montana, west through Idaho into the Blue Mountains of Oregon, and north into the Okanagan and Fraser plateaus of British Columbia and the Canadian Rockies. In Washington, this ecological system occurs at elevations from 1500-5500 ft. (500 to 1650 m), ranging from small meadows to open parks surrounded by conifers within lower montane forests in the mountains surrounding the Columbia Basin and as foothill and valley grasslands below the lower tree line. The system lies above the Intermountain Basins Big Sagebrush Steppe and below or within Northern Rocky Mountain Ponderosa Pine and Northern Rocky Mountain Dry-Mesic Forest ecological systems.



Environment: In Washington, this system typically receives 20-30 inches (50 -75 cm) annual precipitation, much of it as snow and spring rains. Soils are relatively deep to shallow, often with coarse fragments, and non-saline. Soils dry by mid-summer and limit tree and shrub invasion. Unvegetated mineral soil is commonly found between clumps of grass and occasionally a moss/lichen cover particularly on rocky sites. Steep slopes, shallow skeletal soils, and sites with heavy native ungulate use that reduce foliar and litter cover have more exposed soil and apparently support more soil moss/lichens (Johnson and Swanson 2005). Greater crust cover occurs on north- and east-facing slopes at mid elevations with stable, silt-loam or calcareous soils where not disturbed (Tyler 2006) or where vascular cover and litter are not limiting soil moss/lichens.

Vegetation: The most important species are cool-season, perennial bunchgrasses and forbs (>25% cover), sometimes with a sparse (<10% cover) shrub layer. Mid-tall bunchgrasses, such as *Pseudoroegneria spicata, Festuca campestris, Festuca idahoensis* or *Koeleria macrantha*, commonly dominate sites on level to moderate slopes and on steep slopes not associated with canyons. *Danthonia unispicata* and *Poa secunda* are important shorter bunchgrasses. Other possible graminoids include *Achnatherum occidentale (= Stipa occidentalis), Achnatherum richardsonii, Bromus inermis, Calamagrostis rubescens, Carex geyeri, Carex pensylvanica, Elymus trachycaulus, Festuca washingtonica, Hesperostipa comata, Hesperostipa curtiseta, Leymus cinereus,* and *Pascopyrum smithii*. Other grassland species include *Artemisia frigida*, and *Selaginella densa*. Shrub species may be scattered, including *Eriogonum heracleoides*, *Amelanchier alnifolia, Rosa* spp., *Symphoricarpos* spp., *Juniperus communis, Artemisia tridentata*, and *Artemisia tripartita*. Common associated forbs include *Geum triflorum, Galium boreale, Campanula rotundifolia, Antennaria* spp., *Geranium viscosissimum*, and *Potentilla gracilis*.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system:

G273 Central Rocky Mountain Lower Montane, Foothill & Valley Grassland Group	Global/ State Rank	NatureServe/ WNHP Code
Festuca campestris - (Festuca idahoensis) - Achnatherum richardsonii Herbaceous Vegetation	G2G3/SNR	CEGL005869
Festuca campestris - Festuca idahoensis - Geranium viscosissimum Herbaceous Vegetation	G3?/SNR	CEGL005870
Festuca campestris - Festuca idahoensis Herbaceous Vegetation	G3/S1	CEGL005875
Festuca idahoensis - Eriogonum heracleoides Herbaceous Vegetation	G2/S2	CEGL001616
Festuca idahoensis - Hieracium cynoglossoides Herbaceous Vegetation	G1G2/S1	CEGL001619
Festuca idahoensis - Koeleria macrantha Herbaceous Vegetation	G3Q/S1	CEGL001620
Festuca idahoensis - Pseudoroegneria spicata Herbaceous Vegetation	G4/S2	CEGL001624
Lomatium cous - Poa secunda Herbaceous Vegetation	G4/SNA	CEGL001790

Ecological Processes: These grasslands represent a shift in the precipitation regime from summer monsoons and cold snowy winters found in the southern Rockies to predominantly dry summers and winter precipitation in the Pacific Northwest and Northern Rockies. A high-frequency fire regime presumed to be less than 35 years, (Johnson and Swanson 2005), along with soil drought and herbivory, restricts woody species invasion resulting in a patchy distribution of shrubs and trees when present. The most droughty sites produce little and discontinuous fuel and likely have much longer fire regimes. Isolation of grassland patches by fragmentation may also limit seed dispersal of native shrubs leading to persistence of the grassland.

Threats: The primary land uses that alter the natural processes of this system are associated with livestock practices, exotic species, fire regime alteration, direct soil surface disturbance, and fragmentation. Excessive grazing stresses the system through soil disturbance increasing the probability of establishment

of native disturbance increasers and annual grasses, particularly exotic annual bromes (*Bromus commutatus, japonicus, mollis, tectorum*) and *Ventenata dubia*) on more xeric sites and exotic perennial grasses *Bromus inermis*, *Phleum pratense*, and *Poa pratensis* on more mesic sites. Other exotic species threatening this ecological system through invasion and potential complete replacement of native species include *Hypericum perfoliatum, Potentilla recta, Euphorbia esula*, and knapweeds, especially *Centaurea biebersteinii (= Centaurea maculosa)*. Persistent grazing will further diminish native perennial cover, expose bare ground, and increase exotics (Johnson and Swanson 2005). Darambazar (2007) cites Johnston (1962) that when bare ground is approximately 15%, reduced infiltration and increased runoff occurs in *Festuca* grassland ecosystems. Fire further stresses livestock altered vegetation by increasing exposure of bare ground and consequent increases in exotic annuals and decrease in perennial bunchgrass. Grazing effects are usually concentrated in less steep slopes although grazing does create contour trail networks that can lead to addition slope failures. Fire suppression leads to deciduous shrubs, *Symphoricarpos* spp., *Physocarpus malvaceus, Holodiscus discolor*, and *Ribes* spp. and in some areas trees (*Pseudotsuga menziesii*) to increase.

Davies and others (2009) conclude that sites with heavy litter accumulation, (e.g., an ungrazed *Artemisia tridentata* ssp. *wyomingensis/Festuca idahoensis – Achnatherum thurberiana* community) are more susceptible to exotic annual invasion following fire than those with less litter accumulation. They note that introduced species and changes in climate can change ecosystem response to natural disturbance regimes. Johnson and Swanson (2005) note that *Festuca idahoensis* decreases following fire, however following a flush of annuals, *Festuca* regains pre-fire cover after a few years.

Classification Comments: These grasslands are floristically similar to Inter-Mountain Basins Big Sagebrush Steppe, Columbia Basin Foothill and Canyon Dry Grassland, and Columbia Basin Palouse Prairie, but are defined by shorter summers, colder winters, and young soils derived from recent glacial and alluvial material. These grasslands represent a shift in the precipitation regime from summer monsoons and cold snowy winters found in the southern Rockies to predominantly dry summers and winter precipitation in the Pacific Northwest and Northern Rockies. Although currently included in the Inter-Mountain Basins Big Sagebrush Steppe system, there has been past consideration of including Daubenmire's *Artemisia tripartita – Festuca idahoensis*. zone within the Northern Rocky Mountain Lower Montane, Foothill, and Valley Grassland system due to it having similar species composition, climate, and overlap in elevation with the latter.

Related Concepts: This ecological system falls within the Eastside (Interior) Grasslands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the Northern Rocky Mountain Lower Montane, Foothill, and Valley

Grassland as a unique mapping unit. This system is partially within the *Festuca idahoensis – Hieracium cynoglossoides* and *Festuca idahoensis – Rosa nutkana* habitat types of Daubenmire (1970).

References

Darambazar, E., T. DelCurto, D. Damiran, A. A. Clark, and R. V. Taylor. 2007. Species composition and diversity on northwestern bunchgrass prairie rangelands. *In:* Proceedings of Western Section, American Society of Animal Sciences 58:233-236.

Daubenmire. R. 1970. Steppe Vegetation of Washington. Washington Agricultural Experiment Station, College of Agriculture, Washington State University. Technical Bulletin 62. Pullman, Washington

Davies, K.W., T.J. Svejcar and J.D. Bates. 2009. Interaction of historical and nonhistorical disturbances maintains native plant communities. Ecological Applications, 19(6), pp. 1536–1545.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Johnson, C.G. and D.K. Swanson. 2005 Bunchgrass Communities of the Blue and Ochoco Mountains: A Guide for Managers. U.S.D.A. For. Ser. PNW-GTR-641.

Johnston, A. 1962. Effects of grazing intensity and cover on the water-intake rate of fescue grassland. J. Range Manage. 15:79-87.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Tyler, K.J. 2006. Biological Crusts: Analysis of Monitoring Techniques at the Yakima Training Center, Washington. M.S. Thesis Central Washington University, Ellensburg, WA. 117p.

Description Author: Rex Crawford, Marion Reid, and Gwen Kittel.

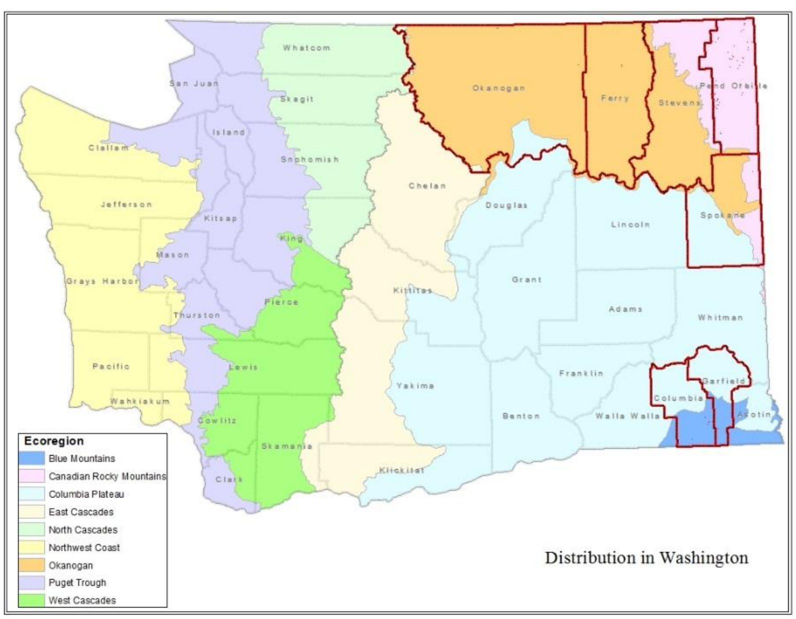
UPLAND GRASSLANDS AND MEADOWS

NORTHERN ROCKY MOUNTAIN SUBALPINE-UPPER MONTANE GRASSLAND

Concept: Upper montane to subalpine grasslands in the mountains of eastern Washington. These grasslands are lush and dominated by perennial grasses and forbs on dry sites, particularly south-facing slopes.

Conservation Status: Vulnerable (S3S4).

Distribution: This large patch ecological system is found at upper montane into subalpine elevations in the mountains of western Montana, west through Idaho into eastern Oregon and Washington, and north into the Okanagan and Fraser plateaus of British Columbia and the Canadian Rockies. They are lush grasslands dominated by perennial grasses and forbs on dry sites, particularly south-facing slopes. They also occur as small meadows to large open parks surrounded by conifer trees but lack tree cover within them. Northern Rocky Mountain Subalpine-Upper Montane Grassland is a large patch to small system within mid to high elevation forests and is most extensive in the Canadian Rockies portion of the Rocky Mountain cordillera. In Washington, this ecological system ranges from small meadows to open parks surrounded by conifers in the upper montane grasslands below the upper tree line.



Environment: Soil textures are generally much finer, and soils are often deeper under these grasslands than in the neighboring forests. These grasslands are also found as "balds" on rocky or shallow soil areas.

Vegetation: Although composed primarily of tussock-forming species, a dense sod can be present which makes root penetration difficult for trees. Typical dominant species include *Festuca campestris, Festuca idahoensis, Festuca viridula* (a characteristic species in Washington), *Elymus trachycaulus, Leymus innovatus (= Elymus innovatus), Koeleria* *macrantha*, *Achnatherum occidentale (= Stipa occidentalis)*, *Achnatherum richardsonii (= Stipa richardsonii)*, *Bromus inermis ssp. pumpellianus (= Bromus pumpellianus)*, *Elymus trachycaulus*, *Phleum alpinum*, *Trisetum spicatum*, and a variety of Carices, such as *Carex hoodii*, *Carex obtusata*, and *Carex scirpoidea*. Important forbs include *Lupinus argenteus* var. *laxiflorus*, *Potentilla diversifolia*, *Potentilla flabellifolia*, *Fragaria virginiana*, and *Chamerion angustifolium (= Epilobium angustifolium)*. *Festuca viridula* sites in undisturbed condition form closed sods with little exposed soils or microphytic crusts and little forb cover (Johnson and Swanson 2005). *Festuca idahoensis* communities are typically associated with more open bunchgrass cover typically with mosses or gravel/bareground (Johnson and Swanson 2005). Balds have an abundance of bryophytes.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Groups and Associations that are associated with this ecological system:

G267 Central Rocky Mountain Montane Grassland Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Carex hoodii - Festuca idahoensis Herbaceous Vegetation	G2/S2	CEGL001595
G268 Southern Rocky Mountain Montane-Subalpine Grassland Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Danthonia intermedia Herbaceous Vegetation	G2G3/S2S3	CEGL001794
G271 Rocky Mountain Subalpine-Montane Mesic Herbaceous Meadow Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Festuca viridula - Carex hoodii Herbaceous Vegetation	G3/SNR	CEGL001596
Festuca viridula - Festuca idahoensis Herbaceous Vegetation	G2?Q/SNR	CEGL001633
Festuca viridula - Lupinus argenteus var. laxiflorus Herbaceous Vegetation	G3Q/SNA	CEGL001634

Ecological Processes: Disturbance such as fire and big game browsing also play a role in maintaining these open grassy areas. Generally sites are too droughty or otherwise too severe to support trees. Late season fires may damage *Festuca viridula* plants (LANDFIRE 2007). It is possible that lack of fire has promoted invasion by *Abies lasiocarpa* and *Pinus albicaulis* (Johnson and Clausnitzer 1992). Average fire return interval is estimated to be over 200 years (1000 yrs. in LANDFIRE2007) although this type lacks fire history data. Over-grazing can cause soil erosion and an increase in forbs and other grasslike species such as *Lupinus* species, *Juncus parryi*, *Carex* species, *Achnatherum occidentale* and *Penstemon* species (LANDFIRE 2007).

Threats: The primary land uses that alter the natural processes of this system are associated with livestock practices, exotic species, direct soil surface disturbance, and fragmentation. Excessive grazing stresses the system through soil disturbance and can cause an increase in forbs and other grasslike species such as *Lupinus* species, *Juncus parryi*, *Carex* species, *Achnatherum occidentale* and *Penstemon* species (LANDFIRE 2007). In Montana in subalpine grassland drier sites, *Potentilla recta*, *Euphorbia esula*, *Centaurea spp.*, *Hypericum perforatum*, and *Cardaria draba* are problematic species while mesic sites include *Hieracium pratense*, *H. ×floribundum*, *H. piloselloides*, *Hieracium aurantiacum*, *Leucanthemum vulgare*, *Ranunculus acris*, and *Cirsium arvense*, *Poa pratensis*, *Phleum pratense*), and *Bromus inermis* can be threats (Montana Field Guide 2010). Persistent grazing will further diminish native perennial cover; expose bare ground, and increase erosion and exotics such as *Poa pratensis* (Johnson and Swanson 2005). Grazing effects are usually concentrated in less steep slopes although grazing does create contour trail networks that can lead to addition slope failures. Cattle and heavy use by elk can reduce fescue cover and lead to erosion during summer storms (Johnson and Swanson 2005).

UPLAND GRASSLANDS AND MEADOWS

Classification Comments: This system is similar to the Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland but this system is found at higher elevations and supports more subalpine taxa. Occurrences of the upper montane system are often more forb-rich than Southern Rocky Mountain Montane-Subalpine Grassland (Rydberg 1915). This system can occur as small patches within the Northern Rocky Mountain Montane Mesic Forest and Rocky Mountain Subalpine Mesic-Wet and Dry-Mesic Forest ecological systems. It can also be confused with the higher elevation Northern Rocky Mountain Subalpine Woodland and Parkland, Rocky Mountain Alpine Turf and North Pacific Alpine and Subalpine Dry Grassland systems.

Related Concepts: This ecological system falls within the Alpine Grasslands and Shrublands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the Northern Rocky Mountain Subalpine-Upper Montane Grassland as a unique mapping unit.

References

Johnson, C.G. 2004. Alpine and Subalpine Vegetation of the Wallowa, Seven Devils and Blue Mountains. U.S.D.A. For. Ser. R6-NR-ECOL-TP-03-04.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Johnson, C.G. and D.K. Swanson. 2005. Bunchgrass Communities of the Blue and Ochoco Mountains: A Guide for Managers. U.S.D.A. For. Ser. PNW-GTR-641.

Johnson, C. G., and R. R. Clausnitzer. 1992. Plant associations of the Blue and Ochoco Mountains. USDA Forest Service, Pacific Northwest Region, Wallowa-Whitman National Forest R6-ERW-TP-036-92. 163 pp. plus appendices.

Montana Field Guide. 2010. Rocky Mountain Subalpine-Upper Montane Grassland — Northern Rocky Mountain Subalpine-Upper Montane Grassland. Retrieved on December 22, 2010. http://FieldGuide.mt.gov/displayES_Detail.aspx?ES=7113

LANDFIRE. 2007. North Pacific Subalpine Upper Montane Grassland. BPS 101140. *in:* Landfire Biophysical Setting Descriptions. http://www.landfire.gov/NationalProductDescriptions20.php

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Rydberg, P. A.1915. Phytogeographical Notes on the Rocky Mountain Region V. Grasslands of the Subalpine and Montane Zones *Bulletin of the Torrey Botanical Club* 42(11):629-642.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Description Author: Rex Crawford and Marion Reid.

ROCKY MOUNTAIN SUBALPINE-MONTANE MESIC MEADOW

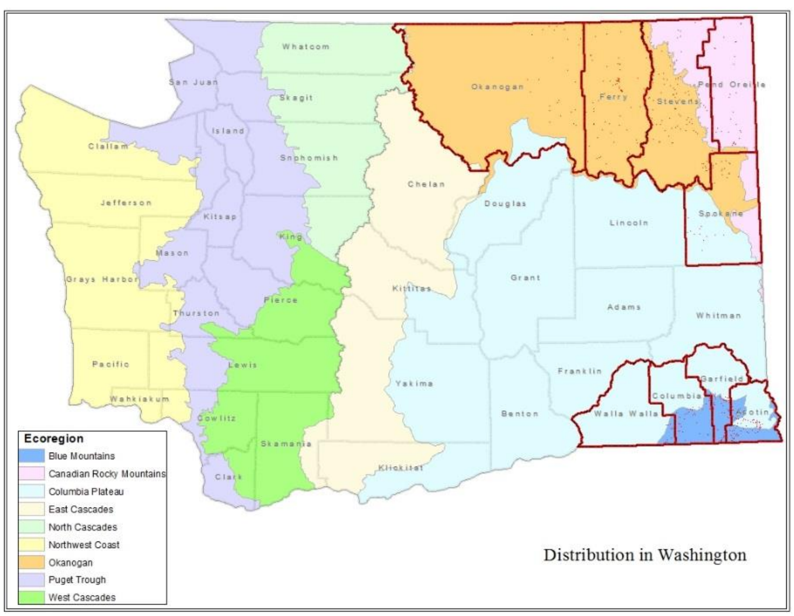
Concept: Subalpine to montane forb-dominated meadows. Many occurrences are small patches found in mosaics with woodlands, dense shrublands, or just below alpine communities. The system is restricted to lower montane to subalpine sites where finely textured soils, snow deposition, or windswept dry conditions limit tree establishment.

Conservation Status: Apparently Secure (S3S5).

Distribution: This is a small to large patch system that occurs throughout the Rocky Mountains restricted to lower montane to subalpine sites where finely textured soils, snow deposition, or windswept dry conditions limit tree establishment.

Environment: Sites have finely textured soils, snow deposition, or windswept dry conditions which limit tree establishment. Sites are gentle to moderate-gradient slopes. Soils are typically seasonally moist to saturated in the spring that will dry out later in the growing season. At montane elevations, soils have an A-horizon over 10 cm (4 in) are usually clays or silt loams, and some occurrences may have inclusions of hydric soils in low, depressional areas (Luna and Vance 2010). At subalpine elevations, soils are derived a variety of parent materials, and are usually rocky or gravelly with good aeration and drainage, but with a well-developed organic layer (Luna and Vance 2010).

Vegetation: Vegetation is typically forb-rich, with forbs often contributing more to overall herbaceous cover than graminoids. Tall forb-dominated mesic meadows are typically composed of a wide diversity of genera. Important forb taxa include *Erigeron* spp., Asteraceae spp., *Mertensia* spp., *Penstemon* spp., *Campanula* spp., *Lupinus* spp., *Solidago* spp., *Ligusticum* spp., *Thalictrum occidentale*, *Valeriana sitchensis*, *Rudbeckia occidentalis*, *Balsamorhiza sagittata*, and *Wyethia* spp. Some stands are comprised of dense grasslands, these often being taxa with relatively broad and soft blades *Luzula* and *Bromus*. Important grasses include *Deschampsia caespitosa*, *Koeleria macrantha*, perennial *Bromus* spp., and a number of *Carex* species. *Dasiphora fruticosa* ssp. *floribunda* and *Symphoricarpos* spp. are occasional shrubs that are never abundant. Northern Rocky Mountain montane elevations can have *Allium schoenoprasum*, *Arnica chamissonis*, *Camassia quamash*, *Erigeron speciosus*, *Eucephalus* and *Symphyotrichum* species, *Mertensia* spp., *Chamerion angustifolium*, *Hackelia* spp., *Penstemon procerus*, *Geum macrophyllum*, *Campanula rotundifolia*, *Solidago canadensis*, *Zigadenus elegans*, *Thalictrum occidentale*, *Senecio hydrophiloides* and *Senecio serra* are important flowering forbs (Luna and Vance 2010). *Camassia quamash* dominates some mesic meadows that were important food gathering sites and were intensively managed for food production by indigenous people. At more subalpine elevations, *Senecio*



Distribution in Washington

triangularis, *Erigeron peregrinus*, *Erythronium grandiflorum*, *Ligusticum* species, *Veratrum viride* and *Valeriana* species become more important forbs (Luna and Vance 2010).

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system:

G271 Rocky Mountain Subalpine-Montane Mesic Herbaceous Meadow Group	Global/ State Rank	NatureServe/ WNHP Code
Chamerion angustifolium Rocky Mountain Herbaceous Vegetation	G4G5/SNR	CEGL005856
Xerophyllum tenax Herbaceous Vegetation	GNR/SNR	CEGL005859

Ecological Processes: Natural burrowing mammal disturbance regimes at montane elevations can increase forb diversity. Early successional stages may be dominated by *Agastache urticifolia*, *Fragaria virginiana*, *Urtica dioica*, *Achillea millefolium*, and other forbs, and small amounts of mesic grasses such as *Bromus carinatus* and *Deschampsia cespitosa*. Stand replacement fires are most common, with an approximate 40 year return interval (Fire regime II LANDFIRE 2007). Mixed severity fires with a mean return interval of 75years influence late development of meadows by removing shrubs (LANDFIRE 2007). Fire starts were likely native peoples or from adjacent shrub or tree-dominated sites (LANDFIRE 2007). Patch size is 10 to 300 acres (LANDFIRE 2007).

Threats: This system is tolerant of moderate-intensity ground fires and late-season livestock grazing (Kovalchik 1987). Herbaceous mesic meadows that have experienced intensive grazing are often susceptible to invasive non-native vegetation. Typically, disturbed meadows contain *Poa pratensis*, *Bromus inermis* and *Phleum pratense* at lower to montane elevations. *Taraxacum officinale* can replace native forb diversity in continuously disturbed areas. Highly invasive noxious species such as *Hieracium caespitosum*, *Hieracium aurantiacum*, *Ranunculus acris*, and *Leucanthemum vulgare* are and pose a real threat to the structure and diversity of these meadows (Luna and Vance 2010). Livestock use and heavy horse or foot traffic can lead to trampling and soil compaction. Slow growth in this habitat prevents rapid recovery.

Classification Comments: Dominance of forbs distinguishes this type from other montane upland herbaceous systems such as the Northern Rocky Mountain Subalpine - Upper Montane Grassland and Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland systems dominated by perennial graminoids. Sites are not as wet as those found in Rocky Mountain Alpine-Montane Wet Meadow system. LANDFIRE (2007) concluded that there is little information about this type. As described, the system appears to be mostly the dry and lower elevation spectrum of the Rocky Mountain Alpine-Montane Wet Meadow system and the forb-rich, wet end of the Northern Rocky Mountain Subalpine-Upper Montane Grassland system. It appears to be a map unit with a mix of local citations/descriptions.

Related Concepts: This ecological system falls within the Subalpine Parkland habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the Rocky Mountain Subalpine-Montane Mesic Meadow as a unique mapping unit.

References

Gregory, S. 1983. Subalpine forb community types of the Bridger-Teton National Forest, Wyoming. Final Report. USDA Forest Service Cooperative Education Agreement: Contract OM 40-8555-3-115. Ogden, UT: USDA Forest Service, Intermountain Region. 97 pp.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

LANDFIRE. 2007. Rocky Mountain Subalpine-Montane Mesic Meadow (0911450) IN: Landfire Biophysical Setting Descriptions. http://www.landfire.gov/NationalProductDescriptions20.php

Luna, T. and L.K. Vance. 2010. Rocky Mountain Subalpine-Montane Mesic Meadow Montana Field Guide. http://FieldGuide.mt.gov/displayES_Detail.aspx?ES=7118

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

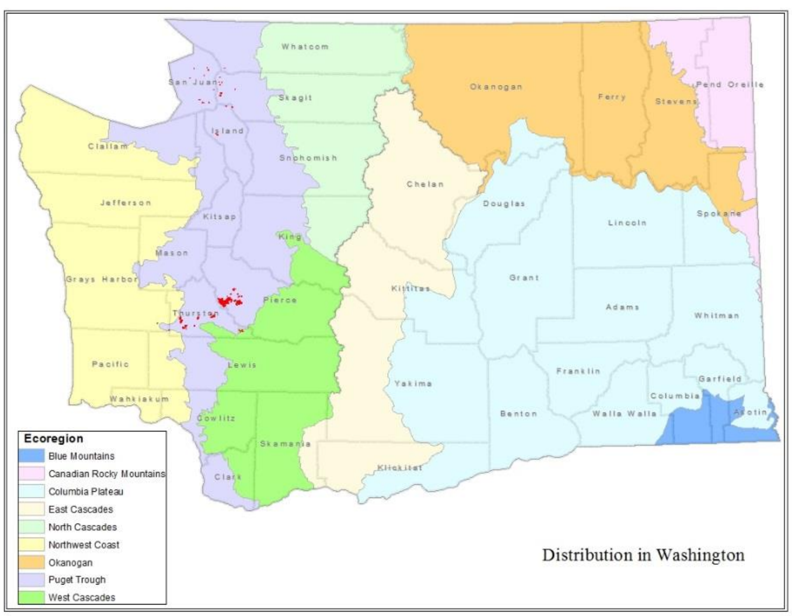
Description Author: Rex Crawford; NatureServe Western Ecology Team.

WILLAMETTE VALLEY UPLAND PRAIRIE AND SAVANNA

Concept: Lowland grassland and savanna system endemic to the Puget Trough and Willamette Valley. In Washington, it is most expansive in the South Puget Sound region (e.g., Pierce and Thurston counties) and is also found in the San Juan Islands and in southwestern Washington.

Conservation Status: Critically Imperiled (S1). This type is very rare. Over 90% of the historical extent of this system has been converted to anthropogenic land uses or to forest due to encroachment of woody species. Exotic and native plant (e.g., woody species) invasion continues and almost all sites require management. Few viable occurrence exist.

Distribution: This is a grassland and savanna system endemic to the Puget Trough and Willamette Valley. Historically, this system occurred as large and small patches in portions of the Georgia Basin, Puget Trough, and Willamette Valley. In Washington, it is most expansive in the South Puget Sound region (e.g., Pierce and Thurston counties) and is also found in the San Juan Islands and in southwestern Washington.



Environment: Most sites are topo-edaphically dry and experience extreme soil drought in the summer. In the South Puget Sound, this system occurs as large patches, usually associated with deep, gravelly/sandy glacial outwash that is excessively well drained within more forested landscapes. Historically, it also occurred as large patches on glacially associated soils of variable texture in localized portions of the Georgia Basin in both Washington and British Columbia, especially within the Olympic Mountain rain shadow. Landforms are usually flat, rolling, or gently sloping, and often part of extensive plains.

UPLAND GRASSLANDS AND MEADOWS

Vegetation: These prairies and savannas are dominated by a native bunchgrass, *Festuca idahoensis* ssp. *roemeri* and, to a lesser degree, *Danthonia californica* and *Carex inops* ssp. *inops*, along with abundant and diverse perennial forbs such as *Achillea millefolium*, *Apocynum androsaemifolium*, *Brodiaea coronaria* ssp. *coronaria*, *Camassia quamash* ssp. *azurea* or ssp. *maxima*, *Campanula rotundifolia*, *Eriophyllum lanatum* var. *leucophyllus*, *Fragaria virginiana*, *Fritillaria affinis* var. *affinis*, *Hieracium cynoglossoides*, *Lomatium utriculatum*, *Lotus micranthus*, *Microseris laciniata*, *Prunella vulgaris* ssp. *lanceolata*, *Ranunculus occidentalis* var. *occidentalis*, *Sericocarpus rigidus*, *Viola adunca*, and *Zigadenus venenosus* var. *venenosus* (Dunwiddie et al. 2006). *Elymus trachycaulus*, *E. glaucus*, *Koeleria macrantha*, and *Stipa lemmonii* can be locally important. Savannas with scattered deciduous (*Quercus garryana*) and/or coniferous (*Pseudotsuga menziesii*, *Pinus ponderosa*) trees are rarely found now, but such savannas historically covered about one-third of the total acreage. Shrubs such as *Symphoricarpos albus*, *Rosa nutkana*, *Toxicodendron diversilobum*, *Amelanchier alnifolia*, and *Arctostaphylos uva-ursi* are common shrubs. Dunwiddie et al. (2006) recorded 278 plant taxa within the South Puget Sound prairies. Of these, 164 (59%) are native species, while 111 (40%) are non-native and four (~1%) are of uncertain origin. Forbs comprise a majority of the species (74%) while graminoids (17%), shrubs (8%), and trees (2%) are of less importance (Dunwiddie et al. 2006). Most of the native forbs are perennial (70%) while most of the nonnative forbs are annuals and biennials. The majority of graminoids are perennial, whether native (94%) or nonnative (67%) (Dunwiddie et al. 2006). In many extant prairies, moss (e.g., *Racomitrium canescens*) and lichen (*Cladina mitis*) cover is high between bunchgrasses, however some researchers postulate that more frequent fires would have resulted in less moss and lichen cover and a higher cover and diversity of native annual species (Dunwiddie et al. 2006).

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Groups and Associations that are associated with this ecological system:

G206 Cascadian Oregon White Oak - Conifer Forest & Woodland Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Quercus garryana / Festuca (roemeri, rubra) Wooded Herbaceous Vegetation	G1/S1	CEGL001714
Pinus ponderosa / Carex inops - Festuca roemeri Woodland	G1/S1	CEGL003348
G488 Southern Vancouverian Shrub & Herbaceous Bald, Bluff & Prairie Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Danthonia californica Valley Grassland Herbaceous Vegetation	G1Q/S1	CEGL001598
Festuca roemeri – Camassia quamash - Cerastium arvense Herbaceous Vegetation	GNR/SH	TBD (Chappell 2004; Rocchio et al. 2012)
Festuca roemeri - Cerastium arvense - Koeleria macrantha Herbaceous Vegetation	G1/S1	CEGL003349
Festuca roemeri - Sericocarpus rigidus Herbaceous Vegetation	G1/S1	CEGL001608

Ecological Processes: These upland prairies and savannas are thought to have developed during the relatively hot and dry hypsithermal period about 10,000 to 7,000 years b.p. (Whitlock 1992). Thereafter, a cooler and moister climate has prevailed creating suitable conditions for encroachment of woody vegetation into many prairies. Historically, frequent fires or extreme environmental conditions (e.g., drier climate and/or excessively drained soils) prevented the establishment of shrubs and trees. The high frequency of fires (< 10 years) was primarily a result of intentional ignition by indigenous peoples who set fires to encourage the growth of food plants such as *Camassia quamash* and *Pteridium aquilinum* and to control the encroachment of woody vegetation. Fires are thought to have occurred every few years (Chappell and

Kagan 2001). Annual soil drought during the summer made it difficult for woody species (especially trees) to establish in these grasslands. However, occasionally *Quercus garryana* and *Pseudotsuga menziesii* would establish and survive long enough to be resistant to frequent fires thereby creating savanna conditions (Chappell and Kagan 2001). Following European settlement of the region, anthropogenic fire became less frequent resulting in widespread encroachment of the prairies and savannas by woody vegetation, especially conifers.

Threats: The exclusion of fire from most of this system over the last 100+ years has resulted in profound changes. Oak savanna has, for all practical purposes, disappeared from the landscape. *Pseudotsuga menziesii* encroachment, in the absence of fire, is a "natural" process that occurs eventually on the vast majority of upland prairie, except perhaps on the very driest sites. This encroachment leads to the conversion of prairies and savannas to forests. Fire exclusion has also resulted in increases in shrub cover and the conversion of some prairies to shrublands. Nonnative species such as *Cytisus scoparium*, *Hypericum perforatum*, *Hypochaeris radicata*, *Holcus lanatus*, *Chrysanthemum leucanthemum*, *Agrostis capillaris*, *Anthoxanthum odoratum*, *Poa pratensis*, *Arrhenatherum elatius*, *Taeniatherum caput-medusae*, *Festuca arundinacea*, *Hieracium pilosella*, *Potentilla recta*, *Centaurea* spp., and *Bromus mollis* are prominent in this habitat and generally increase after ground-disturbing activities like grazing or off-road vehicle use. The dominant native grass, *Festuca roemeri*, can be eliminated with heavy grazing. Prescribed fire and other management tools have been used recently to control *Cytisus scoparium*, *Pseudotsuga menziesii*

Classification Comments: This is the native prairie which occurs in western Washington. Floristically, the North Pacific Herbaceous Bald and Bluff is similar but differs in that the latter support herbaceous vegetation due to shallow soils, steep slopes, and warm aspects while this ecological system is maintained by very well-drained, coarse textured soils and/or frequent fire. Nonetheless, the two systems share many of the same species.

Related Concepts: This ecological system falls within the Westside Grasslands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes Willamette Valley Upland Prairie and Savanna as one of their standard mapping units.

References

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Chappell, C. 2000. Upland Prairies and Savannas. Appendix 11 Willamette Valley – Puget Trough – Georgia Basin Ecoregion Terrestrial Ecological System EO Specs and EO Rank Specs. *In* Floberg, J., M. Goering, G. Wilhere, C. MacDonald, C. Chappell, C. Rumsey, Z. Ferdana, A. Holt, P. Skidmore, T. Horsman, E. Alverson, C. Tanner, M. Bryer, P. Iachetti, A. Harcombe, B. McDonald, T. Cook, M. Summers, D. Rolph. 2004. Willamette Valley-Puget Trough-Georgia Basin Ecoregional Assessment, Volume One: Report. Prepared by The Nature Conservancy with support from the Nature Conservancy of Canada, Washington Department of Fish and Wildlife, Washington Department of Natural Resources (Natural Heritage and Nearshore Habitat programs), Oregon State Natural Heritage Information Center and the British Columbia Conservation Data Centre.

Chappell, C.B. 2004. Upland Plant Associations of the Puget Trough Ecoregion, Washington. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. Online: http://www1.dnr.wa.gov/nhp/refdesk/communities/index.html

Chappell, C.B. and R.C. Crawford. 1997. Native Vegetation of the South Puget Sound Prairie Landscape. In Dunn, P. and K. Ewing, Ecology and Conservation of the South Puget Sound Landscape. The Nature Conservancy, Seattle, WA. Online: http://www.southsoundprairies.org/EcologyandConservationBook.htm

Chappell, C.B. and J. Kagan. 2001. Westside Grasslands. *In* Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington 41-43pp. Oregon State University Press, Corvallis, OR

Chappell, C., E. Alverson, and W. Erickson. 2004. Ecologic and geographic variation in species composition of prairies, herbaceous balds, and oak woodlands of the Willamette Valley-Puget Trough-Georgia Basin Ecoregion. Paper Presented at the Ecological Society of America Annual Conference. Portland, Oregon.

Dunwiddie, P., E. Alverson, A. Stanley, R. Gilbert, S. Pearson, D. Hays, J. Arnett, E. Delvin, D. Grosboll, and C. Marschner. 2006. The Vascular Plant Flora of the South Puget Sound Prairies, Washington, USA. Davidsonia:14(2):51-69

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Rocchio, F. J., R. C. Crawford, and C. Copass. 2012. San Juan Island National historical Park vegetation classification and mapping project report. Natural Resource Report NPS/NCCN/NRR—2012/603. National Park Service, Fort Collins, Colorado.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Whitlock, C. 1992. Vegetation and Climatic History of the Pacific Northwest during the Last 20,000 Years: Implications of Understanding Present-day Biodiversity. The Northwest Environmental Journal, 8: pp. 5-28.

Description Author: Joe Rocchio and Chris Chappell.

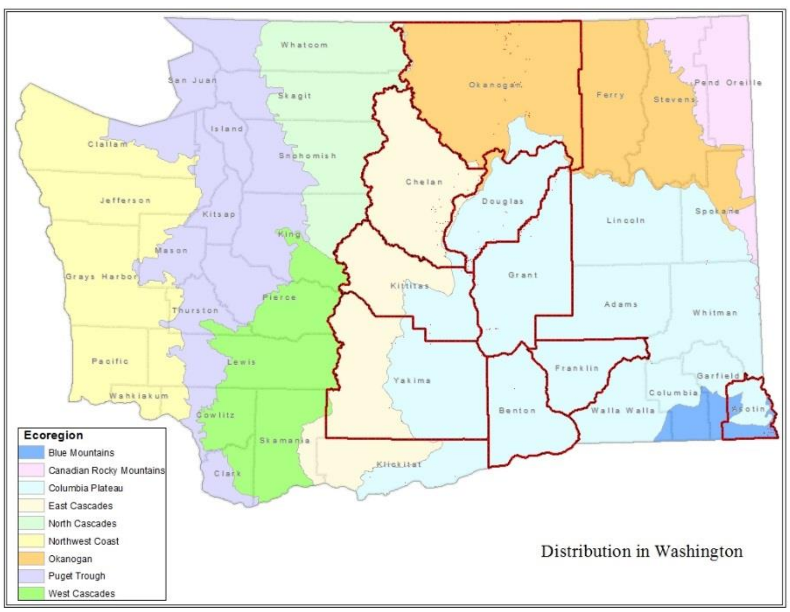
INTER-MOUNTAIN BASINS CLIFF AND CANYON

Concept: Sparse vegetation occurring on steep cliff faces, narrow canyons, unstable scree and talus slopes below cliffs, or smaller rock outcrops of various bedrock types within the Columbia Basin and Okanogan valley.

Conservation Status: Secure (S5).

Distribution: This large patch ecological system is found from lowland to lower montane elevations and includes barren and sparsely vegetated landscapes (generally <10% plant cover) of steep cliff faces, narrow canyons, and smaller rock outcrops of various bedrock types. This includes unstable scree and talus that typically occurs below cliff faces and Pleistocene flood deposits of large, lithic material (NatureServe 2007). The map shows counties where this system is most abundant. However, sporadic occurrences of this system occurs throughout the Columbia Basin where rock outcrops (mostly basalt) occur.

Environment: This system is found on steep open slopes in the canyons and valleys of the Columbia Basin, particularly along the Columbia and Snake River canyons and their tributaries. It is very common within the Scabland Channel topography (Bretz 1959). Basalt is the dominant parent material in the Columbia Basin. Other cliff and canyon parent material includes metamorphic volcanic and marine sedimentary rocks associated with the surrounding mountains, Pliocene sedimentary rocks, and Pleistocene sedimentary rocks.



Vegetation: Vegetation occurs in small patches or widely scattered trees and shrubs that generally cover less than 10% of total area. Common woody plants include *Pinus ponderosa*, *Pseudotsuga menziesii* var. *glauca*, *Amelanchier alnifolia*, *Celtis* *occidentalis* ssp. *reticulata, Holodiscus discolor, Philadelphus lewisii, Rhus glabra, Ribes* spp. and other species often common in adjacent plant communities, such as, *Artemisia tridentata, Cercocarpus ledifolius, Eriogonum compositum, E. niveum* or *Purshia tridentata*. These are often restricted to shelves, cracks and crevices in the rock, or other areas where soil accumulation allows growth. Small patches of grassland can occur among rocks where soil accumulates. Common species include *Pseudoroegneria spicata, Poa* spp., *Lupinus* spp., *Festuca idahoensis* and *Koeleria macrantha.*

In Colorado, species richness of cliff communities appeared to be controlled by aspect, microsite size, and cliff surface roughness (Graham and Knight 2004). Diversity increases when cliff microhabitats are compressed into a small area. Unfractured cliffs with no rooting space for vascular plants is habitat for lichens which is often next to a ledge where accumulated organic matter, minerals and water support grasses, sedges or small trees (Larson et al. 2000). Cliffs, in general, support high endemism of plants, can be refugia for old trees (Larson et al. 2000), and provide habitat for roosting or nesting birds and bats (Johnson and O'Neil 2001). Cliffs also act as refugia for many plants that currently occur on cliffs but were more common prior to increased human disturbance (Larson et al. 2000). Cliff and barren systems have relatively discrete boundaries, very specific ecological settings, and strong links to local landscape conditions (Decker 2007). Decker (2007) stated that such small patch communities are often dependent on ecological processes in the surrounding communities. Graham and Knight (2004) concluded that cliff size appears to less important than the cliff micro-topography and, therefore, larger cliff areas would not necessarily contain greater number of species.

USNVC Associated Types: Classification of these grasslands is needed to identify component plant associations.

Ecological Processes: Due to the sparse nature of vegetation on cliffs, fire rarely has a direct influence on cliff vegetation. This lack of fire influence creates an environment for fire refugia (Graham and Knight 2004). Freeze-thaw or other erosional processes which create unstable scree and talus slopes are important processes. The following summary of environmental processes of cliff ecology is from CNHP (2005):

> "Larson et al. (2000) define three basic parts of a cliff habitat: 1) the relatively level plateau at the top, 2) the vertical or near-vertical cliff face, and 3) the pediment or talus at the bottom of the face. These three elements share some physical characteristics, are linked by similar ecological processes, and often support the same plants and animals (Larson et al. 2000). Within the larger cliff habitat, steep slopes, small terraces ledges, overhangs, cracks and crevices often form a mosaic of microhabitat types that appears to be the primary factor contributing to cliff biodiversity (Graham and Knight 2004). In addition, the cliff rim is often windier than the surrounding plateau, providing a distinct microhabitat that differs from the nearby flatter areas. At cliff faces there is less hydraulic pressure retaining water within the rock, so liquid water is more consistently found than in the surrounding habitat types (Larson et al. 2000).
>
> Cliff environments are shaped by the parent rock type and strength, climate, aspect, and the weathering patterns produced by physical and chemical processes. Physical weathering includes the downward movement of rock and soil under the influence of gravity (mass wasting), including larger slips, slides and rockfalls, shrinking/swelling in response to changes in water content (mostly in shales and mudstones), direct pressure effects from the formation of ice and mineral crystals, thermal stress, and frost action (Larson et al. 2000). Chemical weathering in cliff environments is directly controlled by precipitation amount and chemistry, rock temperature, and the chemical composition of the rock. Chemical weathering is most prevalent under conditions of higher temperature and high precipitation, whereas physical weathering is more important at lower temperatures (Larson et al. 2000). The rate of erosion and the size of eroded rock particles have a strong influence over which organisms occur on cliffs and talus (Larson et al. 2000)."

Threats: This system usually occurs in inaccessible locations and thus is protected from much disturbance resulting from human activities. Direct stressors remove (localized quarry or borrow pit operations) or modify cliff topography and vegetation patches (recreational activities such as climbing and firearm practice and vehicular use of cliffs composed of less consolidated material). Agricultural and residential development adjacent or above cliffs and talus modifies cliff microsites through changes in water surface and sub-surface flow or accelerating deposition fine-textured soil that increases or change vegetation cover from perennial to annual cover.

Classification Comments: This system is characterized by sparse vegetation on steep cliff faces, narrow canyons, unstable scree and talus slopes below cliffs, or smaller rock outcrops of various igneous, sedimentary, and metamorphic bedrock types. It is distinguished from similar ecological systems such as the North Pacific Montane Massive Bedrock Cliff and Talus, North Pacific Alpine and Subalpine Bedrock and Scree, and Rocky Mountain Cliff, Canyon, and Massive Bedrock by occurring in relatively arid regions of the interior western U.S. and consequently supporting a distinct flora relative to those other systems.

Related Concepts: This ecological is not within any explicit habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize the Inter-Mountain Basins Cliff and Canyon as a unique mapping unit and but does aggregate it as a part of the Inter-Mountain Basins Sparsely Vegetated System map unit.

References

Bretz, J., H. 1959. Washington's Channeled Scabland. Washington Division of Mines and Geology Bull. 45. 57 pp.

Colorado Natural Heritage Program. 2005. Rocky Mountain Cliff, Canyon and Massive Bedrock Ecological System Description. Colorado Natural Heritage Program. Colo. State Univ. Ft. Collins. CO. http://www.cnhp.colostate.edu/download/projects/eco_systems/pdf/RM_Cliff_and_Canyon.pdf

Decker, K. 2007 draft. Western Great Plains Cliff, Outcrop and Shale Barren Ecological System Ecological Integrity Assessment. Colorado Natural Heritage Program. Colo. State Univ. Ft. Collins. CO. http://www.cnhp.colostate.edu/download/documents/2007/WGP_Cliff_Outcrop_Shale_Barren_EIA.pdf

Graham, L. and R.L. Knight. 2004. Multi-scale comparison of cliff vegetation in Colorado. Plant Ecology 170:223-234.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Larson, D.W., U. Matthes and P.E. Kelly. 2000. Cliff Ecology: Pattern and Process in Cliff Ecosystems. Cambridge University Press. 340pp.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Description Author: Rex Crawford, NatureServe Western Ecology Team

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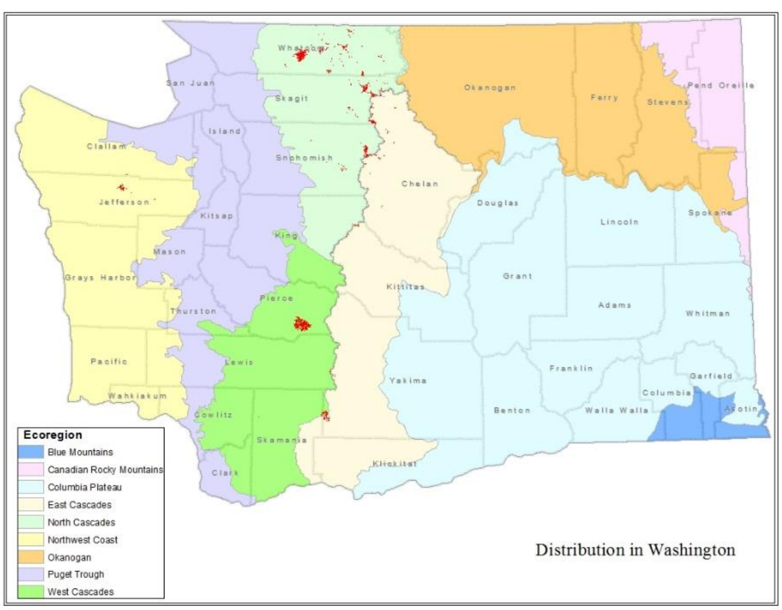
NORTH AMERICAN GLACIER AND ICE FIELD

Concept: Alpine ice fields which typically occur as part of a mosaic with alpine bedrock and scree, tundra dry meadow, wet meadow, fell-fields, and dwarf-shrubland. Large ice fields, such as glaciers, can be extensive, especially in the Cascades.

Conservation Status: Vulnerable (S3?). Washington is the second most glaciated state in the US, however long-term declines have been documented. Glaciers are primarily sensitive to winter snowfall and summer temperature. Winter snowpack on April 1 has declined markedly over the long term whether you begin the comparison in 1934, 1944, 1950 or 1966. The change ranges from a decline of 23 to 48% at five North Cascade sites. These long term declines have occurred despite an increase in winter precipitation. Since 1980, average snowpack has not declined.

Distribution: This large patch system is found throughout North America, from the mountains of Alaska south and east through the cordillera of the Cascades and the Rocky Mountains. In Washington, this system is primarily associated with the major volcanoes and highest portions of the Olympic and Cascade Mountains.

Environment: This system occurs where altitude results in the formation of permanent ice and snow fields. It is composed of unvegetated landscapes of annual/perennial ice and snow at the highest elevations, where snowfall accumulation exceeds melting. The snowpack/ice field never melts or, if so, then for only a few weeks.



Vegetation: Unvegetated.

USNVC Associated Types: No USNVC types are included in this system due to its unvegetated character.

Ecological Processes: Snow/ice retention, wind desiccation, and permafrost are all primary factors related to the maintenance of these ice fields. Short- and long-term climatic variability is a significant driver of the spatial extent of this system in a given location.

Threats: Climate change could decrease the extent of this system. Glaciers are primarily sensitive to winter snowfall and summer temperature. Winter snowpack on April 1 has declined markedly over the long term whether you begin the comparison in 1934, 1944, 1950 or 1966. The change ranges from a decline of 23 to 48% at five North Cascade snow measurement sites. These long term declines have occurred despite an increase in winter precipitation. Since 1980 snowpack has not declined. In the North Cascades National Park, glacier area decreased by 7% from 1958 to 1998 (Granshaw and Fountain, 2006; Granshaw, 2002). Smaller glaciers lost significantly more area than larger glaciers. The well-studied South Cascade Glacier shrank by 22% during this time period (USGS), while the Blue Glacier in Olympic National Park saw a terminus retreat of 2% between 1957 and 1997 (Conway et al. 1999). The glaciers on Mount Rainier decreased in area by 21% between 1913 and 1994 (Nylen 2004).

Classification Comments: Permanent snow/ice fields are characteristic of this system.

Related Concepts: This ecological is not associated with any habitat type identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize the North American Alpine Ice Field as a unique mapping unit but did aggregate it into the North Pacific Sparsely Vegetated Systems.

References

Conway, H., L.A. Rasmussen and H.P. Marshall. 1999. Annual mass balance of Blue Glacier, USA: 1955–97. Geogr. Ann., 81 A(4), 509–520.

Granshaw, F.D. 2002. Glacier change in the North Cascades National Park complex, Washington State, USA, 1958–1998. M.S Thesis, Portland State University.

Granshaw, F.D. and A.G. Fountain. 2006. Glacier change (1958-1998) in the North Cascades National Park Complex, Washington, USA. Journal of Glaciology, Vol. 52, No. 177.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Nylen, T. H., 2004, Spatial and temporal variations of glaciers (1913-1994) on Mt. Rainier and the relation with climate. M.S. Geology, Portland State University.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Description Author: Rex Crawford, NatureServe Western Ecology Team and Marion Reid.

NORTH PACIFIC ACTIVE VOLCANIC ROCK AND CINDER LAND

Concept: Barren or sparsely vegetated (generally <10% plant cover) volcanic substrates. Mount St. Helen's is the prototype and is pictured to the right.

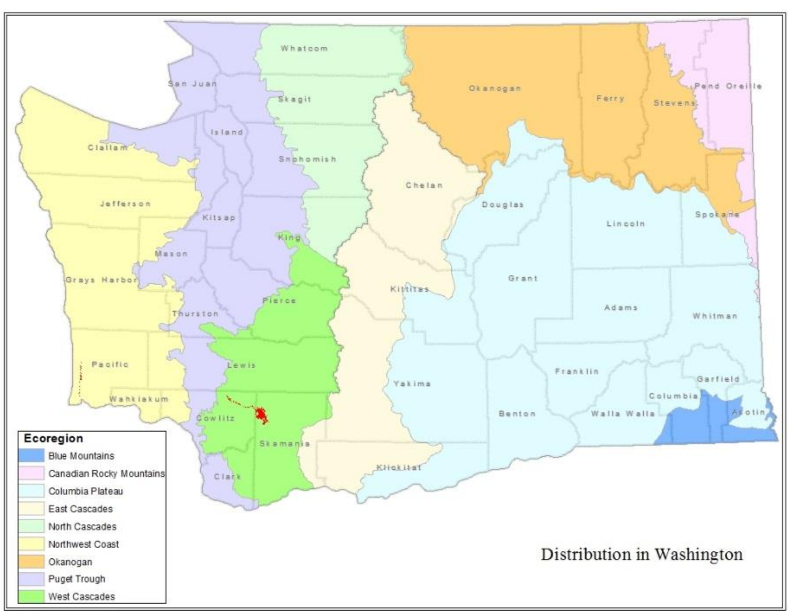
Conservation Status: Secure (S5).

Distribution: This large patch system is found in the Cascades Range from northern California north to Alaska. The distribution map erroneously shows occurrences along the coast in Pacific County (Sayre et al. 2009). This is a mapping error.

Environment: This system is limited to barren and sparsely vegetated volcanic substrates and includes active volcanic landscapes dominated by ash, pyroclastic deposits, lava, landslides and other exposed bare mineral and rock.

Vegetation: Decades of inactivity slowly provide opportunity for development of other systems, such as North American Alpine Ice Field or North Pacific Wooded Volcanic Flowage, or primary successional stages of surrounding vegetated systems to develop. Lichens and mosses establish on substrates and sporadic plant species from surrounding or adjacent plant communities might be found within the system.

USNVC Associated Types: Classification of sparse vegetation assemblages is needed to identify potential component plant associations.



Ecological Processes: Periodic eruptions and earthquakes are the primary processes maintaining a primarily barren environment.

Threats: Much of this system occurs in designated wilderness areas and is not exposed to any serious threats.

Classification Comments: This system is characterized as barren or sparsely vegetated (generally <10% plant cover) volcanic substrates, such as basalt lava (malpais), basalt

dikes with associated colluvium, basalt cliff faces and uplifted "backbones," ash, cinder cones or cinder fields characterize this system.

Related Concepts: This ecological system is not explicitly linked to any habitat type identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize the North Pacific Serpentine Barren as a unique mapping unit.

References

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Description Author: Rex Crawford.

SPARSLEY VEGETATED UPLAND TYPES

NORTH PACIFIC ALPINE AND SUBALPINE BEDROCK AND SCREE

Concept: Barren to sparsely vegetated exposed rock and rubble above the upper tree line (subalpine parkland and above) in the Cascades and Olympic mountains.

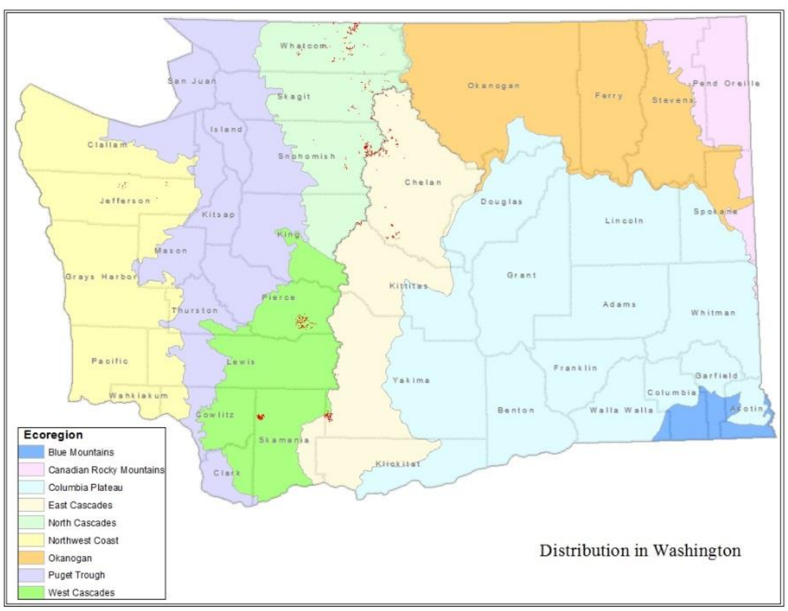
Conservation Status: Apparently Secure (S4).

Distribution: This large patch system is restricted to the highest elevations in the Cascade Range, from southwestern British Columbia south into northern California as well as in the Olympic Mountains in Washington State.

Environment: This system is composed of barren and sparsely vegetated alpine substrates, typically including both bedrock outcrops and scree slopes, with nonvascular- (lichen) dominated communities.

Vegetation: Occurrences are barren or with a sparse cover of forbs, grasses, lichens, shrubs and small trees from surrounding vegetation.

USNVC Associated Types: Classification of sparse vegetation assemblages is needed to identify potential component plant associations.



Ecological Processes: Exposure to desiccating winds, rocky and sometimes unstable substrates, and a short growing season limit plant growth.

Threats: Climate change could increase or possibly decrease any existing plant cover.

Classification Comments: Barren or sparsely vegetated bedrock outcrops and scree slopes in the Cascades and Olympic Mountains.

Related Concepts: This ecological system is not associated with any habitat type identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize the North Pacific Alpine and Subalpine Bedrock and Scree as a unique mapping unit but did aggregate it into the North Pacific Sparsely Vegetated Systems.

References

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Description Author: Rex Crawford, Marion Reid, and Chris Chappell

Sparsley Vegetated Upland Types

North Pacific Coastal Cliff and Bluff

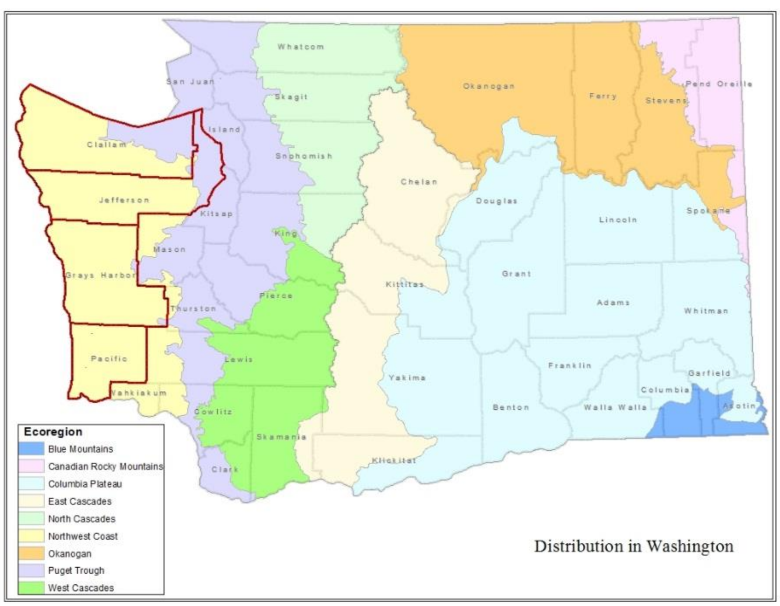
Concept: Unvegetated or sparsely vegetated rock cliffs and very steep bluffs of glacial deposits along Washington's coastline and associated marine and estuarine inlets.

Conservation Status: Apparently Secure (S4).

Distribution: This linear system is found from central Oregon north along the immediate coast into British Columbia. In Washington, it is most abundant along the northwestern coast of the Olympic peninsula.

Environment: Composed of barren and sparsely vegetated substrates, typically including exposed sediments, bedrock, and scree slopes.

Vegetation: There can be a sparse cover of forbs, grasses, lichens and low shrubs that establish from adjacent vegetation types.



Distribution in Washington

In Colorado, species richness of cliff communities appeared to be controlled by aspect, microsite size, and cliff surface roughness (Graham and Knight 2004). Diversity increases when cliff microhabitats are compressed into a small area. Unfractured cliffs with no rooting space for vascular plants is habitat for lichens which is often next to a ledge where accumulated organic matter, minerals and water support grasses, sedges or small trees (Larson et al. 2000). Cliffs, in general, support high endemism of plants, can be refugia for old trees (Larson et al. 2000), and provide habitat for roosting or nesting birds and bats (Johnson and O'Neil 2001). Cliffs also act as refugia for many plants that currently occur on cliffs but were more common prior to increased human disturbance (Larson et al. 2000). Cliff and barren systems have relatively discrete boundaries, very specific ecological settings, and strong links to local landscape conditions (Decker 2007). Graham and Knight (2004) concluded that cliff size appears to less important than the cliff micro-topography and, therefore, larger cliff areas would not necessarily contain greater number of species.

USNVC Associated Types: Classification of sparse vegetation assemblages is needed to identify potential component plant associations.

Ecological Processes: Exposure to waves, eroding and desiccating winds, slope failures and sheet erosion create gravelly to rocky substrates that are often unstable.

The following summary of environmental processes of cliff ecology is from CNHP (2005):

> "Larson et al. (2000) define three basic parts of a cliff habitat: 1) the relatively level plateau at the top, 2) the vertical or near-vertical cliff face, and 3) the pediment or talus at the bottom of the face. These three elements share some physical characteristics, are linked by similar ecological processes, and often support the same plants and animals (Larson et al. 2000). Within the larger cliff habitat, steep slopes, small terraces ledges, overhangs, cracks and crevices often form a mosaic of microhabitat types that appears to be the primary factor contributing to cliff biodiversity (Graham and Knight 2004). In addition, the cliff rim is often windier than the surrounding plateau, providing a distinct microhabitat that differs from the nearby flatter areas. At cliff faces there is less hydraulic pressure retaining water within the rock, so liquid water is more consistently found than in the surrounding habitat types (Larson et al. 2000).
>
> Cliff environments are shaped by the parent rock type and strength, climate, aspect, and the weathering patterns produced by physical and chemical processes. Physical weathering includes the downward movement of rock and soil under the influence of gravity (mass wasting), including larger slips, slides and rockfalls, shrinking/swelling in response to changes in water content (mostly in shales and mudstones), direct pressure effects from the formation of ice and mineral crystals, thermal stress, and frost action (Larson et al. 2000). Chemical weathering in cliff environments is directly controlled by precipitation amount and chemistry, rock temperature, and the chemical composition of the rock. Chemical weathering is most prevalent under conditions of higher temperature and high precipitation, whereas physical weathering is more important at lower temperatures (Larson et al. 2000). The rate of erosion and the size of eroded rock particles have a strong influence over which organisms occur on cliffs and talus (Larson et al. 2000)."

Threats: Due to inaccessibility of this system, there are very few threats to the integrity of this system. Although, sea level rise could inundate some areas of this system.

Classification Comments: Small areas of rock outcrop within a mosaic of vegetated systems are best considered part of a different, adjacent system (e.g., North Pacific Herbaceous Bald and Bluff or North Pacific Hypermaritime Shrub and Herbaceous Headland). The North Pacific Hypermaritime Shrub and Herbaceous Headland and this cliff system sometimes occur adjacent or in a mosaic together (see photo above where the latter occurs in lower portions of the island and the former on top), but not always. It is quite frequent to get cliffs without the vegetated part.

Related Concepts: This ecological system falls within the Coastal Headlands and Islets habitat type identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize the North Pacific Coastal Cliff and Bluff as a unique mapping unit and but did aggregate it into the North Pacific Sparsely Vegetated Systems.

References

Colorado Natural Heritage Program. 2005. Rocky Mountain Cliff, Canyon and Massive Bedrock Ecological System Description. Colorado Natural Heritage Program. Colo. State Univ. Ft. Collins. CO. http://www.cnhp.colostate.edu/download/projects/eco_systems/pdf/RM_Cliff_and_Canyon.pdf

Decker, K. 2007 draft. Western Great Plains Cliff, Outcrop and Shale Barren Ecological System Ecological Integrity Assessment. Colorado Natural Heritage Program. Colo. State Univ. Ft. Collins. CO. http://www.cnhp.colostate.edu/download/documents/2007/WGP_Cliff_Outcrop_Shale_Barren_EIA.pdf

Graham, L. and R.L. Knight. 2004. Multi-scale comparison of cliff vegetation in Colorado. Plant Ecology 170:223-234.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Larson, D.W., U. Matthes and P.E. Kelly. 2000. Cliff Ecology: Pattern and Process in Cliff Ecosystems. Cambridge University Press. 340pp.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Description Author: Rex Crawford and Chris Chappell.

NORTH PACIFIC MONTANE MASSIVE BEDROCK, CLIFF AND TALUS

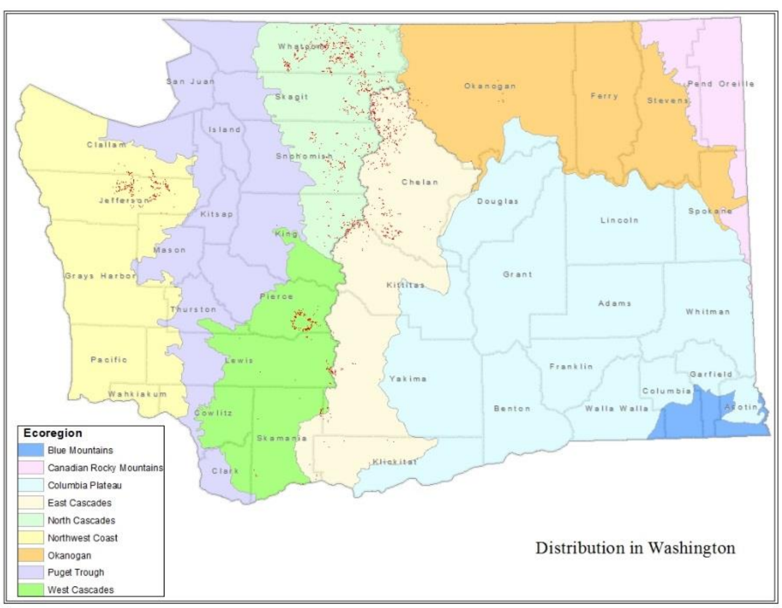
Concept: Barren and sparsely vegetated landscapes (generally <10% plant cover) of steep cliff faces, narrow canyons, and larger outcrops of various igneous, sedimentary, and metamorphic bedrock types. The system is found from foothill to subalpine elevations in the Cascades and Olympic Mountains.

Conservation Status: Apparently Secure (S4S5).

Distribution: This large or small patch system occurs from foothill to subalpine elevations from northern California to southeastern Alaska. In Washington, the system is found from foothill to subalpine elevations in the Cascades and Olympic Mountains and San Juan Islands.

Environment: This system is found on steep cliff faces, narrow canyons, and larger rock outcrops of various igneous, sedimentary, and metamorphic bedrock types. Also included are unstable scree and talus that typically occur below cliff faces. Soil development is limited.

Vegetation: Fractures in the rock surface and less steep or more stable slopes may be occupied by small patches of dense vegetation, typically scattered trees and/or shrubs. Any vegetation established in this system typically reflects species composition of adjacent ecosystems. Vegetation typically includes scattered trees and/or shrubs occasionally with small dense patches of shrubs or herbaceous plants. Characteristic trees include *Chamaecyparis nootkatensis*, *Tsuga* spp., *Thuja plicata*, *Pseudotsuga menziesii*, or *Abies* spp. There may be scattered shrubs present, such as *Acer circinatum*, *Alnus* spp., and *Ribes* spp. Herbaceous cover is limited. Mosses or lichens may be very dense, well-developed and display cover well over 10%.



Distribution in Washington

In Colorado, species richness of cliff communities appeared to be controlled by aspect, microsite size, and cliff surface roughness (Graham and Knight 2004). Diversity increases when cliff microhabitats are compressed into a small area. Unfractured cliffs with no rooting space for vascular plants is habitat for lichens which is often next to a ledge where accumulated organic matter, minerals and water support grasses, sedges or small trees (Larson et al. 2000). Cliffs, in general, support high endemism of plants, can be refugia for old trees (Larson et al. 2000), and provide habitat for roosting or nesting birds and bats (Johnson and O'Neil 2001). Cliffs also act as refugia for many plants that currently occur on cliffs but were more common prior to increased human disturbance (Larson et al. 2000). Cliff and barren systems have relatively discrete boundaries, very specific ecological settings, and strong links to local landscape conditions (Decker 2007). Graham and Knight (2004) concluded that cliff size appears to less important than the cliff micro-topography and, therefore, larger cliff areas would not necessarily contain greater number of species.

USNVC Associated Types: Classification of sparse vegetation assemblages is needed to identify potential component plant associations.

Ecological Processes: Wind and water erosion, chemical and physical effects of plant growth, and the force of gravity are the primary natural processes in the cliff environment. The rate of erosion and the size of eroded rock particles have a strong influence over which organisms occur on cliffs and talus (Larson et al. 2000). Drought and other extreme growing conditions created by exposed rock or unstable slopes typically associated with steep slopes are also primary factors related to vegetation establishment.

The following summary of environmental processes of cliff ecology is from CNHP (2005):

> "Larson et al. (2000) define three basic parts of a cliff habitat: 1) the relatively level plateau at the top, 2) the vertical or near-vertical cliff face, and 3) the pediment or talus at the bottom of the face. These three elements share some physical characteristics, are linked by similar ecological processes, and often support the same plants and animals (Larson et al. 2000). Within the larger cliff habitat, steep slopes, small terraces ledges, overhangs, cracks and crevices often form a mosaic of microhabitat types that appears to be the primary factor contributing to cliff biodiversity (Graham and Knight 2004). In addition, the cliff rim is often windier than the surrounding plateau, providing a distinct microhabitat that differs from the nearby flatter areas. At cliff faces there is less hydraulic pressure retaining water within the rock, so liquid water is more consistently found than in the surrounding habitat types (Larson et al. 2000).
>
> Cliff environments are shaped by the parent rock type and strength, climate, aspect, and the weathering patterns produced by physical and chemical processes. Physical weathering includes the downward movement of rock and soil under the influence of gravity (mass wasting), including larger slips, slides and rockfalls, shrinking/swelling in response to changes in water content (mostly in shales and mudstones), direct pressure effects from the formation of ice and mineral crystals,

thermal stress, and frost action (Larson et al. 2000). Chemical weathering in cliff environments is directly controlled by precipitation amount and chemistry, rock temperature, and the chemical composition of the rock. Chemical weathering is most prevalent under conditions of higher temperature and high precipitation, whereas physical weathering is more important at lower temperatures (Larson et al. 2000). The rate of erosion and the size of eroded rock particles have a strong influence over which organisms occur on cliffs and talus (Larson et al. 2000)."

Threats: This system usually occurs in inaccessible locations and thus is protected from much disturbance resulting from human activities. Direct human stressors to this system may include road construction and maintenance, recreation (climbing), and the effects of mining and quarrying.

Classification Comments: This system differs from the Inter-Mountain Basins Cliff and Canyon and Rocky Mountain Cliff, Canyon, and Massive Bedrock system due to floristic differences related to biogeographic affinities of the species composing the vegetation. In addition, this system can have higher abundance of nonvascular cover on rocks compared to these other, drier systems.

Related Concepts: This ecological system is not explicitly linked to any habitat type identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize the North Pacific Massive Bedrock, Cliff and Talus as a unique mapping unit.

References

Colorado Natural Heritage Program. 2005. Rocky Mountain Cliff, Canyon and Massive Bedrock Ecological System Description. Colorado Natural Heritage Program. Colo. State Univ. Ft. Collins. CO. http://www.cnhp.colostate.edu/download/projects/eco_systems/pdf/RM_Cliff_and_Canyon.pdf

Decker, K. 2007 draft. Western Great Plains Cliff, Outcrop and Shale Barren Ecological System Ecological Integrity Assessment. Colorado Natural Heritage Program. Colo. State Univ. Ft. Collins. CO. http://www.cnhp.colostate.edu/download/documents/2007/WGP_Cliff_Outcrop_Shale_Barren_EIA.pdf

Graham, L. and R.L. Knight. 2004. Multi-scale comparison of cliff vegetation in Colorado. Plant Ecology 170:223-234.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Larson, D.W., U. Matthes and P.E. Kelly. 2000. Cliff Ecology: Pattern and Process in Cliff Ecosystems. Cambridge University Press. 340pp.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Description Author: Rex Crawford.

SPARSLEY VEGETATED UPLAND TYPES

NORTH PACIFIC SERPENTINE BARREN

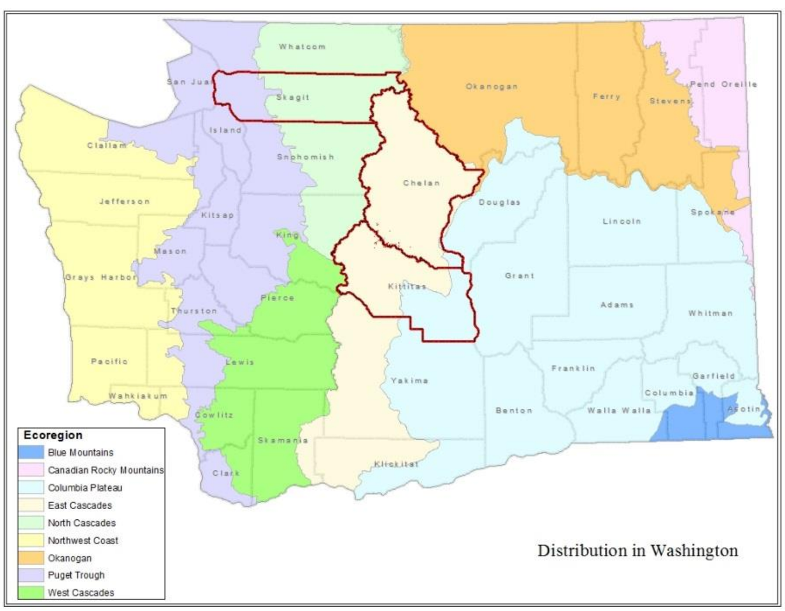
Concept: Uncommon barrens found on loosely consolidated, thin, rocky, ultramafic (peridotite, serpentine) soils primarily in the Wenatchee Mountains in the East Cascades but also on Cypress Island where serpentine outcrops are more vegetated.

Conservation Status: Apparently Secure (S4). Although uncommon, there are few threats to this system.

Distribution: This small patch system is found in east and west of the Cascades, primarily in the Wenatchee Mountains in the east Cascades between 760 and 2100 m elevation (2500-7000 feet) but also on Cypress Island where serpentine outcrops are more vegetated.

Environment: Steep slopes with loosely consolidated, thin, rocky, ultramafic (peridotite, serpentine) soils are diagnostic of this system. These soils result in harsh soil chemical conditions. Size of occurrences varies from small patches up to several square km.

Vegetation: Most sites often support stunted conifers and typically stress-tolerant species. Not all ultramafic outcrops support distinct vegetation. These systems are highly variable and are described here to include barren slopes to patches of nearly closed forests. Low-elevation sites support *Pseudotsuga menziesii*, *Pinus ponderosa*, and *Pinus monticola* trees with a sparse ground cover with *Aspidotis densa*, *Arctostaphylos nevadensis*, and *Pseudoroegneria spicata*. Higher elevations have *Pinus contorta var. latifolia*, *Pinus albicaulis*, *Abies lasiocarpa*, and *Tsuga mertensiana* with *Juniperus communis*, *Ledum glandulosum*, *Vaccinium scoparium*, *Poa curtifolia*, and *Festuca viridula*.



USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system:

G210 Central Rocky Mountain Douglas-fir - Pine Forest Group	Global/ State Rank	NatureServe/ WNHP Code
Pinus ponderosa / Aspidotis densa Woodland	G1/S1	CEGL000847
Pseudotsuga menziesii / Aspidotis densa Woodland	G1/S1	CEGL000896

Ecological Processes: Vegetation composition is affected by either very low soil Ca:Mg ratio and/or increased influence of soil drought on ultramafic material.

Threats: Much of this system occurs in designated wilderness areas or within a Washington Dept. of Natural Resources' Natural Area Preserve and is not exposed to any serious threats.

Classification Comments: Barren to sparsely vegetated sites on ultramafic rocks characterizes this system. Similar to the Mediterranean California Serpentine Barrens of California and southern Oregon but tends to have a more developed woody component, whereas the California serpentine barrens are more herbaceous**.**

Related Concepts: This ecological system is not explicitly linked to any habitat type identified in Johnson and O'Neil (2001) but is likely part of the Eastside (Interior) Mixed Conifer Forest. The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize the North Pacific Serpentine Barren as a unique mapping unit.

References

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Description Author: Rex Crawford.

SPARSLEY VEGETATED UPLAND TYPES

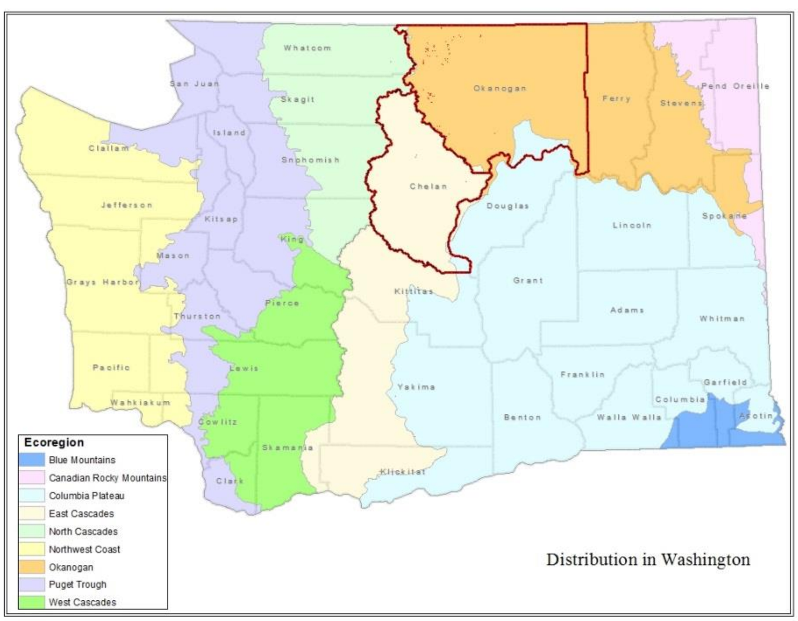
ROCKY MOUNTAIN ALPINE BEDROCK AND SCREE

Concept: Barren and sparsely vegetated alpine substrates, typically including both bedrock outcrop and scree slopes, with nonvascular- (lichen) dominated communities.

Conservation Status: Apparently Secure (S4?). No known threats; uncertain if increase in area with glacier retreat will be offset with transition to vegetated surface?

Distribution: This large patch system is restricted to the highest elevations of the Rocky Mountains, from Alberta and British Columbia south into New Mexico, west into the highest mountain ranges of the Great Basin. In Washington this system is mostly found in the eastern Okanogan Highland (e.g., Loomis State Forest) and potentially on the east side of Mt. Adams.

Environment: Alpine bedrock outcrops and scree slopes found in the Rocky Mountains is diagnostic of this system.



Distribution in Washington

Vegetation: Occurrences are barren or with a sparse cover of forbs, grasses, lichens, shrubs and small trees from surrounding vegetation.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Association that are associated with this ecological system:

G320 North Pacific Alpine-Subalpine Turf & Herbaceous Meadow Group	Global/ State Rank	NatureServe/ WNHP Code
Carex nardina Scree Herbaceous Vegetation	GNR/SNR	CEGL001812

Ecological Processes: Exposure to desiccating winds, rocky and sometimes unstable substrates, and a short growing season limit plant growth.

Threats: Global climate change could alter species composition of this system possibly by allowing more vascular plant species to establish.

Classification Comments: Land cover is mostly exposed rock (usually >90% cover of bedrock, boulders or scree). Nonvascular cover (lichens) may be significant.

Related Concepts: This ecological system is not explicitly linked to any habitat type identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize the Rocky Mountain Alpine Bedrock and Scree as a unique mapping unit but did aggregate it into the Rocky Mountain Alpine/Montane Sparsely Vegetated system.

References

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Description Author: NatureServe Western Ecology Team.

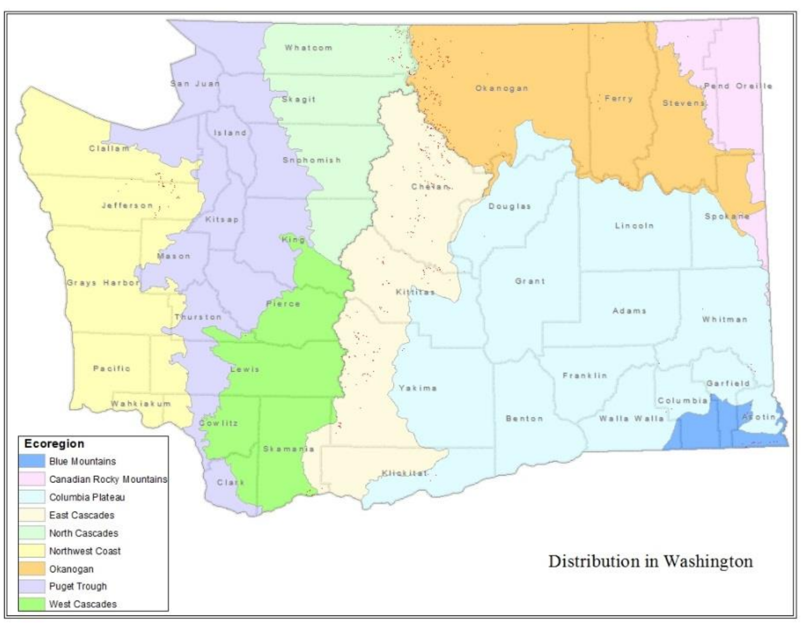
ROCKY MOUNTAIN CLIFF, CANYON AND MASSIVE BEDROCK

Photo by Joe Arnett

Concept: Barren and sparsely vegetated (generally <10% plant cover) steep cliff faces, narrow canyons, and smaller rock outcrops of various bedrock types. This includes unstable scree and talus that typically occurs below cliff face). Found from foothill to subalpine elevations throughout the northeastern Cascade Range and northeastern Olympic Mountains.

Conservation Status: Apparently Secure (S4S5).

Distribution: This ecological system is found from foothill to subalpine elevations throughout the Rocky Mountains including the isolated island ranges of central Montana, northeastern Cascade Range and northeastern Olympic Mountains. The distribution map (Sayre et al. 2009) shows this system as mostly in the East Cascades but it also occurs in the mountains of northeastern Washington.



Distribution in Washington

Environment: Steep cliff faces, narrow canyons, and smaller rock outcrops of various igneous, sedimentary, and metamorphic bedrock types are common locations where this system occurs. Soil development is limited.

Vegetation: Vegetation typically includes scattered trees and/or shrubs occasionally with small dense patches of shrubs or herbaceous plants. Characteristic trees include species from the surrounding landscape, such as *Pseudotsuga menziesii*, *Pinus ponderosa*, *Populus tremuloides*, *Abies lasiocarpa*, or *Juniperus* *occidentalis* at lower elevations. There may be scattered shrubs present, such as *Amelanchier alnifolia*, *Juniperus communis*, or species of *Holodiscus*, *Ribes*, *Penstemon*, *Physocarpus*, *Rosa*, and *Mahonia*. Herbaceous cover is limited and typically patchy. Mosses and lichens can be very common.

In Colorado, species richness of cliff communities appeared to be controlled by aspect, microsite size, and cliff surface roughness (Graham and Knight 2004). Diversity increases when cliff microhabitats are compressed into a small area. Unfractured cliffs with no rooting space for vascular plants is habitat for lichens which is often next to a ledge where accumulated organic matter, minerals and water support grasses, sedges or small trees (Larson et al. 2000). Cliffs, in general, support high endemism of plants, can be refugia for old trees (Larson et al. 2000), and provide habitat for roosting or nesting birds and bats (Johnson and O'Neil 2001). Cliffs also act as refugia for many plants that currently occur on cliffs but were more common prior to increased human disturbance (Larson et al. 2000). Cliff and barren systems have relatively discrete boundaries, very specific ecological settings, and strong links to local landscape conditions (Decker 2007). Graham and Knight (2004) concluded that cliff size appears to less important than the cliff micro-topography and, therefore, larger cliff areas would not necessarily contain greater number of species.

USNVC Associated Types: Classification of sparse vegetation assemblages is needed to identify potential component plant associations.

Ecological Processes: Wind and water erosion, chemical and physical effects of plant growth, and the force of gravity are the primary natural processes in the cliff environment. The rate of erosion and the size of eroded rock particles have a strong influence over which organisms occur on cliffs and talus (Larson et al. 2000). Drought and other extreme growing conditions created by exposed rock or unstable slopes typically associated with steep slopes are also primary factors related to vegetation establishment.

The following summary of environmental processes of cliff ecology is from CNHP (2005):

> "Larson et al. (2000) define three basic parts of a cliff habitat: 1) the relatively level plateau at the top, 2) the vertical or near-vertical cliff face, and 3) the pediment or talus at the bottom of the face. These three elements share some physical characteristics, are linked by similar ecological processes, and often support the same plants and animals (Larson et al. 2000). Within the larger cliff habitat, steep slopes, small terraces ledges, overhangs, cracks and crevices often form a mosaic of microhabitat types that appears to be the primary factor contributing to cliff biodiversity

(Graham and Knight 2004). In addition, the cliff rim is often windier than the surrounding plateau, providing a distinct microhabitat that differs from the nearby flatter areas. At cliff faces there is less hydraulic pressure retaining water within the rock, so liquid water is more consistently found than in the surrounding habitat types (Larson et al. 2000).

Cliff environments are shaped by the parent rock type and strength, climate, aspect, and the weathering patterns produced by physical and chemical processes. Physical weathering includes the downward movement of rock and soil under the influence of gravity (mass wasting), including larger slips, slides and rockfalls, shrinking/swelling in response to changes in water content (mostly in shales and mudstones), direct pressure effects from the formation of ice and mineral crystals, thermal stress, and frost action (Larson et al. 2000). Chemical weathering in cliff environments is directly controlled by precipitation amount and chemistry, rock temperature, and the chemical composition of the rock. Chemical weathering is most prevalent under conditions of higher temperature and high precipitation, whereas physical weathering is more important at lower temperatures (Larson et al. 2000). The rate of erosion and the size of eroded rock particles have a strong influence over which organisms occur on cliffs and talus (Larson et al. 2000).“

Threats: This system usually occurs in inaccessible locations and thus is protected from much disturbance resulting from human activities. Direct human stressors to this system may include road construction and maintenance, recreation (climbing), and the effects of mining and quarrying.

Classification Comments: The North Pacific Montane Massive Bedrock, Cliff and Talus, a similar system, includes similar sites in the Cascades and Olympic Mountains, except has many Vancouverian species, where the Rocky Mountain Cliff, Canyon and Massive Bedrock system occurs in rain shadows and has more Rocky Mountain species. The Rocky Mountain system differs from the Inter-Mountain Basins Cliff and Canyon in that the latter system usually occurs in at lower elevations (< 1800 m) and thus has a slightly different flora associated with it.

Related Concepts: This ecological system is not explicitly linked to any habitat type identified in Johnson and O’Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize the Rocky Mountain Cliff, Canyon and Massive Bedrock as a unique mapping unit but did aggregate it into the Rocky Mountain Alpine/Montane Sparsely Vegetated system.

References

Colorado Natural Heritage Program. 2005. Rocky Mountain Cliff, Canyon and Massive Bedrock Ecological System Description. Colorado Natural Heritage Program. Colo. State Univ. Ft. Collins. CO. http://www.cnhp.colostate.edu/download/projects/eco_systems/pdf/RM_Cliff_and_Canyon.pdf

Decker, K. 2007 draft. Western Great Plains Cliff, Outcrop and Shale Barren Ecological System Ecological Integrity Assessment. Colorado Natural Heritage Program. Colo. State Univ. Ft. Collins. CO. http://www.cnhp.colostate.edu/download/documents/2007/WGP_Cliff_Outcrop_Shale_Barren_EIA.pdf

Graham, L. and R.L. Knight. 2004. Multi-scale comparison of cliff vegetation in Colorado. Plant Ecology 170:223-234.

Johnson, D.H. and T.A. O’Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Larson, D.W., U. Matthes and P.E. Kelly. 2000. Cliff Ecology: Pattern and Process in Cliff Ecosystems. Cambridge University Press. 340pp.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Description Author: Rex Crawford, NatureServe Western Ecology Team and Marion Reid.

SAND DUNE VEGETATION

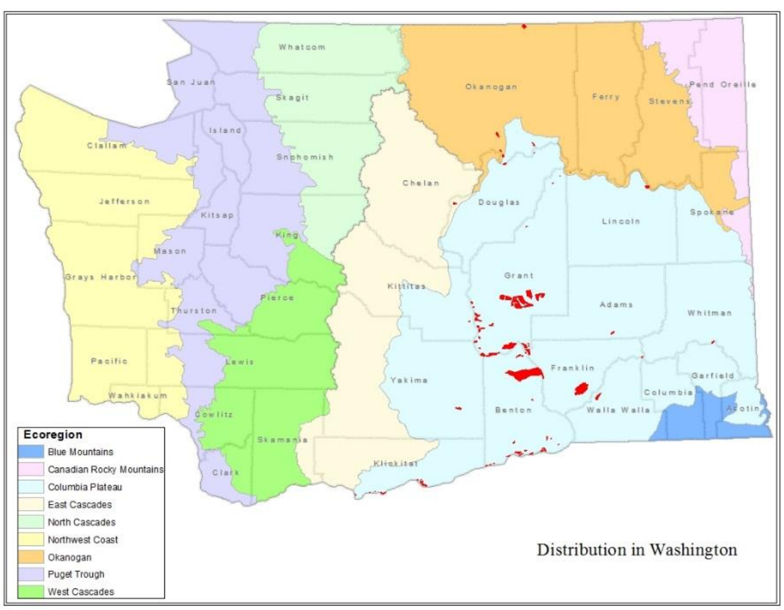
INTER-MOUNTAIN BASINS ACTIVE AND STABILIZED DUNE

Concept: Inland active or stabilized dunes and sandsheets with patchy or sparse vegetation. In Washington, this these sand dunes occur across the Columbia Basin.

Conservation Status: Critically Imperiled (S1). This system was historically relatively rare on the landscape. The total extent of Washington inland sand dunes has declined approximately 76% from the early 1970s, primarily due to agricultural conversion, reservoir flooding and dune stabilization.

Distribution: This is a large patch system which occurs in inter-mountain basins of the western U.S. In Washington, this ecological system occurs across the Columbia Plateau in eastern Washington. The distribution map for Washington was developed by the Washington Natural Heritage Program as a part of a statewide inventory of inland dunes.

Environment: This system is composed of unvegetated to moderately vegetated, active and stabilized dunes and sandsheets. Vegetation cover is related to the amount of annual rainfall and rate of evapotranspiration.



Vegetation: Sand dunes in sub-arid to semi-arid regions support vegetation if wind stress is not too great. Species occupying these environments are often adapted to shifting, coarse-textured substrates (usually quartz sand) and form patchy or open grasslands, shrublands or steppe, and occasionally woodlands. This system includes multiple plant associations that represent a range of conditions from sparse (<20%) to moderate (> 60%) vegetation cover and are often found together in fine scale spatial mosaics. Plant species composition often relates to the degree of sand stabilization / vegetation cover and position on a particular dune. *Psoralidium lanceolatum*, an herb and *Achnatherum hymenoides*, a bunchgrass typically dominate the initial stages of stabilization and are also commonly found on dunes with a wide range of stabilization. Prior to stabilization shrubs tended to be sparse while *Elymus lanceolatus*, a rhizomatous grass, and herbs *Corispermum* sp., *Rumex venosus* and *Phacelia hastata* are common. With increased sand stabilization shrubs *Ericameria nauseosa*, *Chrysothamnus viscidiflorus*, *Purshia tridentata*, and *Artemisia tridentata* ssp. *wyomingensis* are often present to dominant. Herbs such as *Oenothera pallida*, *Penstemon acuminatus*, *Phacelia hastata*, *Balsamorhiza careyana*, *Pteryxia terebinthina*, *Hymenopappus filifolius*, *Erigeron filifolius* and grass *Koeleria macrantha* are common but contribute little to total vegetation cover although at times cover of these herbs can be locally significant. *Pinus ponderosa* or *Juniperus occidentalis* trees can be members of dune vegetation. Exotic annuals, *Bromus tectorum*, *Salsola kali* and *Sisymbrium altissimum* are common and at times abundant. Where dunes have overridden or partially covered "normal" soil, *Pseudoroegneria spicata*, *Poa secunda* or other shrub steppe species are often present **.**

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Groups and Associations that are associated with this ecological system:

G273 Central Rocky Mountain Lower Montane, Foothill & Valley Grassland Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Achnatherum hymenoides – Psoralidium lanceolatum Herbaceous Vegetation	GNR/SNR	TBD (Hallock et al. 2007)
Corispermum spp. Herbaceous Vegetation	GNR/SNR	TBD (Hallock et al. 2007)
Elymus lanceolatus - Hesperostipa comata Herbaceous Vegetation	G1/S1	CEGL001746
Ericameria nauseosa – Chrysothamnus viscidiflorus – Eriogonum niveum Herbaceous Vegetation	GNR/SNR	TBD (Hallock et al. 2007)
Hesperostipa comata Herbaceous Vegetation	GNR/SNR	TBD (Hallock et al. 2007)
Leymus flavescens Herbaceous Vegetation	G2/SNR	CEGL001563
Rumex venosus Herbaceous Vegetation	GNR/SNR	TBD (Hallock et al. 2007)
G302 Intermountain Mesic Tall Sagebrush Shrubland & Steppe Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Artemisia tridentata ssp. wyomingensis – Purshia tridentata Shrubland	GNR/SNR	TBD (Hallock et al. 2007)
G213 Central Rocky Mountain Ponderosa Pine Woodland & Savanna	**Global/ State Rank**	**NatureServe/ WNHP Code**
Pinus ponderosa / Purshia tridentata / Achnatherum hymenoides Woodland	G1/SNR	CEGL000196

Ecological Processes: Wind and continual supply of sand are necessary for dune dynamics. Four simple dune types have been observed in Washington: (1) longitudinal dunes, which form when there is a small to moderate supply of sand, much wind and little vegetation; (2) transverse dunes, which form when there is a copious sand supply, little to moderate wind and little vegetation; (3) parabolic or u-shaped dunes, which form when there is a moderate supply of sand, wind and vegetation; and (4) climbing dunes, which climb the windward side of hills as sand sheets. Species occupying these environments are often adapted to shifting, coarse-textured substrates (usually quartz sand) and form patchy or open grasslands, shrublands or steppe, and occasionally woodlands.

SAND DUNE VEGETATION


Photo by Rex Crawford

Threats: Currently, the major threats to inland sand dunes in Washington are stabilization by invasive species, agricultural conversion including effects from adjacent irrigation, off-road vehicle (ORVs) use, intentional sand dune stabilization, conversion to residential lots, mining activities and livestock grazing (Hallock et al. 2007). The total extent of Washington inland sand dunes has declined approximately 76% from the early 1970s, primarily due to agricultural conversion, reservoir flooding and dune stabilization.

Classification Comments: This system is characterized by active or stabilized dunes and sandsheets within the Columbia Basin and has patchy or sparse vegetation. Patches of open grasslands, shrublands or steppe, and occasionally woodlands, occur in a predominantly barren landscape. Where complete stabilization has occurred, vegetation might be considered part of another system such as the Inter-Mountain Basins Big Sagebrush Steppe.

Related Concepts: This ecological system falls within the Shrub-steppe habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize the Inter-Mountain Basin Active and Stabilized Dune as a unique mapping unit and but does aggregate it as a part of the Inter-Mountain Basins Sparsely Vegetated System map unit.


Photo by Lisa Hallock

References

Hallock, L.A., R.D. Haugo, and R. Crawford. 2007. Conservation Strategy for Washington State Inland Sand Dunes. Washington Natural Heritage Program, Washington Department of Natural Resources, Olympia, WA. Natural Heritage Report 2007-05. http://www.fs.fed.us/r6/sfpnw/issssp/documents/planning-docs/cs-blm-wa-state-inland-sand-dunes-2007-06.pdf

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Hallock, L.A., R.D. Haugo, and R. Crawford. 2007. Conservation Strategy for Washington State Inland Sand Dunes. Washington Natural Heritage Program, Washington Department of Natural Resources, Olympia, WA. Natural Heritage Report 2007-05.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Description Author: Rex Crawford, Keith Schultz and Marion Reid

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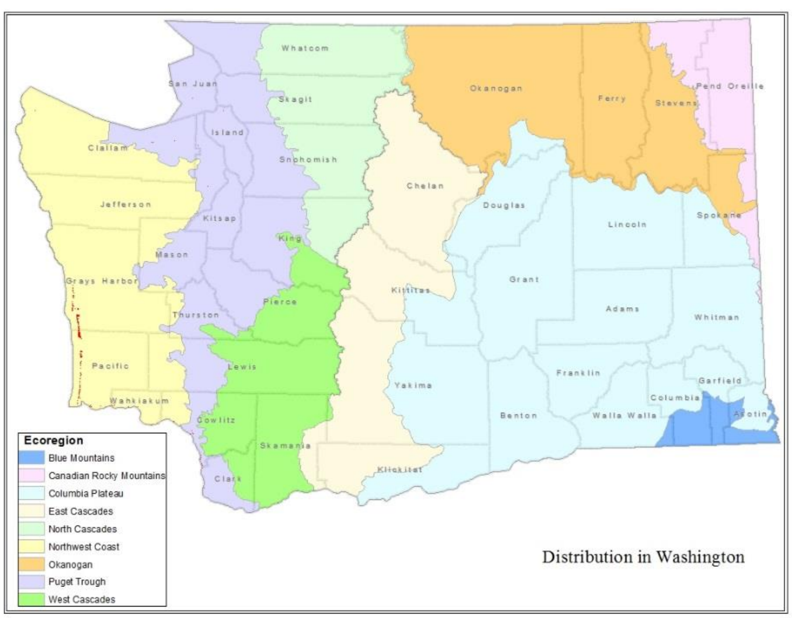
SAND DUNE VEGETATION

NORTH PACIFIC MARITIME COASTAL SAND DUNE AND STRAND

Concept: Coastal active or stabilized dunes and sandsheet. They are most abundant on the Washington coast south of the Copalis River and in scattered small locations along the Strait of Juan de Fuca and in the Puget Sound. In their natural state these are dominated by short to medium-tall grasses, sedges, or forbs, often with abundant bare sandy or gravelly surface exposed.

Conservation Status: Critically Imperiled (S1). Coastal dunes comprise 45% percent of the Oregon and Washington coastline. Although there are many element occurrences most are small and many have been degraded due to development and logging. On the outer coast, elk have been noted as impacting many sites due to intensive trampling which has resulted in the spread of nonnative species in some areas.

Distribution: This ecological system occurs along the northern Pacific Coast, from south-central Alaska to the central Oregon coast (roughly Coos Bay) (Wiedemann 1984). In Washington, this large patch system is most abundant on the Washington coast south of the Copalis River and in scattered small locations along the Strait of Juan de Fuca and in the Puget Sound.



Environment: Coastal dunes include beach strand (not the beach itself but sparsely or densely vegetated areas behind the beach), foredunes, sand spits, and active to stabile backdunes and sandsheets. Coastal dunes often front portions of inlets and tidal marshes.

Vegetation: Coastal dune vegetation typically includes herbaceous, succulent, shrub and tree species with varying degrees of tolerance for salt spray, wind and sand abrasion, and substrate stability. Dune succession is highly variable, so species composition can vary significantly among occurrences and add significantly to the overall species richness of a locale (Peinado and other 2007). Beach strands and low dunes may have *Ambrosia chamissonis*, *Abronia latifolia*, *Cakile maritime* and *C. edentula*. Dunes can be dominated by grasses, *Leymus arenarius* (= *Elymus arenarius*), *Festuca rubra*, *Leymus mollis*, or various forbs adapted to salty, dry conditions. *Gaultheria shallon* and *Vaccinium ovatum* are major shrub species. Forested portions of dunes are included within this system and are characterized in Washington by *Pinus contorta* var. *contorta* early in succession, *Picea sitchensis* somewhat later in the sere, and in some seres *Tsuga heterophylla*. Characteristic Pacific Northwest coastal dune species include *Abronia latifolia, Abronia umbellata* ssp. *breviflora, Ambrosia chamissonis, Calystegia soldanella, Camissonia cheiranthifolia, Leymus mollis, Lathyrus japonicas, Polygonum paronychia,* and *Tanacetum camphoratum* (Zarnetske and other 2007). The mosaic of sparse to dense vegetation development in dune system is driven by sand deposition, erosion, and lateral movement (Wiedemann 1984).

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Groups and Associations that are associated with this ecological system:

G205 Vancouverian Dry Coastal & Lowland Beach Pine Forest & Woodland	**Global/ State Rank**	**NatureServe/ WNHP Code**
Pinus contorta var. contorta / Arctostaphylos uva-ursi Woodland	G1/S1	CEGL002605
G751 North Pacific Western Hemlock - Sitka Spruce - Western Red-cedar Seasonal Rainforest Group [Proposed]	**Global/ State Rank**	**NatureServe/ WNHP Code**
Picea sitchensis - Pinus contorta / Gaultheria shallon - Vaccinium ovatum Forest	G3/S2	CEGL000403
G498 North Pacific Maritime Coastal Scrub & Herb Beach & Dune Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Agrostis pallens Herbaceous Vegetation	G1Q/S1	CEGL001600
Artemisia campestris - Festuca rubra / Racomitrium canescens Herbaceous Vegetation	G1/S1	CEGL003370
Carex macrocephala Herbaceous Vegetation	G1G2/S1	CEGL003368
Festuca rubra - Ambrosia chamissonis Herbaceous Vegetation	G1/S1	CEGL003290
Festuca rubra Stabilized Dune Herbaceous Vegetation	G1/S1	CEGL001774
Leymus mollis ssp. mollis - Abronia latifolia Herbaceous Vegetation	G2?/S2	CEGL001796
Lupinus littoralis Dune Herbaceous Vegetation	G3/S1	CEGL001974
Poa macrantha Herbaceous Vegetation	G1/S1	CWWA000184

Ecological Processes: The mosaic of sparse to dense vegetation in dune system is driven by sand deposition, erosion, and lateral movement. Disturbance processes include dune blowouts caused by wind and occasional wave overwash during storm tidal surges. Pacific Northwest coastal dunes are dynamic, transgressive, wind-controlled systems in their natural condition (citations in Zarnetske and others 2010). These communities are dependent upon longshore drift and wind. Most of these are spits or berms behind sandy beaches.

Threats: Currently, the major threats to coastal sand dunes in Washington are stabilization by invasive species, off-road vehicle (ORVs) use, intentional sand dune stabilization, road construction, and conversion to residential lots. The exotic *Ammophila arenaria* has been extensively planted for stabilization purposes and has also spread widely on its own for over 125 years (Wiedemann and Pickart 1996). Similarly, the eastern North American native *A. breviligulata* has been planted and spreading along the Long Beach peninsula (Seabloom and Wiedemann 1994). Unstabilized sand is now a relatively rare condition primarily because of the effects of the introduction of these species. Once they form dominant communities, the physical form and natural processes of dunes are altered and change the native species of foredunes (Pavlik

1983). Although Wiedemann and Pickart (1996) concluded that *Ammophila* will not significantly alter the natural stabilization-rejuvenation cycles. Invasion of *Ammophila arenaria* has resulted in the physical form of these sand dunes changing from more sparsely vegetated, hummocky foredunes to a higher, steeper foredune that decreases sand flow to interior dunes (Wiedemann 1984, Pickart 1997). It shortens the stabilization time, and drastically alters natural succession. Forests are probably forming at a greater rate than they did in the past because of increased stabilization. However, housing development has altered many of the forested examples of this system. Zarnetske and others (2010) summarize *Ammophila* impact as having changed Pacific Northwest coastal dunes from open, sparsely vegetated and low-lying, mobile systems to large, continuous, and highly stable, foredunes. *Ammophila* is now so widespread on the west coast of the U. S. that its eradication is not practical unless a more economic means of control is found. Other exotic species, especially sweet *Anthoxanthum odoratum* and *Holcus lanatus* are now a constant component of herb-dominated communities. The spread of such species may be related to past livestock grazing in many areas. *Cytisus scoparius* and *Ulex europaeus* are aggressive invasive exotic shrub that were planted for stabilization and have since spread widely. Off-road vehicle use has resulted in complete destruction of native herbaceous communities in some areas.

Classification Comments: This system is located in coastal active or stabilized dunes and sandsheets. Late-sere forests, dominating stabilized dune systems where active dune processes are nearly absent and that compositionally represent the adjacent forest matrix system, are excluded from this dune system. Interdunal wetlands occur commonly within the matrix of this system and sometimes are extensive in deflation plains or old dune troughs, but are considered part of the North Pacific Maritime Interdunal Coastal Wetland ecological system.

Related Concepts: This ecological system falls within the Coastal Dunes and Beaches habitat type identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize the North Pacific Maritime Coastal Sand Dune and Strand as a unique mapping unit and but did aggregate it into the Pacific Coastal Dunes and Other Sparsely Vegetated Systems but did not map it.

References

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Pavlik, B.M., 1983. Nutrient and productivity relations of the dune grasses *Ammophila arenaria* and *Elymus mollis*. 3. Spatial aspects of clonal expansion with reference to rhizome growth and dispersal of buds. Bulletin of the Torrey Botanical Club. 110:271-279.

Peinado, M., J.L. Aguirre, J. Delgadillo, and M.A. Macıas. 2007. Zonobiomes, zonoecotones and azonal vegetation all on the Pacific Coast of North America. Plant Ecology. 191:221-252.

Pickart, A. J. 1997. Control of European Beachgrass (Ammophila arenaria) on the West Coast of the United States. California Exotic Pest Plant Council Symposium proceedings.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Seabloom, EW. and A.M. Wiedemann. 1994. Distribution and effects of *Ammophila breviligulata* Fern. (American beachgrass) on the foredunes of the Washington coast. *Journal of Coastal Research*, 10(1), 178-188.

Wiedemann, A.M. 1984. The ecology of Pacific Northwest coastal sand dunes: a community profile. U.S. Fish Wildl. Serv. FWS/OBS-84-04. 130p.

Wiedemann A. M. and A. J. Pickart, 1996. The Ammophila problem on the Northwest Coast of North America. Landscape and Urban Planning 34(3):287-299.

Zarnetske, P. L., E. W. Seabloom, and S. D. Hacker. 2010. Non-target effects of invasive species management: beachgrass, birds, and bulldozers in coastal dunes. Ecosphere 1(5):13.

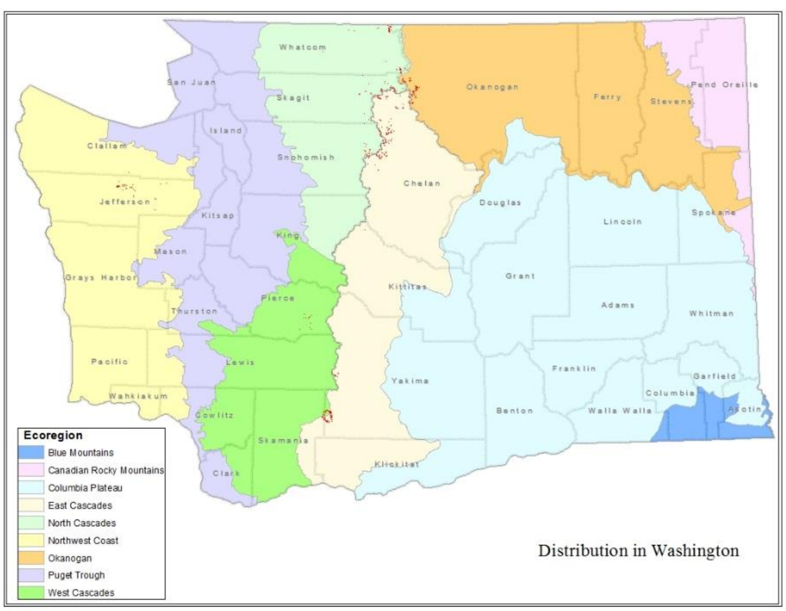
Description Author: Rex Crawford, Keith Boggs, Chris Chappell, and Gwen Kittel.

NORTH PACIFIC DRY AND MESIC ALPINE DWARF-SHRUBLAND, FELL-FIELD AND MEADOW

Concept: Cold, wind-blown areas supporting a mosaic of dwarf-shrublands, fell-fields, tundra (sedge turfs), and sparsely vegetated snowbed communities found above environmental limit of trees, at the highest elevations of the mountain regions of the Olympic and Cascade Mountains. Small patches of krummholz (shrub-form trees) are also part of this system. This system includes all vegetated areas in the alpine zone of the North Pacific region.

Conservation Status: Apparently Secure (S4).

Distribution: This large patch system occurs in the mountain regions of the Pacific Northwest coast. In Washington, this system is found at the highest elevations of the mountain regions of the Olympic and Cascade Mountains.



Environment: Sites are slopes and depressions where snow lingers, areas where the soil has become relatively stabilized, and where the water supply is more or less constant except in late summer.

Vegetation: This system is often expressed as a mosaic of dwarf-shrublands, fell-fields, tundra (sedge turfs), and sparsely vegetated snowbed communities. Small patches of krummholz (shrub-form trees) are also part of this system and occur at the lower elevations of this system's range. Communities are dominated by graminoids, foliose lichens, dwarf-shrubs, and/or forbs. Characteristic species include

Cassiope mertensiana, Phyllodoce empetriformis, Phyllodoce glanduliflora, Luetkea pectinata, Saxifraga tolmiei, and *Carex* spp. Vegetation cover ranges from about 5 or 10% (snowbeds) to nearly 100%. The alpine tundra of the northern Cascades has floristic affinities with many mountain regions in western North America. The strongest relationships are with the Arctic and Cordilleran regions to the north and east.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Groups and Associations that are associated with this ecological system:

G317 North Pacific Alpine-Subalpine Dwarf-Shrubland & Heath Group	Global/ State Rank	NatureServe/ WNHP Code
Arctostaphylos uva-ursi Dwarf-shrubland	G3G4/S3S4	CEGL001392
Cassiope mertensiana - Phyllodoce empetriformis Dwarf-shrubland	G5/S5	CEGL001398
Cassiope mertensiana / Luetkea pectinata Dwarf-shrubland	G3G4/S3S4	CEGL001397
Cassiope mertensiana Dwarf-shrubland	G3G4/S3S4	CEGL001395
Dryas octopetala Dwarf-shrub Herbaceous Vegetation	G3?/S3?	CEGL001891
Empetrum nigrum / Lupinus sellulus var. lobbii Dwarf-shrubland	G3G4/S3S4	CEGL001400
Empetrum nigrum Dwarf-shrubland	G3G4/S3S4	CEGL001399
Luetkea pectinata - Saxifraga tolmiei Herbaceous Vegetation	G5/S4	CEGL001918
Phyllodoce empetriformis / Lupinus latifolius Dwarf-shrubland	G4?/S4	CEGL001406
Phyllodoce empetriformis / Vaccinium deliciosum Dwarf-shrubland	G4/S4	CEGL001407
Phyllodoce empetriformis Parkland Dwarf-shrubland	G5/SNA	CEGL001404
Phyllodoce glanduliflora / Oreostemma alpigenum Dwarf-shrubland	G3G4/S3S4	CEGL001408
Salix cascadensis / Festuca brachyphylla Dwarf-shrubland	G3G4/S3S4	CEGL001433
Salix nivalis / Festuca brachyphylla Dwarf-shrubland	G3G4/S3S4	CEGL001434
Tauschia stricklandii - Vaccinium deliciosum Herbaceous Vegetation	G2/S2	CEGL001994
Vaccinium deliciosum Parkland Dwarf-shrubland	G4G5/S4S5	CEGL001427
Vaccinium membranaceum - Vaccinium deliciosum Dwarf-shrubland	G4?Q/S4?	CEGL001428
G320 North Pacific Alpine-Subalpine Turf & Herbaceous Meadow Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Antennaria lanata Herbaceous Vegetation	G4/S4	CEGL001949
Calamagrostis purpurascens Herbaceous Vegetation	G2/S2	CEGL001850
Carex breweri Herbaceous Vegetation	G3?/S3?	CEGL001805
Carex capitata Herbaceous Vegetation	G3?/S3?	CEGL001807
Carex nardina Scree Herbaceous Vegetation	GNR/SNR	CEGL001812
Carex proposita Herbaceous Vegetation	G3?/S1	CEGL001859
Carex scirpoidea ssp. pseudoscirpoidea Herbaceous Vegetation	G3?/S2	CEGL001865
Carex spectabilis - Polygonum bistortoides Herbaceous Vegetation	G4/S4	CEGL001828
Carex spectabilis Herbaceous Vegetation	G5/S4S5	CEGL001827
Festuca brachyphylla Herbaceous Vegetation	G4?/SNR	CEGL001797
Festuca roemeri - Delphinium glareosum Herbaceous Vegetation	G2/S2	CEGL001613
Festuca roemeri - Phlox diffusa ssp. longistylis Herbaceous Vegetation	G2/S2	CEGL001622
Erigeron aureus - Lupinus sellulus var. lobbii Herbaceous Vegetation	G3G4/S3S4	CEGL001961
Eriogonum pyrolifolium - Luzula piperi Herbaceous Vegetation	G4/S4	CEGL001963

ALPINE VEGETATION

G320 North Pacific Alpine-Subalpine Turf & Herbaceous Meadow Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Lupinus arcticus ssp. subalpinus - Carex spectabilis Herbaceous Vegetation	G4/S4	CEGL001973
Minuartia obtusiloba - Lupinus sellulus var. lobbii Herbaceous Vegetation	G3G4/S3S4	CEGL001952
Pedicularis contorta - Carex spectabilis Herbaceous Vegetation	G3?/S3?	CEGL001977
Phlox diffusa ssp. longistylis - Arenaria capillaris Herbaceous Vegetation	G3?/S3?	CEGL001978
Phlox diffusa ssp. longistylis - Carex spectabilis Herbaceous Vegetation	GNR/S3?	CEGL001979
Saxifraga tolmiei - Luzula piperi Herbaceous Vegetation	G4/S4	CEGL001986

Ecological Processes: Snow retention, wind desiccation, permafrost, and a short growing season influence vegetation patterns.

Threats: Trampling and associated recreational impacts, e.g., tent sites, are a major source of human disturbance. Resistance and resilience of vegetation to these impacts varies by life form. Sedge turfs are perhaps most resilient to trampling and heaths are least resilient. Trampling induced degradation and erosion can result in continuous bare ground, largely unsuitable for vascular plant growth thus limiting restoration potential. Introduction of exotic ungulates have had noticeable impacts (e.g., mountain goats in the Olympic Mountains).

Classification Comments: This system differs from the North Pacific Alpine and Subalpine Dry Grassland in that it has more mesic vegetation and includes dwarf shrubs. This system differs from the closely related Rocky Mountain Alpine Dwarf Shrubland, Rocky Mountain Alpine Fell-Field, and Rocky Mountain Alpine Turf systems mostly in terms of geography and because it has a Vancouverian flora.

Related Concepts: This ecological system falls within Alpine Grasslands and Shrublands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes North Pacific Dry and Mesic Alpine Dwarf-Shrubland, Fell-field and Meadow as one of their standard mapping units.

References

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Description Author: Keith Boggs, Chris Chappell, and Rex Crawford.

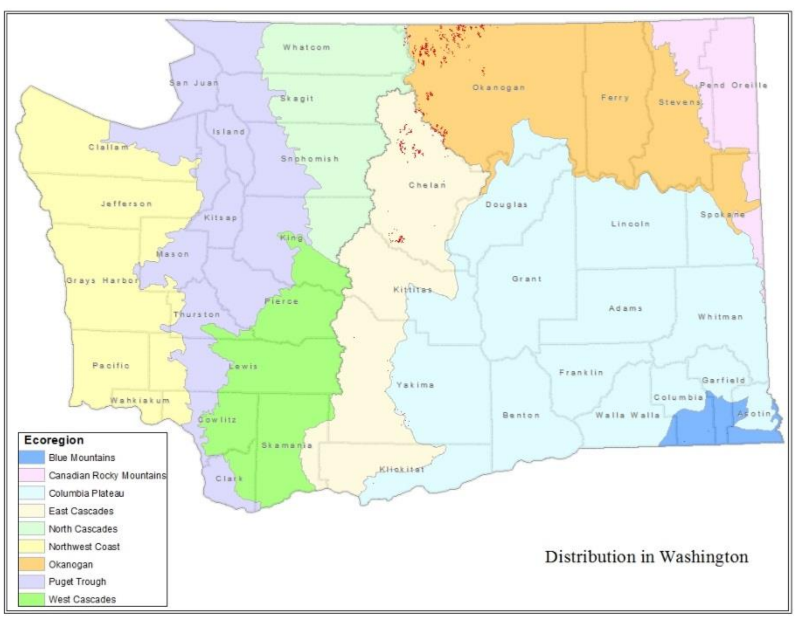
ROCKY MOUNTAIN ALPINE DWARF SHRUBLAND, FELL-FIELD, AND TURF

Photo by David Wilderman

Concept: This description addresses three distinct ecological systems: Rocky Mountain Alpine Dwarf-Shrubland, Rocky Mountain Alpine Fell-Field, and Rocky Mountain Alpine Turf. In Washington, these three systems co-occur in a mosaic over small areas in the alpine areas of the Okanogan Highlands (e.g., Loomis State Forest), East Cascades and potentially on the east side of Mt. Adams. These systems include alpine land cover with dwarf shrublands, significant of herbaceous vegetation (typically dominated by cushion plants), and exposed gravels and rock outcrop (50-90% cover).

Conservation Status: Apparently Secure (S4?). No known threats; uncertain if increase in area with glacier retreat will be offset with transition to forested systems moving upwards due to climate change.

Distribution: This large patch system is restricted to the highest elevations of the Rocky Mountains, from Alberta and British Columbia south into New Mexico, west into the highest mountain ranges of the Great Basin. In Washington this system is mostly found in the Okanogan Highlands (e.g., Loomis State Forest), East Cascades and potentially on the east side of Mt. Adams.



Distribution in Washington

Environment: Dwarf shrublands are often found on level or concave glacial topography, with late-lying snow and subirrigation from surrounding slopes. Soils have become relatively stabilized in these sites, are moist but well-drained, strongly acidic. Fell-fields are found in wind-scoured areas such as ridgetops and exposed saddles. Soils on these windy unproductive sites are shallow, stony, low in organic matter, and poorly developed. Turf communities are found on gentle to moderate slopes, flat ridges, valleys, and basins, where the soil has become relatively stabilized and the water supply is more or less constant except in late summer.

Vegetation: Dwarf shrublands consists of a semi-continuous layer of ericaceous dwarf-shrubs or dwarf willows which form a heath type ground cover less than 0.5 m in height. Dense tuffs of graminoids and scattered forbs occur. *Cassiope mertensiana, Salix arctica, Salix reticulata, Salix vestita*, or *Phyllodoce empetriformis* can be dominant shrubs. *Vaccinium* spp., *Ledum glandulosum, Phyllodoce glanduliflora*, and *Kalmia microphylla* may also be shrub associates. The herbaceous layer is a mixture of forbs and graminoids, especially sedges, including, *Erigeron* spp., *Luetkea pectinata, Antennaria lanata, Oreostemma alpigenum (= Aster alpigenus), Pedicularis* spp., *Castilleja* spp., *Deschampsia caespitosa, Caltha leptosepala ssp. howellii, Erythronium* spp., *Juncus parryi, Luzula piperi, Carex spectabilis, Carex nigricans*, and *Polygonum bistortoides*. Fell fields often intermingle with the alpine dwarf-shrubland. Most fell-field plants are cushioned or matted, frequently succulent, flat to the ground in rosettes and often densely haired and thickly cutinized. Plant cover is 15-50%, while exposed rocks make up the remaining cover. Fell-fields are usually within or adjacent to alpine tundra dry meadows. Common species include *Arenaria capillaris, Geum rossii, Kobresia myosuroides, Minuartia obtusiloba, Myosotis asiatica, Paronychia pulvinata, Phlox pulvinata, Sibbaldia procumbens, Silene acaulis, Trifolium dasyphyllum*, and *Trifolium parryi*. Turfs are comprised of a dense cover of low-growing, perennial graminoids and forbs. Rhizomatous, sod-forming sedges are the dominant graminoids, and prostrate and mat-forming plants with thick rootstocks or taproots characterize the forbs. Dominant species include *Artemisia arctica, Carex elynoides, Carex siccata, Carex scirpoidea, Carex nardina, Carex rupestris, Festuca brachyphylla, Festuca idahoensis, Geum rossii, Kobresia myosuroides, Phlox pulvinata*, and *Trifolium dasyphyllum*. Many other graminoids, forbs, and prostrate shrubs can also be found, including *Calamagrostis purpurascens, Deschampsia caespitosa, Dryas octopetala, Poa arctica, Saxifraga* spp., *Selaginella densa, Sibbaldia procumbens, Silene acaulis, Solidago* spp., and *Trifolium parryi*.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Groups and Associations that are associated with this ecological system. However, additional classification effort is needed to full account for the vegetation diversity of these ecological systems.

G317 North Pacific Alpine-Subalpine Dwarf-Shrubland & Heath Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Dryas octopetala Dwarf-shrub Herbaceous Vegetation	G3?/S3?	CEGL001891
G320 North Pacific Alpine-Subalpine Turf & Herbaceous Meadow Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Festuca brachyphylla Herbaceous Vegetation	G4?/SNR	CEGL001797

Ecological Processes: Dwarf shrublands are controlled by snow retention, wind desiccation, permafrost, and a short growing season. Fell-field experience harsh winds, resulting in snow-free areas in the winter. Wind deflation often results in a gravelly pavement. Turf vegetation is controlled by snow retention, wind desiccation, permafrost, and a short growing season.

Threats: Trampling and associated recreational impacts, e.g., tent sites are a major source of human disturbance. Resistance and resilience of vegetation to these impacts varies by life form. Sedge turfs are perhaps most resilient to trampling and heaths are least resilient. Trampling induced degradation and erosion can result in continuous bare ground, largely unsuitable for vascular plant growth thus limiting restoration potential.

Classification Comments: NatureServe separates this system into three distinct types: Rocky Mountain Alpine Dwarf Shrubland, Rocky Mountain Alpine Turf, and Rocky Mountain Alpine Fell-Field. In

Washington, these three systems occur as a mosaic of very small patch types and thus were combined into one unit. This system differs from the North Pacific Dry and Mesic Alpine Dwarf-Shrubland, Fell-field and Meadow system mostly in terms of geography and because it has a more Rocky Mountain flora.

Related Concepts: This ecological system falls within the Alpine Grasslands and Shrublands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the Rocky Mountain Alpine Fell-Field but did not map it.

References

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

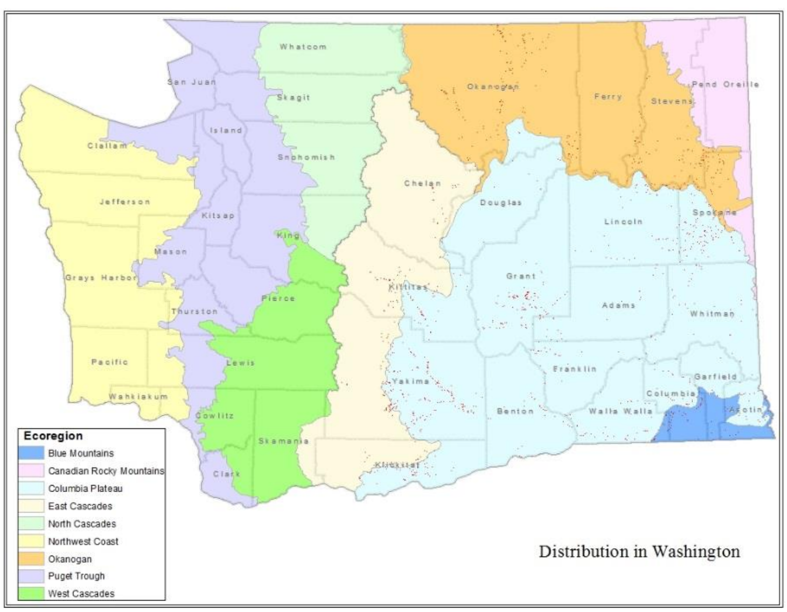
Description Author: NatureServe Western Ecology Team and Marion Reid.

COLUMBIA BASIN FOOTHILL RIPARIAN WOODLAND AND SHRUBLAND

Concept: Riparian woodlands and shrublands found in the Columbia Basin. These riparian areas are associated with all streams at and below lower treeline, including permanent, intermittent and ephemeral streams with woody riparian vegetation.

Conservation Status: Critically Imperiled (S1). This ecological system has experienced a dramatic decline in extent due to woody vegetation removal for fuel and building materials, and to clear areas for agriculture. Water use and management in the Columbia Basin has likely affected some areas as well. Livestock grazing, both historical and contemporary, continue to degrade any remaining occurrences.

Distribution: This linear riparian system is found in the Columbia Basin of eastern Washington. This system is associated with all streams at and below lower treeline, including permanent, intermittent and ephemeral streams with woody riparian vegetation.



Distribution in Washington

Environment: This system is found in low-elevation canyons and draws, on floodplains, steep-sided canyons, or narrow V-shaped valleys with rocky substrates. This includes both perennial and intermittent streams. Most sites are subject to overbank flooding while stands associated with seeps and/or springs often do not experience seasonal flooding. Rather, such sites are supported by seasonal or perennial subirrigation from discharging groundwater. Bottomlands may have large occurrences, but most have been cut over or cleared for agriculture. In some areas, such as along the Yakima River, stands of cottonwoods have decreased in extent due to hydrological alteration (Braatne et al. 2007).

Vegetation: Important and diagnostic trees include *Populus balsamifera* ssp. *trichocarpa*, *Betula occidentalis, Alnus rhombifolia, Populus tremuloides, Celtis laevigata* var. *reticulata, Pinus ponderosa, Salix amygdaloides, Salix lasiandra,* and *Salix lasiolepis*. Important shrubs associated with smaller streams include *Crataegus douglasii, Philadelphus lewisii, Cornus sericea, Salix exigua, Rosa nutkana, Rosa woodsii, Amelanchier alnifolia, Prunus virginiana,* and *Symphoricarpos albus* (Crawford 2003). *Philadelphus lewisii, Celtis laevigata var. reticulata,* and *Rosa spp.* are common dominates of seeps and headwater streams in the driest portions of the Columbia Basin. *Betula occidentalis*, *Populus balsamifera* ssp. *trichocarpa, Populus tremuloides,* and *Salix lasiandra* are common dominants of perennial (often spring-supported) larger streams. *Populus tremuloides*, *Cornus sericea*, and *Betula occidentalis* are also common dominants of seeps/springs found within the scabland portions of the Columbia Basin. Larger streams and rivers have a mosaic of vegetation primarily controlled by valley width, sediment type, and overbank flooding. *Populus balsamifera* ssp. *trichocarpa, Alnus rhombifolia, Salix amygdaloides,* and *Salix lasiandra* are common dominants in areas with significant floodplain development. *Alnus rhombifolia* and *Quercus garryana* are common on small and headwater streams in the southwest portion of the Columbia Basin (e.g., Klickitat County).

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Groups and Associations that are associated with this ecological system:

G526 Rocky Mountain & Great Basin Lowland & Foothill Riparian Shrubland Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
(Populus tremuloides) / Crataegus douglasii / Heracleum maximum Shrubland	G1/S1	CEGL001094
(Populus tremuloides) / Crataegus douglasii / Symphoricarpos albus Shrubland	G3/S2?	CEGL001096
Acer glabrum var. douglasii - (Symphoricarpos albus) Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Amelanchier alnifolia - Philadelphus lewisii / Pseudoroegneria spicata Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Amelanchier alnifolia / Toxicodendron rydbergii Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Betula occidentalis - Celtis laevigata var. reticulata Shrubland	G2/SNR	CEGL003450
Betula occidentalis / Cornus sericea Shrubland	G3/S1	CEGL001161
Betula occidentalis / Crataegus douglasii Shrubland	G1/S1	CEGL001081
Betula occidentalis / Equisetum arvense Shrubland (Provisional)	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Betula occidentalis / Maianthemum stellatum Shrubland	G4?/S1	CEGL001162
Betula occidentalis / Philadelphus lewisii - Symphoricarpos albus Shrubland	G1G2/S1?	CEGL000489
Betula occidentalis / Philadelphus lewisii Shrubland	G2/SNR	CEGL002668
Betula occidentalis / Rosa woodsii Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Crataegus douglasii / Rosa woodsii Shrubland	G2/S1	CEGL001095
Philadelphus lewisii / Symphoricarpos albus Shrubland	G1G2/S1S2	CEGL000875
Philadelphus lewisii Intermittently Flooded Shrubland	G2/S1S2	CEGL001170
Prunus virginiana Temporarily Flooded Shrubland	G3?/S1?	CWWA000186
Rhamnus alnifolia Shrubland	G3/S1?	CEGL001132

Riparian Systems

G526 Rocky Mountain & Great Basin Lowland & Foothill Riparian Shrubland Group	Global/ State Rank	NatureServe/ WNHP Code
Salix (melanopsis, sitchensis) Alluvial Bar Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Salix (melanopsis, sitchensis) Cobble Bar Shrubland	G3G4/S1?	CEGL002705
Salix exigua / Barren Shrubland	G5/S2	CEGL001200
Salix exigua / Equisetum arvense Shrubland	G3/S2S3	CEGL001201
Salix exigua / Mesic Graminoids Shrubland	G5/SNR	CEGL001203
Salix exigua Temporarily Flooded Shrubland	G5/S2	CEGL001197
Salix lasiolepis / Barren Ground Shrubland	G3?/SNR	CEGL001216
Salix lucida ssp. caudata Shrubland	G3Q/S1	CEGL001215
Salix lutea - Salix exigua Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Salix lutea / Cornus sericea Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
G796 Northern Rocky Mountain Lowland & Foothill Riparian Forest Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Acer macrophyllum / Holodiscus discolor Woodland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Alnus rhombifolia / Betula occidentalis Forest	G1/S1	CEGL000632
Alnus rhombifolia / Celtis laevigata var. reticulata Forest	G1?/S1?	CEGL000633
Alnus rhombifolia / Cornus sericea Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Alnus rhombifolia / Equisetum arvense Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Alnus rhombifolia / Philadelphus lewisii Forest	G1/S1	CEGL000634
Celtis laevigata var. reticulata / Philadelphus lewisii Woodland	G1/S1	CEGL000792
Celtis laevigata var. reticulata / Toxicodendron rydbergii Woodland	G2/SNR	CEGL003451
Juniperus occidentalis / Philadelphus lewisii - Salix lasiolepis Intermittently Flooded Woodland [Provisional]	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Pinus ponderosa / Crataegus douglasii Woodland	G1/S1	CEGL000855
Pinus ponderosa / Symphoricarpos albus Temporarily Flooded Woodland	G2/S1	CEGL000866
Populus balsamifera ssp. trichocarpa - Alnus rhombifolia Forest	G1/S1	CEGL000668
Populus balsamifera ssp. trichocarpa / Alnus incana Forest	G3/S3	CEGL000667
Populus balsamifera ssp. trichocarpa / Cicuta douglasii Forest	G1/S1	CEGL000671
Populus balsamifera ssp. trichocarpa / Cornus sericea Forest	G3G4/S2?	CEGL000672
Populus balsamifera ssp. trichocarpa / Crataegus douglasii Forest	G1/SH	CEGL000673
Populus balsamifera ssp. trichocarpa / Equisetum hyemale Forest	GNRQ/S1	CWWA000185
Populus balsamifera ssp. trichocarpa / Salix exigua Forest	G1/S1	CEGL000676
Pseudotsuga menziesii / Symphoricarpos albus Temporarily Flooded Woodland	G2?/S1S2	CWWA000021
Quercus garryana / Elymus glaucus Woodland	G1S2/S1	CEGL000550
Quercus garryana / Symphoricarpos albus Woodland	G2G3/S2S3	CEGL000553
Salix amygdaloides / Salix exigua Woodland	G1Q/S1	CEGL000948
Pinus ponderosa - Quercus garryana / Symphoricarpos albus Woodland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)

G796 Northern Rocky Mountain Lowland & Foothill Riparian Forest Group	Global/ State Rank	NatureServe/ WNHP Code
Pinus ponderosa / Camassia quamash Woodland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Pinus ponderosa / Lomatium nudicaule Woodland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Populus balsamifera ssp. trichocarpa - Betula occidentalis / Philadelphus lewisii Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Populus balsamifera ssp. trichocarpa / Acer glabrum Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Populus balsamifera ssp. trichocarpa / Alnus incana - Cornus sericea Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Populus balsamifera ssp. trichocarpa / Juniperus scopulorum Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Populus balsamifera ssp. trichocarpa / Philadelphus lewisii Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Pseudotsuga menziesii / Trautvetteria caroliniensis Woodland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Quercus garryana / Corylus cornuta - Symphoricarpos albus Woodland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)

Ecological Processes: Sites are typically subject to temporary flooding during spring or late winter runoff. Overbank flooding and some gravel areas are required for regeneration of many of these riparian forests and woodlands, especially for cottonwoods. Beavers crop younger cottonwood and willows and frequently dam side channels. Groundwater discharge is an important driver for some sites.

Threats: Historical and contemporary land use practices have impacted hydrologic, geomorphic, and biotic structure and function of riparian areas in eastern Washington. Human land uses both within the riparian area as well as in adjacent and upland areas have fragmented many riparian reaches which has reduced connectivity between riparian patches and upland areas. Adjacent and upstream land uses also have the potential to contribute excess nutrients into riparian areas. Reservoirs, water diversions, ditches, roads, and human land uses in the contributing watershed can have a substantial impact on the hydrological regime. Management effects on woody riparian vegetation can be obvious, e.g., removal of vegetation by dam construction, roads, logging, or they can be subtle, e.g., removing beavers from a watershed, removing large woody debris, or construction of a weir dam for fish habitat. Grazing is a major influence in altering structure, composition, and function of the system (Kauffman et al 2004). In general, excessive livestock or native ungulate use leads to less woody cover and an increase in sod-forming grasses particularly on fine-textured soils. *Phalaris arundinacea* is present and often dominant in most occurrences of this system. Some forb species, such as *Urtica* and *Equisetum*,

increase with livestock use. Non-native plants or animals, which can have wide-ranging impacts, also tend to increase with these stressors. All of these stressors have resulted in many riparian areas being incised, supporting altered riparian plant communities, as well as numerous non-native species. This system has also decreased in extent due to agricultural development, roads, dams and other flood-control activities.

Classification Comments: This system occurs along riparian areas and seeps in the foothills and canyons within the Columbia River Basin at and below lower tree line.

Related Concepts: This ecological system falls within the Eastside (Interior) Riparian Wetlands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize the Columbia Basin Foothill Riparian Woodland and Shrubland as a standard mapping unit.

References

Braatne, J.H., R. Jamieson, K.M. Gill, and S.B. Rood. 2007. Instream flows and the decline of riparian cottonwoods along the Yakima River, Washington, USA. River Research and Applications. Vol. 23, Issue 3. Pp. 247-267.

Crawford, R.C. 2003. Riparian Vegetation Classification of the Columbia Basin, Washington. Report for BLM, Spokane District, TNC. and EPA. WA. Dept. Natural Resources. Natural Heritage Program, Olympia WA. 98 pp., plus tables.

Crawford, R.C. and J. Kagan. 2001. Eastside Riparian-Wetlands. *In* Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Kauffman, J.B. and W.C. Krueger, 1984. Livestock Impacts on Riparian Ecosystems and Streamside Management Implications: A Review. J. Range Manage. 37(5):430-438.

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. Pacific Northwest Research Station, Forest Service, U.S. Department of Agriculture. In cooperation with: Pacific Northwest Region, Colville, Okanogan, and Wenatchee National Forests. General Technical Report PNW-GTR-593. Portland, OR.

LANDFIRE. 2005. Landfire Biophysical Setting Model for Rocky Mountain Subalpine/Upper Montane Riparian Systems. BpS1011600. Online: http://www.landfire.gov/NationalProductDescriptions24.php

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Rocchio, F.J. and R.C. Crawford. *In Progress*. Ecological Classification of Native Wetland & Riparian Vegetation of Washington State. Natural Heritage Report 20XX-XX. Washington Dept. of Natural Resources, Natural Heritage Program. Olympia, WA.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Description Author: Joe Rocchio, Rex Crawford, NatureServe Western Ecology Team.

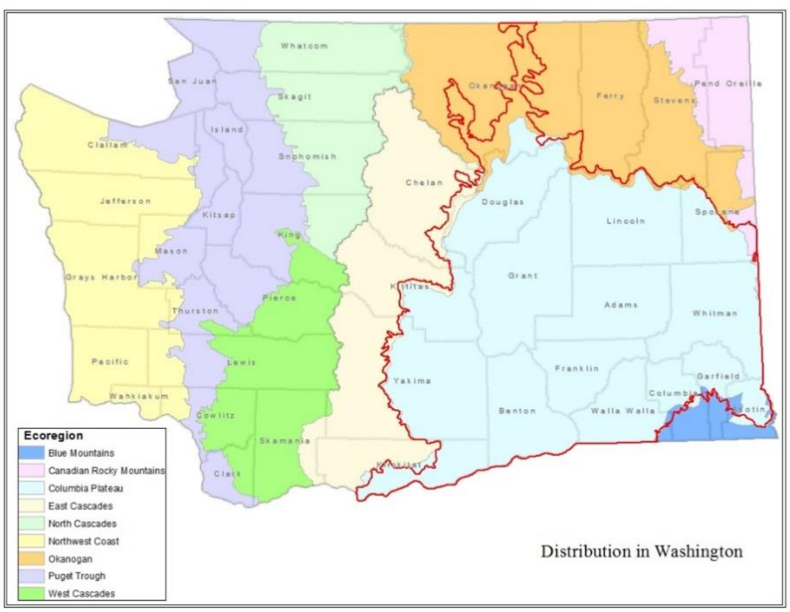
RIPARIAN SYSTEMS

INTER-MOUNTAIN BASINS WASH

Concept: Intermittent flooded and sparsely vegetated streambeds found in the Columbia Basin. The component vegetation is distinct from adjacent upland vegetation.

Conservation Status: Vulnerable (S3). Very little is known about this system. Field observations suggest that the system is localized, relatively uncommon, likely has not experienced widespread loss, but some occurrences may have experienced degradation from nonnative species.

Distribution: This linear system occurs throughout the Inter-Mountain western U.S., extending east into the western Great Plains. In Washington it is found within the Columbia Basin but is not very common. The map depicts the area where this system may occur.



Environment: The system is restricted to intermittently flooded streambeds and banks. Sites occur in or near temporary watercourses on sandy terraces, wash bottoms, and basin floors that are flat or gently sloping. Soils are variable but are generally well drained sandy or gravelly.

Vegetation: Vegetation in this system is usually scattered, occurring in parts of the channel protected from the most intense flooding. Shrubs have extensive root systems that allow them to resprout quickly when damaged or partially uprooted by flooding. This system is typically sparsely vegetated (generally <10% plant cover). Streambanks are often lined with shrubs such as *Sarcobatus vermiculatus*, *Ericameria nauseosa*, *Artemisia tridentata* ssp. *tridentata*, and *Philadelphus lewisii* that form relatively dense stringers in open dry uplands. Shrubs form a continuous or intermittent linear canopy in and along drainages but do not extend out into flats.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Groups and Associations that are associated with this ecological system:

G300 Intermountain Shadscale - Saltbush Scrub Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Grayia spinosa / Poa secunda Shrubland	G1/S1	CEGL001351
G531 Arid West Inland Freshwater Emergent Marsh Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Lomatium grayi Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
G537 North American Desert Alkaline-Saline Shrub Wetland Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Sarcobatus vermiculatus / Distichlis spicata Shrubland	G4/S2?	CEGL001363
Sarcobatus vermiculatus / Leymus cinereus Shrubland	G3/S1	CEGL001366
G538 North American Desert Alkaline-Saline Herbaceous Wetland & Playa Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Distichlis spicata Herbaceous Vegetation	G5/S1?	CEGL001770
Distichlis spicata - (Scirpus nevadensis) Herbaceous Vegetation	G4/SNA	CEGL001773

Ecological Processes: Dry conditions, coarse-textured substrates and intermittent severe flood disturbance and streamflow control vegetation patterns.

Threats: Invasive, exotic shrubs such as *Tamarix* spp. and other exotics such as *Salsola kali*, *Sisymbrium altissimum*, and *Bromus tectorum* may be present to dominant in these washes. These non-native species can replace native grasses and change the structure of the native habitat.

Classification Comments: This system is restricted to intermittently flooded streambeds and banks and is distinct from adjacent vegetation. Where the stringers or patches of *Artemisia tridentata ssp. tridentata* are large enough to be mapped separately from both the wash and from the adjacent upland, then they should be mapped as Inter-Mountain Basins Big Sagebrush Steppe. *Sarcobatus vermiculatus* dominated examples of this system are restricted to the periphery of the wash and distinct from adjacent vegetation. If *Sarcobatus* continues into adjacent vegetation then the type

should be considered as the Inter-Mountain Basins Greasewood Flat system. This wash system differs intermittent/ephemeral types associated with the Columbia Basin Riparian Woodlands and Shrublands by not being dominated by obvious riparian and wetland species such as *Salix* spp. *Populus balsamifera* ssp. *trichocarpa*, *Carex* spp., etc.

Related Concepts: This ecological is falls within the Desert Playa and Salt Scrub Shrublands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize the Inter-Mountain Basins Wash as a unique mapping unit but does aggregate it as a part of the Inter-Mountain Basins Sparsely Vegetated System map unit.

References

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

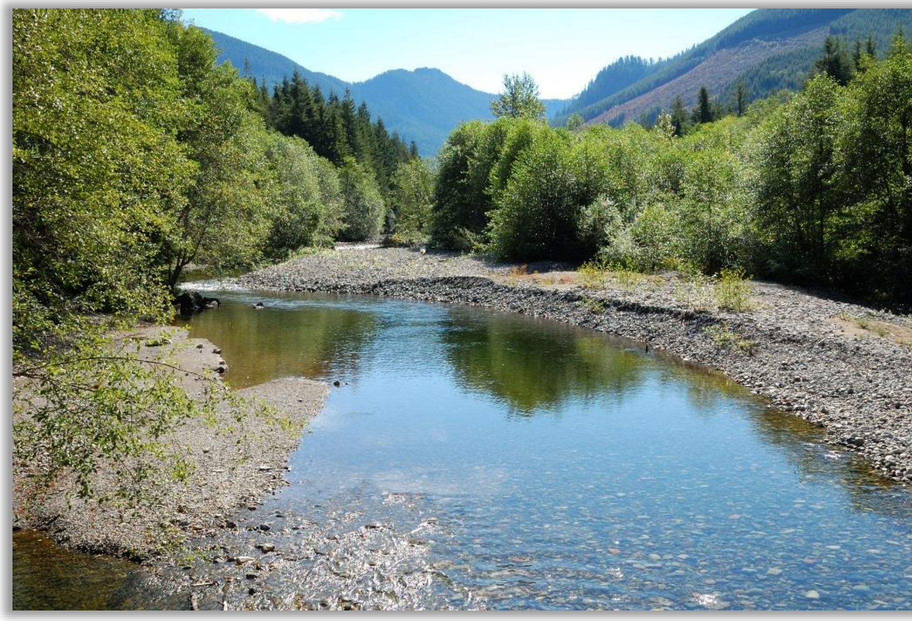
NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Rocchio, F.J. and R.C. Crawford. *In Progress*. Ecological Classification of Native Wetland & Riparian Vegetation of Washington State. Natural Heritage Report 20XX-XX. Washington Dept. of Natural Resources, Natural Heritage Program. Olympia, WA.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Description Author: Keith Schultz.

NORTH PACIFIC LOWLAND RIPARIAN FOREST AND SHRUBLAND

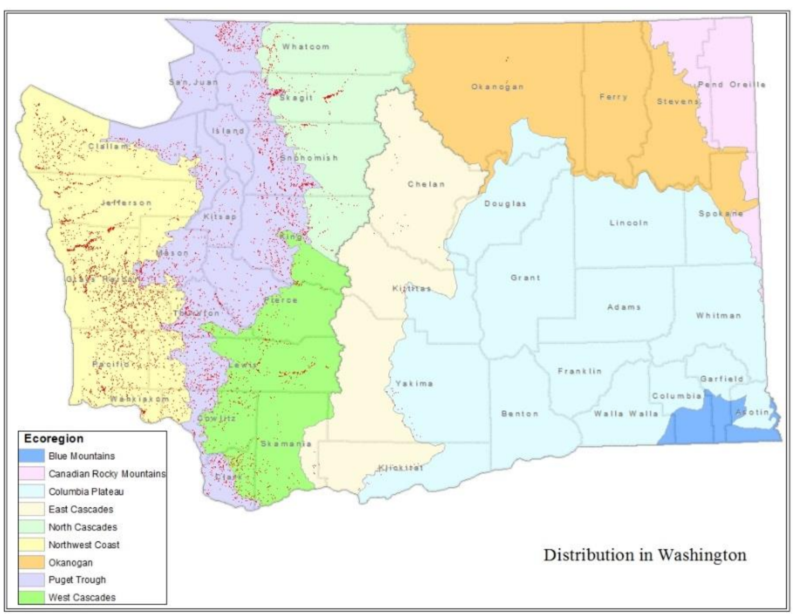


Concept: Riparian forests and shrublands found throughout low elevations west of the Cascades and is also found along the eastern base of the Cascades south of Lake Chelan. These forests and tall shrublands are linear in character, occurring on low-elevation, alluvial floodplains that are confined by valleys and inlets or lower terraces of rivers and streams.

Conservation Status: Imperiled (S2). Over half of this ecological system is estimated to have been lost. In addition, many, if not the majority, of extant occurrences have been degraded from a variety of stressors.

Distribution: This riparian ecological system occurs throughout the Pacific Northwest. In Washington it is most abundant throughout low elevations west of the Cascades and is also found along the eastern base of the Cascades south of Lake Chelan. This system is found below the *Abies amabilis* forest zone.

Environment: These forests and tall shrublands are linear in character, occurring on low-elevation, alluvial floodplains that are confined by valleys and inlets or lower terraces of rivers and streams. The systems occurs on a diversity of soil textures.



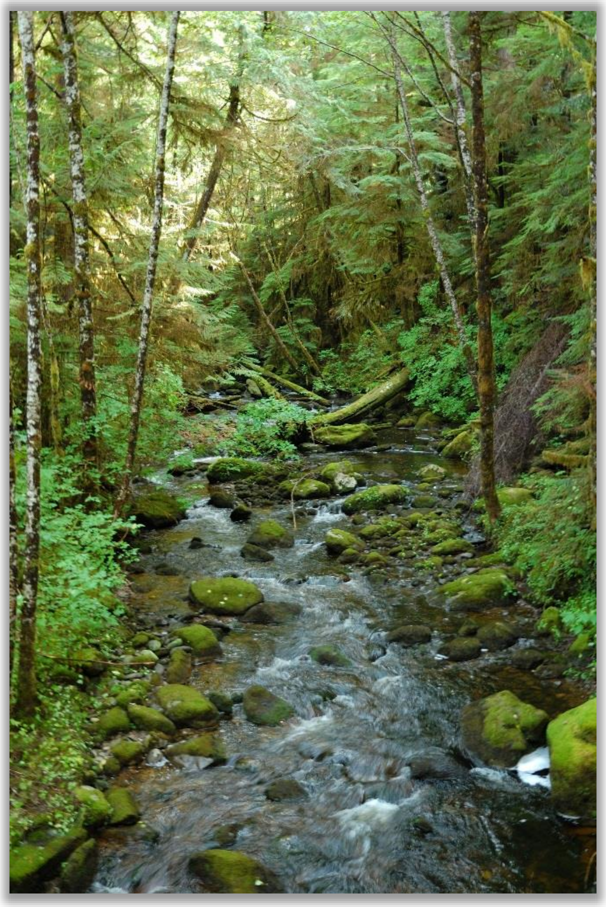
Vegetation: Riparian forests are the most structurally and floristically diverse type of vegetation in the Pacific coastal region (Naiman and Bilby 1998). Annual flooding is a key ecological processes which results in a diversity of patch types such as woodlands, shrublands, wet meadows, and marshes. These various plant communities are adapted to specific flooding regimes or seral stages. Very early successional stages can be sparsely vegetated or dominated by herbaceous vegetation. These early successional type are included in the Temperate Pacific Freshwater Emergent Marsh system. Willows such as *Salix sitchensis* may also dominate early- to mid-seral types. Dominant species of mid- to late-seral patches are typically deciduous trees (i.e., *Populus balsamifera* ssp. *trichocarpa* and *Alnus rubra*) but conifers can be dominant as well. Conifers such as *Abies grandis*, *Pseudotsuga menziesii*, *Picea sitchensis*, and *Thuja plicata* tend to increase with succession in the absence of major disturbance. Conifer-dominated plant communities are now very rare and not well described. Major broadleaf dominant species are *Acer macrophyllum, Alnus rubra, Populus balsamifera ssp. trichocarpa, Salix sitchensis, Salix lucida* ssp. *lasiandra, Cornus sericea*, and *Fraxinus latifolia*.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Groups and Associations that are associated with this ecological system:

G254 North Pacific Lowland Riparian Forest & Woodland Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Acer macrophyllum / Oxalis oregana Forest	G3G4/S2S3	CWWA000205
Acer macrophyllum / Polystichum munitum - Tolmiea menziesii Forest	G3G4/S3S4	CWWA000206
Acer macrophyllum / Rubus spectabilis Forest	G4/S3S4	CEGL000561
Acer macrophyllum / Rubus ursinus Forest	G3/SNA	CEGL003395
Acer macrophyllum / Symphoricarpos albus / Urtica dioica ssp. gracilis Forest	G3/SU	CEGL003396
Acer macrophyllum / Urtica dioica ssp. gracilis Forest	G3/SU	CEGL003397
Alnus rubra / Acer circinatum / Claytonia sibirica Forest	G4G5/S4	CEGL003298
Alnus rubra / Acer circinatum Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Alnus rubra / Achlys triphylla Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Alnus rubra / Alnus sinuata Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Alnus rubra / Elymus glaucus Forest	G4/S3S4	CEGL003398
Alnus rubra / Oplopanax horridus - Rubus spectabilis Forest	G4G5/S4	CEGL003399
Alnus rubra / Oplopanax horridus / Athyrium filix-femina Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Alnus rubra / Oxalis (oregana, trilliifolia) Forest	G4/S3S4	CEGL003400
Alnus rubra / Rubus parviflorus Forest	G4/S4	CEGL003402
Alnus rubra / Rubus spectabilis Forest	G4G5/S4S5	CEGL000639
Alnus rubra / Stachys chamissonis var. cooleyae - Tolmiea menziesii Forest	G4/S3S4	CEGL003403
Fraxinus latifolia - (Populus balsamifera ssp. trichocarpa) / Cornus sericea Forest	G4/S2	CEGL003390
Fraxinus latifolia - Populus balsamifera ssp. trichocarpa / Acer circinatum Forest	G3/S1Q	CEGL003404
Fraxinus latifolia - Populus balsamifera ssp. trichocarpa / Carex deweyana - Urtica dioica ssp. gracilis Forest	G1/S1	CEGL003365
Fraxinus latifolia - Populus balsamifera ssp. trichocarpa / Corylus cornuta - Physocarpus capitatus Forest	G3/S1?	CEGL003364
Fraxinus latifolia - Populus balsamifera ssp. trichocarpa / Rubus spectabilis Forest	G2/S1	CEGL003405
Fraxinus latifolia - Populus balsamifera ssp. trichocarpa / Symphoricarpos albus Forest	G4/S2?	CEGL000641

G254 North Pacific Lowland Riparian Forest & Woodland Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Fraxinus latifolia / Symphoricarpos albus Forest	G4/S2?	CEGL003393
Populus balsamifera ssp. trichocarpa - Acer macrophyllum / Equisetum hyemale Forest	G3/S2?	CEGL003406
Populus balsamifera ssp. trichocarpa - Acer macrophyllum / Symphoricarpos albus Forest	G3/S2S3	CEGL003363
Populus balsamifera ssp. trichocarpa - Alnus rubra / Carex obnupta Woodland	G2/S2	CEGL003361
Populus balsamifera ssp. trichocarpa - Alnus rubra / Rubus spectabilis Forest	G2G3/S2?	CEGL003407
Populus balsamifera ssp. trichocarpa - Alnus rubra / Symphoricarpos albus Forest	G3/S2?	CEGL003362
Populus balsamifera ssp. trichocarpa - Picea sitchensis - (Acer macrophyllum) / Oxalis oregana Forest	G2G3/S2	CEGL003418
Populus balsamifera ssp. trichocarpa / Cornus sericea / Carex obnupta Forest	GNR/SNR	CEGL002844
Populus balsamifera ssp. trichocarpa / Oplopanax horridus Woodland	G3/SNR	CEGL003284
Quercus garryana - (Fraxinus latifolia) / Symphoricarpos albus Forest	G2/S2	CEGL003299
Salix lucida ssp. lasiandra / Salix fluviatilis Woodland	G3Q/S2	CEGL000949
Salix lucida ssp. lasiandra / Urtica dioica ssp. gracilis Woodland	G2/S1S2	CEGL003409
G322 Vancouverian Wet Shrubland Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Cornus sericea - Salix spp. - Spiraea douglasii Shrubland	GNR/S2	CWWA000249
Oplopanax horridus Pacific Coast Shrubland	G4/S4	CWWA000114
Physocarpus capitatus Shrubland	GNR/SUQ	CWWA000232
Rubus spectabilis Wet Shrubland	G4/SU	CEGL003472
Salix (hookeriana, lucida ssp. lasiandra, sitchensis) Shrubland [Provisional]	G3Q/S3	CWWA000167
Salix hookeriana - (Salix sitchensis) Shrubland	G2/S2	CEGL003387
Salix sitchensis / Equisetum arvense - Petasites frigidus Shrubland	G4?/S4?	CEGL003296
Salix spp. - Spiraea douglasii / Carex (aquatilis var. dives, obnupta, utriculata) Shrubland	G3G4/S2Q	CWWA000199

Ecological Processes: This ecological system is spatially heterogeneous with a multitude of vegetation patches occurring within the riparian zone (Naiman and Bilby 1998). Complex geomorphic and biotic components and processes maintain the long-term integrity of this system (Gregory et al. (1991). Riverine flooding and the succession that occurs after major flooding events are the major natural processes that drive this system. Infrequent, high-powered floods determine large geomorphic patterns that persist on the landscape for hundreds to thousands of years (Hubert 2004). Floods of intermediate frequency and power produce floodplain landforms which persist for tens to hundreds of years as well as reset succession to early seral vegetation types (LANDIRE 2007; Hubert 2004). Seasonal and episodic flooding erode and/or deposit sediment resulting in complex patterns of soil development which subsequently have a strong influence on the distribution of riparian vegetation (Gregory et al. 1991; Poff et al. 1997). Bare alluvium provides suitable substrate for the germination of willow seedlings and is thus a critical patch type for continued regeneration of many woody species (Poff et al. 1997; Hubert 2004). Beaver activity is an important driver of hydrological change and subsequent development of a diversity of habitat patches. The contribution of



large woody debris (LWD) from riparian or adjacent upland trees is important to maintaining the hydrological and sediment regimes. LWD has a significant impact on the evolution of channel morphology and also contributes to the spatial distribution and diversity of habitat patches within this system (Naiman and Bilby 1998). Hyporheic flow can also be important for maintaining many community types.

Threats: Historical and contemporary use practices have impacted hydrologic, geomorphic, and biotic structure and function of riparian areas in Washington. Human land uses both within the riparian area as well as in adjacent and upland areas have fragmented many riparian reaches which has reduced connectivity between riparian patches and riparian and upland areas. Adjacent and upstream land uses also have the potential to contribute excess nutrients into riparian areas. Reservoirs, water diversions, ditches, roads, and human land uses in the contributing watershed can have a substantial impact on the hydrologic and sediment regimes. Alterations to both processes can affect the establishment of new and maintenance of existing riparian vegetation. Management effects on woody riparian vegetation can be obvious, e.g., removal of vegetation by dam construction, roads, logging, or they can be subtle, e.g., removing beavers from a watershed, removing large woody debris, or construction of a weir dam for fish habitat. Logging activities tend to remove future sources of large woody debris. Timber harvest can also alter hydrology, most often resulting in post-harvest increases in peak flows. Mass wasting and related disturbances (stream sedimentation, debris torrents) in steep topography can increase in frequency with road building and timber harvest. Roads and water diversion/retention structures change watershed hydrology with wide-ranging and diverse effects, including major vegetation changes. The most significant of these are the major flood controlling dams, which have greatly altered the frequency and intensity of bottomland flooding. Increases in nutrients and pollutants are other common anthropogenic

impacts. *Phalaris arundinacea* is an abundant invasive species in many, if not most, occurrences. Many other exotic species also occur. This system has also decreased in extent due to agricultural development, roads, dams and other flood-control activities.

Classification Comments: This is a floodplain associated system found below *Abies amabilis* forests, mostly west of the Cascade crest. The system is clearly influenced by periodic flooding and does not develop under stagnant hydrological regimes (i.e. is not a swamp). Dominant species are typically deciduous trees but conifers can be codominant. Very early successional stages can be sparsely vegetated or dominated by herbaceous vegetation. These early successional type are included in the Temperate Pacific Freshwater Emergent Marsh system.

Related Concepts: This ecological system falls within the Westside Riparian Wetlands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the North Pacific Lowland Riparian Forest and Shrubland as a unique mapping unit.

References

Chappell, C. 2000. Riparian Forests and Shrublands Appendix 11 Willamette Valley – Puget Trough – Georgia Basin Ecoregion Terrestrial Ecological System EO Specs and EO Rank Specs. *In* Floberg, J., M. Goering, G. Wilhere, C. MacDonald, C. Chappell, C. Rumsey, Z. Ferdana, A. Holt, P. Skidmore, T. Horsman, E. Alverson, C. Tanner, M. Bryer, P. Iachetti, A. Harcombe, B. McDonald, T. Cook, M. Summers, D. Rolph. 2004. Willamette Valley-Puget Trough-Georgia Basin Ecoregional Assessment, Volume One: Report. Prepared by The Nature Conservancy with support from the Nature Conservancy of Canada, Washington Department of Fish and Wildlife, Washington Department of Natural Resources (Natural Heritage and Nearshore Habitat programs), Oregon State Natural Heritage Information Center and the British Columbia Conservation Data Centre.

Chappell, C.B. and J. Kagan. 2001. Westside Riparian-Wetlands. *In* Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Gregory, S.V., F.J. Swanson, W.A. McKee, and K.W. Cummins. 1991. An Ecosystem Perspective of Riparian Zones. BioScience 41(8): 540-551.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Naiman, R.J. and R.E. Bilby. 1998. River Ecology and Management: Lessons from the Pacific Coastal Ecoregion. Springer-Verlag. New York, NY.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Rocchio, F.J. and R.C. Crawford. *In Progress*. Ecological Classification of Native Wetland & Riparian Vegetation of Washington State. Natural Heritage Report 20XX-XX. Washington Dept. of Natural Resources, Natural Heritage Program. Olympia, WA.

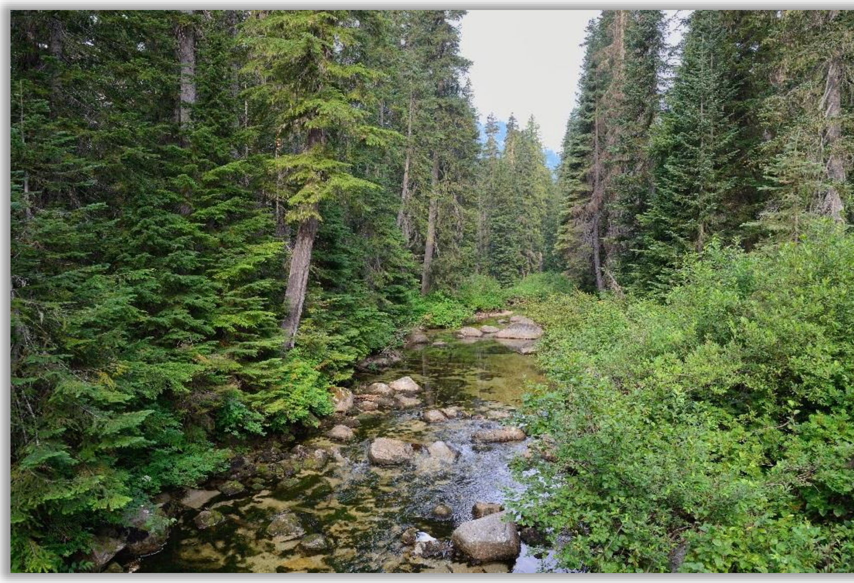
Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Description Author: Joe Rocchio, Gwen Kittel and Chris Chappell.

RIPARIAN SYSTEMS

NORTH PACIFIC MONTANE RIPARIAN WOODLAND AND SHRUBLAND

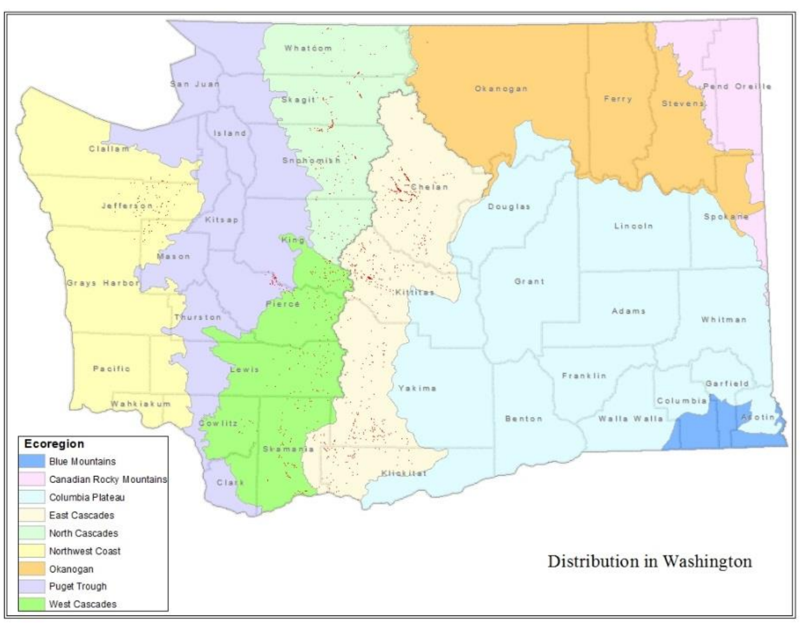
Concept: Montane riparian woodlands and shrublands on steep streams and narrow floodplains between the *Tsuga heterophylla* zone and the alpine environments in the Cascades and Olympics. It is the primary riparian system in the *Abies amabilis* and *Tsuga mertensiana* zones on both sides of the Cascade crest.



Conservation Status: Apparently Secure (S4). The system remains relatively common on the landscape but has likely experienced some degradation.

Distribution: This linear ecological system occurs throughout the coastal mountains of the Pacific Northwest. In Washington it is most abundant on steep streams and narrow floodplains between the *Tsuga heterophylla* zone and the alpine environments in the Cascades and Olympics. It is the primary riparian system in the *Abies amabilis* and *Tsuga mertensiana* zones on both sides of the Cascade crest.

Environment: Winters are moderate with 3-10+ foot snowpack. This system commonly occurs in V-shaped, narrow valleys and canyons (where there is cold-air drainage). Occurrences are less frequently found in moderate-wide valley bottoms on floodplains along meandering rivers, and on pond or lake margins. It is also associated with drainages, stream terraces, semi-riparian flats and spring or seep fed slopes.



Vegetation: Confined occurrences of this system (mostly along Rosgen A and B channels) are conifer woodlands dominated by *Abies amabilis, Abies lasiocarpa, Tsuga mertensiana* or *Pinus contorta* var. *murrayana.* Lower elevation occurrences with less confined channels may contain deciduous trees, such as, *Populus balsamifera* ssp. *trichocarpa, Alnus incana* ssp. *tenuifolia* (= *Alnus tenuifolia)* and *Alnus rubra*. Major shrub species include *Alnus viridis* ssp. *sinuata, Acer circinatum, Salix sitchensis, Oplopanax horridus, Rubus* *spectabilis*, and *Ribes bracteosum* and herbaceous *Senecio triangularis, Saxifraga arguta*, and *Petasites frigidus* plants. *Vaccinium alaskense* and *Vaccinium ovalifolium* can be frequent above bankfull riparian zones (Diaz and Mellen 1996).

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Groups and Associations that are associated with this ecological system:

G322 Vancouverian Wet Shrubland Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
(Rubus spectabilis) / Athyrium filix-femina Shrubland	G5/S5	CWWA000135
Acer circinatum - Alnus incana Shrubland	G4G5/S4S5	CWWA000028
Acer circinatum - Rubus parviflorus Shrubland	GNR/SNR	CEGLPGW06
Acer circinatum / Athyrium filix-femina - Tolmiea menziesii Shrubland	G5/S4	CEGL003291
Acer circinatum Shrubland	G4/S4	CWWA000204
Alnus viridis ssp. sinuata / Acer circinatum Shrubland	G4G5/S4S5	CEGL001155
Alnus viridis ssp. sinuata / Oplopanax horridus Shrubland	G4G5/S4	CEGL001157
Alnus viridis ssp. sinuata / Rubus spectabilis / Athyrium filix-femina Shrubland	G4G5/S4	CWWA000045
Cornus sericea Pacific Coast Shrubland [Provisional]	GNR/SU	CWWA000216
Oplopanax horridus Interior Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Ribes spectabilis - Ribes hudsonianum Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
G507 North Pacific Montane Riparian Woodland Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Abies amabilis - Picea engelmannii / Vaccinium membranaceum Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Abies amabilis - Tsuga heterophylla / Oplopanax horridus Forest	G5/S5	CEGL000004
Abies amabilis - Tsuga heterophylla / Tiarella trifoliata var. unifoliata Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Abies amabilis / Acer circinatum Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Abies amabilis / Achlys triphylla Forest	G4/S4	CEGL000003
Abies amabilis / Athyrium filix-femina Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Abies amabilis / Rubus spectabilis - Vaccinium alaskaense Forest [Provisional]	G2G4Q/S2S4	CWWA000200
Abies lasiocarpa / Rubus spectabilis Forest [Provisional]	G2G4Q/S2S4	CWWA000203
Alnus rubra / Vaccinium ovalifolium / Trautvetteria caroliniensis Shrubland	G3G4/S3S4	CWWA000044
Thuja plicata / Athyrium filix-femina - Stachys chamissonis var. cooleyae Forest	GNR/S3?	CWWA000240
Thuja plicata / Rubus spectabilis / Oxalis oregana Forest	G3/S2	CWWA000157
Tsuga mertensiana - Abies amabilis / Oplopanax horridus Forest	G3G4/S3	CEGL000507

Ecological Processes: Riparian woodland and shrubland development is driven by the magnitude and frequency of flooding, valley and substrate type, and beaver activity. Infrequent, high-powered floods determine large geomorphic patterns that persist on the landscape for hundreds to thousands of years (Hubert 2004). Floods of intermediate frequency and power produce floodplain landforms which persist for tens to hundreds of years as well as reset succession to early seral vegetation types (LANDIRE 2007; Hubert 2004). Seasonal and episodic flooding erode and/or deposit sediment resulting in complex patterns of soil development which subsequently have a strong influence on the distribution of riparian vegetation (Gregory et al. 1991; Poff et al. 1997). Bare alluvium provides suitable substrate for the germination of willow seedlings and is thus a critical patch type for continued regeneration of many woody species (Poff et al. 1997; Hubert 2004). Other types of willows can propagate through rooting of broken stems or roots, branch layering, and in a few species sprouting from subsurface runners (Kovalchik and Clausnitzer 2004). Valley type may be the most important variable, as riparian woodlands are mostly found in V-shaped, steep valleys with many large boulders and coarse soils. The forest vegetation in these environments is often very similar to the adjacent uplands (Baker 1987, Kovalchik and Clausnitzer 2004, LANDFIRE 2007). Narrow and steep (i.e. confined) occurrences have minimal to no floodplain development whereas less steep and wider valley bottoms (i.e., unconfined) occurrences are often associated with substantial floodplain development (Gregory et al. 1991). Floodplains associated with the latter are comprised of a complexity of geomorphic surfaces which support a diverse array of vegetation communities and are able to store and release water slowly throughout the growing season (Hubert 2004). Confined streams typically have shallow soils with minimal alluvium and transport water downstream rapidly through step-pool channels armored by boulders, bedrock, and large woody debris (LANDFIRE 2007; Hubert 2004).

Beaver can be an important hydrogeomorphic driver of montane riparian systems, especially along unconfined reaches. The presence of beaver creates a heterogeneous complex of wet meadows, marshes and riparian shrublands and increases species richness on the landscape. Naiman et al. (1986) note that beaver-influenced streams are very different from those not impacted by beaver activity by having numerous zones of open water and vegetation, large accumulations of detritus and nutrients, more wetland areas, having more anaerobic biogeochemical cycles, and in general are more resistance to disturbance.

Threats: Historical and contemporary land use practices have impacted hydrologic, geomorphic, and biotic structure and function of riparian areas in Washington. Human land uses both within the riparian area as well as in adjacent and upland areas have fragmented many riparian reaches which has reduced connectivity between riparian patches and riparian and upland areas. Adjacent and upstream land uses also have the potential to contribute excess nutrients into riparian areas. Reservoirs, water diversions, ditches, roads, and human land uses in the contributing watershed can have a substantial impact on the hydrologic and sediment regimes. Alterations to both processes can affect the establishment of new, and maintenance of existing, riparian vegetation. Management effects on woody riparian vegetation can be obvious, e.g., removal of vegetation by dam construction, roads, logging, or they can be subtle, e.g., removing beavers from a watershed, removing large woody debris, or construction of a weir dam for fish habitat. Logging activities tend to remove future sources of large woody debris. Timber harvest can also alter hydrology, most often resulting in post-harvest increases in peak flows. Mass wasting and related disturbances (stream sedimentation, debris torrents) in steep topography increase in frequency with road building and timber harvest. Roads and other water diversion/retention structures change watershed hydrology with wide-ranging and diverse effects, including major vegetation changes.

Classification Comments: This subalpine to montane riparian associated system occurs on both sides of the Cascade crest. This system is distinguished from Rocky Mountain Subalpine-Montane Riparian Shrubland and Rocky Mountain Subalpine-Montane Riparian Woodland systems by having more Vancouverian species such as *Alnus rubra*, *Abies amabilis*, *Rubus spectabilis*, and *R. bracteosum*. In addition, this system generally occurs south of Chelan while the Rocky Mountain riparian types occur north and east of Chelan. This system occurs at a higher elevation than the North Pacific Lowland Riparian Forest and Shrubland system.

Related Concepts: This ecological system falls within the Westside Riparian Wetlands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools

Project (i.e. LANDFIRE) recognizes the North Pacific Montane Riparian Woodland and Shrubland as a unique mapping unit.

References

Baker, W.L. 1987. Recent Changes in the Riparian Vegetation of the Montane and Subalpine Zones of Western Colorado, U.S.A. PhD Dissertation. University of Wisconsin. Madison, WI.

Diaz, N.M. and T.K. Mellen. 1996. Riparian ecological types Gifford Pinchot and Mt. Hood National Forests, Columbia River Gorge National Scenic Area. U.S.D.A. For. Serv. PNW Region. R6-NR-TP-10-96. 203p.

Gregory, S.V., F.J. Swanson, W.A. McKee, and K.W. Cummins. 1991. An Ecosystem Perspective of Riparian Zones. BioScience 41(8): 540-551.

Hubert, W.A. 2004. Ecological Processes in Riverine Wetland Habitats. Pages 52-73 *in* M. C. McKinstry, W.A. Hubert, and S.H. Anderson, editors. Wetland and Riparian Areas of the Intermountain West: Ecology and Management. University of Texas Press, Austin, TX.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

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. Pacific Northwest Research Station, Forest Service, U.S. Department of Agriculture. In cooperation with: Pacific Northwest Region, Colville, Okanogan, and Wenatchee National Forests. General Technical Report PNW-GTR-593. Portland, OR.

LANDFIRE. 2007. Landfire Biophysical Setting Model for North Pacific Montane Riparian Woodland and Shrubland-Wet System. BpS0111581. Online: http://www.landfire.gov/NationalProductDescriptions24.php

Naiman, R.J. and R.E. Bilby. 1998. River Ecology and Management: Lessons from the Pacific Coastal Ecoregion. Springer-Verlag. New York, NY.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Poff, N.L., J.D. Allan, M.B. Bain, J.R. Karr, K.L. Presegaard, B.D. Richter, R.E. Sparks, and J.C. Stromburg. 1997. The Natural Flow Regime: A Paradigm for River Conservation and Restoration. BioScience 47: 769-784.

Rocchio, F.J. and R.C. Crawford. *In Progress*. Ecological Classification of Native Wetland & Riparian Vegetation of Washington State. Natural Heritage Report 20XX-XX. Washington Dept. of Natural Resources, Natural Heritage Program. Olympia, WA.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Description Author: Joe Rocchio, Rex Crawford, Gwen Kittel and Chris Chappell.

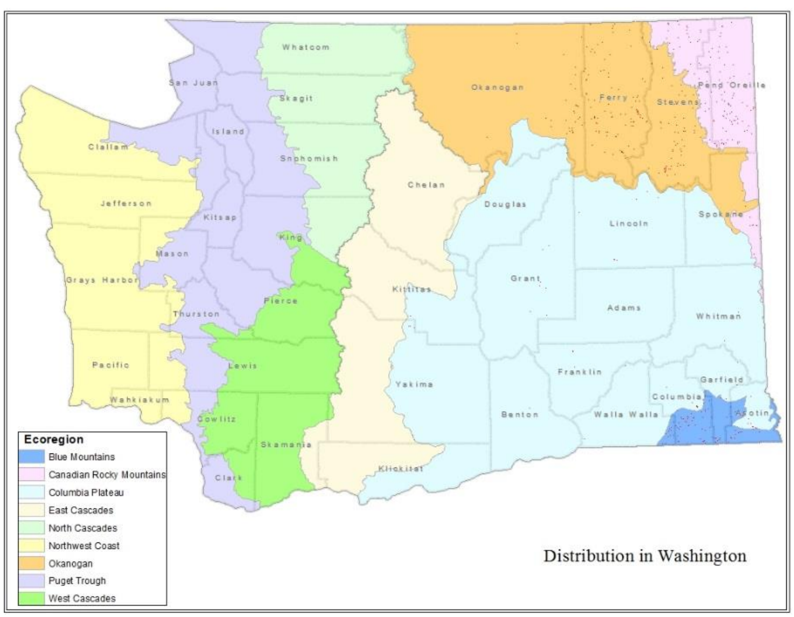
RIPARIAN SYSTEMS

NORTHERN ROCKY MOUNTAIN LOWER MONTANE RIPARIAN WOODLAND AND SHRUBLAND

Concept: Riparian woodlands and shrublands consisting of deciduous, coniferous, and mixed conifer-deciduous trees and shrubs. This system occurs on streambanks and river floodplains of the lower montane and foothill zones in the northern Rocky Mountains, the Okanogan Highlands, the Blue Mountains, and sporadically on the slopes of the northeast Cascades (north of Chelan). *Tsuga heterophylla* and *Thuja plicata* are diagnostic indicators in northeastern Washington where inland maritime conditions prevail.

Conservation Status: Imperiled (S2). This system remains widespread on the landscape, however most occurrences have been degraded from a variety of stressors.

Distribution: This linear ecological system includes riparian woodlands and shrublands that occur on streambanks and river floodplains in the lower montane and foothill zones of the Northern Rocky Mountains. In Washington, this linear system occurs on streambanks and river floodplains of the lower montane and foothill zones in the northern Rocky Mountains, the Okanogan Highlands, the Blue Mountains, and sporadically on the slopes of the northeast Cascades (north of Chelan). In the Okanogan, this is defined as all the cottonwood-dominated or codominated riparian systems below subalpine and above the ponderosa pine zone.



Environment: This riparian system is found on various soil types located on streambanks, point bars, and floodplains of the lower montane and foothill zones.

Vegetation: Woodlands are often dominated by *Populus balsamifera* ssp. *trichocarpa*. Several other tree species can be mixed in the canopy, including *Populus tremuloides*, *Betula papyrifera*, and *Betula occidentalis*. *Tsuga heterophylla* and *Thuja plicata* dominated stands represent inland maritime climatic conditions in northeast Washington. Shrub understory components include *Cornus sericea*, *Acer glabrum*, *Alnus incana*, *Betula papyrifera*, *Oplopanax horridus* and *Symphoricarpos albus*. Ferns and forbs of mesic sites are commonly present in many occurrences, including such species as *Athyrium filix-femina*, *Gymnocarpium dryopteris*, and *Senecio triangularis*. *Alnus rubra* stands in the Blue Mountains of southeast Washington are included here.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Groups and Associations that are associated with this ecological system:

G505 Rocky Mountain & Great Basin Swamp Forest Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Thuja plicata / Gymnocarpium dryopteris Forest	G3/SNR	CEGL000476
Thuja plicata – (Tsuga heterophylla) / Oplopanax horridus Rocky Mountain Forest	G3/S2S3	CEGL000479
Tsuga heterophylla / Gymnocarpium dryopteris Forest	G3G4/S3	CEGL000494
G507 North Pacific Montane Riparian Woodland Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Alnus rubra / Alluvial Bar Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Alnus rubra / Athyrium filix-femina - Asarum caudatum Forest	G1/S1	CEGL000008
Alnus rubra / Athyrium filix-femina Forest	G1/S1	CWWA000171
Alnus rubra / Cornus sericea Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Alnus rubra / Petasites frigidus Forest	G4/S4	CEGL003401
Alnus rubra / Physocarpus capitatus - Philadelphus lewisii Forest	G1/S1	CEGL000002
Alnus rubra / Symphoricarpos albus Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
G796 Northern Rocky Mountain Lowland & Foothill Riparian Forest Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Acer macrophyllum / Holodiscus discolor Woodland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Alnus rhombifolia / Cornus sericea Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Alnus rhombifolia / Equisetum arvense Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Juniperus occidentalis / Philadelphus lewisii - Salix lasiolepis Intermittently Flooded Woodland [Provisional]	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Picea engelmannii - Thuja plicata / Vaccinium membranaceum Riparian Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Pinus ponderosa - Quercus garryana / Symphoricarpos albus Woodland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Pinus ponderosa / Camassia quamash Woodland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Pinus ponderosa / Crataegus douglasii Woodland	G1/S1	CEGL000855

RIPARIAN SYSTEMS

G796 Northern Rocky Mountain Lowland & Foothill Riparian Forest Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Pinus ponderosa / Lomatium nudicaule Woodland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Populus balsamifera (ssp. trichocarpa, ssp. balsamifera) / Symphoricarpos (albus, oreophilus, occidentalis) Forest	G2/S1S2	CEGL000677
Populus balsamifera ssp. trichocarpa - Alnus rhombifolia Forest	G1/S1	CEGL000668
Populus balsamifera ssp. trichocarpa - Betula occidentalis / Philadelphus lewisii Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Populus balsamifera ssp. trichocarpa / Acer glabrum Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Populus balsamifera ssp. trichocarpa / Alnus incana - Cornus sericea Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Populus balsamifera ssp. trichocarpa / Alnus incana Forest	G3/S3	CEGL000667
Populus balsamifera ssp. trichocarpa / Cornus sericea Forest	G3G4/S2?	CEGL000672
Populus balsamifera ssp. trichocarpa / Juniperus scopulorum Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Populus balsamifera ssp. trichocarpa / Oplopanax horridus Woodland	G3/SNR	CEGL003284
Populus balsamifera ssp. trichocarpa / Philadelphus lewisii Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Populus balsamifera ssp. trichocarpa / Salix lucida ssp. caudata Woodland	G2/S1	CEGL003431
Populus balsamifera ssp. *trichocarpa / Acer glabrum* Woodland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Pseudotsuga menziesii / Symphoricarpos albus Temporarily Flooded Woodland	GNR/SNR	CWWA000021
Pseudotsuga menziesii / Trautvetteria caroliniensis Woodland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Quercus garryana / Corylus cornuta - Symphoricarpos albus Woodland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Thuja plicata - (Abies grandis) / Acer circinatum Riparian Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Thuja plicata / Alnus incana Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Thuja plicata / Pachistima myrsinites / Clintonia uniflora Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Tsuga heterophylla / Acer circinatum Riparian Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)

Ecological Processes: Complex geomorphic and biotic components and processes maintain the long-term integrity of this system (Gregory et al. (1991). Annual flooding is a key ecological process which results in a diversity of patch types such as woodlands, shrublands, wet meadows, and marshes. Beaver activity is an important driver of hydrological change. The moisture associated with riparian areas promotes lower fire frequency compared with adjacent uplands. Stand replacement fires are rare but may occur when replacement fires occur in adjacent uplands (Fire regime III; average fire frequency of 100 years; LANDFIRE 2007). More frequent surface fires (~ every 50 years) can affect shrub patches through a combination of replacement fire from uplands and occasional native burning (LANDFIRE 2007). Following stand replacement fires deciduous woody species (e.g., *Populus tremuloides*, *Salix* spp., etc.) can be top-killed but generally resprout within a short period. Post-fire establishment of conifers occurs from seed.

Threats: Historical and contemporary land use practices have impacted hydrologic, geomorphic, and biotic structure and function of riparian areas in eastern Washington. Human land uses both within the riparian area as well as in adjacent and upland areas have fragmented many riparian reaches which has reduced connectivity between riparian patches and riparian and upland areas. Adjacent and upstream land uses also have the potential to contribute excess nutrients into riparian areas Reservoirs, water diversions, ditches, roads, and human land uses in the contributing watershed can have a substantial impact on the hydrology regime. Excessive livestock or native ungulate use can impact riparian shrublands by altering nutrient concentrations and cycles, changing surface and subsurface water movement and infiltration, shifting species composition, and reducing regeneration of woody species (Kauffman and Krueger 1984; Elmore and Kauffman 1984; Weixelman et al. 1997; Flenniken et al. 2001; Kauffman et al. 2004). Management effects on woody riparian vegetation can be obvious, e.g., removal of vegetation by dam construction, roads, logging, or they can be subtle, e.g., removing beavers from a watershed, removing large woody debris, or construction of a weir dam for fish habitat. Non-native plants or animals, which can have wide-ranging impacts, also tend to increase with these stressors. Reed canarygrass (*Phalaris arundinacea*) can be a major invasive in these shrublands. All of these stressors have resulted in many riparian areas being incised, supporting altered riparian plant communities, as well as numerous non-native species. This system has also decreased in extent due to agricultural development, roads, dams and other flood-control activities.

Classification Comments: This system lacks a distinctive North Pacific flora and occurs in fire-dominated landscapes, which distinguishes it from the North Pacific Lowland and Montane riparian systems. The *Thuja plicata* and *Tsuga heterophylla* types included in this system represent the interior maritime regions of the northern Rockies and thus are included in this system. *Alnus rubra* stands in the Blue Mountains of southeast Washington are included here. This system is distinguished from the similar Rocky Mountain Subalpine-Montane Riparian Woodland by having a more predominant northern Rocky Mountain floristic component, both in the woody layers and in the herbaceous taxa, and by generally occurring at lower elevations. This system differs from the Columbia Basin Foothill Riparian Woodland Shrubland by occurring at slightly higher elevations (above lower tree line), although many of the component plant associations may occur above and below lower tree line (thus those Associations occur in two different systems).

Related Concepts: This ecological system falls within the Eastside (Interior) Riparian-Wetlands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize the Northern Rocky Mountain Lower Montane Riparian Woodlands and Shrubland as a unique mapping unit but aggregates it into the Rocky Mountain Montane Riparian Systems unit.

References

Crawford, R.C. and J. Kagan. 2001. Eastside Riparian-Wetlands. *In* Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Gregory, S.V., F.J. Swanson, W.A. McKee, and K.W. Cummins. 1991. An Ecosystem Perspective of Riparian Zones. BioScience 41(8): 540-551.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

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. Pacific Northwest Research Station, Forest Service, U.S. Department of Agriculture. In cooperation with: Pacific Northwest Region, Colville, Okanogan, and Wenatchee National Forests. General Technical Report PNW-GTR-593. Portland, OR.

LANDFIRE. 2007. Rocky Mountain Montane Riparian Systems. BpS 1011590. Online: http://www.landfire.gov/NationalProductDescriptions24.php

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Rocchio, F.J. and R.C. Crawford. *In Progress*. Ecological Classification of Native Wetland & Riparian Vegetation of Washington State. Natural Heritage Report 20XX-XX. Washington Dept. of Natural Resources, Natural Heritage Program. Olympia, WA.

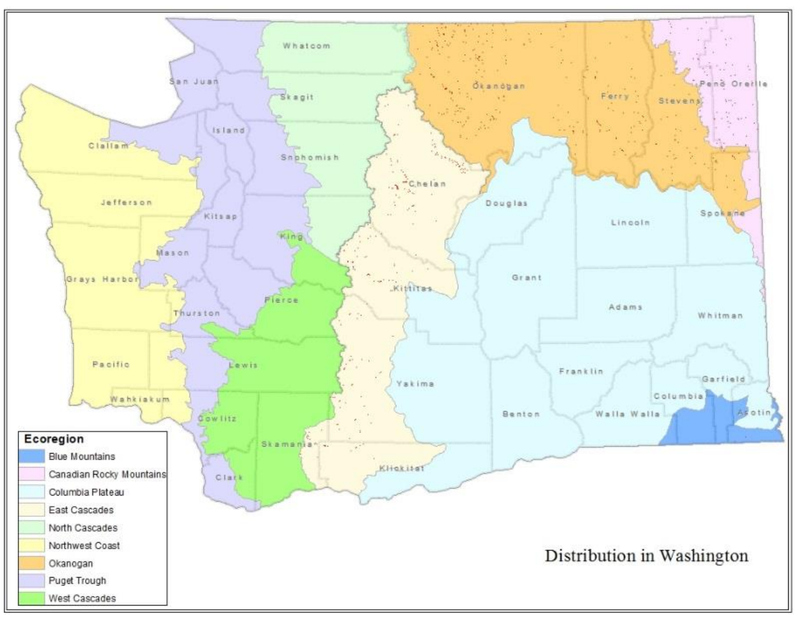
Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Description Author: Joe Rocchio and Marion Reid.

ROCKY MOUNTAIN SUBALPINE-MONTANE RIPARIAN SHRUBLAND

Concept: Montane to subalpine riparian shrublands occurring as narrow bands or large expanses of shrubs lining streambanks and alluvial terraces in narrow to wide, low-gradient valley bottoms and floodplains with sinuous stream channels. The system is found at high elevations within dry and cold portions of the East Cascades, throughout the Okanogan Highlands, and in the Northern Rocky Mountains. In Washington, *Alnus sinuata* and *Cornus sericea* are common dominant shrubs along confined, steep and/or gravelly streams A variety of willows (*Salix* sp.) and mountain alder (*Alnus incana*) are common dominant shrubs along unconfined, gently sloped streams with finer sediment.

Conservation Status: Vulnerable (S3). This system remains relatively common on the landscape but some occurrences have experienced degradation due to livestock grazing and hydrological alterations.



Distribution: This linear system is comprised of montane to subalpine riparian shrublands occurring as narrow bands or large expanses of shrubs lining streambanks and alluvial terraces in narrow to wide, low-gradient valley bottoms and floodplains with sinuous stream channels. The system is found along the Rocky Mountain cordillera, from southern New Mexico north into Montana and Idaho, and west into the Intermountain region and the Colorado Plateau. In Washington, the system occurs at high elevations within dry and cold portions of the East Cascades, throughout the Okanogan

Highlands, and in the Northern Rocky Mountains. The distribution map is based on National Wetland Inventory maps and likely overestimates the extent of this system.

Environment: In Washington, stands typically occur at elevations between approximately 2,000 – 7,500 feet (Kovalchik and Clausnitzer 2004). This system most commonly occurs in drainages, stream terraces, semi-riparian flats and spring or seep fed slopes. Soils vary but are typically well-developed, fine-textured, poorly drained, and often have histic epipedons. Sites can be quite wet, with saturated soils and standing water occasionally present. Sites histosols (i.e. > 40 cm of organic soil) would be classified as Rocky Mountain Subalpine-Montane Fen Ecological System.

Vegetation: Typically, this system occurs as a mosaic of shrub and herbaceous-dominated communities and includes snowmelt-fed headwater basins above-treeline that are willow-dominated. Valley geomorphology and substrate dictate the types of riparian shrublands which typically develop. The dominant shrubs reflect the wide elevational and stream gradients associated with this system and includes *Alnus incana*, *A. sinuata*, *Betula glandulosa*, *Betula occidentalis*, *Cornus sericea*, *Salix bebbiana*, *S. boothii*, *S. brachycarpa*, *S. drummondiana*, *S. geyeriana*, and *S. planifolia*.

In Washington, *Alnus sinuata* and *Cornus sericea* are common dominant shrubs along confined (mostly along Rosgen A and B channels), steep and/or gravelly streams (Kovalchik and Clausnitzer 2004). Occasionally, trees such as *Picea engelmannii*, *Abies lasiocarpa*, *Populus balsamifera* ssp. *trichocarpa*, and *Thuja plicata* can occur in the shrublands. Along these steep reaches, the understory can be depauperate but species such as *Hydrophyllum fendleri*, *Senecio triangularis*, *Athyrium filix-femina*, and *Gymnocarpium dryopteris* are often present (Kovalchik and Clausnitzer 2004). A variety of willows (*Salix* spp.) and mountain alder (*Alnus incana*) are common dominant shrubs along unconfined, gently sloped streams with finer sediment. Tall willow species (e.g., *Salix bebbiana*, *S. boothii*, *S. drummondiana*, *S. geyeriana*, *S. lasiandra*, etc.) are dominant at low to moderate elevations while short willow species (e.g., *S. cascadensis*, *S. commutata*, *S. planifolia*, *S. nivalis*, *S. farriae*, etc.) are dominant in subalpine and alpine shrublands. Understory species are highly variable. Graminoids (*Carex utriculata*, *C. scopulorum*, *C. spectabilis*, *C. disperma*, *Eleocharis* spp., *Calamagrostis canadensis*, *Glyceria elata*) typically dominate the understory of willow types and composition varies according to elevation and site type (Kovalchik and Clausnitzer 2004). *Equisetum* ssp. and forbs can be abundant in some willow sites (Kovalchik and Clausnitzer 2004). *Alnus incana* shrublands often support other shrubs such as *Cornus sericea*, *Symphoricarpos albus*, *Spiraea douglasii*, and *Rosa* spp. (Kovalchik and Clausnitzer 2004). Cover of understory species generally has an inverse relationship with the cover of *Alnus incana*. Typical species include *Carex utriculata*, *C. disperma*, *Calamagrostis canadensis*, *Glyceria elata*, *Equisetum* spp. *Athyrium filix-femina*, *Maianthemum stellatum*, *Viola spp.*, *Senecio triangularis*, *Pyrola secunda*, and a variety of other forbs (Kovalchik and Clausnitzer 2004).

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Groups and Associations that are associated with this ecological system:

G322 Vancouverian Wet Shrubland Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Spiraea douglasii Inland Maritime Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
G527 Western Montane-Subalpine Riparian & Seep Shrubland Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Alnus incana - Betula occidentalis Shrubland	G2G3/S1	CEGL001142
Alnus incana / Carex utriculata Shrubland	G4/S3S4	CWWA000004
Alnus incana / Alluvial Bar Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Alnus incana / Athyrium filix-femina Shrubland	G3/S3?	CEGL002628
Alnus incana / Calamagrostis canadensis Shrubland	G3Q/S2	CEGL001143
Alnus incana / Carex (bolanderi, infirminervia, leptopoda) Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Alnus incana / Carex pellita Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Alnus incana / Carex scopulorum var. prionophylla Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Alnus incana / Cornus sericea Shrubland	G3G4/S3	CEGL001145
Alnus incana / Equisetum arvense Shrubland	G3/S3	CEGL001146
Alnus incana / Glyceria striata Shrubland	G3/S3	CEGL000228
Alnus incana / Gymnocarpium dryopteris Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Alnus incana / Lysichiton americanus Shrubland	G3/S1S2	CEGL002629
Alnus incana / Mesic Forbs Shrubland	G3/SNR	CEGL001147
Alnus incana / Ribes (inerme, hudsonianum, lacustre) Shrubland	G3/S1	CEGL001151
Alnus incana / Salix lutea Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Alnus incana / Scirpus microcarpus Shrubland	G2G3/S2	CEGL000481
Alnus incana / Senecio triangularis Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Alnus incana / Spiraea douglasii Shrubland	G3/S3?	CEGL001152
Alnus incana / Symphoricarpos albus Shrubland	G3G4/S3	CEGL001153
Alnus viridis ssp. sinuata - Cornus sericea Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Alnus viridis ssp. sinuata - Ribes lacustre Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Alnus viridis ssp. sinuata / Alluvial Bar Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Alnus viridis ssp. sinuata / Athyrium filix-femina - Cinna latifolia Shrubland	G4/S3	CEGL001156
Alnus viridis ssp. sinuata / Mesic Forbs Shrubland	G3G4/S3S4	CEGL002633
Alnus viridis ssp. sinuata Shrubland [Placeholder]	GNRQ/S4S5	CEGL001154
Cornus sericea / Athyrium filix-femina Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)

G527 Western Montane-Subalpine Riparian & Seep Shrubland Group	Global/ State Rank	NatureServe/ WNHP Code
Cornus sericea / Equisetum arvense Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Cornus sericea / Heracleum maximum Shrubland	G3/SNR	CEGL001167
Cornus sericea / Symphoricarpos albus Shrubland	G4?/S3S4	CWWA000177
Cornus sericea Rocky Mountain Shrubland	G4Q/S2S4	CEGL001165
Crataegus douglasii / Spiraea douglasii Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Dasiphora fruticosa ssp. floribunda / Deschampsia caespitosa Shrubland	G4/SNR	CEGL001107
Rhododendron albiflorum Shrubland [Provisional]	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Ribes lacustre / Cinna latifolia Shrubland	G2?/S2	CWWA000023
Salix (boothii, geyeriana) / Carex aquatilis Shrubland	G3/S1?	CEGL001176
Salix boothii / Mesic Forbs Shrubland	G3/SNR	CEGL001180
Salix commutata / Senecio triangularis Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Salix drummondiana / Calamagrostis canadensis Shrubland	G3/S2?	CEGL002667
Salix drummondiana / Carex scopulorum var. prionophylla Shrubland	G2G3/S2?	CEGL001584
Salix drummondiana / Carex utriculata Shrubland	G4/S3	CEGL002631
Salix scouleriana / Elymus glaucus Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Salix scouleriana / Pachistima myrsinites Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Salix sitchensis - (Alnus incana) / Angelica arguta Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Salix sitchensis / Glyceria elata Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Spiraea douglasii - (Salix sitchensis, drummondiana) Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Spiraea douglasii / Calamagrostis canadensis Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Vaccinium caespitosum - (Salix farriae) / Danthonia intermedia Dwarf-shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)

Ecological Processes: Riparian shrubland development is driven by the magnitude and frequency of flooding, valley and substrate type, and beaver activity. Infrequent, high-powered floods determine large geomorphic patterns that persist on the landscape for hundreds to thousands of years (Hubert 2004). Floods of intermediate frequency and power produce floodplain landforms which persist for tens to hundreds of years as well as reset succession to early seral vegetation types (LANDIRE 2005; Hubert 2004). Seasonal and episodic flooding erode and/or deposit sediment resulting in complex patterns of soil development which subsequently have a strong influence on the distribution of riparian vegetation (Gregory et al. 1991; Poff et al. 1997). Bare alluvium also provides suitable substrate for the germination of willow seedlings and is thus a critical patch type for continued regeneration of some riparian shrublands (Poff et al. 1997; Hubert 2004). Other types of willows can propagate through rooting of broken stems or roots, branch layering, and in a few species sprouting from subsurface runners (Kovalchik and Clausnitzer 2004).

Narrow and steep (i.e. confined) occurrences have minimal to no floodplain development whereas less steep and wider valley bottoms (i.e., unconfined) occurrences are often associated with substantial floodplain development (LANDFIRE 2005; Gregory et al. 1991). Floodplains associated with the latter are comprised of a complexity of geomorphic surfaces which support a diverse array of vegetation communities and are able to store and release water slowly throughout the growing season (Hubert 2004). Confined streams typically have shallow soils with minimal alluvium and transport water downstream rapidly through step-pool channels armored by boulders, bedrock, and large woody debris (LANDFIRE 2005; Hubert 2004).

Beaver are an important hydrogeomorphic driver especially along unconfined reaches. The presence of beaver creates a heterogeneous complex of wet meadows, marshes and riparian shrublands and increases species richness on the landscape. Naiman et al. (1986) note that beaver-influenced streams are very different from those not impacted by beaver activity by having numerous zones of open water and vegetation, large accumulations of detritus and nutrients, more wetland areas, having more anaerobic biogeochemical cycles, and in general are more resistance to disturbance.

The moisture associated with riparian areas promotes lower fire frequency compared with adjacent uplands. Stand replacement fires are rare but may occur when replacement fires occur in adjacent uplands (Fire regime III; average fire frequency of 100 years; LANDFIRE 2005). More frequent surface fires (~ every 50 years) can affect shrub patches through a combination of replacement fire from uplands and occasional native burning (LANDFIRE 2005). Wet meadows seldom burn and when they do, they typically recover within a single growing season (LANDFIRE 2005).

Threats: Historical and contemporary land use practices have impacted hydrologic, geomorphic, and biotic structure and function of riparian areas in eastern Washington. Human land uses both within the riparian area as well as in adjacent and upland areas have fragmented many riparian reaches which has reduced connectivity between riparian patches and riparian and upland areas. This can adversely affect the movement of surface/groundwater, nutrients, and dispersal of plants and animals. Roads, bridges, and development can also fragment both riparian and upland areas. Intensive grazing and recreation can also create barriers to ecological processes.

Reservoirs, water diversions, ditches, roads, and human land uses in the contributing watershed can have a substantial impact on the hydrology as well as biotic integrity of riparian shrublands (Woods 2001; Kattelmann and Embury 1996; Poff et al. 1997; Baker 1987). All these stressors can induce downstream erosion and channelization, reduce changes in channel morphology, reduce base and/or peak flows, lower water tables in floodplains, and reduce sediment deposition in the floodplain (Poff et al. 1997). Vegetation responds to these changes by shifting from wetland and riparian dependent species to more mesic and xeric species typical of adjacent uplands (typical of herbaceous species) and/or encroaching into the stream channel. Floodplain width and the abundance and spatial distribution of various patch types also typically decline. Excessive livestock or native ungulate use can impact riparian shrublands by altering nutrient concentrations and cycles, changing surface and subsurface water movement and infiltration, shifting species composition, and reducing regeneration of woody species (Kauffman and Krueger 1984; Elmore and Kauffman 1984; Weixelman et al. 1997; Flenniken et al. 2001; Kauffman et al. 2004). Management effects on woody riparian vegetation can be obvious, e.g., removal of vegetation by dam construction, roads, logging, or they can be subtle, e.g., removing beavers from a watershed, removing large woody debris, or construction of a weir dam for fish habitat. Non-native plants or animals, which can have wide-ranging impacts, also tend to increase with these stressors. Reed canarygrass (*Phalaris arundinacea*) can be a major invasive in these shrublands. All of these stressors have resulted in many riparian areas being incised, supporting altered riparian plant communities, as well as numerous non-native species. This system has also decreased in extent due to agricultural development, roads, dams and other flood-control activities.

Classification Comments: Species of *Salix, Alnus* or *Betula* are commonly present. Sites with true organic soils (i.e. > 40 cm of organic soil with hemic to fibric peat) would be classified as Rocky Mountain Subalpine-Montane Fens. Shrublands with > 40 cm of sapric organic soils are included here (i.e. shrub swamps). In the East Cascades, these shrublands are distinguished from those associated with the North Pacific Lowland Riparian Forest and Shrubland system by occurring at a higher elevation and supporting few, if any, Vancouverian species. These shrublands also occur at a higher elevation than those associated with the Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland system. This system is distinguished from North Pacific Montane Riparian Woodland and Shrubland system by lacking Vancouverian species such as *Rubus spectabilis* and *R. bracteosum*. In general this system is more likely to be found north and east of Chelan. South of Chelan, these riparian shrubland merge with the North Pacific types.

Related Concepts: This ecological system falls within the Eastside (Interior) Riparian-Wetlands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize the Rocky Mountain Subalpine-Montane Riparian Shrubland as a unique mapping unit but did aggregate it into the Rocky Mountain Subalpine/Upper Montane Riparian Systems unit.

References

Baker, W.L. 1987. Recent Changes in the Riparian Vegetation of the Montane and Subalpine Zones of Western Colorado, U.S.A. PhD Dissertation. University of Wisconsin. Madison, WI.
Crawford, R.C. and J. Kagan. 2001. Eastside Riparian-Wetlands. *In* Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Dwire, K.A. and J.B. Kauffman. 2003. Fire and riparian ecosystems in landscapes of the western USA. Forest Ecology and Management 178 : 61–74

Elmore, W. and B. Kauffman. 1994. Riparian and Watershed Systems: Degradation and Restoration. *In*: Ecological implications of livestock herbivory in the west. Society of Range Mgmt. Denver, CO.

Flenniken, M., R.R. McEldowney, W.C. Leininger, G.W. Frasier, and M.J. Trlica. Hydrologic responses of a montane riparian ecosystem following cattle use. Journal of Range Management 54: 567-574.

Gregory, S.V., F.J. Swanson, W.A. McKee, and K.W. Cummins. 1991. An Ecosystem Perspective of Riparian Zones. BioScience 41(8): 540-551.

Hubert, W.A. 2004. Ecological Processes in Riverine Wetland Habitats. Pages 52-73 *in* M. C. McKinstry, W.A. Hubert, and S.H. Anderson, editors. Wetland and Riparian Areas of the Intermountain West: Ecology and Management. University of Texas Press, Austin, TX.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Kattelmann, R. and M. Embury. 1996. Riparian Areas and Wetlands. *in* Sierra Nevada Ecosystem Project: Final Report to Congress, Vol. III, Assessment and Scientific Basis for Management Options. Center for Water and Wildland Resources, University of California, Davis, CA.

Kauffman, J.B. and W.C. Krueger. 1984. Livestock Impacts on Riparian Ecosystems and Streamside Management Implications: A Review. J. Range Manage. 37(5):430-438.

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. Pacific Northwest Research Station, Forest Service, U.S. Department of Agriculture. In cooperation with: Pacific Northwest Region, Colville, Okanogan, and Wenatchee National Forests. General Technical Report PNW-GTR-593. Portland, OR.

LANDFIRE. 2005. Landfire Biophysical Setting Model for Rocky Mountain Subalpine/Upper Montane Riparian Systems. BpS1011600. Online: http://www.Landfire.gov/NationalProductDescriptions24.php

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Poff, N.L., J.D. Allan, M.B. Bain, J.R. Karr, K.L. Presegaard, B.D. Richter, R.E. Sparks, and J.C. Stromburg. 1997. The Natural Flow Regime: A Paradigm for River Conservation and Restoration. BioScience 47: 769-784.

Rocchio, J. 2006. Rocky Mountain Subalpine-Montane Riparian Shrubland Ecological Integrity Assessment. Unpublished report prepared for NatureServe. Colorado Natural Heritage Program. Colorado State University, Fort Collins, CO.

Rocchio, F.J. and R.C. Crawford. *In Progress*. Ecological Classification of Native Wetland & Riparian Vegetation of Washington State. Natural Heritage Report 20XX-XX. Washington Dept. of Natural Resources, Natural Heritage Program. Olympia, WA.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Weixelman D.A., D.C. Zamudio, K.A. Zumudio, and R.T. Tausch. 1997. Classifying ecological types and evaluating site degradation. Journal of Range Management 50: 315-321.

Woods, S.W. 2001. Ecohydrology of subalpine wetlands in the Kawuneeche Valley, Rocky Mountain National Park, Colorado. PhD Dissertation. Department of Earth Sciences, Colorado State University, Fort Collins, CO.

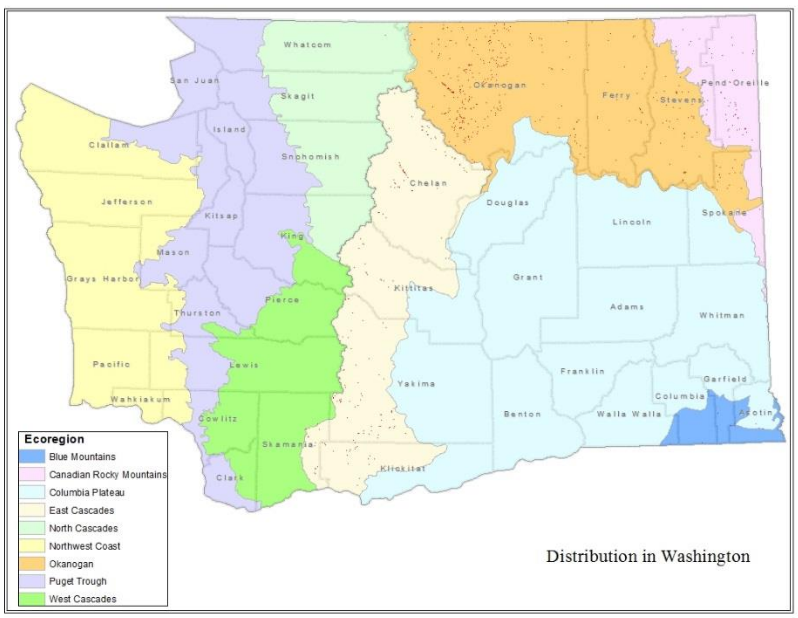
Description Author: Joe Rocchio, NatureServe Western Ecology Team.

ROCKY MOUNTAIN SUBALPINE-MONTANE RIPARIAN WOODLAND

Concept: Riparian forests and woodlands found at montane to subalpine elevations within dry and cold portions of the East Cascades, throughout the Okanogan Highlands, and in the Northern Rocky Mountains. This system most commonly occurs in V-shaped, narrow valleys and canyons (where there is cold-air drainage).

Conservation Status: Apparently Secure (S4). This system is relatively common on the landscape but has likely experienced some loss of ecological integrity due to stressors.

Distribution: This linear system is comprised of seasonally flooded forests and woodlands found at montane to subalpine elevations of the Rocky Mountain cordillera, from southern New Mexico north into Montana, and west into the Intermountain region and the Colorado Plateau. In Washington, the system occurs at high elevations within dry and cold portions of the East Cascades, throughout the Okanogan Highlands, and in the Northern Rocky Mountains.



Distribution in Washington

Environment: In Washington, stands typically occur at elevations between 2,000 – 7,000 feet (Kovalchik and Clausnitzer 2004). This system most commonly occurs in V-shaped, narrow valleys and canyons (where there is cold-air drainage). Less frequently, occurrences are found in moderate-wide valley bottoms on large floodplains along broad, meandering rivers, and on pond or lake margins. Soils are well drained and although they may remain seasonally wet they rarely are saturated year-round and rarely anoxic.

Vegetation: Conifer and aspen woodlands dominate the canopy of this system. In Washington, confined occurrences (mostly along Rosgen A and B channels) are dominated by *Abies lasiocarpa* and/or *Picea engelmannii* (Kovalchik and Clausnitzer 2004). In older stands, *Picea engelmannii* may dominate the canopy while *Abies lasiocarpa* forms multi-aged canopies in the understory (Kovalchik and Clausnitzer 2004). Both *Abies lasiocarpa* and/or *Picea engelmannii* may be reproducing in the understory. *Pinus contorta*, *Pseudotsuga menziesii*, and *Larix occidentalis* are common early seral species. Common understory shrubs in confined woodlands include *Alnus viridis* ssp. *sinuata*, *Lonicera involucrata*, *Oplopanax horridus*, *Rosa gymnocarpa*, *Rubus parviflorus*, *Cornus canadensis*, *Ledum glandulosum*, *Vaccinium scoparium*, and *V. cespitosum*. *Arnica latifolia*, *Clintonia uniflora*, *Galium trifidum*, *Polemonium pulcherrimum*, *Senecio triangularis*, *Maianthemum stellatum*, *Streptopus amplexifolius*, *Athyrium filix-femina*, and *Gymnocarpium dryopteris* are common herbaceous species (Kovalchik and Clausnitzer 2004). Unconfined occurrences (mostly Rosgen C and E channels) are most often dominated by a canopy of *Picea engelmannii* while *Populus tremuloides*, *Betula papyrifera*, and occasionally *Pinus contorta* occur as early seral species. Common shrubs include *Cornus sericea*, *Symphoricarpos albus*, *Cornus canadensis*, *Lonicera involucrata*, *Rubus parviflorus*, *Pachistima myrsinites*, *Salix* ssp. *Alnus incana*, *A. viridis* ssp. *sinuata*, and *Ribes lacustre.* Herbaceous species often found in unconfined occurrences include *Carex scopulorum* var. *prionophylla*, *C. disperma*, *Elymus glaucus*, *Aralia nudicaulis*, *Streptopus amplexifolius*, *Gymnocarpium dryopteris*, and *Equisetum* ssp. Riparian woodlands dominated by *Populus tremuloides* are less common than coniferous dominated sites, however they can be found along riparian zones along low to moderate gradient channels (mostly Rosgen C and B channels) and ephemeral draws or depressions (Kovalchik and Clausnitzer 2004). Moderately large *Populus tremuloides* individuals are found in mature stands. *Betula papyrifera* and *Pinus contorta* are occasionally found in these stands. Regenerating *Populus tremuloides* and occasionally *Betula papyrifera*, *Pseudotsuga menziesii*, or *Picea engelmannii* can be found in the understory. Shrub diversity can be high and include *Cornus sericea*, *Symphoricarpos albus*, *Alnus incana*, *Acer glabrum* var. *douglasii*, *Amelanchier alnifolia*, *Ribes lacustre*, *Rosa gymnocarpa*, *Rubus parviflorus*, and *Salix* ssp. Herbaceous species are sparse in stands with high shrub cover. However, species such as *Carex pellita*, *Calamagrostis canadensis*, *Deschampsia cespitosa*, *Angelica arguta*, *Fragaria virginiana* var. *platypetala*, *Petasites sagittatus*, *Maianthemum stellatum*, and *Equisetum arvense* are often found in these woodlands (Kovalchik and Clausnitzer 2004).

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system:

G506 Rocky Mountain & Great Basin Montane Riparian Forest Group	Global/ State Rank	NatureServe/ WNHP Code
Abies grandis - Thuja plicata / Alnus viridis ssp. sinuata / Achlys triphylla Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Abies grandis / Athyrium filix-femina Forest	G3Q/S1	CEGL000270
Abies grandis / Gymnocarpium dryopteris Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Abies grandis / Symphoricarpos albus Riparian Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Abies lasiocarpa / Rubus lasiococcus Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Abies lasiocarpa - Picea engelmannii / Oplopanax horridus Forest	G3/SNR	CEGL000322
Abies lasiocarpa - Picea engelmannii / Streptopus amplexifolius Forest	G4/S2S3	CEGL000336
Abies lasiocarpa / Athyrium filix-femina Woodland	G2/S2	CWWA000002
Abies lasiocarpa / Gymnocarpium dryopteris Forest	GNRQ/SNR	CEGL002611
Abies lasiocarpa / Ledum glandulosum Forest	G4/S1S2	CEGL000314

G506 Rocky Mountain & Great Basin Montane Riparian Forest Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Abies lasiocarpa / Rhododendron albiflorum / Luzula hitchcockii Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Abies lasiocarpa / Rhododendron albiflorum / Senecio triangularis Woodland	G3G4/S2S3	CEGL002613
Abies lasiocarpa / Senecio triangularis - Saxifraga odontoloma Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Abies lasiocarpa / Trautvetteria caroliniensis Forest	G3/S3	CEGL000339
Abies lasiocarpa / Vaccinium caespitosum Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Abies lasiocarpa / Vaccinium membranaceum Forest	G4/S4	CEGL000342
Larix lyallii / Cassiope mertensiana - Phyllodoce empetriformis Riparian Woodland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Picea engelmannii - Abies lasiocarpa / Valeriana sitchensis Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Picea engelmannii - (Abies lasiocarpa) / Trollius laxus Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Picea engelmannii / Alnus sinuata Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Picea engelmannii / Aralia nudicaulis Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Picea engelmannii / Athyrium filix-femina Woodland	G2?/S1?	CWWA000183
Picea engelmannii / Cornus canadensis Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Picea engelmannii / Cornus sericea Woodland	G3/S2?	CEGL002677
Populus tremuloides / Cornus sericea Forest	G4/S1S2	CEGL000582
Populus tremuloides / Symphoricarpos albus Forest	G3?/S2	CEGL000609
Picea engelmannii / Gymnocarpium dryopteris Forest [Provisional]	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)

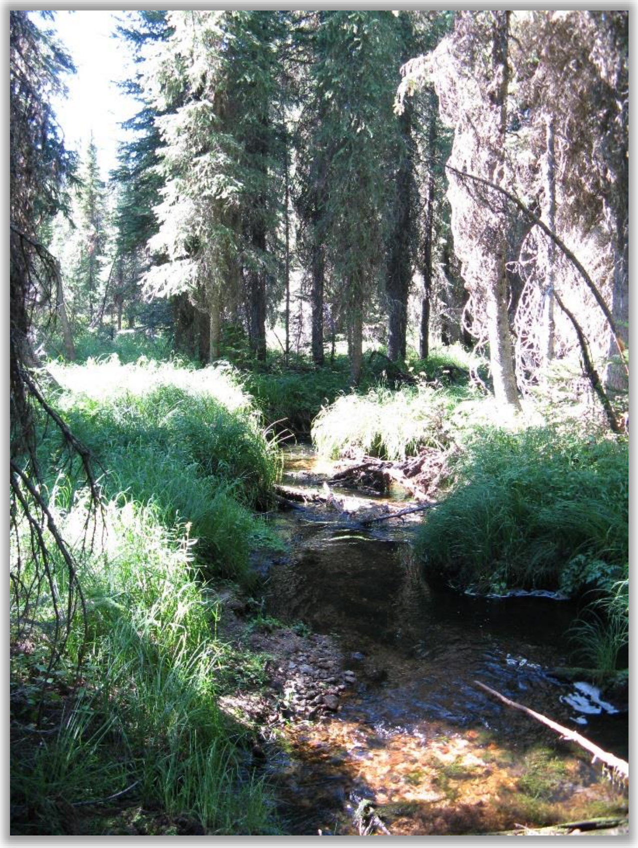
Ecological Processes: Riparian woodland development is driven mostly by the magnitude and frequency of flooding, valley type, and stand replacing disturbances such as crown-fire, disease, windthrow, or clearcutting by humans or beaver. Valley type may be the most important variable, as riparian woodlands are mostly found in V-shaped, steep valleys with many large boulders and coarse soils. The forest vegetation in these environments is often very similar to the adjacent uplands (Baker 1987, Kovalchik and Clausnitzer 2004). Disturbances may create gaps in the canopy and allows pioneer species, such as aspen or shrubs to establish. Less steep and wider valleys can lead to shrubland or woodland development. Flooding inundates vegetation, can physically dislodge seedlings/saplings, and alter channel morphology through erosion and deposition of sediment. Infrequent, high-powered floods determine large geomorphic patterns that persist on the landscape for hundreds to thousands of years (Hubert 2004). Floods of intermediate frequency and power produce floodplain landforms which persist for tens to hundreds of years as well as reset succession to early seral vegetation types (LANDIRE 2005; Hubert 2004). High frequency low-powered floods which occur nearly annually determine short-term patterns such as seed germination and seedling survival (Hubert 2004).

Narrow and steep (i.e. confined) occurrences have minimal to no floodplain development whereas less steep and wider valley bottoms (i.e., unconfined) occurrences are often associated with substantial floodplain development (LANDFIRE 2005; Gregory et al. 1991). Floodplains associated with the latter are comprised of a complexity of geomorphic surfaces which support a diverse array of vegetation communities and are able to store and release water slowly throughout the growing season (Hubert 2004). Confined streams typically have shallow soils with minimal alluvium and transport water downstream rapidly through step-pool channels armored by boulders, bedrock, and large woody debris (LANDFIRE 2005; Hubert 2004).

Beaver, are of minimal significance in confined riparian woodlands as the steep nature of this system and the lack or minimal cover of deciduous trees typically precludes beaver activity. However, beaver activity can have an impact on hydrology and vegetation in unconfined occurrences.

The moisture associated with riparian areas promotes lower fire frequency compared with adjacent uplands. Stand replacement fires are rare but may occur when replacement fires occur in adjacent uplands (Fire regime III; average fire frequency of 100 years; LANDFIRE 2005). More frequent surface fires (~ every 50 years) can affect shrub patches through a combination of replacement fire from uplands and occasional native burning (LANDFIRE 2005). Following stand replacement fires deciduous woody species (e.g., *Populus tremuloides*, *Salix* spp., etc.) can be top-killed but generally resprout within a short period. Post-fire establishment of conifers occurs from seed.

Threats: Historical and contemporary land use practices have impacted hydrologic, geomorphic, and biotic structure and function of riparian areas in eastern Washington. Human land uses both within the riparian area as well as in adjacent and upland areas have fragmented many riparian reaches which has reduced connectivity between riparian patches and riparian and upland areas. This can adversely affect the movement of surface/groundwater, nutrients, and dispersal of plants and animals. Roads, bridges, and development can also fragment both riparian and upland areas. Intensive grazing and recreation can also create barriers to ecological processes.



Reservoirs, water diversions, ditches, roads, and human land uses in the contributing watershed can have a substantial impact on the hydrology as well as biotic integrity of riparian woodlands (Woods 2001; Kattelmann and Embury 1996; Poff et al. 1997; Baker 1987). All these stressors can induce downstream erosion and channelization, reduce changes in channel morphology, reduce base and/or peak flows, lower water tables in floodplains, and reduce sediment deposition in the floodplain (Poff et al. 1997). Vegetation responds to these changes by shifting from wetland and riparian dependent species to more mesic and xeric species typical of adjacent uplands (typical of herbaceous species) and/or encroaching into the stream channel. Although already narrow, floodplain width and the abundance and spatial distribution of various patch types also typically decline.

Livestock grazing is typically not a significant threat in confined riparian woodlands. However, in unconfined reaches, excessive livestock or native ungulate use can impact riparian woodlands by altering nutrient concentrations and cycles, changing surface and subsurface water movement and infiltration, shifting species composition, and reducing regeneration of woody species (Kauffman and Krueger 1984; Elmore and Kauffman 1984; Weixelman et al. 1997; Flenniken et al. 2001; Kauffman et al. 2004).

Management effects on woody riparian vegetation can be obvious, e.g., removal of vegetation by dam construction, roads, logging, or they can be subtle, e.g., removing beavers from a watershed, removing large woody debris, or construction of a weir dam for fish habitat. Non-native plants or animals, which can have wide-ranging impacts, also tend to increase with these stressors.

All of these stressors have resulted in many riparian areas being incised, supporting altered riparian plant communities, as well as numerous non-native species. This system has also decreased in extent due to agricultural development, roads, dams and other flood-control activities.

Classification Comments: Sites are typically dominated by conifers or a mosaic of conifers and shrublands along riparian zones. This system differs from the similar North Pacific Montane Riparian Woodland and Shrubland in that the latter occurs in on the west side of the Cascades and on the east side of the Cascades, it is usually found south of Chelan. This system mostly occurs at high elevations within dry and cold portions of the east Cascades (e.g., north of Chelan), throughout the Okanogan Highlands, and in the Northern Rocky Mountains. Occurrences along pond or lake shores differ from the Northern Rocky Mountain Conifer Swamp system by having relatively well-drained soils that are rarely anoxic for extended periods. Northern Rocky Mountain Conifer Swamps usually are saturated and often have muck or sapric organic soils and have understory species indicative of these saturated conditions.

Related Concepts: This ecological system falls within the Eastside (Interior) Riparian-Wetlands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize the Rocky Mountain Subalpine-Montane Riparian Woodland as a unique mapping unit but did aggregate it into the Rocky Mountain Subalpine/Upper Montane Riparian Systems unit.

References

Baker, W.L. 1987. Recent Changes in the Riparian Vegetation of the Montane and Subalpine Zones of Western Colorado, U.S.A. PhD Dissertation. University of Wisconsin. Madison, WI.

Crawford, R.C. and J. Kagan. 2001. Eastside Riparian-Wetlands. *In* Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Elmore, W. and B. Kauffman. 1994. Riparian and Watershed Systems: Degradation and Restoration. *In*: Ecological implications of livestock herbivory in the west. Society of Range Mgmt. Denver, CO.

Flenniken, M., R.R. McEldowney, W.C. Leininger, G.W. Frasier, and M.J. Trlica. Hydrologic responses of a montane riparian ecosystem following cattle use. Journal of Range Management 54: 567-574.

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Hubert, W.A. 2004. Ecological Processes in Riverine Wetland Habitats. Pages 52-73 *in* M. C. McKinstry, W.A. Hubert, and S.H. Anderson, editors. Wetland and Riparian Areas of the Intermountain West: Ecology and Management. University of Texas Press, Austin, TX.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Kattelmann, R. and M. Embury. 1996. Riparian Areas and Wetlands. In Sierra Nevada Ecosystem Project: Final Report to Congress, Vol. III, Assessment and Scientific Basis for Management Options. Center for Water and Wildland Resources, University of California, Davis, CA.

Kauffman, J.B. and W.C. Krueger. 1984. Livestock Impacts on Riparian Ecosystems and Streamside Management Implications: A Review. J. Range Manage. 37(5):430-438.

Kauffman, J.B., A.S. Thorpe, and E.N.J. Brookshire. 2004. Livestock exclusion and belowground ecosystem responses in riparian meadows of eastern Oregon. Ecological Applications 14(6): 1671-1679.

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. Pacific Northwest Research Station, Forest Service, U.S. Department of Agriculture. In cooperation with: Pacific Northwest Region, Colville, Okanogan, and Wenatchee National Forests. General Technical Report PNW-GTR-593. Portland, OR.

LANDFIRE. 2005. Landfire Biophysical Setting Model for Rocky Mountain Subalpine/Upper Montane Riparian Systems. BpS1011600. Online: http://www.landfire.gov/NationalProductDescriptions24.php

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Poff, N.L., J.D. Allan, M.B. Bain, J.R. Karr, K.L. Presegaard, B.D. Richter, R.E. Sparks, and J.C. Stromburg. 1997. The Natural Flow Regime: A Paradigm for River Conservation and Restoration. BioScience 47: 769-784.

Rocchio, J. 2006. Rocky Mountain Subalpine-Montane Riparian Woodland Ecological Integrity Assessment. Report Prepared for NatureServe, Arlington, VA. Colorado Natural Heritage Program, Colorado State University. Fort Collins, CO. Online:

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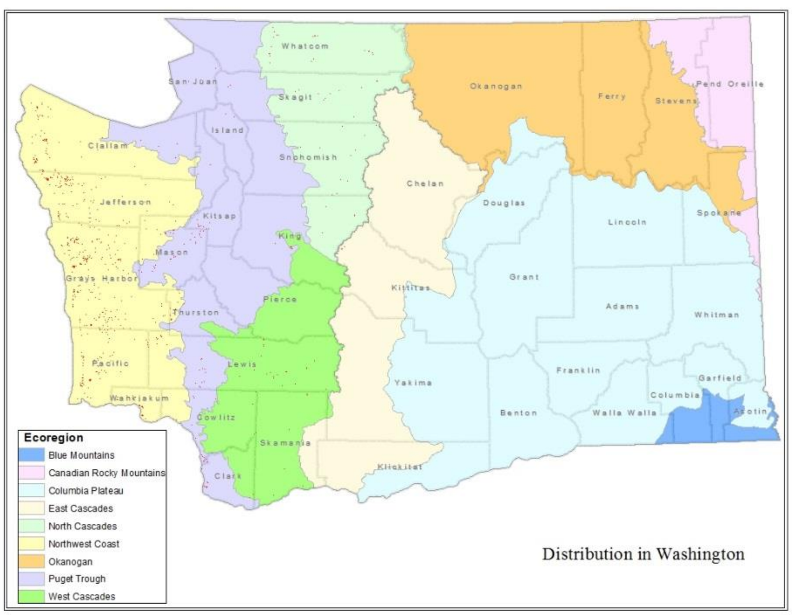
Description Author: Joe Rocchio, Rex Crawford, NatureServe Western Ecology Team.

NORTH PACIFIC HARDWOOD-CONIFER SWAMP

Concept: Coniferous or hardwood tree-dominated swamps that occur in poorly drained environments with slowly moving or stagnant surface water. These sites are indicative of poorly drained, mucky areas. These swamps are dominated by any one or a number of conifer and hardwood species (*Tsuga heterophylla, Picea sitchensis, Tsuga mertensiana, Chamaecyparis nootkatensis, Pinus contorta* var. *contorta, Alnus rubra, Fraxinus latifolia*) that are capable of growing on saturated or seasonally flooded soils.

Conservation Status: Imperiled (S2). Although there has not been a significant loss of extent (although many occurrences have likely been converted to a different wetland type as a result of logging), most occurrences of this system have been degraded from logging and roads.



Distribution: This ecological system is dominated by coniferous or hardwood trees in poorly drained environments with slowly moving or stagnant surface water. They are primarily found in the lowland lowlands up to 457 m (1500 feet) elevation but also occur in montane environments west of the Cascades This system may occur at higher elevations on the east side of the Cascades.

Environment: These swamps mostly occur as small-patches in glacial depressions, river valleys, around the edges of lakes and marshes, or on seepage slopes. They are primarily found in the lowlands up to 457 m (1500 feet) elevation but also occur in montane environments. Groundwater or streams and creeks which do not experience significant overbank flooding are major hydrological drivers. Surface water may be slowly moving through the site or occur as stagnant pools. Accumulation of organic matter (woody peat or muck) can be important in some occurrences. Soils can be woody peat but are more typically muck or mineral soils often with a thin veneer of organic surface layers.

Vegetation: These swamps are dominated by any one or a number of conifer and hardwood species (*Tsuga heterophylla*, *Picea sitchensis*, *Tsuga mertensiana*, *Chamaecyparis nootkatensis*, *Pinus contorta* var. *contorta*, *Alnus rubra*, *Fraxinus latifolia*) that are capable of growing on saturated or seasonally flooded soils. Younger stands often have a significant component of *Alnus rubra*. Other trees which may be present include *Rhamnus purshiana*, *Pyrus fusca*, *Abies amabilis*, and *Populus balsamifera* ssp. *trichocarpa*. Old-growth *Thuja plicata* trees often have broken-tops and develop candelabra-form limbs. *Tsuga heterophylla* is usually found on higher microsites such as buttress roots, stumps, and nurse logs. The overstory can be less than 50% cover while the shrub understory can be over 50% and dense. Many shrubs are often found growing on elevated microsites, especially on downed trees and pit-mound topography created from windthrow. On extremely wet sites, shrubs are often confined to higher microsites such as root wads, rotten logs, and root buttresses. Shrub species include *Oplopanax horridus*, *Salix lucida* ssp. *lasiandra*, *S. sitchensis*, *Acer circinatum*, *Vaccinium ovalifolium*, *Rubus spectabilis*, *Cornus sericea*, *Rubus parviflorus*, *Ribes bracteosum*, *Physocarpus capitatus*, *Gaultheria shallon*, *Spiraea douglasii*, and *Symphoricarpos albus*. Herbaceous species, *Lysichiton americanus* and *Carex obnupta* often dominate water-filled depressions sometimes created by windthrow. *Athyrium filix-femina*, *Blechnum spicant*, *Adiantum pedatum*, *Petasites frigidus*, *Dryopteris expansa*, *Stachys ciliata*, *Tolmiea menziesii*, *Viola glabella*, *Tiarella trifoliata*, *Polystichum munitum*, *Maianthemum dilatatum*, *Galium triflorum*, *Montia sibirica*, and *Urtica dioica* are other common herbaceous species found in these swamps. Patches of shade-tolerant *Sphagnum* species (*S. girgensohnii*, *S. fimbriatum*, *S. palustre*, etc.) are sporadic around tree bases, as small lawns or carpets in low-lying areas, or on downed wood.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system:

G256 North Pacific Maritime Hardwood-Conifer Swamp Group	Global/ State Rank	NatureServe/ WNHP Code
Abies amabilis - Tsuga heterophylla / Oplopanax horridus Forest	G5/S5	CEGL000004
Abies amabilis / Gymnocarpium dryopteris Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Alnus rubra / Athyrium filix-femina - Lysichiton americanus Forest	G3G4/S3	CEGL003388

FORESTED & SHRUB SWAMPS

G256 North Pacific Maritime Hardwood-Conifer Swamp Group	Global/ State Rank	NatureServe/ WNHP Code
Alnus rubra / Glyceria striata Woodland	GNR/S3S4	CWWA000207
Alnus rubra / Rubus spectabilis / Carex obnupta - Lysichiton americanus Forest	G3G4/S3S4	CEGL003389
Alnus rubra / Rubus spectabilis / Chrysosplenium glechomifolium Forest	G3G4/S3S4	CWWA000208
Fraxinus latifolia / Carex obnupta Forest	G4/S2?	CEGL000640
Fraxinus latifolia / Spiraea douglasii Forest	G3/S2?	CEGL003392
Picea sitchensis - (Alnus rubra) / Rubus spectabilis / Polystichum munitum Forest	G3/S3	CEGL000060
Picea sitchensis - Alnus rubra / Lysichiton americanus - Chrysosplenium glechomifolium Forest	GNR/S2	CWWA000233
Picea sitchensis - Tsuga heterophylla - (Alnus rubra) / Oplopanax horridus / Polystichum munitum Forest	G2G3/S2S3	CWWA000234
Picea sitchensis / Rubus spectabilis / Carex obnupta - Lysichiton americanus Forest	G2G3/S2	CEGL000400
Populus tremuloides / Carex obnupta Forest	G2/S1?	CEGL003371
Tsuga heterophylla - (Pseudotsuga menziesii - Thuja plicata) / Polystichum munitum - Athyrium filix-femina Forest	G4G5/4	CEGL002627
Tsuga heterophylla - (Thuja plicata - Alnus rubra) / Lysichiton americanus - Athyrium filix-femina Forest	G3?/S2S3	CEGL002670
Tsuga heterophylla - Abies amabilis / Vaccinium alaskaense / Lysichiton americanus Forest	G3/S3	CEGL000223
Tsuga heterophylla - Pseudotsuga menziesii - (Thuja plicata) / Oplopanax horridus / Polystichum munitum Forest	G3/S2S3	CEGL000497
Tsuga heterophylla - Thuja plicata / Gaultheria shallon / Lysichiton americanus Forest	G5/SNR	CEGL003226
Tsuga mertensiana - Abies amabilis / Caltha leptosepala ssp. howellii Forest	G3/S3	CEGL000501

Ecological Processes: Groundwater or streams and creeks which do not experience significant overbank flooding are major hydrological drivers. Surface water may be slowly moving through the site or as stagnant pools. Windthrow creates canopy gaps and pit-mound topography which increases microsite diversity. Downed trees, root wads, and mounds provide suitable substrates for tree and shrub species that are not able to establish on saturated soils. Hollows created by windthrow are often dominated by species tolerant of saturated soil conditions. Canopy gaps create a diversity of light conditions in the swamp. Beaver activity might also occur in these swamps.

Threats: Historical and contemporary use practices have impacted hydrologic, geomorphic, and biotic structure and function of hardwood-conifer swamps in Washington. Adjacent and upstream land uses also have the potential to contribute excess nutrients, alter hydrology, and provide a vector for non-native species into this ecological system. Intense logging disturbance often results in establishment of *Alnus rubra*. This activity has converted many conifer-dominated stands to hardwood dominance. *Rubus spectabilis* responds similarly and tends to dominate the understory after logging. Logging activities tend to reduce the amount and remove future sources of large woody debris. Logging also increases insolation of the soil surface resulting in higher temperatures, lower humidity, and more sunlight reaching the understory all of which can affect hydrological and nutrient processes and species composition. Timber harvest can also alter hydrology, most often resulting in post-harvest increases in peak flows due to decreased evapotranspiration from removing trees. Logging can also result in mass wasting and related disturbances (sedimentation, debris torrents) in steep topography. Increases in nutrients and pollutants are other common anthropogenic impacts. Reed canarygrass (*Phalaris arundinacea*) is an abundant non-native species in low-elevation, disturbed sites. Many other exotic species also occur. This system has also decreased in extent due to agricultural development, roads, dams and other flood-control activities.

Classification Comments: Similar ecological systems include: (1) the North Pacific Shrub Swamp system, which is usually in wetter environments and dominated by shrubs; (2) the North Pacific Lowland Riparian Forest and Shrubland and North Pacific Montane Riparian Woodland and Shrubland but that differ in that they typically consist of a mix of trees and shrubs and occur as a linear fringe along stream or river channels where exposure to overbank flooding is an important ecological driver; and (3) wooded portions of North Pacific Bog and Fen where trees are typically stunted and have a relatively open canopy. Stands of North Pacific Hardwood-Conifer Swamp on peat soils typically have a closed canopy and individual trees do not show signs of stress such as extremely stunted growth. On the east side of the Cascade crest, this system can occur at higher elevations. The Northern Rocky Mountain Conifer Swamp system occurs at lower elevations in the Cascades and throughout the mountains of eastern Washington.

Related Concepts: This ecological system falls within the Westside Riparian Wetlands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize the North Pacific Hardwood-Conifer Swamp as a unique mapping unit and but did aggregate and map it (along with North Pacific Shrub Swamp) as the North Pacific Swamp system.

References

Chappell, C. 2000. Riparian Forests and Shrublands Appendix 11 Willamette Valley – Puget Trough – Georgia Basin Ecoregion Terrestrial Ecological System EO Specs and EO Rank Specs. *In* Floberg, J., M. Goering, G. Wilhere, C. MacDonald, C. Chappell, C. Rumsey, Z. Ferdana, A. Holt, P. Skidmore, T. Horsman, E. Alverson, C. Tanner, M. Bryer, P. Iachetti, A. Harcombe, B. McDonald, T. Cook, M. Summers, D. Rolph. 2004. Willamette Valley-Puget Trough-Georgia Basin Ecoregional Assessment, Volume One: Report. Prepared by The Nature Conservancy with support from the Nature Conservancy of Canada, Washington Department of Fish and Wildlife, Washington Department of Natural Resources (Natural Heritage and Nearshore Habitat programs), Oregon State Natural Heritage Information Center and the British Columbia Conservation Data Centre.

Chappell, C.B. and J. Kagan. 2001. Westside Riparian-Wetlands. *In* Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Cooke Scientific Services, Inc. 2005. Pacific Northwest Forested Wetland Literature Survey Synthesis Paper. Prepared for Cooperative Monitoring Evaluation and Research Committee/Wetland Scientific

Advisory Group. Washington State Department of Natural Resources Contract #02-10. Prepared by Cooke Scientific Services, Inc., Seattle, WA. Online at: http://www.cookescientific.com/Downloads/Forest%20Wetlands%20Literature%20Survey.pdf

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Painter, L. 2007. Growth Rates and the Definition of Old-Growth in Forested Wetlands of the Puget Sound Region. M.S. Thesis, The Evergreen State College. Olympia, WA. Online: http://archives.evergreen.edu/masterstheses/Accession86-10MES/Painter_L%20MESThesis%202007.pdf

Rocchio, F.J. and R.C. Crawford. *In Progress*. Ecological Classification of Native Wetland & Riparian Vegetation of Washington State. Natural Heritage Report 20XX-XX. Washington Dept. of Natural Resources, Natural Heritage Program. Olympia, WA.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Description Author: Joe Rocchio and Chris Chappell.

NORTH PACIFIC SHRUB SWAMP

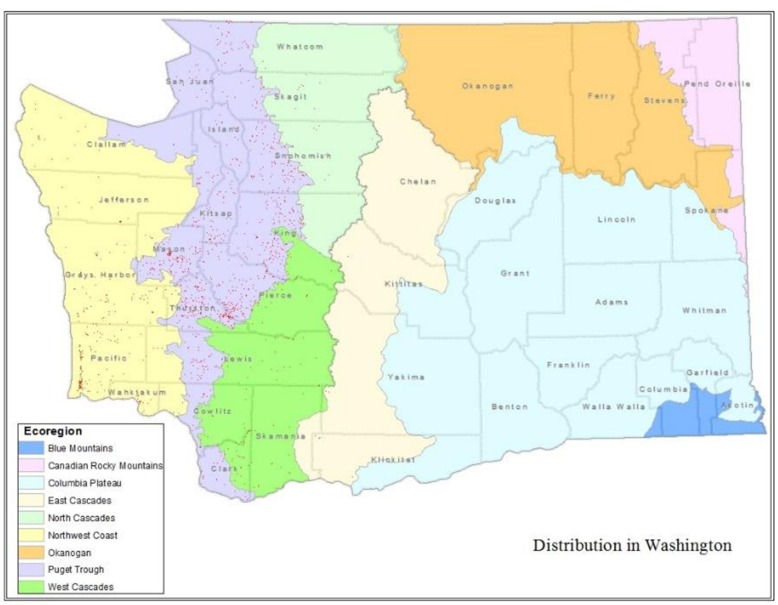
Concept: Shrub swamps dominated by deciduous broadleaf tall shrubs and located in depressions, around lakes or ponds, in laggs around bogs, or river terraces where water tables fluctuate seasonally.

Conservation Status: Vulnerable (S3). This system remains abundant on the landscape, and may have even increased in extent from historical acreage. However, logging, development, agriculture, hydrological changes, nutrient enrichment, and nonnative species have degraded many occurrences.

Distribution: This small to large patch ecological system occurs throughout the Maritime Pacific Northwest, from Cook Inlet and Prince William Sound, Alaska, to the southern coast of Oregon.

Environment: These shrub swamps occurs in depressions, around lakes or ponds, in laggs around bogs, or river terraces where water tables fluctuate seasonally. Soils are muck or mineral soils and typically nutrient rich. Surface water may be slowly moving through the site or occurs as stagnant pools.

Vegetation: These swamps are dominated by one or more of various species of *Salix spp.*, *Spiraea douglasii*, *Malus fusca*, *Myrica gale*, *Cornus sericea*, *Alnus incana* ssp. *tenuifolia* (= *Alnus tenuifolia*), and *Alnus viridis* ssp. *sinuata* (= *Alnus sinuata*) are the major dominants**.** *Spiraea douglasii* is a common dominant shrub in lowland shrub swamps, especially in sites that have experienced human-induced disturbance. These stands are often very dense and have few associated herbaceous species. *Alnus* spp. shrubs are more common at higher elevations but occasionally are found in lagg swamps which surround bogs/poor fens in the Puget lowlands. *Malus fusca* and *Spiraea douglasii* are also common dominant species of lagg shrub swamps. *Cornus sericea* and *Salix* spp. are common around beaver ponds and along slow-moving



surface water tracts. *Myrica gale* is a common species in coastal shrub swamps. Understory species of this system are variable depending on the dominant shrubs and overall shrub cover. *Carex obnupta, C. cusickii, C. exsiccata, C. utriculata, Torreyochloa pauciflora*, and *Glyceria striata* are common graminoids while *Lysichiton americanus, Oenanthe sarmentosa* and *Urtica dioica* are common forbs. Numerous other herbaceous can be present.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system:

G322 Vancouverian Wet Shrubland Group	Global/ State Rank	NatureServe/ WNHP Code
Alnus (incana, viridis ssp. sinuata) / Lysichiton americanus - Oenanthe sarmentosa Shrubland	G1/S1	CEGL003293
Cornus sericea - Salix spp. - Spiraea douglasii Shrubland	GNR/S2	CWWA000249
Malus fusca - (Salix hookeriana) / Carex obnupta Shrubland	G3/S2	CEGL003294
Malus fusca / Boykinia major / Carex obnupta Shrubland	GNR/SUQ	CWWA000254
Malus fusca Shrubland	G3/S2S3	CEGL003385
Myrica gale / Boykinia intermedia - Carex obnupta Shrubland	G1/S1	CEGL003336
Myrica gale / Boykinia intermedia - Deschampsia cespitosa Shrubland	GNR/SNR	CWWA000255
Myrica gale / Lysichiton americanus Shrubland	G1/S1	CWWA000109
Physocarpus capitatus Shrubland	GNR/SUQ	CWWA000232
Salix (hookeriana, lucida ssp. lasiandra, sitchensis) Shrubland [Provisional]	G3Q/S3	CWWA000167
Salix commutata Shrubland	GNR/S2	CWWA000236
Salix geyeriana - Salix hookeriana Shrubland	G1/S1	CEGL003295
Salix hookeriana - (Salix sitchensis) Shrubland	G2/S2	CEGL003387
Salix hookeriana - Spiraea douglasii Shrubland	GNR/S1	CWWA000237
Salix sitchensis Shrubland	G4/S3?	CEGL002896
Salix spp. - Spiraea douglasii / Carex (aquatilis var. dives, obnupta, utriculata) Shrubland	G3G4/S2Q	CWWA000199
Spiraea douglasii Shrubland	G5/S5	CEGL001129

Ecological Processes: Groundwater or streams and creeks which do not experience significant overbank flooding and have low velocity flow are major hydrological drivers. Surface water may be slowly moving through the site or as stagnant pools. Surface water can be somewhat deep above the soil surface during late winter and spring but typically drops below the soil surface by summer's end. However, swamps associated with beaver ponds or other impoundment could remain flooded through much of the year. These shrub swamps may occur in mosaics with marshes or forested swamps. Beaver activity is also a significant ecological driver as many of occurrences of these shrub swamps are associated with beaver ponds.

Threats: Historical and contemporary land use practices have impacted hydrologic, geomorphic, and biotic structure and function of hardwood-conifer swamps in Washington. Adjacent and upstream land uses also have the potential to contribute excess nutrients, alter hydrology, and provide a vector for non-native species into this ecological system. Logging activities tend to reduce the amount and remove future sources of large woody debris, and increase insolation of the soil surface resulting in higher temperatures, lower

humidity, and more sunlight reaching the understory all of which can affect hydrological and nutrient processes and species composition, to alter hydrology, most often resulting in post-harvest increases in peak flows, and to increase mass wasting and related disturbances (sedimentation, debris torrents) in steep topography. Increases in nutrients and pollutants are other common anthropogenic impacts. Reed canarygrass (*Phalaris arundinacea*) is an abundant non-native species in low-elevation, disturbed settings dominated by shrubs or deciduous trees. Many other exotic species also occur. This system has also decreased in extent due to agricultural development, roads, dams and other flood-control activities.

Classification Comments: Shrub swamps may occur in mosaics with marshes or forested swamps. However, it is also common for this system to dominate entire wetlands. The North Pacific Hardwood-Conifer Swamp system is usually in slightly drier environments than this system. The North Pacific Lowland Riparian Forest and Shrubland and the North Pacific Montane Riparian Woodland and Shrubland are somewhat similar systems but differ in that they typically consist of a mix of trees and shrubs and occur as a linear fringe along stream or river channels where exposure to overbank flooding is an important ecological driver.

Related Concepts: This ecological system falls within the Westside Riparian Wetlands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the North Pacific Shrub Swamp as a unique mapping unit.

References

Chappell, C. 2000. Riparian Forests and Shrublands Appendix 11 Willamette Valley – Puget Trough – Georgia Basin Ecoregion Terrestrial Ecological System EO Specs and EO Rank Specs. *In* Floberg, J., M. Goering, G. Wilhere, C. MacDonald, C. Chappell, C. Rumsey, Z. Ferdana, A. Holt, P.

Skidmore, T. Horsman, E. Alverson, C. Tanner, M. Bryer, P. Iachetti, A. Harcombe, B. McDonald, T. Cook, M. Summers, D. Rolph. 2004. Willamette Valley-Puget Trough-Georgia Basin Ecoregional Assessment, Volume One: Report. Prepared by The Nature Conservancy with support from the Nature Conservancy of Canada, Washington Department of Fish and Wildlife, Washington Department of Natural Resources (Natural Heritage and Nearshore Habitat programs), Oregon State Natural Heritage Information Center and the British Columbia Conservation Data Centre.

Chappell, C.B. and J. Kagan. 2001. Westside Riparian-Wetlands. *In* Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

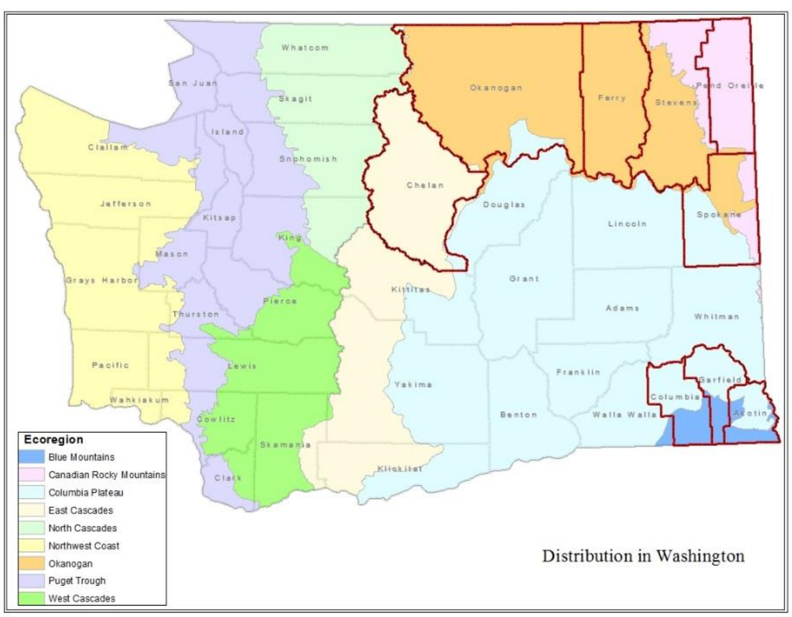
Description Author: Rex Crawford, Joe Rocchio, Gwen Kittel, Pat Comer, Keith Boggs, and Chris Chappell.

NORTHERN ROCKY MOUNTAIN CONIFER SWAMP

Concept: Conifer dominated swamps on poorly drained, seasonally or permanently saturated, soil occurring in eastern Washington above lower treeline. In the Cascades it is more common at lower elevations while the North Pacific Hardwood-Conifer Swamp can occur at higher elevations on the eastside of the Cascade crest.

Conservation Status: Vulnerable (S3). This ecological system has likely not been significantly reduced in extent. However many occurrences are likely degraded from impacts associated with roads, hydrological management, and livestock grazing.

Distribution: This large patch ecological systems occurs in the northern Rocky Mountains from northwestern Wyoming north into the Canadian Rockies and west into eastern Oregon and Washington. In Washington, these are conifer dominated swamps on poorly drained, seasonally or permanently saturated, soil occurring in eastern Washington above lower treeline. In the East Cascades, it is more common at lower elevations while the North Pacific Hardwood-Conifer Swamp can occurs at higher elevations on the eastside of the Cascade crest. The distribution map depicts those counties where this system is most common. It may occur in other portions of the East Cascades ecoregion.



Environment: These swamps are primarily on gently sloping lowlands but also occur near the upper limits of continuous forests (below subalpine parklands). This system occurs on poorly drained soils that are saturated year-round or may have seasonal flooding or saturation in the spring. It can occur on flats, in depressions, around lake and pond shore margins, and on slopes where groundwater discharge occurs. Soils can be woody peat, muck or mineral but tend toward mineral.

FORESTED & SHRUB SWAMPS

Vegetation: Stands are usually dominated by conifers, but can have hardwoods mixed or dominant. Abundant tree species include *Abies grandis*, *Abies lasiocarpa*, *Betula papyrifera*, *Picea engelmannii*, *Pinus contorta var. latifolia*, *Populus balsamifera ssp. trichocarpa*, *Populus tremuloides*, *Thuja plicata*, or *Tsuga heterophylla*. These wetland types are generally distinguishable from other upland forests and woodlands by shallow water tables and mesic or hydric undergrowth vegetation. Some of the most typical herbaceous species include *Alopecurus aequalis, Athyrium filix-femina, Calamagrostis canadensis, Carex disperma*, *Carex vesicaria*, *Dryopteris* spp., *Eleocharis palustris*, *Equisetum arvense*, *Lysichiton americanus*, *Mitella breweri*, *Mitella pentandra*, *Phalaris arundinacea*, *Senecio triangularis*, and *Streptopus amplexifolius*. Common shrubs include *Alnus incana*, *Cornus sericea*, *Rhamnus alnifolia*, and *Salix* spp.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system:

G505 Rocky Mountain & Great Basin Swamp Forest Group	Global/ State Rank	NatureServe/ WNHP Code
Abies lasiocarpa - Picea engelmannii / Calamagrostis canadensis Forest	G5/SNA	CEGL000300
Betula papyrifera / Alnus incana Woodland	G2?/S1	CWWA000174
Betula papyrifera / Aralia nudicaulis Woodland	G2?/S1	CWWA000175
Betula papyrifera / Cornus canadensis Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Betula papyrifera / Cornus sericea Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Picea (engelmannii x glauca, engelmannii) / Carex disperma Forest	G2Q/SNR	CEGL000405
Picea engelmannii - Thuja plicata / Equisetum arvense Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Picea engelmannii - Tsuga heterophylla / Lysichiton americanus Forest	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Picea engelmannii / Carex scopulorum var. prionophylla Woodland	G3/S3	CEGL002630
Picea engelmannii / Equisetum arvense Forest	G4/S3	CEGL005927
Pinus contorta / Spiraea douglasii Forest	G3G4/SNR	CEGL002604
Populus tremuloides / Calamagrostis canadensis Forest	G3/S1	CEGL000574
Populus tremuloides / Carex pellita Forest	G2/S1	CEGL000577
Thuja plicata / Athyrium filix-femina Forest	G3G4/SNR	CEGL000473

Ecological Processes: Groundwater discharge (as seeps or springs) or streams and creeks which do not experience significant overbank flooding are major hydrological drivers. Surface water may be slowly moving through the site or occur as stagnant pools. Windthrow creates canopy gaps and pit-mound topography which increases microsite diversity. Downed trees, root wads, and mounds provide suitable substrates for tree and shrub species that are not able to establish on saturated soils. Hollows created by windthrow are often dominated by species tolerant of saturated soil conditions. Canopy gaps create a diversity of light conditions in the swamp. Beaver activity might also occur in these swamps.

Threats: Historical and contemporary use practices have impacted hydrologic, geomorphic, and biotic structure and function of these conifer swamps. Adjacent and upstream land uses also have the potential to

contribute excess nutrients, alter hydrology, and provide a vector for non-native species into this ecological system. Logging activities tend to reduce the amount and remove future sources of large woody debris. Logging also increases insolation of the soil surface resulting in higher temperatures, lower humidity, and more sunlight reaching the understory all of which can affect hydrological and nutrient processes and species composition. Timber harvest can also alter hydrology, most often resulting in post-harvest increases in peak flows. Logging can also result in mass wasting and related disturbances (sedimentation, debris torrents) in steep topography. Increases in nutrients and pollutants are other common anthropogenic impacts. Exotic species such as reed canarygrass (*Phalaris arundinacea*) can be problematic where soils have been disturbed and/or the canopy has been opened and more light is able to penetrate the stands. This system has also decreased in extent due to agricultural development, roads, dams and other flood-control activities.

Classification Comments: This system characteristically occurs on poorly drained soils which are perennially saturated or exposed to seasonal flooding in an area with a mosaic of moving and stagnant water. In the East Cascades it is more at lower elevations where drier conditions and a Rocky Mountain flora prevail while the North Pacific Hardwood-Conifer Swamp system tends to occur at higher elevations.

Wooded portions of the Rocky Mountain Fen are distinguished from system due to sites having hemic/fibric peat soils and stunted and/or sporadic cover of trees. Those sites tend to be on peat derived from herbaceous plants or mosses. Peat soils associated with Northern Rocky Mountain Conifer Swamp stands are derived from woody peat and usually more decomposed (i.e. sapric) and canopy cover of trees is more dense and typically not stunted or stressed as in the wooded or treed fen sites.

Related Concepts: This ecological system falls within the Montane Coniferous Wetlands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the Northern Rocky Mountain Conifer Swamp as a unique mapping unit.

References

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Rocchio, F.J. and R.C. Crawford. *In Progress*. Ecological Classification of Native Wetland & Riparian Vegetation of Washington State. Natural Heritage Report 20XX-XX. Washington Dept. of Natural Resources, Natural Heritage Program. Olympia, WA.

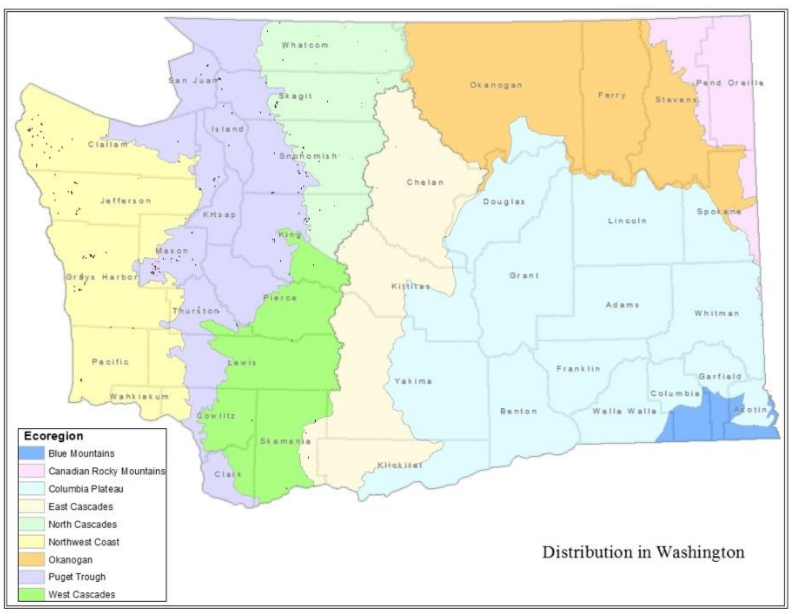
Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Description Author: Joe Rocchio and Marion Reid.

NORTH PACIFIC BOG AND FEN

Concept: Bogs and fens found within the Puget lowlands, Olympic peninsula and southwest coastal area of western Washington. These peatlands are most common in areas previously affected by continental or alpine glaciation. Bogs and fens are collectively called peatlands, which are wetlands with a substrate composed of at least 40 inches of relatively undecomposed organic material. Vegetation is usually a mix of a conifer-dominated overstory, acid-loving shrubs, and open *Sphagnum* or sedge lawns, often with small ponds and pools interspersed. Many species common to boreal continental bogs and fens, such as *Ledum groenlandicum, Vaccinium uliginosum, Myrica gale, Vaccinium oxycoccos, Equisetum fluviatile, Comarum palustre*, and *Drosera rotundifolia* are common.

Conservation Status: Imperiled (S2). In the Puget lowlands many occurrences have been lost or converted due to development and agriculture. Logging and roads have isolated many of these peatlands which restricts connectivity of some ecological and biological processes. Some forested peatlands have been selectively logged. An extremely rare peatland type called a raised plateau bog (the only one known in the western United States) is found along the northwest coast of the Olympic peninsula. Another rare peatland type, serpentine fens, occur on Cypress Island and portions of the mountains in Whatcom County.



Distribution in Washington

Distribution: This ecological system occurs as small patches along the Pacific coast from southeastern Alaska to northern California, in and west of the coastal mountain summits. In Washington, this system is most common within the Puget lowlands, Olympic peninsula and southwest coastal area. In the lowlands the system is most common in areas previously affected by continental or alpine glaciation. Montane peatlands are scattered but never very abundant except in the area southwest of Mount Adams where numerous relatively large montane fens occur. The distribution map is based on NatureServe's Ecological Systems map (Sayre et al. 2009) and Washington Natural Heritage Program's database of significant plant community occurrences.

Environment: This system mostly occurs below 457 m (1500 feet) but occurrences are found in the montane and subalpine areas of the Cascades and Olympic Mountains. Annual precipitation ranges from 890-3050 mm (35-120 inches) across this gradient. The system is found in glaciated landscapes, river valleys, around lakes and marshes, behind coastal sand dunes, or on slopes where groundwater discharges. Bogs (ombrogenous peatlands) generally form in glacial scours, kettles, isolated oxbows, old lake beds, and around pond/lake shorelines. Fens can form along shorelines of lakes/ponds or very slow moving streams (=limnogenous peatlands), in confined basins (=topogenous peatlands), or in areas of groundwater discharge (=soligenous peatlands). Floating mats often form in limnogenous peatlands. Basin fens (topogenous fens) can form in depressions where surface water and/or upwelling groundwater provide continual saturation of the substrate within which dominant plants are rooted. Sloping or soligenous fens occur on or at the base of slopes where groundwater discharges due to a break in the topography or a change in geology or in valley bottoms where alluvial groundwater supports peat formation. Often bogs and fens are intermixed in the same wetland because of variation in water source, ecosystem development and/or vegetation succession. Additionally, other wetland types can surround or occur adjacent to bogs and fens. However, bogs and fens can also be hydrologically isolated from each other and other wetland types. Topography is typically flat but some sites have 20-50 cm tall hummocks formed by *Sphagnum* spp., especially in bogs. Substrates are composed of at least 40 inches of organic material, typically in the form of relatively undecomposed peat.

Vegetation: Vegetation is variable depending on hydrogeomorphic characteristics and can include a conifer-dominated overstory, acid-loving shrubs, and open *Sphagnum* or sedge lawns, often with small ponds and pools interspersed. Many species common to boreal continental bogs and fens, such as *Ledum groenlandicum*, *Vaccinium uliginosum*, *Myrica gale*, *Vaccinium oxycoccos*, *Equisetum fluviatile*, *Comarum palustre*, and *Drosera rotundifolia* are common. However, the presence of Pacific coastal species, including *Pinus contorta* var. *contorta*, *Picea sitchensis*, *Tsuga heterophylla*, *Thuja plicata*, *Gaultheria shallon*, *Spiraea douglasii*, *Carex aquatilis* var. *dives*, *Carex obnupta*, *Carex pluriflora*, *Sphagnum pacificum*, *Sphagnum henryense*, and *Sphagnum mendocinum*, provide a unique floristic character to this ecological system. In bogs and some poor fens, shrubs are typically less than 50cm in height and open enough to allow for a nearly continuous ground cover of *Sphagnum* and expected feather mosses (e.g. *Pleurozium schreberi*).

Bogs and poor fens in the Puget lowlands are primarily found in depressions left by past glaciation. They are commonly dominated by *Ledum groenlandicum* and *Kalmia microphylla* over a continuous lawn or hummocks of various *Sphagnum* species. In the driest bogs and/or those recently disturbed, *Ledum* and *Kalmia* can be quite dense and tall (near to or > than 1 m) to the extent that they exclude other species, even *Sphagnum*, from growing underneath their canopy. In relatively wet areas such as floating mats, *Ledum* and *Kalmia* are typically well spaced and exhibit a short-statured stunted growth form (often < 50 cm high). *Sphagnum fuscum* and *S. capillifolium* are common hummock forming species in Puget lowland bogs and poor fens. *Pleurozium schreberi* is also common on top of hummocks. *S. rubellum* may also be present in the most oligotrophic hummocks or lawns. *Sphagnum angustifolium*, *S. miyabeanum* and *S. mendocinum* are common in pools or very wet hollows. *Vaccinium oxycoccos* and *Drosera rotundifolia* are often common on hummocks. On top of the driest hummocks reindeer lichen (*Cladina* spp.) can be abundant, sometimes to the extent that it outcompetes *Sphagnum* species. Some researchers believe these lichens proliferate following fire (Hebda 1977, Hebda and Biggs 1981) while others note a recurring cycle between lichen and *Sphagnum* dominance (Foster and Glaser 1986). *Pteridium aquilinum* is common in many bogs, sometimes forming dense stands which may indicate recent disturbance or fire. *Gaultheria shallon* can be abundant, typically in a much reduced, short-statured form than commonly observed in upland environments. Soaks, wet hollows and shorelines are often dominated by *Eriophorum chamissonis*, *Dulichium arundinaceum*, and/or *Rhynchospora alba*. *Lysichiton americanus* is sometimes found in bogs forming "wells", which are deep holes in which these plants appear to have inhabited for decades if not longer (Tureson 1916; Osvald 1933). Tree species such as *Tsuga heterophylla*, *Pinus contorta var. contorta*, *Thuja plicata*, and occasional *Picea sitchensis* or *Pinus monticola* are often scattered through these bogs and poor fens. *Tsuga heterophylla*, *Thuja plicata*, and *Pinus contorta var.*

contorta can also form bog woodlands in these sites. When present in bogs and poor fens, trees are represented by relatively short, stunted, bonsai-like growth forms with rounded tops. Often these trees are of small diameter and stature but exhibit furrowed bark suggesting a much older age than size alone. More minerotrophic or slightly less acidic sites (poor to intermediate fens) support a variety of *Carex* including *C. aquatilis* var. *dives*, *C. utriculata*, *C. exsiccata*, *C. leptalea*, *C. cusickii* along with a higher diversity of forbs such as *Menyanthes trifoliata*, *Comarum palustre*, *Lycopus uniflorus*, etc. *Spiraea douglasii*, *Malus fusca*, *Populus tremuloides*, *Cornus sericea* and *Salix* spp. are common species which occur in the laggs (i.e., non-bog vegetation commonly ringing bogs) that surround bogs and basin poor fens.

Coastal peatlands are floristically and ecologically distinct from the Puget lowland peatlands due to receiving much more rainfall, exposure to summer fog, and support coastally restricted species. Most coastal peatlands appear to occur on fine-texture alpine glacial outwash deposits which, along with groundwater discharge and copious rainfall of the region, results in abundant peatland development. In Washington, species such as *Myrica gale*, *Sanguisorba officinalis*, *Carex echinata* subsp. *phyllomanica*, *Empetrum nigrum*, *Xerophyllum tenax*, and numerous rare plants are primarily restricted to these coastal peatlands. However, *Empetrum nigrum* and *Xerophyllum tenax* are also found in upland habitats; the former in dry alpine sites while the latter is found in lowland prairie and more commonly montane upland forests. *Ledum* and *Kalmia* are dominant shrubs and they are typically well spaced and exhibit a short-statured stunted growth form (< 50 cm high) in these coastal peatlands. *Sphagnum papillosum* is very abundant in coastal peatlands while *S. fuscum* and *S. rubellum* are abundant in the most oligotrophic sites. An extremely rare peatland type called a raised plateau bog (the only one known in the western United States) is found along the northwest coast of the Olympic peninsula. The abundant rainfall and summer fog are thought to provide suitable conditions for these unique peatlands to form (see discussion below).

Montane to subalpine peatlands (all of which are fens) are primarily supported by groundwater discharge or occur along lake or pond shorelines. Species such as *Carex utriculata*, *C. cusickii*, *C. limosa*, *C. luzulina*, *C. exsiccata*, *C. scopulorum* ssp. *bracteosa*, *Trichophorum caespitosum*, *Pedicularis groenlandica*, *Kalmia microphylla*, *Eriophorum angustifolium*, *Alnus viridis* subsp. *sinuata*, *A. incana*, *Vaccinium uliginosum*, and *Betula glandulosa* are common.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Groups and Associations that are associated with this ecological system:

G284 North Pacific Bog & Acidic Fen Group	Global/ State Rank	NatureServe/ WNHP Code
Carex (livida, utriculata) / Sphagnum spp. Herbaceous Vegetation	G1G2/S1	CEGL003423
Carex cusickii - (Carex aquatilis var. dives) / Sphagnum spp. Herbaceous Vegetation	G2/S1	CWWA000061
Carex echinata ssp. echinata Herbaceous Vegetation [Provisional]	GNR/S1Q	CWWA000213
Carex exsiccata Poor Fen Herbaceous Vegetation [Provisional]	GNR/SNR	CWWA000259
Carex lasiocarpa / (Sphagnum spp.) Herbaceous Vegetation [Provisional]	GNR/SNR	CWWA000261
Carex luzulina Pacific Coast Herbaceous Vegetation	G3/S1	CWWA000012
Carex utriculata - Carex aquatilis var. dives - Sanguisorba officinalis / Sphagnum spp. Herbaceous Vegetation	G3?/S2	CEGL003422
Dulichium arundinaceum Poor Fen Herbaceous Vegetation [Provisional]	GNR/SNR	CWWA000265
Eriophorum angustifolium ssp. subarcticum var. majus / Sphagnum spp. Herbaceous Vegetation	G4?/S2	CWWA000016
Eriophorum chamissonis / Sphagnum spp. Herbaceous Vegetation	G4/S1	CEGL003333
Juncus balticus - Comarum palustre / Sphagnum spp. Herbaceous Vegetation [Provisional]	GNR/S1Q	CWWA000247
Juncus supiniformis - (Carex livida, Rhynchospora alba) Herbaceous Vegetation	GNR/S1	CWWA000201
Kalmia microphylla - Ledum groenlandicum - Gaultheria shallon - Pteridium aquilinum / Sphagnum spp. Shrubland	GNR/S1Q	CWWA000221
Kalmia microphylla - Ledum groenlandicum / Carex utriculata / Sphagnum spp. Shrubland	GNR/S1Q	CWWA000222
Kalmia microphylla - Ledum groenlandicum / Xerophyllum tenax Shrubland	G1/S1	CEGL003359
Kalmia microphylla - Vaccinium oxycoccos / Carex (livida, obnupta) / Sphagnum spp. Dwarf-shrubland	GNR/S1Q	CWWA000223
Kalmia microphylla - Vaccinium oxycoccos / Empetrum nigrum / Sphagnum spp. Dwarf-shrubland	GNR/S1	CWWA000256
Kalmia microphylla - Vaccinium oxycoccos / Sphagnum spp. Dwarf-shrubland	GNR/S2	CWWA000224
Kalmia microphylla / Carex spp. - Caltha leptosepala ssp. howellii / Sphagnum spp. Dwarf-shrubland	GNR/S2	CWWA000225
Ledum groenlandicum - Gaultheria shallon / Sphagnum spp. Shrubland	GNR/SNR	CWWA000226
Ledum groenlandicum - Kalmia microphylla / Sphagnum spp. Shrubland	G4/S2	CEGL003414
Ledum groenlandicum - Myrica gale / Sphagnum spp. Shrubland	G2/S1	CEGL003335
Ledum groenlandicum / Carex utriculata / Sphagnum spp. Shrubland	GNR/S2	CWWA000229
Ledum groenlandicum / Typha latifolia / Sphagnum spp. Shrubland [Provisional]	GNR/S1Q	CWWA000231
Myrica gale - Spiraea douglasii / Sphagnum spp. Shrubland	G2?/S1	CEGL003420
Myrica gale / Carex (aquatilis var. dives, utriculata) Shrubland	G3/S2	CEGL003376
Myrica gale / Sanguisorba officinalis / Sphagnum spp. Shrubland	G1?/S1?	CEGL003419
Rhynchospora alba - (Vaccinium oxycoccos) / Sphagnum spp. Herbaceous Vegetation	G3/S2	CEGL003338

PEATLANDS

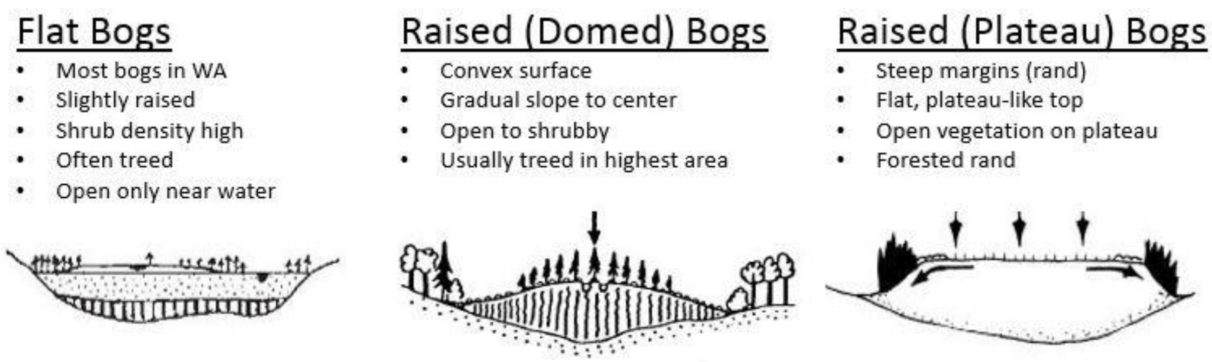
G284 North Pacific Bog & Acidic Fen Group	Global/ State Rank	NatureServe/ WNHP Code
Spiraea douglasii / Carex aquatilis var. dives Shrubland	G4/S2	CEGL003415
Spiraea douglasii / Sphagnum spp. Shrubland	G3/S1	CEGL003416
Vaccinium uliginosum / (Carex aquatilis var. dives) Dwarf-shrubland	G4/S2	CEGL001249
G285 North Pacific Neutral - Alkaline Fen Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Betula glandulosa / Carex aquatilis var. dives Shrubland	GNR/S1	CWWA000209
Carex (aquatilis var. dives, nigricans, utriculata) - Caltha leptosepala ssp. howellii Herbaceous Vegetation [Provisional]	G2G3Q/S1S2	CWWA000169
Carex aquatilis var. dives - (Eleocharis quinqueflora) Herbaceous Vegetation	GNR/S3	CWWA000211
Carex aquatilis var. dives - Carex utriculata Herbaceous Vegetation	G3G4/S2	CWWA000057
Carex aquatilis var. dives Herbaceous Vegetation	G4/S3S4	CEGL001826
Carex cusickii - (Menyanthes trifoliata) Herbaceous Vegetation	G2G3/S2	CEGL003332
Carex interior - Hypericum anagalloides Herbaceous Vegetation	G2?Q/S2?	CEGL001857
Carex obnupta - (Carex cusickii) Herbaceous Vegetation	GNR/SNR	CWWA000251
Carex scopulorum - Eleocharis quinqueflora Herbaceous Vegetation [Provisional]	GNR/SNR	CWWA000263
Carex utriculata Pacific Coast Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Dulichium arundinaceum Rich Fen Herbaceous Vegetation [Provisional]	GNR/SNR	CWWA000266
Equisetum arvense Fen Herbaceous Vegetation [Provisional]	GNR/SNR	CWWA000267
Eriophorum chamissonis - Carex interior Herbaceous Vegetation	GNR/S1	CWWA000246
Juncus balticus - Festuca rubra - Carex cusickii Herbaceous Vegetation [Provisional]	GNR/S1	CWWA000220
Ledum groenlandicum / Carex (cusickii, interior, utriculata) - Festuca rubra Shrubland [Provisional]	GNR/S1	CWWA000227
Ledum groenlandicum / Carex cusickii Shrubland [Provisional]	GNR/S1Q	CWWA000228
Spiraea douglasii / Carex obnupta Shrubland [Provisional]	GNR/S1Q	CWWA000239
Trichophorum caespitosum - (Hypericum anagalloides) Herbaceous Vegetation	GNR/SNR	CEGL002679
Vaccinium uliginosum / Dodecatheon jeffreyi - Caltha leptosepala ssp. howellii Dwarf-shrubland	G3/SU	CWWA000244
G322 Vancouverian Wet Shrubland Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Alnus incana / Carex (aquatilis, deweyana, lenticularis, luzulina, pellita) Shrubland	G3/S1	CEGL001144
G610 North Pacific Maritime Poor Fen & Bog Forest & Woodland Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Pinus contorta var. contorta - Thuja plicata / Myrica gale / Sphagnum spp. Woodland	G3G4/S1	CEGL001691
Thuja plicata - Tsuga heterophylla / Lysichiton americanus / Sphagnum spp. Forest	G3G4/S1	CEGL001787
Pinus contorta var. contorta - Betula papyrifera / Ledum groenlandicum Woodland [Provisional]	GNR/S1Q	CWWA000235
Pinus contorta var. contorta - Thuja plicata / Alnus incana / Carex (aquatilis var. dives, echinata ssp. echinata) Woodland	GNR/SUQ	CWWA000258

G610 North Pacific Maritime Poor Fen & Bog Forest & Woodland Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Pinus contorta var. contorta - Tsuga heterophylla / Gaultheria shallon / Sphagnum spp. Woodland	GNR/S1	CWWA000257
Pinus contorta var. contorta / Ledum glandulosum / Sphagnum spp. Woodland	G1/SU	CWWA000121
Pinus contorta var. contorta / Ledum groenlandicum / Sphagnum spp. Woodland	G3/S2	CEGL003337
Pinus contorta var. contorta / Ledum groenlandicum / Xerophyllum tenax / Sphagnum spp. Woodland	GNR/S1Q	CWWA000202
Pinus monticola / Ledum groenlandicum / Sphagnum spp. Woodland	G1/S1	CEGL003360
Tsuga heterophylla - (Thuja plicata) / Ledum groenlandicum / Carex (obnupta, utriculata) / Sphagnum spp. Woodland	GNR/S1	CWWA000253
Tsuga heterophylla - (Thuja plicata) / Ledum groenlandicum / Sphagnum spp. Forest	G3/S2	CEGL003339
Tsuga heterophylla - (Thuja plicata) / Sphagnum spp. Forest	G1/S1	CEGL003417

Ecological Processes: Bogs and fens are collectively called peatlands, which are wetlands with at least 40 cm of organic soils (consist of at least 12-18% organic-carbon content by weight; USDA 1994). Organic soil forms where the rate of plant growth exceeds the rate of decomposition of litter. Both saturated soils and cool temperatures slow decomposition to the point that productivity exceeds decomposition, resulting in an accumulation of organic matter (i.e. peat). The relative degree of decomposition of organic soil layers is distinguished as being either fibric, hemic, or sapric (muck). Most peatlands have hemic to fibric peat. The accumulation of undecomposed or slightly decomposed organic matter contributed by *Sphagnum* (poor fens and bogs) or sedges, shrubs, and/or non-*Sphagnum* mosses (fens) is the primary ecological driver distinguishing peatlands from other wetland types. Stable groundwater, surface water, or precipitation inputs are crucial for continual integrity of these organic soils. Peat cores from many western Washington peatlands show that succession, climatic changes, fire, or other disturbances often results in a variety of peat deposits over the course of a peatland's history (Rigg 1958). Initial development of most western Washington peatlands occurred soon after the retreat of the last glacial phase. Washington peat accumulates at an approximate rate of 1 inch/40 years and peat depth ranges from a few to over 50 feet (Rigg 1956; 1958).

Soil and water chemistry are important factors in the development and structure of peatland ecosystems. Factors such as pH, mineral concentration, available nutrients, and cation exchange capacity influence the vegetation types and their productivity. One of the common approaches to classifying peatlands is according to pH and associated vegetation. Bogs are very acidic, have low cation concentrations, and are dominated by acid-loving species and oligotrophic *Sphagnum* spp. Poor fens are also very acidic, have low cation concentrations, and are dominated by sedges, acid-loving shrubs, and oligotrophic *Sphagnum* spp. Intermediate fens are slightly acidic to circumneutral, have moderate cation concentrations, and are dominated by sedges, *Betula* spp., *Salix* spp., minerotrophic *Sphagnum* spp., and other mosses (especially those from the Amblystegiaceae family). Extreme rich fens are circumneutral to very basic, have high cation concentrations, and are dominated by numerous calciphile species; sedges, *Betula* spp., *Salix* spp., and other mosses (especially those from the Amblystegiaceae family). Another approach to distinguishing peatland types is based on water source. In this approach fens are limited to those areas where surface and groundwater occurs within the rooting zone of plants. Bogs are limited to those areas where peat has accumulated deep and high enough so that the rooting zone is above the influence of minerotrophic groundwater, limiting hydrological sources to precipitation (i.e., is ombrotrophic). As such, "true" bogs are only found in areas of high precipitation. There has been very little, if any, research to demonstrate the degree to which Washington's "bogs" are ombrotrophic. In lieu of those data, vegetation and surface contours are primarily used as surrogate indicators. Based on these indicators, poor fens and bogs are often difficult to distinguish as they both have low pH (<5.5) and share many of the same vascular and *Sphagnum* species. In Washington, local researchers have suggested using the term "*Sphagnum*-dominated peatlands" to refer to 'bogs and poor fens' to avoid the complicated determination of whether a site meets a strict bog definition (Kulzer et al. 2001).

Early literature about Washington's peatlands (Rigg 1940; 1951; 1958) noted that two types of bogs were found in the State: (1) flat bogs and (2) raised bogs. Flat bogs have also been referred to elsewhere as "raised, level bogs" (Gawler and Cutko 2010), "gently convex bogs" (Davis and Anderson 2001), and "flat and basin bogs" (NWWG 1997). Based on recent research (Kunze 1994; Kulzer et al. 2001) and the author's experience, almost all bogs in Washington are flat bogs. These bogs are slightly raised at their edges, relatively flat across their surface but with a distinct hummock/hollow pattern, and never form distinctive convex surfaces. Flats bogs appear to be raised high enough that their dominant vegetation is mostly limited to typical bog plants (*Ledum groenlandicum*, *Kalmia microphylla*, and *Vaccinium oxycoccos*) and oligotrophic *Sphagnum* species (*S. fuscum* and *S. rubellum*). However, the ombrotrophic peat layer in these flat bogs can be shallow enough to allow some mineratrophic species (e.g., *Carex utriculata, Spiraea douglasii*, *Malus fusca*, etc.) to access underlying, more nutrient rich groundwater. Consequently, many flat bogs support sporadic or restricted patches of species typically not found in 'true' bogs. Raised bogs are noticeably elevated above the level of the surrounding area (Rydin and Jeglum 2013). Raised bogs are a biological landform---they are formed by thousands of years of peat accumulation, primarily from dead remains of peat mosses (*Sphagnum* spp.). The process of peat accumulation creates a conspicuous raised surface that develops above the surrounding topography and isolates the bog surface from surface and/or groundwater influence. This creates ombrotrophic conditions (meaning the bog only receives water and nutrients from precipitation). There are generally three types of raised bogs recognized in circumboreal regions across the world: domed bogs, plateau bogs, and blanket bogs (Moore and Bellamy 1974; Rydin and Jeglum 2013).



Modified from Damman and French 1987

Two bogs on the northwest coast of the Olympic peninsula have conspicuous indicators of being raised. One of these peatlands, Crowberry Bog, exhibits numerous indicators of being a raised plateau bog. Plateau bogs are extremely rare within North America and have previously only been documented along a narrow coastal strip in Maine, New Brunswick, Nova Scotia, and the western coast of Newfoundland (Davis and Anderson 2001; Damman 1977; Damman and French 1987; Worley 1980). Globally, they have also been noted along the coast of southern Finland, southeast Sweden, and the eastern Baltic region (Davis and Anderson 2001; Damman 1977; Moore and Bellamy 1974). Vegetation patterns and surface topography of a bog within the coastal strip of Olympic National Park suggest it might be a raised, domed bog (Bach and Conca 2004; J. Rocchio, unpublished data), another rarity for the western United States. Domed bogs have been documented in British Columbia (Hebda et al. 2000) but no domed (or for that matter, truly raised bogs) have been previously documented in the western United States. Rigg (1940; 1951; 1958) reported raised bogs as occurring within Washington but upon field verification by DNR-Natural Heritage ecologists, it was concluded that these sites were either sloping fens that have terraced peat bodies (e.g.

Cape Alava Prairie, Olympic National Park and Lost Creek Bog, Pend Oreille County) or sites that more closely represent contemporary definitions of flat bogs (Rydin and Jeglum 2013; NWWG 1997).

Native Americans were known to use fire in peatlands found on the coast of the Olympic peninsula to maintain and encourage growth of usable plants (Anderson 2009). Fire scars on snags have been observed by the author in many peatlands. Some of these fires may have been a result of purposeful burning of upland areas subsequent to logging. Given the saturated nature of the underlying peat, fire would presumably only occur during very dry years when vegetation and the upper peat surface were relatively dry.

Threats: Historical and contemporary land use practices have impacted hydrologic, geomorphic, and biotic structure and function of peatlands in western Washington. Conversion of peatlands for agriculture has resulted in significant loss of peatland extent. These areas are often cultivated for blueberries, cranberries, etc. Many coastal peatlands, especially along the southwest coast of Washington, have been converted to cranberry production. Puget lowland peatlands have been lost to development and conversion to agriculture.

Direct alteration of hydrology (i.e., channeling, draining, damming) or indirect alteration (i.e., roads or removing vegetation on adjacent slopes) results in changes in species composition and wetland extent. Water diversions and ditches can have a substantial impact on the hydrology as well as biotic integrity of peatlands. For example, if the water table is lowered, peat oxidization and subsequent decomposition occurs which can lead to reduced peat depth, altered hydrological patterns, and increased nutrient flux all of which can result in a change of species composition. Conversely, increased surface flow into a bog or fen could result in the site being converted into a new wetland type that reflects the new hydrology, e.g., marsh. Since fens are reliant on groundwater any disturbances that impact water quality or quantity are a threat. These threats include groundwater pumping, mining, and improper placement of septic systems, water diversions, dams, roads, etc.

Peat mining can have a substantial impact on bogs and fens. Given the slow accumulation rates of peat, once it is mined (i.e. removed) the fen or bog cannot be restored to historical conditions in a time frame relevant to management activities. The removal of peat alters the subsurface hydrological storage capacity of the peatland and tends to channelize surface flow which might result in further degradation. Peat mining can also alter species composition. A special type of peat mining occurred in the early 20th century where live *Sphagnum* (specifically *S. papillosum*) was harvested as surgical dressing for World War I (Nichols 1920). The mining occurred as community activities called “moss dirves” and often resulted in 2,000 sacks of moss being gatherd per day (Nichols 1920). Althought this activity did not disrupt underlying peat deposits, it is not known what the impact on peat accumulation or vegetation composition this activity may have had.

When upland forests adjacent to bogs and fens are logged, decreases in evaporation rates and subsequent increased surface flow from such areas can contribute excess water and/or sediment into the peatland. Such impacts could have negative consequences to hydrological regime of the peatland resulting in changes of decomposition and species composition. Likewise, roads in a peatland’s watershed can have similar deleterious effects on the hydrological regime as well as increasing sediment, contaminant, and nutrient inputs into a peatland. Increased nutrients (wherever the source) can alter species composition and, in *Sphagnum*-dominated peatlands, result in the loss of *Sphagnum* or a shift in *Sphagnum* composition.

In general, excessive livestock or native ungulate use leads to a shift in plant species composition. Non-native plants or animals, which can have wide-ranging impacts, also tend to increase with these stressors. Although most wetlands receive regulatory protection at the national, state, and county level, many wetlands have been and continued to be filled, drained, grazed, and farmed extensively.

Classification Comments: This system is distinguished from other wetland types by having a substrate composed of relatively undecomposed organic materials (i.e. they have organic soils) and a corresponding unique flora. Treed stands of this system are distinguished from the North Pacific Hardwood-Conifer Swamp system by the degree of canopy closure and growth form of individual trees. Treed peatlands typically support relatively short, stunted, bonsai-like growth forms with rounded tops and furrowed bark (even in short, small diameter individuals) while forested swamps typically have a closed to nearly closed canopy and tree growth is much more vigorous in terms of wood volume and height. That said, trees in forested swamps often show modified growth forms such as the conspicuous candelabra tops formed by *Thuja plicata* in swamps. However, those trees often still reach extremely large sizes. This system is distinguished from the Rocky Mountain Subalpine-Montane Fen system due to the overwhelming influence of a maritime climate and a resulting flora unique to those conditions. The Rocky Mountain Subalpine-Montane Fen system has a distinct Rocky Mountain and boreal flora.

Related Concepts: This ecological system falls within the Westside Riparian Wetlands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize the North Pacific Bog and Fen as a unique mapping unit and did not aggregate it into another mapping unit.

References

Anderson, M.K. 2009. The Ozette Prairies of Olympic National Park: Their Former Indigenous Uses and Management. Final Report to Olympic National Park, Port Angeles, Washington.

Bach, A. And D. Conca. 2004. Draft report: Natural History of the Ahlstrom's and Roose's Prairies, Olympic National Park, Washington. Report of Olympic National Park. Online: http://www.cfr.washington.edu/research.cesu/reports/J9W88040025_Final_Report.pdf

Damman, A.W.H. 1977. Geographical Changes in the Vegetation Pattern of Raised Bogs in the Bay of Fundy Region of Maine and New Brunswick. Vegetatio Vol. 35. pp. 137-151.

Damman, A.W. and T.W. French. 1987. The Ecology of Peat Bogs of the Glaciated Northeastern United States: A Community Profile. U.S. Fish and Wildlife Service. Biological Report 85(7.16). 100 pp.

Davis, R.B. and D.S. Anderson. 2001. Classification and Distribution of Freshwater Peatlands in Maine. Northeastern Naturalist 8(1): 1-50

Foster, D.R. and P.H. Glaser. 1986. The raised bogs of south-eastern Labrador, Canada: classification, distribution, vegetation and recent dynamics. Journal of Ecology 74: 47-71

Gawler, S. and A. Cutko. 2010. Natural Landscapes of Maine: A Guide to Natural Communities and Ecosystem. Maine Natural Areas Program. Department of Agriculture, Conservation, and Forestry. Augusta, ME.

Hebda, R.J. 1977. Paleoecology of a Raised Bog and Associated Deltaic Sediments of the Fraser River Delta. PhD. Dissertation. University of British Columbia. Vancouver, British Columbia.

Hebda, R.J. and W.G. Biggs. 1981. The Vegetation of Burns Bog, Fraser Delta, Southwestern British Columbia. Syesis, Vol. 14, p. 1-19

Hebda, R.J., K. Gustavson, K. Golinski, A.M. Calder. 2000. Burns Bog Ecosystem Review Synthesis Report for Burns Bog, Fraser River Delta, Southwestern British Columbia, Canada. Environmental Assessment Office, Victoria, BC.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Kulzer, L., S. Luchessa, S. Cooke, R. Errington, and F. Weinmann. 2001. Characteristics of the Low-elevation *Sphagnum*-dominated Peatlands of Western Washington: A Community Profile. Report Prepared for U.S. Environmental Protection Agency, Region 10. Online: http://www.kingcounty.gov/environment/waterandland/stormwater/documents/sphagnum-bogs.aspx

Kunze, L.M. 1994. Preliminary classification of native, low elevation, wetland vegetation in western Washington. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 120 pp.

Moore, P.D. and D.J. Bellamy. 1974. Peatlands. Springer-Verlag. New York, New York.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

National Wetland Working Group (NWWG). 1997. The Canadian Wetland Classification System. 2nd ed. Wetlands Research Center, University of Waterloo, Waterloo, Ontario, Canada. 68 pp.

Nichols, G.E. 1920. Sphagnum Moss: War Substitute for Cotton in Absorbent Surgical Dressings. From the Smithsonian Report for 1918, pages 221-234. Smithsonian Publication 2558.

Osvald, H. 1933. Vegetation of the Pacific Coast Bogs of North America. Acta Phytogeographica suecica.
Rigg, G.B. 1940. The development of Sphagnum bogs in North America. Botanical Review. Vol. 6, pp. 666-693.

Rigg, G.B. 1951. The development of Sphagnum bogs in North America. II Botanical Review. Vol. 17, No. 2, pp. 109-131.

Rigg, G.B. and S.P. Gessel. 1956. Peat Deposits of the State of Washington. Soil Science Society Proceedings, 1956.

Rigg, George B. 1958. Peat Resources of Washington. Washington Department of Conservation, Division of Mines and Geology. Bulletin No. 44. Olympia, Washington.

Rocchio, F.J. and R.C. Crawford. *In Progress*. Ecological Classification of Native Wetland & Riparian Vegetation of Washington State. Natural Heritage Report 20XX-XX. Washington Dept. of Natural Resources, Natural Heritage Program. Olympia, WA.

Rydin, H. and J.K. Jeglum. 2013. The Biology of Peatlands. 2nd ed. Oxford University Press.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Tureson, G. 1916. Lysichiton camschatcense (L.) Schott, and its behaviors in Sphagnum bogs. American Journal of Botany, 4.

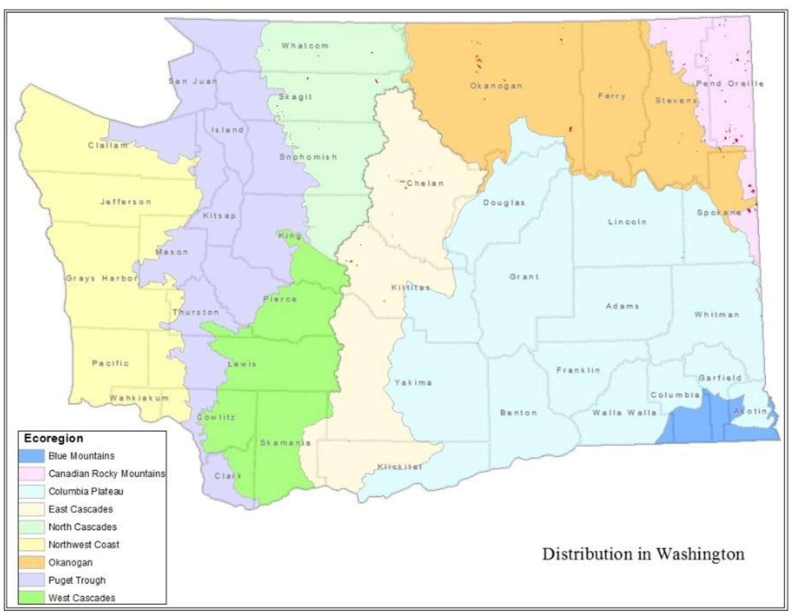
Description Author: Joe Rocchio.

ROCKY MOUNTAIN SUBALPINE-MONTANE FEN

Concept: Fens found throughout montane regions east of the Cascade crest. These fens seem to be the most abundant in the Okanogan Highlands. A few fens occur at the periphery of the Columbia Basin. Fens are confined to specific environments where saturated soils and cool temperatures result in the formation of hemic and fibric peat soils. Fens are primarily dominated by graminoids, especially *Carex* spp.. No true bogs occur east of the Cascade crest but poor fens (very acidic fens) are present.

Conservation Status: Vulnerable (S3). This ecological system has likely not been significantly reduced in extent due to occurring on USFS managed lands. However, impacts from roads, hydrological management, and livestock grazing have degraded some occurrences. Calcareous fens and patterned fens are two rare peatland types found in north-central and northeastern Washington.

Distribution: This system occurs infrequently throughout the Rocky Mountains from Colorado north into Canada. It is confined to specific environments where saturated soils and cool temperatures slow decomposition to the point that productivity exceeds decomposition, resulting in an accumulation of at least 40 cm of organic soils (USDA 1994). In Washington, fens are sporadically found throughout montane regions east of the Cascade crest and seem to be the most abundant in the Okanogan Highlands and Selkirk Mountains (especially within the Kaniksu National Forest). A few fens occur at the periphery of the Columbia Basin. The distribution map is based on combination of NatureServe's Ecological Systems map (Sayre et al. 2009), Washington Natural Heritage Program's database of



significant plant community occurrences, and peat deposits depicted in Washington Dept. of Natural Resources' 1:100K surface geology layer.

Environment: Washington's Rocky Mountain fens remain saturated primarily as a result of discharging groundwater, seasonal and/or perennial surface water input, or due to their location on the fringes of lakes and ponds. Thus, these peatlands only occur in confining basins, near persistent groundwater discharge sites, or near permanent water bodies. These peatlands can form floating mats along lake/pond shorelines and along very slow moving streams, in confined basins, or in areas of groundwater discharge. Basins fens (those associated with shorelines or confined basins) are most common in areas with past glaciation or river valleys. They occur in depressions where surface water and/or upwelling groundwater provide continual saturation of the substrate. Sloping fens occur on or at the base of slopes where groundwater discharges due to a break in the topography, a change in geology, or in valley bottoms where alluvial groundwater supports peat formation. Surface topography is typically smooth with slopes ranging from 0-10%. Peat depth varies according to topographic position and nutrient status and typically ranges from less than 1 meter up to 4 meters. Water levels are maintained at or near the soil surface most of the growing season. More than a few inches of standing water above the soil surface is typically not present and if so, only in scattered locations such as pools, soaks/rivulets or in hollows between hummocks. Soil and water chemistry is determined by bedrock associated with the contributing water source.

Vegetation: Fens are primarily dominated by graminoids, which may constitute 40-100% of the herbaceous layer. Species such as *Carex aquatilis var. aquatilis*, *C. utriculata*, *C. lasiocarpa*, *C. scopulorum var. prionophylla*, *Carex buxbaumii*, *C. limosa*, *C. saxatilis*, *C. simulata*, *Eriophorum* spp., *Calamagrostis canadensis* are common dominants. *Carex limosa*, *Rhynchospora alba*, *Eriophorum angustifolium* ssp. *subarcticum*, *Menyanthes trifoliata*, *Comarum palustre*, *Scheuchzeria palustris* are limited to soaks, floating mats, and shorelines of lakes and ponds. *Eleocharis quinqueflora* is also found in soaks or areas where there is strong upwelling groundwater. A variety of forbs are also found in this system. Shrubs such as *Betula glandulosa*, *Alnus, incana*, *A. viridis ssp. sinuata*, *Salix planifolia*, *S. pedicellaris*, *S. drummondiana*, and *S. farriae* are also common. These shrublands generally have an open canopy so that graminoids and forb diversity is high. Occasional trees such as *Pinus contorta* var. *latifolia* and *Picea engelmannii* may be scattered or form woodlands (i.e. treed fens). The trees can be stunted relative to their growth forms in upland but generally not to the extent that they are stunted in bogs/poor fens associated with the North Pacific Bog and Fen system.

When found in Washington peatlands the following species are primarily found in calcareous fens: *Carex buxbaumii*, *C. capillaris*, *C. flava*, *C. gynocrates*, *C. hystericina*, *C. interior*, *C. viridula*, *Eleocharis rostellata*, *Eriophorum viridicarinatum*, *Muhlenbergia glomerata*, *Salix brachycarpa*, *S.*

candida, *S. maccalliana*, *Symphyotrichum boreale*, and *Triglochin palustris*. Similarly, numerous mosses are also primarily found in calcareous fens including *Helodium blandowii*, *Meesia triquetra*, *Scorpidium scorpioides*, and *Tomenthypnum nitens*.

Patterned fens are a unique type of peatland characteristic of northern temperate and boreal regions where distinct, ribbed surface patterns occur perpendicular to the direction of groundwater flow (Rydin and Jeglum 2013). The ribbed pattern is produced from an alternating occurrence of strings (linear, raised peat ridges) and flarks (wet hollow or mudflats between strings). Flarks typically support vegetation characteristic of soaks and floating mats. In Washington, *Carex rostrata* (a rare species) forms monotypic stands in flarks of these patterned fens. Strings support vegetation more typical of slightly less wet fen habitats. Within Washington, patterned fens are only known to occur at a few sites in Pend Oreille County.

Climatic conditions do not appear to be conducive for the formation of true bogs in eastern Washington. Chadde et al. (1998) and Bursik and Moseley (1995) note small microsites of "ombrotrophic bog" in some Northern Rocky Mountain peatlands. Bursik and Moseley (1995) list *Sphagnum fuscum*, *S. magellanicum*, *S. centrale*, *S. angustifolium*, and *Polytrichum commune* as dominating these microsites. However, other than *S. fuscum* and *S. magellanicum*, these species are not strong indicators of ombrotrophic habitats as they can all occur in acidic, slightly minerotrophic fens. Furthermore, *S. centrale* is typically found in circumneutral or even rich fens (Andrus 2004). Upon field visits to the peatlands in northeastern Washington noted by Chadde et al. (1998) and Bursik and Moseley (1995), no hummocks or microsites were observed that supported true bog vegetation. Tall hummocks supporting oligotrophic *Sphagnum fuscum* and *S. capillifolium* were observed but in all cases minerotrophic vascular plants were rooted in these hummocks suggesting that minerotrophic groundwater was near the surface. Although characteristic bog species such *Kalmia microphylla*, *Drosera* spp., and *Vaccinium oxycoccos* are found in a few poor fens in eastern Washington, the predominant vegetation of these sites consists of various *Carex* species, *Salix* spp. and forbs that are typically considered minerotrophic indicators. Additionally, oligotrophic *Sphagnum* species such as *S. fuscum* and *S. capillifolium*, never form a continuous cover in these sites. If present, they are limited to the tops of tall, sporadic hummocks suggesting minerotrophic water is at the peat surface and limiting their ability to thrive over large areas.

Mosses provide a critical role in the accumulation of peat, formation of hummocks, and nutrient cycling within many fens. Important species in Washington fens include but not limited to *Aulacomnium palustre*, *Bryum pseudotriquetrum*, *Calliergon stramineum*, *Drepanocladus aduncus*, and *Polytrichum commune. Tomenthypnum nitens*, a common component to southern Rocky Mountain fens, is not as common in Washington's fens but appears to be locally abundant in rich to calcareous fens in the Okanogan Highlands. Isolated hummocks or small-scale lawns of minerotrophic *Sphagnum* species such as *S. teres*, *S. warnstorfii*, and *S. squarrosum* are not uncommon in Washington's fens. *S. fuscum* and *S. capillifolium* are often found on the top of tall hummocks. *S. magellanicum* and *S. russowii* occur in wet lawns in poor fens. Numerous rare *Sphagnum* species occur in northeastern Washington fens, especially Bunchgrass Meadows Research Natural Area, where numerous boreal disjunct species are associated with a unique patterned fen complex.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Groups and Associations that are associated with this ecological system:

G505 Rocky Mountain & Great Basin Swamp Forest Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Picea engelmannii / Betula glandulosa / Tomenthypnum nitens Woodland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Picea engelmannii / Carex interior Woodland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Picea engelmannii / Carex scopulorum var. prionophylla Woodland	G3/S3	CEGL002630
Pinus contorta / Calamagrostis canadensis Forest	G5/SNR	CEGL000138
Pinus contorta var. latifolia / Betula glandulosa / Carex utriculata Woodland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
G515 Rocky Mountain Acidic Fen Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Carex limosa / Sphagnum Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Carex utriculata - Sphagnum spp. Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Dulichium arundinaceum Seasonally Flooded Herbaceous Vegetation	G3/S2S3	CEGL001831
Eriophorum angustifolium ssp. subarcticum var. majus-Scheuchzeria palustris / Sphagnum spp. Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Salix pedicellaris / Rhynchospora alba / Sphagnum Dwarf-shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
G516 Rocky Mountain Neutral - Alkaline Fen Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Carex aquatilis var. aquatilis Herbaceous Fen Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Carex buxbaumii Herbaceous Vegetation	G3/SNR	CEGL001806
Carex canescens Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Carex cusickii Herbaceous Vegetation	G2/S2S3	CEGL000230
Carex diandra / Hamatocaulis vernicosus Herbaceous Fen Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Carex interior - Carex hystricina Herbaceous Seep Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Carex lasiocarpa Herbaceous Vegetation	G4?/S3?	CEGL001810
Carex limosa Herbaceous Vegetation	G2/S1	CEGL001811
Carex luzulina Rocky Mountain Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Carex pellita - Carex simulata Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Carex rostrata Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Carex saxatilis Herbaceous Vegetation	G3/S1	CEGL001769

G516 Rocky Mountain Neutral - Alkaline Fen Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Carex scopulorum var. prionophylla Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Carex simulata Herbaceous Vegetation	G4/SNA	CEGL001825
Carex utriculata Herbaceous Vegetation	G5/S5	CEGL001562
Deschampsia caespitosa - (Aster occidentalis) Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Deschampsia caespitosa - (Ligusticum grayi) Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Deschampsia caespitosa - Carex aquatilis var. aquatilis Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Deschampsia cespitosa Herbaceous Fen Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Eleocharis quinqueflora Herbaceous Vegetation	G4/S3	CEGL001836
Eleocharis rostellata - Epipactis gigantea Herbaceous Seep Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Eleocharis rostellata Herbaceous Fen Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Eleocharis rostellata Herbaceous Fen Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Eriophorum angustifolium ssp. subarcticum var. majus - Eleocharis quinqueflora / Sphagnum spp. Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Salix farriae / Eleocharis quinqueflora Saturated Shrubland	G2/S2	CEGL000229
G527 Western Montane-Subalpine Riparian & Seep Shrubland Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Alnus incana / Athyrium filix-femina Shrubland	G3/S3?	CEGL002628
Alnus incana / Calamagrostis canadensis Shrubland	G3Q/S2	CEGL001143
Alnus incana / Carex amplifolia Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Alnus incana / Carex scopulorum var. prionophylla Shrubland	G1/S1	CEGL000122
Alnus incana / Carex utriculata Shrubland	G4/S3S4	CWWA000004
Alnus incana / Equisetum arvense Shrubland	G3/S3	CEGL001146
Alnus incana / Lysichiton americanus Shrubland	G3/S1S2	CEGL002629
Alnus incana / Scirpus microcarpus Shrubland	G2G3/S2	CEGL000481
Alnus incana / Senecio triangularis Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Alnus viridis ssp. sinuata / Mesic Forbs Shrubland	G3G4/S3S4	CEGL002633
Betula glandulosa / Calamagrostis canadensis Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Betula glandulosa / Carex lasiocarpa Shrubland	G3/S1	CEGL002700
Betula glandulosa / Carex utriculata Shrubland	G4?/SNR	CEGL001079
Cornus sericea / Saxifraga arguta Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Dasiphora fruticosa ssp. floribunda / Deschampsia caespitosa Shrubland	G4/SNR	CEGL001107
Salix (boothii, geyeriana) / Carex aquatilis Shrubland	G3/S1?	CEGL001176
Salix (farriae, planifolia) / Carex utriculata Shrubland	G3G4/S2?	CEGL001228
Salix bebbiana / Mesic Graminoids Shrubland	G3?/SNR	CEGL001174

G527 Western Montane-Subalpine Riparian & Seep Shrubland Group	Global/ State Rank	NatureServe/ WNHP Code
Salix boothii / Mesic Forbs Shrubland	G3/SNR	CEGL001180
Salix commutata / Carex scopulorum Shrubland	G3/SNR	CEGL001189
Salix commutata / Senecio triangularis Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Salix drummondiana / Calamagrostis canadensis Shrubland	G3/S2?	CEGL002667
Salix drummondiana / Carex scopulorum var. prionophylla Shrubland	G2G3/S2?	CEGL001584
Salix drummondiana / Carex utriculata Shrubland	G4/S3	CEGL002631
Salix planifolia / Carex scopulorum Shrubland	G3G4/S2?	CEGL001229
Spiraea douglasii - (Salix sitchensis, drummondiana) Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Spiraea douglasii / Calamagrostis canadensis Shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Vaccinium caespitosum - (Salix farriae) / Danthonia intermedia Dwarf-shrubland	G1G2/S1S2	CEGL000484

Ecological Processes: Organic soil forms where the rate of plant growth exceeds the rate of decomposition of litter. Both saturated soils and cool temperatures slow decomposition to the point that productivity exceeds decomposition, resulting in an accumulation of organic matter (i.e. peat). The accumulation of undecomposed or slightly decomposed organic matter contributed by *Sphagnum* (poor fens) or sedges, shrubs, and/or brown mosses (rich fens) is a primary ecological driver. Stable groundwater, surface water, or precipitation inputs are crucial for continual integrity of these organic soils. Fens form at low points in the landscape or near slopes where ground water intercepts the soil surface. Groundwater levels are dependent on the underlying bedrock, watershed topography, soil characteristics, and season (Rink and Kiladis 1986). In areas of thin soils, little surface water is retained as groundwater, however in areas of deep alluvial soils surface water collects in alluvial aquifers which support numerous wetlands including fens (Rink and Kiladis 1986). Groundwater discharge also occurs in areas where subsurface flow is forced to the surface due to underlying impermeable bedrock or soils or a break in topography. Surface water flow is a function of snowmelt, watershed and valley topography and area, late-summer rainfall, and the extent of upstream riparian wetlands (Rink and Kiladis 1986).

Historically, many different criteria have been used to distinguish different types of peatlands, including water chemistry, floristics, hydrology, and topography. Although there is some correspondence between these approaches, they are not always consistent which has resulted in much confusion about the precise definitions of a fen versus a bog. Soil and water chemistry are important factors in the development and structure of peatland ecosystems. Factors such as pH, mineral concentration, available nutrients, and cation exchange capacity influence the vegetation types and their productivity. One of the common approaches to classifying peatlands is according to pH and associated vegetation. Bogs are very acidic, have low cation concentrations, and are dominated by acid-loving species and oligotrophic *Sphagnum* spp. Poor fens are also very acidic, have low cation concentrations, and are dominated by sedges, acid-loving shrubs, and oligotrophic *Sphagnum* spp. Intermediate fens are slightly acidic to circumneutral, have moderate cation concentrations, and are dominated by sedges, *Betula* spp., *Salix* spp., minerotrophic *Sphagnum* spp., and other mosses (especially those from the Amblystegiaceae family). Extreme rich fens are circumneutral to very basic, have high cation concentrations, and are dominated by numerous calciphile species; sedges, *Betula* spp., *Salix* spp., and other mosses (especially those from the Amblystegiaceae family). Another approach is to use water source as a primary division between bog and fen where minerotrophic surface and groundwater occurs within the rooting zone of fens whereas in bogs peat has accumulated deep and high enough that the rooting zone is above the influence of minerotrophic groundwater, limiting

hydrological sources to precipitation. As such, "true" bogs are only found in areas of high precipitation. As noted previously, climatic conditions do not appear to be conducive for the formation of true bogs in eastern Washington.

Mountain fens can be difficult to classify according to the traditional pH/nutrient gradient (which was based on data from boreal peatlands) due to the discrepancy between the pH and nutrient content of these fens (Johnson 2001). The chemistry of mountain fens is overwhelmingly determined by bedrock associated with the contributing water source rather than successional status of peat development. For example, many mountain fens have a pH which is slightly acidic to circumneutral; however, cation concentrations are often very low due to the underlying bedrock (Johnson 2001). Glacial outwash and sedimentary bedrock result in the formation of more base-rich fens (Cooper 1993; Johnson and Steingraeber 2003). For example, the levels of calcium, magnesium, and other cations in the groundwater of extreme rich fens (e.g., calcareous fens) are very high. The groundwater picks up these elements as it percolates through base-rich bedrock in the contributing watershed. In Washington, calcareous fens occur in the Myers Creek drainage of the Okanogan Highlands and numerous locations in Ferry, Stevens, and Pend Oreille counties.

Threats: Groundwater pumping, water diversions, ditches, peat mining, septic systems, dams, and roads all can have a negative impact on hydrology of fens. Livestock management can compact peat, destroy hummocks, create pugging (creation of pedestals in the peat by hooves), and can create exposed patches of peat which could lead to a negative carbon budget and therefore a net loss of peat (Cooper et al. 2005). Excessive livestock or native ungulate use can lead to a shift in plant species composition. Excessive trampling by recreation could have a similar effect. Timber management and associated roads in adjacent areas could alter hydrology and introduce excess nutrients and sediment. Increased nutrients can alter species composition by allowing invasive non-native species or aggressive native species to become dominant. When upland forest areas adjacent to fens are logged, decreases in evaporation rates and subsequent increased surface flow from such areas can contribute excess water and/or sediment into the peatland. Such impacts could have negative consequences to hydrological regime of the peatland resulting in changes of decomposition and species composition. Likewise, roads in a peatland's watershed can have similar deleterious effects on the hydrological regime as well as increasing sediment, contaminant, and nutrient inputs into a peatland. Increased nutrients (wherever the source) can alter species composition and, in *Sphagnum*-dominated peatlands, result in the loss of *Sphagnum* or a shift in *Sphagnum* composition. Restoration of peat substrates is not achievable within a meaningful management time frame.

Classification Comments: Snowmelt maintains high water tables through June in many high elevation wetland types (wet meadows, fens, riparian areas, etc.), however only those areas with soil saturation or a water table within 30 cm of the soil surface through late summer accumulates peat (Cooper 1990; Chimner and Cooper 2003). Thus, a distinguishing characteristic between Rocky Mountain Alpine-Montane Wet Meadow system and the Rocky Mountain Subalpine-Montane Fen system is the depth of the water table in later summer and the resulting formation of organic soils (although other wetlands such as wet meadows or marshes may have histic epipedons or mucky or sapric organic soils). Distinctive geochemical environments (extremely rich/calcareous/marl fens, intermediate fens, poor fens), persistently saturated substrates, and organic soils results in fens having distinctive floristic composition relative to other wetland types. *Alnus* spp., *Betula glandulosa*, and some *Salix* shrublands occurring in areas with > 40 cm of fibric or hemic soils are included in this system. Some peatlands near the Cascade crest may better fit into the North Pacific Bog and Fen system, depending on the degree to which a Vancouverian flora is present.

Related Concepts: This ecological system falls within the Herbaceous Wetlands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize Rocky Mountain Subalpine-Montane Fen as a unique mapping unit and did not aggregate it into any other unit.

References

Andrus, R. E. 2004. Sphagnaceae. *In* Bryophyte Flora of North America, Volume 1. Introduction, Acrocarpous Mosses, Part 1. Online: http://www.efloras.org/flora_page.aspx?flora_id=50

Bursik, R.J. and R.K. Moseley. 1995. Ecosystem Conservation Strategy for Idaho Panhandle Peatlands. Idaho Department of Fish and Game, Boise, Idaho.

Chadde, S.W., J.S. Shelly, R.J. Bursik, R.K. Moseley, A.G. Evenden, M. Mantas, F. Rabe, and B. Heidel. 1998. Peatlands on National Forests of the Northern Rocky Mountains: Ecology and Conservation. United States Dept. of Agriculture, Forest Service. Rocky Mountain Research Station. General Technical Report RMRS-GTR-11.

Chimner, R.A. and D.J. Cooper. 2003. Influence of water table levels on CO2 emissions in a Colorado subalpine fen: an in situ microcosm study. Soil Biology & Biochemistry 35: 345-351.

Cooper, D.J. 1990. Ecology of Wetlands in Big Meadows, Rocky Mountain National Park, Colorado. U.S. Fish and Wildlife Service, Biological Report 90(15).

Cooper, D.J. R. Chimner, and E. Wolf. 2005. Livestock use and sustainability of Sierra Nevada fens. Unpublished report, submitted to Inyo National Forest, California.

Johnson, J.B. 2001. The Ecology of Calcareous Fens in Park County, Colorado. PhD Dissertation. Department of Biology, Colorado State University. Fort Collins, CO.

Johnson, J.B. and D.A. Steingraeber. 2003. The vegetation and ecological gradients of calcareous mires in the South Park valley, Colorado. Canadian Journal of Botany 81: 201-219.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

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 descriptions. Gen. Tech. Rep. PNW-GTR-593. Portland, OR. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Rink, L.P. and G.N Kiladis. 1986. Geology, hydrology, climate, and soils of the Rocky Mountains. Pages 42-65 *in* J.T. Windell, B.E. Willard, D.J. Cooper, S.Q. Foster, C.F. Knud-Hansen, L.P. Rink, and G.N. Kiladis, editors. An ecological characterization of Rocky Mountain montane and subalpine wetlands. U.S. Fish and Wildlife Service, Biological Report 86.

Rocchio, J. 2006. Rocky Mountain Subalpine-Montane Fen Ecological Integrity Assessment. Unpublished report prepared for NatureServe. Colorado Natural Heritage Program. Colorado State University, Fort Collins, CO.

Rocchio, F.J. and R.C. Crawford. *In Progress*. Ecological Classification of Native Wetland & Riparian Vegetation of Washington State. Natural Heritage Report 20XX-XX. Washington Dept. of Natural Resources, Natural Heritage Program. Olympia, WA.

Rydin, H. and J.K. Jeglum. 2013. The Biology of Peatlands. 2nd ed. Oxford University Press.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

United State Department of Agriculture (USDA). 1994. Keys to Soil Taxonomy. Soil Survey Staff, Soil Conservation Service, U.S. Department of Agriculture. Sixth Edition. Pocahontas Press, Inc. Blacksburg, VA.

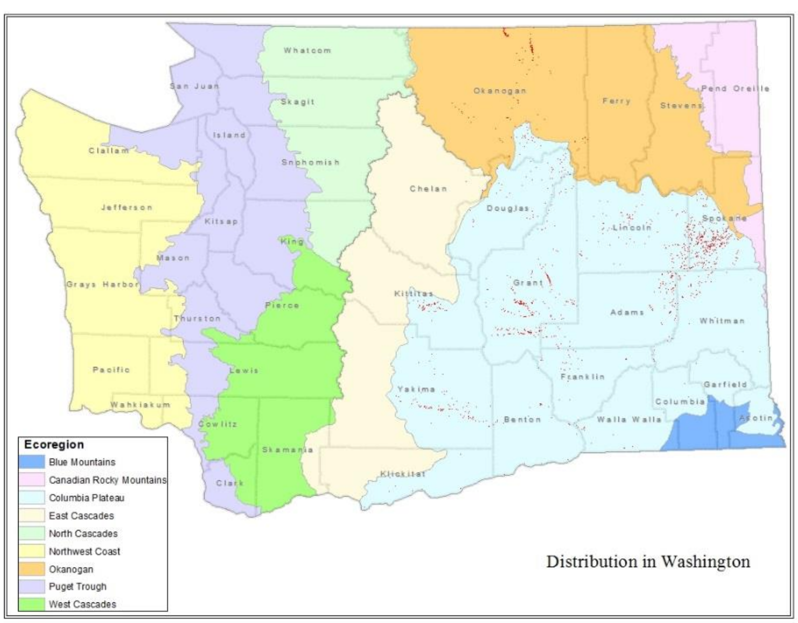
Description Author: Joe Rocchio.

NORTH AMERICAN ARID WEST EMERGENT MARSH

Concept: Marshes and freshwater wet meadows found in the arid and semi-arid regions of eastern Washington below lower treeline. Hydrophytic vegetation dominates these wetlands. Common emergent and floating vegetation includes *Scirpus microcarpus, Schoenoplectus acutus, S. tabernaemontani, Typha latifolia, Juncus spp., Potamogeton spp., Polygonum spp.,* and *Nuphar lutea ssp. polysepala*.

Conservation Status: Imperiled (S2). This system remains widespread on the landscape; however, almost all occurrences have been impacted and many are completely dominated by the invasive, nonnative species *Phalaris arundinacea*. Grazing, hydrological alterations, and invasion by nonnative and invasive species are primary reasons for widespread degradation of this system. Although most wetlands receive regulatory protection at the national, state, and county level, many wetlands have been and continued to be filled, drained, grazed, and farmed extensively.

Distribution: This small patch ecological system occurs throughout much of the arid and semi-arid regions of western North America. It occurs throughout eastern Washington below lower treeline where semi-permanently flooded habitats are found as small patches in the matrix of a relatively dry landscape. The system is typically surrounded by savanna, shrub steppe, steppe, or semi-desert vegetation. The distribution map is based on the National Wetland Inventory maps.



Environment: Natural marshes may occur in depressions (ponds, kettle ponds), pond and lake fringes, and along slow-flowing streams and rivers. Marshes are frequently or continually inundated, with water depths up to 2 m. Water levels may be stable, or may fluctuate 1 m or more over the course of the growing season. Water chemistry may be alkaline or semi-alkaline, but the alkalinity is highly variable even within the same complex of wetlands. Soils have characteristics that result from long periods of anaerobic conditions in the soils (e.g., gleyed soils, high organic content, redoximorphic features) and can be mineral or organic. If organic soils are present they are typically well decomposed (sapric or muck).

Vegetation: Hydrophytic vegetation dominates these wetlands. Common emergent and floating vegetation includes *Scirpus microcarpus*, *Schoenoplectus acutus*, *S. tabernaemontani*, *Typha latifolia*, *Juncus spp.*, *Potamogeton spp.*, *Polygonum spp.*, and *Nuphar lutea ssp. polysepala*. This ecological system also includes aquatic bed communities of relatively deep water with submerged or floating-leaved plants (*Lemna*, *Potamogeton*, and *Brasenia*) and submergent and floating plants (*Myriophyllum*, *Ceratophyllum*, and *Elodea*). Species diversity is usually low due to the dense monocultures formed by many of the dominant species.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Groups and Associations that are associated with this ecological system.

G336 Great Plains Wet Prairie, Wet Meadow & Seepage Fen Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Spartina pectinata Western Herbaceous Vegetation	G3?/S1	CEGL001476
G521 Vancouverian & Rocky Mountain Montane Wet Meadow Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Carex praegracilis Herbaceous Vegetation	G3G4/SNR	CEGL002660
G531 Arid West Interior Emergent Marsh Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Apocynum cannabinum - Artemisia (lindleyana, ludoviciana) Herbaceous Vegetation	G3Q/S1	CWWA000172
Artemisia ludoviciana Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Bolboschoenus fluviatilis Western Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Carex nebrascensis - Argentina anserina Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Carex pellita - Argentina anserina Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Carex pellita - Eleocharis palustris Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Carex utriculata - Mimulus guttatus Herbaceous Vegetation [Provisional]	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Deschampsia cespitosa - Juncus balticus Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Eleocharis palustris Arid Marsh Herbaceous Vegetation	G3/S1?	CWWA000179
Equisetum arvense - Juncus balticus Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Hordeum brachyantherum Herbaceous Vegetation	G2/SNR	CEGL003430
Juncus balticus - Argentina anserina Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Lomatium grayi Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Phragmites australis Western North America Temperate Native Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Schoenoplectus acutus Herbaceous Vegetation	G5/S4	CEGL001840

G531 Arid West Interior Emergent Marsh Group	Global/ State Rank	NatureServe/ WNHP Code
Schoenoplectus americanus Western Herbaceous Vegetation	G3Q/S1	CEGL001841
Schoenoplectus maritimus Herbaceous Vegetation	G4/S1?	CEGL001843
Schoenoplectus tabernaemontani Temperate Herbaceous Vegetation	G5/S3S4	CEGL002623
Scirpus microcarpus Herbaceous Vegetation	G4/S3S4	CEGL003322
Typha latifolia Western Herbaceous Vegetation	G5/S4	CEGL002010
G544 Western North American Temperate Freshwater Aquatic Bed Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Azolla (filiculoides, mexicana) Herbaceous Vegetation	G4/S4	CEGL003017
Callitriche (heterophylla, palustris) Herbaceous Vegetation	G4/S2	CEGL003301
Ceratophyllum demersum Western Herbaceous Vegetation	G5/S4S5	CEGL004017
Elodea canadensis Herbaceous Vegetation	G5/S4?	CEGL003303
Menyanthes trifoliata Herbaceous Vegetation	G5/S4?	CEGL003410
Nuphar lutea ssp. polysepala Herbaceous Vegetation	G5/S4S5	CEGL002001
Polygonum amphibium Permanently Flooded Herbaceous Vegetation [Placeholder]	G5/S3?	CEGL002002
Potamogeton (filiformis, foliosus, gramineus) Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Potamogeton amplifolius Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Potamogeton natans Herbaceous Vegetation	G5?/S5	CEGL002925
Ranunculus aquatilis Herbaceous Vegetation	G5/S4	CEGL003307
Sparganium angustifolium Herbaceous Vegetation	G4/S3S4	CEGL001990
Sparganium eurycarpum Herbaceous Vegetation	G4/S2S3	CEGL003323

Ecological Processes: Marsh development along riparian areas is driven by the magnitude and frequency of flooding, valley and substrate type, and beaver activity. Seasonal and episodic flooding scour depressions in the floodplain, create side channels and floodplain sloughs, and force channel migration which can result in oxbows. Marsh vegetation establish in these landforms if there is semi-permanent to permanent water contained within them. Marshes also occur near the fringes of lakes and ponds where their development is dictated by the shoreline gradient and fluctuation of lake or pond water levels. Relatively flat or gently sloping shorelines support a much larger marsh system than a steep sloping shoreline. Water is at or above the surface for most of the growing season but in some areas can water levels fluctuate with dramatic drawdowns exposing bare soil by later summer. Water level fluctuations support the development of different marsh zones (floating, submergent, emergent, etc.) which vary according to the degree of inundation. Floating (planmergent) communities are restricted to ponds, small lakes, and sheltered bays of larger lakes as these communities are not tolerant of wave action (Pierce and Jensen 2002). Submergent community distribution is determined by water depth, water movement, and potentially substrate (Pierce and Jensen 2002).

Threats: Historical and contemporary land use practices have impacted hydrologic, geomorphic, and biotic structure and function of marshes in eastern Washington. Reservoirs, water diversions, ditches, roads, and human land uses in the contributing watershed can have a substantial impact on the hydrological regime. Direct alteration of hydrology (i.e., channeling, draining, damming) or indirect alteration (i.e., roads or removing vegetation on adjacent slopes) results in changes in amount and pattern of herbaceous wetland habitat. If the alteration is long term, wetland systems may reestablish to reflect new hydrology, e.g., cattail is an aggressive invader. Human land uses both within marshes as well as in adjacent upland areas have

reduced connectivity between wetland patches and upland areas. Land uses in contributing the watershed have the potential to contribute excess nutrients into to the system which could lead to the establishment of non-native species and/or dominance of native increasing species. In general, excessive livestock or native ungulate use leads to a shift in plant species composition. Non-native plants or animals, which can have wide-ranging impacts, also tend to increase with these stressors. A keystone species, the beaver, has been trapped to near extirpation in parts of the Pacific Northwest and its population has been regulated in others. Herbaceous wetlands (including freshwater emergent marsh) have decreased along with the diminished influence of beavers on the landscape. However, in the Columbia Basin of eastern Washington, the abundance of marshes has increased in many areas due to the amount of irrigation water being used across the landscape. This 'wastewater' emerges in various locations to form herbaceous marshes and wet meadows.

Direct alteration of hydrology (i.e., channeling, draining, damming) or indirect alteration (i.e., roads or removing vegetation on adjacent slopes) results in changes in species composition and wetland extent. If the alteration is long term, wetland systems may reestablish to reflect new hydrology, e.g., cattail is an aggressive invader in roadside ditches. Severe livestock grazing and trampling can decrease the abundance of native sedge and grass species, increase the abundance of nonnative and native, weedy species. As mentioned above, irrigation wastewater has also played a role in altering the natural range of variation of many marshes in the basin. This wastewater has created new wetlands in some areas and increased flow volume in others, which could lead to corresponding changes in species composition.

Classification Comments: This system differs from the Temperate Pacific Freshwater Emergent Marsh by supporting more aridland and Rocky Mountain species. The two systems are also geographically distinct with the latter being limited to western Washington while this system is restricted to the lowlands of eastern Washington. This system includes both aquatic and emergent communities.

Related Concepts: This ecological system falls within the Herbaceous Wetlands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize the North American Arid West Emergent Marsh as a unique mapping unit and did not aggregate it into another mapping unit.

References

Crawford, R.C. and J. Kagan. 2001. Eastside Riparian-Wetlands. *In* Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Crawford. Rex C. 2003. Riparian vegetation classification of the Columbia Basin, Washington. Natural Heritage Program Report 2003-03. Washington Dept. Natural Resources. Olympia, WA. 118 pp.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

MacKenzie,W.H. and J.R. Moran. 2004. Wetlands of British Columbia. A Guide to Identification. Research Branch, B.C. Ministry of Forestry, Victoria, British Columbia.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Rocchio, J. 2006. North American Arid Freshwater Marsh Ecological Integrity Assessment. Report Prepared for NatureServe, Arlington, VA. Colorado Natural Heritage Program, Colorado State University. Fort Collins, CO. Online:

Rocchio, F.J. and R.C. Crawford. *In Progress*. Ecological Classification of Native Wetland & Riparian Vegetation of Washington State. Natural Heritage Report 20XX-XX. Washington Dept. of Natural Resources, Natural Heritage Program. Olympia, WA.

Description Author: Joe Rocchio, Rex Crawford, NatureServe Western Ecology Team.

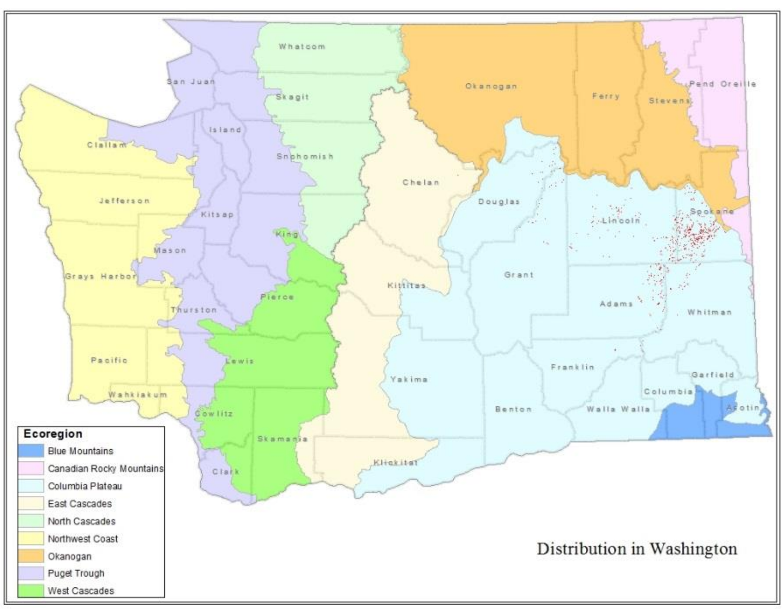
NORTHERN COLUMBIA PLATEAU BASALT POTHOLE PONDS

Concept: Shallow freshwater water bodies found in small depressions gouged into basalt by Pleistocene floods. These pothole ponds are found throughout the channeled scablands of the Columbia Plateau in eastern Washington. This ecological system is very similar and might best be considered a subset of the North American Arid West Emergent Marsh ecological system.

Conservation Status: Imperiled (S1S2). Most occurrences have been impacted by grazing and/or nonnative species. However, very little, focused inventory of this system has occurred and it isn't clear what proportion of sites have been visited.

Distribution: It is found within *Artemisia* shrub-steppe and *Pinus ponderosa* savanna or woodland landscapes. The distribution map is based on the National Wetland Inventory maps overlain with the location of the Channel Scablands. The map is an overestimate of actual abundance of this system.

Environment: This system is occupies the bottom of a basalt cliff (1-20+ m tall) lined circular or linear depression where seasonal water fluctuations maintain the vegetation community.



Vegetation: Characteristic emergent species include *Scirpus microcarpus*, *Schoenoplectus acutus*, *S. tabernaemontani*, *Typha latifolia*, *Juncus spp.*, *Potamogeton spp.*, *Polygonum spp.*, and *Nuphar lutea ssp. polysepala*. This system may also include areas of relatively deep water with floating-leaved plants (species of *Lemna*, *Potamogeton*, and *Brasenia*). Woody plants, including *Populus tremuloides*, *Salix exigua*, *Crataegus douglasii*, or *Rosa woodsii*, occur adjacent to more northerly potholes.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system.

G531 Arid West Interior Emergent Marsh Group	Global/ State Rank	NatureServe/ WNHP Code
Schoenoplectus acutus Herbaceous Vegetation	G5/S4	CEGL001840
Schoenoplectus americanus Western Herbaceous Vegetation	G3Q/S1	CEGL001841
Schoenoplectus tabernaemontani Temperate Herbaceous Vegetation	G5/S3S4	CEGL002623
Typha latifolia Western Herbaceous Vegetation	G5/S4	CEGL002010

Ecological Processes: Seasonal fluctuation in water levels control vegetation patterns and invertebrate communities.

Threats: Many pothole ponds are accessible to livestock and thus overgrazing is a potential threat. Non-native genotypes of *Phragmites communis* and the invasive *Phalaris arundinacea* have established and are invading some of these ponds. Adjacent land uses such as agriculture and grazing could potential result in excess nutrients and sediment moving into these ponds.

Classification Comments: This ecological system is very similar and might best be considered a subset of the North American Arid West Emergent Marsh ecological system. It could also be considered a freshwater aquatic system with primarily zoological species composition (amphibians and invertebrates).


Photo by Rex Crawford

Related Concepts: This ecological system falls within the Herbaceous Wetlands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize Northern Columbia Plateau Basalt Pothole Ponds as a unique mapping unit.

References

Crawford. Rex C. 2003. Riparian vegetation classification of the Columbia Basin, Washington. Natural Heritage Program Report 2003-03. Washington Dept. Natural Resources. Olympia, WA. 118 pp.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Description Author: Rex Crawford and Joe Rocchio.

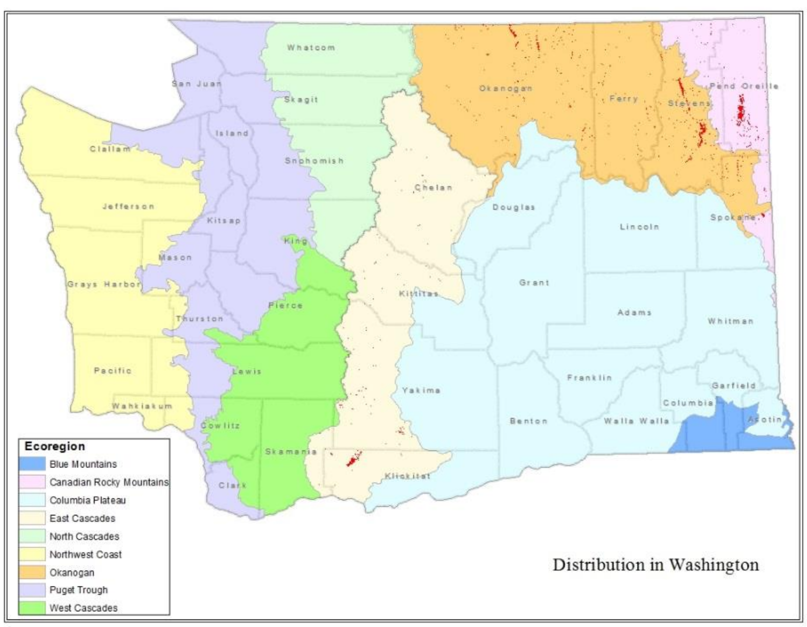
MARSHES AND WET MEADOWS

ROCKY MOUNTAIN ALPINE-MONTANE WET MEADOW

Concept: Montane to alpine marshes and wet meadows that are typically dominated by graminoids and occasionally forbs. Soils do not have > 40 cm of organic matter. These wet meadows are found above lower tree line up to alpine areas within the East Cascades, Okanogan Highlands, Blue Mountains, and Northern Rocky Mountains. In the upper subalpine/alpine areas of the East Cascades this ecological system may merge with the Temperate Pacific Subalpine-Montane Wet Meadow.

Conservation Status: Vulnerable (S3). Many occurrences have been degraded but there likely has not been a significant loss of extent.

Distribution: This small patch ecological system is found throughout the high elevations of Rocky Mountains and Intermountain regions. In Washington, these wet meadows are found through the East Cascades, Okanogan Highlands, Blue Mountains, and Northern Rocky Mountains. In the upper subalpine/alpine areas of the East Cascades this ecological system may merge with the Temperate Pacific Subalpine-Montane Wet Meadow. The distribution map is based on the National Wetland Inventory maps.



Environment: This system occurs as large meadows in montane or subalpine valleys associated with groundwater discharge or as smaller meadows associated with seasonally high water tables such as narrow strips bordering ponds, lakes, and streams, and along toe slope. They are typically found on flat areas or gentle slopes, but may also occur on sub-irrigated sites with slopes up to 10%. In alpine regions, sites typically are small depressions located below late-melting snow patches or on snowbeds tightly associated with snowmelt and typically not subjected to high disturbance events such as flooding, however montane wet meadows may be seasonally flooded. Soils of this system are mineral and may have large amount of organic matter but less than 40 cm (16 in) thick. Typical hydric soil characteristics, including high organic content and/or low chroma and redoximorphic features.

Vegetation: This system includes marshes (permanently to semi-permanently wet) and wet meadows (seasonally wet) and often occurs as a mosaic of several plant associations. Common species include *Calamagrostis stricta*, *Caltha leptosepala ssp. howellii*, *Carex illota*, *C. aperta*, *C. vesicaria*, *C. nigricans*, *C. scopulorum*, *C. utriculata*, *Deschampsia caespitosa*, *Juncus drummondii*, *Rorippa alpina*, *Senecio triangularis*, and *Trifolium parryi*. Often alpine dwarf-shrublands, especially those dominated by *Salix* spp., are immediately adjacent to the wet meadows.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system.

G521 Vancouverian & Rocky Mountain Montane Wet Meadow Group	Global/ State Rank	NatureServe/ WNHP Code
Athyrium filix-femina - Gymnocarpium dryopteris Herbaceous Vegetation [Provisional]	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Carex amplifolia Herbaceous Vegetation	G3/S1?	CEGL003427
Carex aperta Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Carex illota Herbaceous Vegetation	GUQ/SNR	CEGL001876
Carex lacustris Western Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Carex nebrascensis Herbaceous Vegetation	G4/SNR	CEGL001813
Carex scopulorum var. bracteosa Herbaceous Vegetation	G4/S3S4	CEGL001822
Carex spectabilis - Potentilla flabellifolia Herbaceous Vegetation	G4Q/S4	CEGL001829
Carex vesicaria Herbaceous Vegetation	G4Q/S4	CEGL002661
Cassiope mertensiana - Carex nigricans Alpine Wet Dwarf-shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Danthonia californica - Senecio hydrophiloides Wet Meadow Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Danthonia intermedia Wet Meadow Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Deschampsia caespitosa - Carex nebrascensis Herbaceous Vegetation	G3?Q/SNR	CEGL001601
Deschampsia caespitosa - Danthonia intermedia Rocky Mountain Wet Meadow Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Eleocharis palustris Herbaceous Vegetation	G5/S3?	CEGL001833
Elymus hirsutus - Caltha leptosepala ssp. howellii Herbaceous Vegetation	GNR/SNR	CEGL001566
Equisetum fluviatile Herbaceous Vegetation	G4/S3?	CEGL002746
Glyceria borealis Herbaceous Vegetation	G4/S1	CEGL001569
Glyceria elata Herbaceous Vegetation [Provisional]	G3/S2	CWWA000017
Glyceria grandis Herbaceous Vegetation	G2?/S1S2	CEGL003429
Glyceria striata Herbaceous Vegetation	G3/S2	CEGL000219
Heracleum maximum Herbaceous Vegetation	G3G4/SNR	CEGL005857
Juncus balticus Herbaceous Vegetation	G5/S3S4	CEGL001838

MARSHES AND WET MEADOWS

G521 Vancouverian & Rocky Mountain Montane Wet Meadow Group	Global/ State Rank	NatureServe/ WNHP Code
Lupinus latifolius Herbaceous Vegetation	G4?/SNR	CEGL003491
Mimulus guttatus - (Mimulus spp.) Herbaceous Vegetation	GNR/SNR	CEGL005305
Mimulus lewisii Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Phyllodoce empetriformis / Vaccinium deliciosum / Carex nigricans Dwarf-shrubland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Torreyochloa pallida var. pauciflora Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Veronica americana Herbaceous Vegetation	G3Q/S2	CWWA000193
Wyethia amplexicaulis Wet Meadow	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)

Ecological Processes: These meadows are associated with groundwater discharge or seasonally high water tables associated with streams, depressions, seepage slopes, and/or late melting snowbanks. At higher elevations, the system is often tightly associated with snowmelt and typically not subjected to high disturbance events such as flooding.

Threats: Historical and contemporary land use practices have impacted hydrologic, geomorphic, and biotic structure and function of wetlands in Washington. Reservoirs, water diversions, ditches, roads, and human land uses in the contributing watershed can induce lower water tables and contribute excess nutrients and sediment. Increased nutrients can alter species composition by allowing aggressive, invasive species to displace native. Human land uses in adjacent and upland areas can fragment the landscape and thereby reduce connectivity between wet meadow patches and between wetland and upland areas. The intensity and types of land use within and near wet meadows can have a significant effect on plant community composition. Direct alteration of hydrology (i.e., channeling, draining, damming) or indirect alteration (i.e., roads or removing vegetation on adjacent slopes) results in changes in amount and pattern of herbaceous wetland habitat. Livestock management can impact wet meadows by compacting soil, pugging (creation of pedestals by hooves) on the soil surface, altering nutrient concentrations and cycles, changing surface and subsurface water movement and infiltration, and shifting species composition. In general, excessive livestock or native ungulate use leads to a shift in plant species composition. Non-native plants or animals, which can have wide-ranging impacts, also tend to increase with these stressors. Non-native species can displace native species, alter hydrology, alter structure, and affect food web dynamics by changing the quantity, type, and accessibility to food for fauna. Wetland dominated by non-native, invasive species typically support fewer native animals. Wet meadows are susceptible to invasion by many non-native species, especially pasture grasses such as *Poa pratensis* and *Phleum pratense* as well as exotics species common to other wetland types such as *Cirsium arvense* and *Taraxacum officinale*. *Phalaris arundinacea* is also common exotics in wet meadows. Native increasers such as *Juncus arcticus*, *Iris missouriensis*, *Argentea anserina*, and *Dasiphora floribunda* often increase with overgrazing and or changes in the water table.

Classification Comments: The concept used by WNHP for this ecological system varies from NatureServe's original description. NatureServe included many areas which would technically be considered fens. We include those sites in the Rocky Mountain Fen Ecological System. This system is characterized as montane to alpine wet meadows that are typically dominated by graminoids and occasionally forbs and have soils with < 40 cm of organic matter. Sites with soils with > 40 cm of organic matter would be classified as Rocky Mountain Subalpine-Montane Fens. In the upper subalpine/alpine areas of the East Cascades this ecological system may merge with the Temperate Pacific Subalpine-Montane Wet Meadow which has more Vancouverian species. The Boreal Wet Meadow system, which occurs further north in boreal regions where the climatic regime is generally colder for longer durations, has less Cordilleran and more boreal floristic patterns.

Related Concepts: This ecological system falls within the Herbaceous Wetlands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize Rocky Mountain Alpine-Montane Wet Meadow as a unique mapping unit and did not aggregate it into any other unit.

References

Collins, J.N., E. Stein, and M. Sutula. 2008. (2008) California rapid assessment method (CRAM) for wetlands. Version 5.0.2. San Francisco Estuary Institute. San Francisco, California. Available online at: http://www.cramwetlands.org/

MacKenzie, W.H. and J.R. Moran. 2004. Wetlands of British Columbia. A Guide to Identification. Research Branch, B.C. Ministry of Forestry, Victoria, British Columbia.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Rocchio, J. 2006. Rocky Mountain Alpine-Montane Wet Meadow Ecological Integrity Assessment. Unpublished report prepared for NatureServe. Colorado Natural Heritage Program. Colorado State University, Fort Collins, CO.

Rocchio, F.J. and R.C. Crawford. *In Progress*. Ecological Classification of Native Wetland & Riparian Vegetation of Washington State. Natural Heritage Report 20XX-XX. Washington Dept. of Natural Resources, Natural Heritage Program. Olympia, WA.

Description Author: Joe Rocchio, Rex Crawford; NatureServe Western Ecology Team.

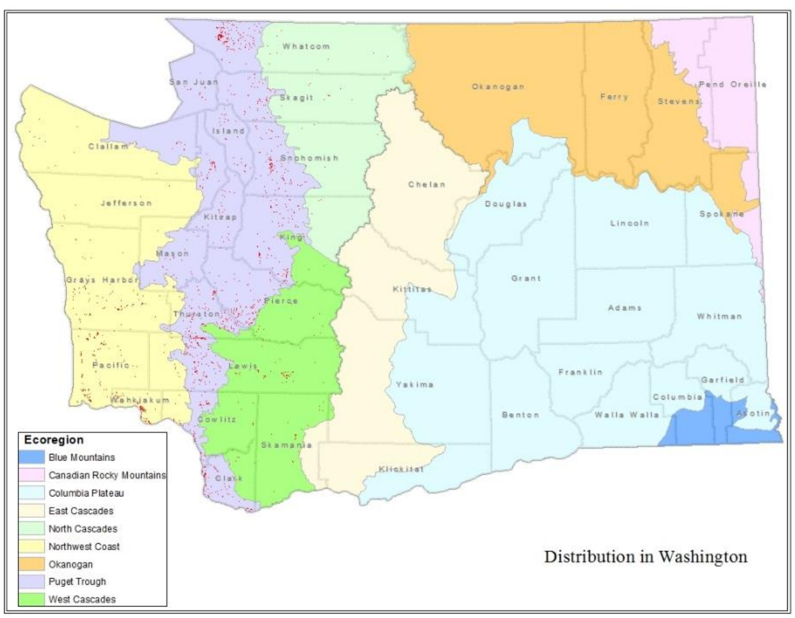
MARSHES AND WET MEADOWS

TEMPERATE PACIFIC FRESHWATER EMERGENT MARSH

Concept: Freshwater marshes found at all elevations below timberline western Washington, however are most abundant in the lowlands. These semi-permanently to permanently flooded wetlands are dominated by emergent herbaceous species, mostly tall graminoids (*Carex*, *Scirpus* and/or *Schoenoplectus*, *Eleocharis*, *Juncus*, *Typha latifolia*) with some forbs.

Conservation Status: Imperiled (S2). The system has likely experienced significant decline in extent (even though it remains widespread) from its historical distribution. Even more significantly is the degree to which extant occurrences have been degraded from adjacent development, agriculture, timber activity, roads, and water management.

Distribution: This small patch ecological system is found at all elevations below timberline throughout the temperate Pacific Coast. However, the dynamic hydrological regimes, high nutrient status, and relatively warm growing season of lowlands in western Washington make this system more abundant at lower than at higher elevations (MacKenzie and Moran 2004). The distribution map is based on the National Wetland Inventory maps.



Environment: This system mostly occurs as a small patch and is confined to suitable areas in floodplain or basin topography. At higher elevations, marshes are most commonly found along wave-washed lakeshores and stream floodplains where continuous, oxygenated water flow prevents peat accumulation and keeps nutrient availability high (MacKenzie and Moran 2004). Water is at or above the surface for most of the growing season. Soils are muck or mineral, and water is nutrient rich. High nutrients favor highly competitive species resulting in relatively low diversity of plant species (MacKenzie and Moran 2004).

Vegetation: These freshwater marshes are dominated by emergent herbaceous species, mostly tall graminoids (*Carex exsiccata*, *C. utriculata*, *Scirpus microcarpus*, *Schoenoplectus acutus*, *Eleocharis palustris*, *Juncus effusus*, *Typha latifolia*) with some forbs. Trees, shrubs and bryophytes are typically absent or very sparse (MacKenzie and Moran 2004). Occurrences of this system typically are found in a mosaic with other wetland types. Common emergent and floating vegetation includes species of *Scirpus* and/or *Schoenoplectus, Typha, Eleocharis, Sparganium, Sagittaria, Bidens, Cicuta, Rorippa, Mimulus*, and *Phalaris*. However, numerous species are found in this system. When associated with relatively deep water, this system may co-occur with the Temperate Pacific Freshwater Aquatic Bed system where floating-leaved genera such as *Lemna*, *Potamogeton*, *Polygonum*, *Nuphar*, *Hydrocotyle*, and *Brasenia* are dominant.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Groups and Associations that are associated with this ecological system.

G517 Vancouverian Freshwater Wet Meadow & Marsh Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Adiantum pedatum Pacific Coast Herbaceous Vegetation [Provisional]	G4G5/S3	CWWA000027
Bidens cernua Herbaceous Vegetation	G3/S2S3	CEGL003324
Bidens frondosa Herbaceous Vegetation	G4/S1	CTWA003325
Carex aperta Herbaceous Vegetation	G1?/S1	CEGL001801
Carex aquatilis var. dives - Comarum palustre Herbaceous Vegetation	G2/S2	CEGL003433
Carex exsiccata Herbaceous Vegetation	G2G3/S2S3	CEGL003312
Carex interrupta Herbaceous Vegetation	G3G4/S3?	CWWA000176
Carex obnupta - (Carex aquatilis var. dives, utriculata) Herbaceous Vegetation	GNR/SNR	CWWA000250
Carex obnupta Herbaceous Vegetation	G4/S4	CEGL003313
Deschampsia caespitosa - Artemisia lindleyana Herbaceous Vegetation	G1/S1	CEGL003425
Eleocharis palustris Pacific Coast Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Eleocharis rostellata Herbaceous Vegetation	G3/S1	CEGL003428
Equisetum arvense Herbaceous Vegetation	G5/S5	CEGL003314
Equisetum fluviatile Pacific Coast Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Equisetum telmateia Herbaceous Vegetation	GNR/S4Q	CWWA000218
Euthamia occidentalis Herbaceous Vegetation	G3/S3	CEGL003328
Glyceria striata Pacific Coast Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Glyceria striata Pacific Coast Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Juncus articulatus Herbaceous Vegetation	GNR/SUQ	CWWA000219
Juncus balticus Pacific Coast Herbaceous Vegetation	GNR/S3	CWWA000248
Juncus bufonius Herbaceous Vegetation	G5/S5	CTWA003316

MARSHES AND WET MEADOWS

G517 Vancouverian Freshwater Wet Meadow & Marsh Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Juncus effusus var. brunneus Pacific Coast Herbaceous Vegetation	G5/S5	CEGL003317
Ludwigia palustris - Polygonum hydropiperoides Herbaceous Vegetation	G2/S1S2	CEGL003330
Mimulus guttatus - Bryum miniatum Herbaceous Vegetation	G4/S3S4	CTWA003373
Mimulus guttatus Seep Herbaceous Vegetation [Provisional]	GNR/SNR	CWWA000268
Oenanthe sarmentosa Herbaceous Vegetation	G4/S3S4	CEGL003319
Paspalum distichum Herbaceous Vegetation	G3/S2	CEGL003320
Petasites frigidus Herbaceous Vegetation	G5/S5	CWWA000116
Ranunculus flammula - Juncus nevadensis - Carex lenticularis Herbaceous Vegetation	G1/S1	CEGL003426
Sagittaria latifolia Herbaceous Vegetation	G2/S1	CEGL003321
Schoenoplectus (acutus, tabernaemontani) Pacific Coast Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Scirpus atrocinctus Herbaceous Vegetation [Provisional]	GNR/SUQ	CWWA000238
Scirpus microcarpus Pacific Coast Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Stachys ciliata Herbaceous Vegetation	G4/S4	CWWA000156
G521 Vancouverian & Rocky Mountain Montane Wet Meadow Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Carex aquatilis var. aquatilis Herbaceous Vegetation	G5/S3	CEGL001802
Carex exsiccata Montane Herbaceous Vegetation [Provisional]	GNR/SNR	CWWA000260
Carex lenticularis Herbaceous Vegetation	G3?/S2S3	CWWA000011
Carex scopulorum var. bracteosa Herbaceous Vegetation	G4/S3S4	CEGL001822
Carex utriculata Marsh Herbaceous Vegetation [Provisional]	GNR/SNR	CWWA000264
Corydalis scouleri Herbaceous Vegetation	G3?Q/S3?	CEGL001939
Eleocharis acicularis Herbaceous Vegetation	G4?/SNR	CEGL001832
Lysichiton americanus Herbaceous Vegetation	G4?/S3S4	CEGL003318
Mimulus guttatus Herbaceous Vegetation	G4/S4	CWWA000105
Trautvetteria caroliniensis - (Senecio triangularis) Herbaceous Vegetation	GNR/S3?	CWWA000241

Ecological Processes: Marsh development along riparian areas is driven by the magnitude and frequency of flooding, valley and substrate type, and beaver activity. Seasonal and episodic flooding scour depressions in the floodplain, create side channels and floodplain sloughs, and force channel migration which can result in oxbows. Marsh vegetation establishes in those landforms if there is semi-permanent to permanent water present. Marshes also occur near the fringes of lakes and ponds where their development is dictated by shoreline gradient and fluctuation of lake or pond levels. Relatively flat or gently sloping shorelines support a much larger marsh system than steep sloping shorelines. Water is at or above the surface for most of the growing season. In some areas water levels fluctuate with dramatic drawdowns that can expose bare soil by late summer. The frequency and magnitude of water level fluctuations determine the extent of each marsh zone (floating, submerged, emergent, etc.). Water level fluctuations also support the development of different marsh zones which vary according to the degree of inundation.

Threats: Historical and contemporary land use practices have impacted hydrologic, geomorphic, and biotic structure and function of marshes in western Washington. Reservoirs, water diversions, ditches, roads, and human land uses in the contributing watershed can also have a substantial impact on the hydrological regime. Direct alteration of hydrology (i.e., channeling, draining, damming) or indirect alteration (i.e., roads or removing vegetation on adjacent slopes) results in changes in amount and pattern of herbaceous wetland habitat. If the alteration is long term, wetland systems may reestablish to reflect new hydrology,. Human land uses both within the marshes as well as in adjacent upland areas have reduced connectivity between wetland patches and upland areas. Land uses in contributing watersheds have the potential to contribute excess nutrients into to the system which could lead to the establishment of non-native species (i.e., *Phalaris arundinacea*) and/or dominance of native disturbance-increasing species (e.g., *Typha latifolia*). In general, excessive livestock or native ungulate use leads to a shift in plant species composition. Non-native plants or animals, which can have wide-ranging impacts, also tend to increase with these stressors. Montane wetlands are less altered than lowland wetlands even though they have undergone modification as well. A keystone species, the beaver, has been trapped to near extirpation in parts of the Pacific Northwest and its population has been regulated in others. Herbaceous wetlands (including freshwater emergent marsh) have decreased along with the diminished influence of beavers on the landscape.

Classification Comments: This system differs from the North American Arid West Emergent Marsh by occurring in a more maritime and moderate climate and consequently supporting more Vancouverian species. The two systems are also geographically distinct with this system being limited to western Washington while North American Arid West Emergent Marsh is restricted to the lowlands of eastern Washington.

Related Concepts: This ecological system falls within the Herbaceous Wetlands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize Temperate Pacific Freshwater Emergent Marsh as a unique mapping unit and did not aggregate it into another system.

References

Christy, J. 2000. Freshwater Marshes Appendix 11 Willamette Valley – Puget Trough – Georgia Basin Ecoregion Terrestrial Ecological System EO Specs and EO Rank Specs. *In* Floberg, J., M. Goering, G. Wilhere, C. MacDonald, C. Chappell, C. Rumsey, Z. Ferdana, A. Holt, P. Skidmore, T. Horsman, E. Alverson, C. Tanner, M. Bryer, P. Iachetti, A. Harcombe, B. McDonald, T. Cook, M. Summers, D. Rolph. 2004. Willamette Valley-Puget Trough-Georgia Basin Ecoregional Assessment, Volume One: Report.

Marshes and Wet Meadows

Prepared by The Nature Conservancy with support from the Nature Conservancy of Canada, Washington Department of Fish and Wildlife, Washington Department of Natural Resources (Natural Heritage and Nearshore Habitat programs), Oregon State Natural Heritage Information Center and the British Columbia Conservation Data Centre.

Chappell, C.B. and J. Kagan. 2001. Westside Riparian-Wetlands. *In* Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

MacKenzie, W.H. and J.R. Moran. 2004. Wetlands of British Columbia. A Guide to Identification. Research Branch, B.C. Ministry of Forestry, Victoria, British Columbia.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Rocchio, F.J. and R.C. Crawford. *In Progress*. Ecological Classification of Native Wetland & Riparian Vegetation of Washington State. Natural Heritage Report 20XX-XX. Washington Dept. of Natural Resources, Natural Heritage Program. Olympia, WA.

Description Author: Joe Rocchio, Chris Chappell and Gwen Kittel.

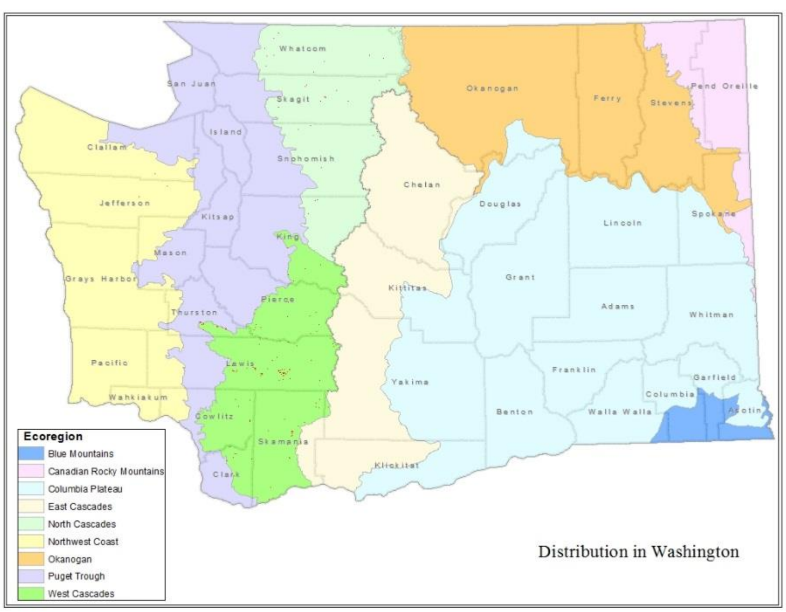
TEMPERATE PACIFIC SUBALPINE-MONTANE WET MEADOW

Concept: Wet meadows found in the montane and subalpine forests west of or near the Cascade crest and in the Olympic Mountains. Sites are open wet depressions, basins and flats that are usually seasonally wet, often drying by late summer. Sites can also be associated with groundwater discharge or associated with snowmelt.

Conservation Status: Apparently Secure (S4). This system has likely not been dramatically reduced in extent. Some occurrences have been degraded but most likely remain in good condition.

Distribution: This is a small patch system which occurs among montane and subalpine forests from California's Transverse and Peninsular ranges north to the Alaskan coastal forests. In Washington, this ecological system is a high-elevation (montane to alpine) wetland mostly found west of or near the Cascade crest and in the Olympics. The distribution map is based on the National Wetland Inventory maps.

Environment: Sites are open wet depressions, basins and flats that are usually seasonally wet, often drying by late summer. Seasonal surface water depths rarely exceed a few centimeters. Soils show typical hydric soil characteristics, including high organic content (often with histic epipedons) and/or low chroma and redoximorphic features. Site often are associated with groundwater discharge or seasonally high water tables. The system is often tightly associated with snowmelt and typically not subjected to high disturbance events such as flooding.



Vegetation: Vegetation of this system expresses itself as a mosaic of several plant associations with various dominant herbaceous species that may include (but not limited to) *Camassia quamash*, *Carex utriculata*, *Carex exsiccata*, *Dodecatheon jeffreyi*, *Glyceria* *striata* (= *Glyceria elata*), *Carex nigricans*, *Calamagrostis canadensis*, *Juncus nevadensis*, *Caltha leptosepala* ssp. *howellii*, *Saxifraga odontoloma*, *Senecio triangularis*, *Veratrum californicum*, and *Scirpus* and/or *Schoenoplectus* spp. Trees occur peripherally or on elevated microsites and include *Picea engelmannii*, *Abies lasiocarpa*, *Abies amabilis*, *Tsuga mertensiana*, and *Chamaecyparis nootkatensis*. Common shrubs may include *Salix* spp., *Kalmia microphylla*, *Vaccinium uliginosum*, and *Betula nana*.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Groups and Associations that are associated with this ecological system.

G520 Vancouverian & Rocky Mountain Subalpine Snowbed, Wet Meadow & Dwarf-Shrubland Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Caltha leptosepala ssp. howellii Herbaceous Vegetation	G4/S4	CEGL001954
Carex nigricans - (Petasites frigidus var. frigidus) / Philonotis fontana Herbaceous Vegetation [Provisional]	GNR/S3	CWWA000245
Carex nigricans Herbaceous Vegetation	G4/S4	CEGL001816
Kalmia microphylla / Carex nigricans Dwarf-shrubland	G3G4/S3	CEGL001402
Marchantia polymorpha - Philonotis fontana Bryophyte Vegetation	G3/SU	CWWA000103
Polytrichum commune Bryophyte Vegetation	G4/SU	CWWA000126
Potentilla flabellifolia - Polygonum bistortoides Herbaceous Vegetation	G4Q/S4	CEGL001981
Saxifraga odontoloma - Senecio triangularis Herbaceous Vegetation	G3G4/S3	CWWA000190
G521 Vancouverian & Rocky Mountain Montane Wet Meadow Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Calamagrostis canadensis Western Herbaceous Vegetation	G4/S3S4	CEGL001559
Carex exsiccata Montane Herbaceous Vegetation [Provisional]	GNR/SNR	CWWA000260
Carex pellita Herbaceous Vegetation	G3/S1	CEGL001809
Deschampsia caespitosa Herbaceous Vegetation	G4/S2?	CEGL001599
Equisetum arvense Herbaceous Vegetation	G5/S5	CEGL003314
Mimulus guttatus Herbaceous Vegetation	G4/S4	CWWA000105
Saussurea americana - Heracleum maximum Herbaceous Vegetation	G3G4/S3S4	CEGL001945
Senecio triangularis Herbaceous Vegetation	G5?/S3	CEGL001987
Trautvetteria caroliniensis - (Senecio triangularis) Herbaceous Vegetation	GNR/S3?	CWWA000241

Ecological Processes: This system is associated with groundwater discharge or seasonally high water tables. Water tables may be above the soil surface early in the growing season but typically drop below the soil surface by late summer. High elevation sites are often tightly associated with snowmelt and typically not subjected to high disturbance events such as flooding.

Threats: Historical and contemporary land use practices have impacted hydrologic, geomorphic, and biotic structure and function of wetlands in western Washington. High elevation wetlands are generally less altered than lowland wetlands. Human land uses in adjacent and upland areas can fragment the landscape and thereby reduce connectivity between wet meadow patches and between wetland and upland areas. The intensity and types of land use within and near wet meadows can have a significant effect on plant community composition. Direct alteration of hydrology (i.e., channeling, draining, damming) or indirect alteration (i.e., roads or removing vegetation on adjacent slopes) results in changes in amount and pattern of herbaceous wetland habitat. Livestock management can impact wet meadows by compacting soil, pugging (creation of pedestals by hooves) on the soil surface, altering nutrient concentrations and cycles,

changing surface and subsurface water movement and infiltration, and shifting species composition. In general, excessive livestock or native ungulate use leads to a shift in plant species composition. Non-native plants or animals, which can have wide-ranging impacts, also tend to increase with these stressors. Non-native species can displace native species, alter hydrology, alter structure, and affect food web dynamics by changing the quantity, type, and accessibility to food for fauna. Wetland dominated by non-native, invasive species typically support fewer native animals. Wet meadows are susceptible to invasion by many non-native species, especially pasture grasses such as *Poa pratensis* and *Phleum pratense* as well as exotics species common to other wetland types such as *Cirsium arvense* and *Taraxacum officinale*. *Phalaris arundinacea* is also common exotics in wet meadows.

Classification Comments: Sites with soils over 40 cm of organic matter would be classified as North Pacific Bog and Fen ecological system. Biogeographic characteristics distinguishes this from the similar Rocky Mountain Alpine-Montane Wet Meadow, which occurs to the east of the Cascades, and the Boreal Wet Meadow system, which occurs further north in boreal regions where the climatic regime is generally colder for longer durations than the coastal Pacific Northwest region.

Related Concepts: This ecological system falls within the Herbaceous Wetlands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize Temperate Pacific Subalpine-Montane Wet Meadow as a unique mapping unit and did not aggregate it into another system.

References

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Description Author: Joe Rocchio, Pat Comer, Gwen Kittel, and Chris Chappell.

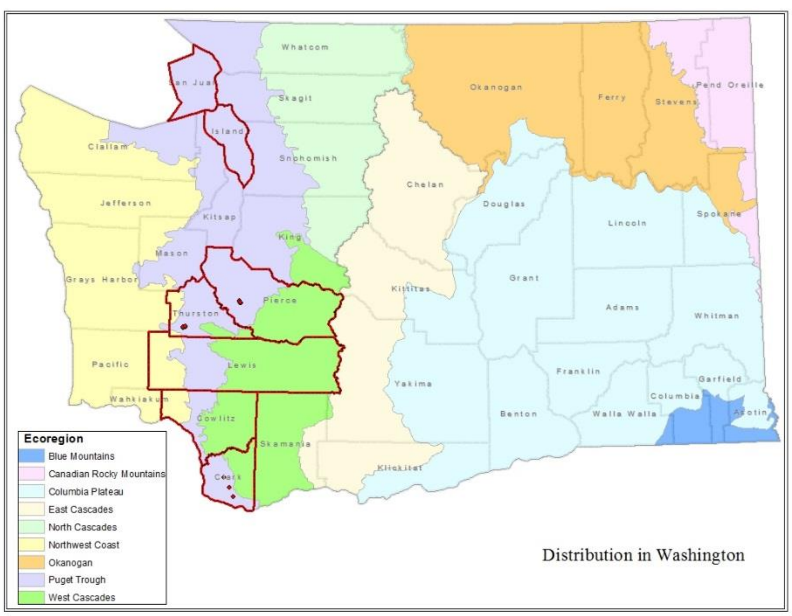
Marshes and Wet Meadows

Willamette Valley Wet Prairie

Concept: Primarily grass-dominated, seasonally wet meadows found in the prairie-oak landscapes of western Oregon and Washington. Within Washington, these wet prairies are primarily found in two geographic areas: South Puget Sound and southwest Washington (i.e., Clark, Cowlitz, and Lewis counties). Small areas of mesic to wet prairies also occur in prairie landscapes of San Juan and Island counties.

Conservation Status: Critically Imperiled (S1). The system is extremely rare and nearly extirpated from Washington. Most former wet prairies have been lost to development or converted to wet pastures dominated by nonnative grasses or have been developed. There is very little of this ecosystem remaining on the landscape and the few extant remnants have been heavily degraded.

Distribution: This small patch, wet meadow system is restricted to the Willamette Valley of Oregon and parts of western Washington. Within Washington, these wet prairies are found in two geographic areas: South Puget Sound and southwest Washington (i.e., Clark, Cowlitz, and Lewis counties). Small areas of mesic to wet prairies also occur in prairie landscapes of San Juan and Island counties. The best remaining examples of native dominated wet prairies are shown in the distribution map as dots. Red highlighted counties depict the historical distribution of this system. Additional occurrences may be found (especially in Clark County) but are likely small and degraded examples.



Environment: The wet prairies of southwest Washington and the Willamette Valley of Oregon are often perched on clay-rich soils and historically covered large areas. The South Puget Sound wet prairies differ from Willamette Valley wet prairies in that they are associated with permeable glacial outwash and thus are restricted to swales and riparian areas where surface topography intersects local groundwater tables (Easterly et al. 2005). Aquitards may have also formed from lahars or volcanic ash (Easterly et al. 2005). In addition to having different soil characteristics, the South Puget Sound wet prairies were historically much more localized than Willamette Valley wet prairies. Although soils dry during the typical summer drought, they have hydric characteristics typical of wetlands and support facultative or obligate wetland plant species.

Vegetation: South Puget Sound wet prairies have been drastically reduced in extent and remaining wet prairies are so altered that the original composition, diversity and structure of the vegetation are largely unknown (Easterly et al. 2005). However, the South Puget Sound wet prairies are thought to be floristically similar to the Willamette Valley, of which more natural remnants remain. Based on the composition of the Willamette Valley wet prairies, it is thought that the South Puget Sound Prairie wet prairies were dominated primarily by graminoids, especially *Danthonia californica*, *Deschampsia caespitosa*, *Carex densa*, and *Carex unilateralis,* and to a lesser degree by forbs (e.g., *Camassia leichtlinii*) or shrubs (e.g., *Rosa nutkana*). The few remaining remnants in southwest Washington are dominated by *Deschampsia caespitosa*, *Carex densa*, *Carex feta,* and *Carex unilateralis* with patches of *Carex pellita* found in areas with longer duration of standing water. Very small patches of vernal pool vegetation also occur within the context of wet prairies. These areas hold standing water then dry by late summer and typically support an abundance of annual species such as *Downingia elegans*, *Plagiobothrys* spp., and *Eryngium petiolatum* (Alverson 2009b). Chappell et al. (2004) compiled a list of species known from prairies in the Willamette Valley, Puget Trough and Georgia Basin ecoregion. This list has been maintained and updated by Alverson (2009b) and indicates which prairie-associated habitat type each species occurred in, including oak woodland and savanna, herbaceous balds and rock outcrops, upland prairies, seasonal wet prairies, and vernal pools and seepages. Those resources should be consulted for a more comprehensive list of associated species in this system.

Areas supporting larger and wider wet prairies, such as in outwash channels and depressions, would have been more isolated from woody encroachment and would likely have persisted longer than narrow strips along wooded riparian areas (Easterly et al. 2005). The composition of woody species would have included many that are present today, but likely in different proportions. Relatively fire-tolerant trees like *Quercus garryana*, *Populus tremuloides* and probably *P. balsamifera* ssp. *trichocarpa*, would have likely been more abundant than the fire intolerant *Fraxinus latifolia*, which is presumed to have increased since European settlement (Easterly et al. 2005). Shrubby species likely included *Symphoricarpos albus*, *Crataegus douglasii*, *Rosa nutkana*, *R. pisocarpa*, *Oemleria cerasiformis*, *Amelanchier alnifolia*, *Spiraea douglasii* and *Salix* spp. In addition, until recently *Alnus sinuata* was apparently common around wetland edges in the Tacoma area, and may have been a component of these systems and *Pteridium aquilinum* may have been aggressive and had significant cover in some sites (Easterly et al. 2005).

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Groups and Associations that are associated with this ecological system.

G517 Vancouverian Freshwater Wet Meadow & Marsh Group	Global/ State Rank	NatureServe/ WNHP Code
Camassia quamash - Triteleia hyacinthina Herbaceous Vegetation	GNR/S1S2	CWWA000210
Camassia quamash Wet Prairie Herbaceous Vegetation	G3/S1S2	CEGL003341
Carex densa - Deschampsia caespitosa Herbaceous Vegetation	G2/S1	CEGL003455
Carex densa - Eleocharis palustris Herbaceous Vegetation [Provisional]	G4/SU	CEGL003456
Carex deweyana ssp. leptopoda Herbaceous Vegetation [Provisional]	GNR/SU	CWWA000212
Carex feta Herbaceous Vegetation [Provisional]	GNR/SU	CWWA000214

MARSHES AND WET MEADOWS

G517 Vancouverian Freshwater Wet Meadow & Marsh Group	Global/ State Rank	NatureServe/ WNHP Code
Carex pachystachya Herbaceous Vegetation	GNR/SU	CWWA000215
Carex pellita Wet Prairie Herbaceous Vegetation	GNR/SNR	CWWA000269
Carex unilateralis - Hordeum brachyantherum Herbaceous Vegetation	G2/S1	CEGL001830
Deschampsia caespitosa - Danthonia californica Herbaceous Vegetation	G2/S1	CEGL001604
Eleocharis palustris - Carex unilateralis Herbaceous Vegetation	G2/S1	CEGL003411
Isoetes nuttallii Herbaceous Vegetation	G3/S1	CEGL003343
Paspalum distichum Herbaceous Vegetation	G3/S2	CEGL003320
Rosa nutkana / Deschampsia cespitosa Shrubland [Provisional]	G2/SU	CEGL003344
Triteleia hyacinthina Herbaceous Vegetation	GNR/S2	CWWA000243

Ecological Processes: Given their location within a fire-maintained, open grassland landscape, these wet prairies experienced periodic fire, which is a distinguishing feature from similar wetland types elsewhere in western Washington and Oregon. Frequent fires resulted in this system being productive and dynamic. Fire frequency were likely similar to those in adjacent oak-prairie landscapes (see the North Pacific Oak Woodland, page 44, and Willamette Valley Upland Prairie and Savanna, page 199)

Threats: Wet prairies have been nearly extirpated in western Washington. Due to their productive nature, many wet prairies were converted to agriculture use, others were overgraze d, and others experienced invasion of woody vegetation due to fire suppression. Many other sites have been altered by draining, roads, and groundwater withdrawal. The hydrologic regime of remaining wet prairie sites has likely been altered by draining and/or recession of the water table (Easterly et al. 2005). Fire suppression and altered hydrology of the current landscape has likely had a profound influence on the ecological processes and dynamics, such as nutrient cycling and successional status, of remaining wet prairie sites (Easterly et al. 2005). Nonnative species, especially *Phalaris arundinacea*, now dominate most former wet prairies.

Classification Comments: In Washington, this system is characterized as graminoid dominated seasonal wetlands restricted to prairie landscapes. More permanently flooded wetlands are considered to be part of the Temperate Pacific Freshwater Emergent Marsh system. Very small patches of vernal pool vegetation also occur within the context of wet prairies. These areas hold standing water then dry by summer end and typically support an abundance of annual species such as *Downingia elegans*, *Plagiobothrys* spp., and *Eryngium petiolatum* (Alverson 2009b). More study is needed to determine whether these areas are better considered part of the North Pacific Hardpan Vernal Pool system.

Related Concepts: This ecological system falls within the Herbaceous Wetlands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize Willamette Valley Wet Prairie as a unique mapping unit.

References

Alverson, E. 2009a. Key Ecological Attributes and Indicators for Willamette Valley Prairie and Oak Systems. Excel spreadsheet. The Nature Conservancy, Eugene, Oregon.

Alverson, E. 2009b. Vascular Plants of the Prairies and associated habitats of the Willamette Valley-Puget Trough-Georgia Basin ecoregion. Excel Spreadsheet which includes fidelity values. The Nature Conservancy, Eugene, Oregon.

Chappell, C. 2000. Upland Prairies and Savannas. Appendix 11 Willamette Valley – Puget Trough – Georgia Basin Ecoregion Terrestrial Ecological System EO Specs and EO Rank Specs. *In* Floberg, J., M. Goering, G. Wilhere, C. MacDonald, C. Chappell, C. Rumsey, Z. Ferdana, A. Holt, P. Skidmore, T. Horsman, E. Alverson, C. Tanner, M. Bryer, P. Iachetti, A. Harcombe, B. McDonald, T. Cook, M. Summers, D. Rolph. 2004. Willamette Valley-Puget Trough-Georgia Basin Ecoregional Assessment, Volume One: Report. Prepared by The Nature Conservancy with support from the Nature Conservancy of Canada, Washington Department of Fish and Wildlife, Washington Department of Natural Resources (Natural Heritage and Nearshore Habitat programs), Oregon State Natural Heritage Information Center and the British Columbia Conservation Data Centre.

Chappell, C.B. 2004. Upland Plant Associations of the Puget Trough Ecoregion, Washington. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. Online: http://www1.dnr.wa.gov/nhp/refdesk/communities/index.html

Chappell, C.B. and R.C. Crawford. 1997. Native Vegetation of the South Puget Sound Prairie Landscape. In Dunn, P. and K. Ewing, Ecology and Conservation of the South Puget Sound Landscape. The Nature Conservancy, Seattle, WA. Online: http://www.southsoundprairies.org/EcologyandConservationBook.htm

Chappell, C., E. Alverson, and W. Erickson. 2004. Ecologic and geographic variation in species composition of prairies, herbaceous balds, and oak woodlands of the Willamette Valley-Puget Trough-Georgia Basin Ecoregion. Paper Presented at the Ecological Society of America Annual Conference. Portland, Oregon.

Chappell, C.B. and J. Kagan. 2001. Westside Grasslands. *In* Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Easterly, R.T., D.L. Salstrom, and C.B. Chappell. 2005. Wet Prairie Swales of the South Puget Sound, Washington. Reported Submitted to South Puget Sound Office of The Nature Conservancy. Olympia, WA. Online: http://www.southsoundprairies.org/documents/WetPrairieSwalesofSPS2005_000.pdf

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Description Author: Joe Rocchio and Chris Chappell.

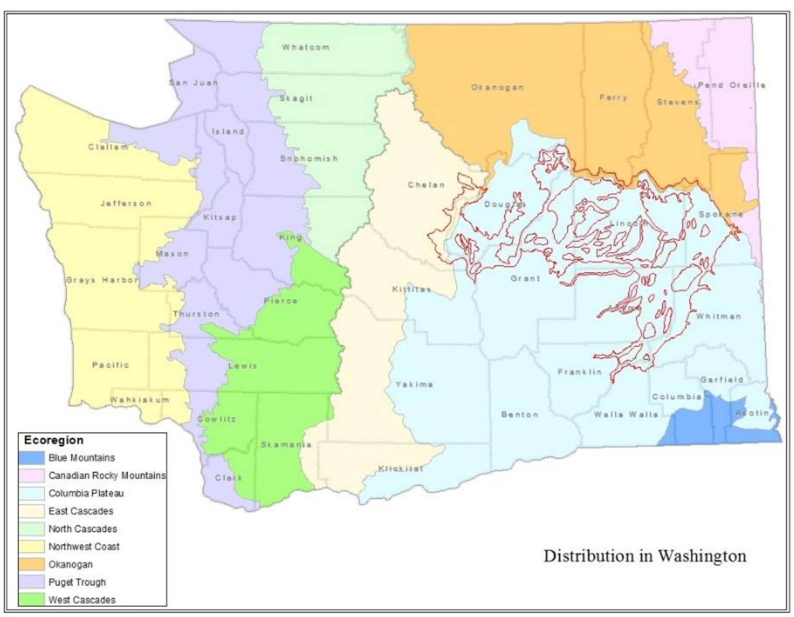
VERNAL POOLS

COLUMBIA PLATEAU VERNAL POOL

Concept: Shallow ephemeral wetlands, or vernal pools, in very small to rarely large depressions throughout the exposed, volcanic scablands on the Columbia Plateau. They are characterized by freshwater inundation for much of the winter and spring, followed by dramatic lowering of the water table at the approach of summer. Vegetation is dominated primarily by annual forbs.

Conservation Status: Imperiled (S2S3). This system is geographically limited but can be locally common. Although there has not been much direct loss of vernal pools, most have been degraded by livestock grazing and roads.

Distribution: This small patch system occurs throughout the exposed volcanic scablands on the Columbia Plateau in Washington, Oregon, and northern Nevada. Washington occurrences are concentrated in the Channeled Scablands and glaciated areas in Adams, Douglas, Grant, Lincoln, southern Okanogan, and Spokane counties. The distribution maps shows the outline of the Channeled Scablands, where This system is most commonly found.



Distribution in Washington

Environment: These vernal pools are mostly located on massive basalt flows exposed by Pleistocene floods but also occur on andesite or rhyodacite caprock. These vernal pools are shallow ephemeral wetlands in very small (3 square meters or 32 sq. ft.) to rarely large depressions (260 ha or 1 square mile). Bjork and Dunwiddie (2004) measured 242 vernal pools in Washington to be between 3 sq. m. and 4610 sq. m. (1.1 ac) with a 1590 sq. m (0.4 acre) average. They are often found within a mounded or biscuit-swale topography within *Artemisia* shrub-steppe, bunchgrass steppe or rarely *Pinus ponderosa* savanna. Often perched above the surrounding landscape, vernal pools are generally not subject to runoff from major stream systems. Climatically, the system is defined by wet winters (November through January) and severe summer drought (July-September), although May or June can be wet. Depressions usually (but not always) fill with water during winter and spring and generally dry again within 9 months, though in exceptional times they can remain inundated for two years in a row. Soils are shallow and soil texture is typically silty clay, sometimes with sandy margins.

Vegetation: Characteristic plants species of this system are predominantly annual forbs. Diversity can be high, especially over the course of a growing season. The periodic inundation and drying leads to development of concentric zones of different plants as the pools dry (Crowe et al. 1994). Floristically this system is akin to the California vernal pool flora (approximately one-third of species are shared); however, many of the most abundant species are not reported in Californian pools (Bjork and Dunwiddie 2004). Characteristic species include *Callitriche marginata, Camissonia tanacetifolia, Elatine* spp., *Epilobium densiflorum (= Boisduvalia densiflora), Eryngium vaseyi, Juncus uncialis, Myosurus X clavicaulis, Plagiobothrys* spp., *Polygonum polygaloides* ssp. *confertiflorum, Polygonum polygaloides* ssp. *polygaloides*, *Psilocarphus brevissimus*, *Psilocarphus elatior*, *Psilocarphus oregonus*, and *Trifolium cyathiferum* (Bjork 1997; Bjork and Dunwiddie 2004). Other species commonly found in these pools include *Allium columbianum*, *A. geyeri* var. *geyeri*, *Alopecurus saccatus*, *Camissonia hilgardii*, *Centaurium curvistamineum*, *Cirsium brevifolium*, *Clarkia pulchella*, *Cyperus squarrosus*, *Danthonia unispicata*, *Delphinium distichum*, *Deschampsia danthonioides*, *Downingia elegans*, *Grindelia columbiana*, *Lomatium ambiguum*, *L. bicolor* subsp. *leptocarpum*, *L. grayi*, *Madia* spp., *Microgilia micrantha*, *Microsteris gracilis*, *Navarretia leucocephala* subsp. *diffusa*, *Orthocarpus barbatus*, *O. tenuifolius*, *Plantago patagonica*, and *Talinum spinescens* (Bjork and Dunwiddie 2004).

Mosses such as *Bryum algovicum*, *Ceratodon purpureus*, *Funaria hygrometrica*, *Physcomitrium kellermanii*, *P. pygmaeum*, *P. pyriforme*, and *Tortula bistratosa* can form a distinct band along the outer edges of the pools (Bjork and Dunwiddie 2004). In the eastern portion of the Columbia Basin, dense cover of *Cratoneuron commutatum* and *C. filicinum* sometimes occurs across pool basins (Bjork and Dunwiddie 2004). Liverworts such as *Riccia beyrichiana*, *R. cavernosa*, *Ricciocarpos natans*, *Fossombronia* sp., *Sphaerocarpos mitchellii*, and *S. texanus* are sometimes found along pool margins (Bjork and Dunwiddie 2004).

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Groups and Associations that are associated with this ecological system.

G529 North Pacific Vernal Pool Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Danthonia unispicata - Poa secunda Herbaceous Vegetation	G3/SNA	CEGL001783
Deschampsia danthonioides - Grindelia squarrosa Herbaceous Vegetation [Provisional]	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Deschampsia danthonioides - Juncus bufonius Grassland [Provisional]	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Deschampsia danthonioides Grassland [Provisional]	G2/S1	CWWA000178
Eleocharis macrostachya - (Eleocharis acicularis, Carex douglasii) Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Eleocharis palustris Vernal Pool Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Navarretia leucocephala - Plagiobothrys leptocladus - (Downingia spp.) Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Polygonum polygaloides Verna Pool Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)

VERNAL POOLS

G796 Northern Rocky Mountain Lowland & Foothill Riparian Forest Group	Global/ State Rank	NatureServe/ WNHP Code
Pinus ponderosa / Camassia quamash Woodland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Pinus ponderosa / Lomatium nudicaule Woodland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)

Ecological Processes: Pool inundation primarily results from direct precipitation and varies yearly and seasonally. The size of the associated small upland watershed and surface runoff from adjacent pools or wetlands affects duration and depth of inundation (Environmental Science Associates 2007). Inundation is highly irregular, sometimes not occurring for several years. Depressions usually (but not always) fill with water during winter and spring and generally dry well within 9 months. In exceptional times they can remain inundated for two consecutive years. When full, the pool's water column and saturated substrates support assemblages of macroinvertebrates as well as habitat for mobile invertebrates adapted to ephemeral wetlands (Environmental Science Associates 2007).

Threats: Historical and contemporary land use practices have impacted hydrologic, geomorphic, and biotic structure and function of vernal pools on the Columbia Basin. Direct alteration of hydrology (i.e., channeling, draining, impounding) or indirect alteration (i.e., roads or removing vegetation on adjacent slopes) results in changes in amount and pattern of herbaceous wetland habitat. In general, excessive livestock use leads to a shift in plant species composition. Several exotic species can invade this habitat with grazing or other soil disturbance. Native species, such as *Juncus bufonius* and *Polygonum aviculare* increase with excessive livestock use and *Eleocharis* spp. decrease (Brown 2001). Vernal pool invasibility depends on multiple biotic and physical factors including hydrologic regime, soil nutrient properties, the native plant community, site disturbance history and climatic variability (Environmental Science Associates 2007). Southern Oregon vernal pools showed a pattern noted in California vernal pools of non-native plant species occurring in higher abundance in the outer edge or "flank" zone of pools (Environmental Science Associates 2007). Invasion likely occurs as an indirect result of the prevalence of non-native upland plants in the surrounding uplands (Environmental Science Associates 2007). Zedler (1987) stated that "moderate cattle or horse grazing does not seem to pose much of a threat to the persistence of vernal pool plants despite the disruptive effect of trampling". However, Brown (2001) following a 2-year study in eastern Washington found a significantly greater cover of "weedy species" in grazed vernal pools.

Several exotic species invade vernal pools particularly upper zones: *Centaurea spp., Cirsium arvense, Descurainia sophia, Elytrigia repens, Phalaris arundinacea, Poa compressa, Poa pratensis,* and *Sisymbrium altissimum* (Bjork and Dunwiddie 2004). Wetland animals, such as waterbirds, amphibians, or invertebrates can be affected by changes in hydrology.

Classification Comments: Biogeographic differences separate this system from the Modoc Basalt Flow Vernal Pool and the North Pacific Hardpan Vernal Pool. Annual plant dominance and lack of surface salt deposits distinguish this system from the Inter-Mountain Basins Alkaline Closed Depression and Inter-Mountain Basins Playa systems.

Related Concepts: This ecological system is not explicitly in any of the habitat types as identified in Johnson and O'Neil (2001); however, it may fit into the Herbaceous Wetland habitat type. The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize the Columbia Plateau Vernal Pool as a unique mapping unit and did not aggregate it into another mapping unit.

References

Bjork, C. R. 1997. Vernal pools of the Columbia Plateau of eastern Washington. Report to the Washington Field Office of The Nature Conservancy. 29 pp. plus 7 appendices.

Bjork. C.R. And P. W. Dunwiddie. 2004. Floristics and Distribution of Vernal Pools on the Columbia Plateau of eastern Washington. RHODORA 106 (928): 327–347.

Brown, W. L. 2001. Eastern Washington vernal pools: Ecology and conservation, pp. 144–150. In: S. H. Reichard, P. Dunwiddie, J. Gamon, A. Kruckeberg, and D. Salstrom, eds., Conservation of Washington's Rare Plants and Ecosystems. Washington Native Plant Society, Seattle, WA.

Crowe, E. A., A. J. Busacca, J. P. Reganold, and B. A. Zamora. 1994. Vegetation zones and soil characteristics in vernal pools in the Channeled Scabland of eastern Washington. Great Basin Naturalist 54: 234–247.

Environmental Science Associates. 2007. *Agate Desert Vernal Pool Functional Assessment Methodology*. Environmental Science Associates, Sacramento, CA.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Rocchio, F.J. and R.C. Crawford. *In Progress*. Ecological Classification of Native Wetland & Riparian Vegetation of Washington State. Natural Heritage Report 20XX-XX. Washington Dept. of Natural Resources, Natural Heritage Program. Olympia, WA.

Zedler, P. H. 1987. The Ecology of Southern California Vernal Pools: A Community Profile. Biol. Report 85(7.11), U.S. Fish Wild. Service, U.S. Dept. Interior, Washington, DC.

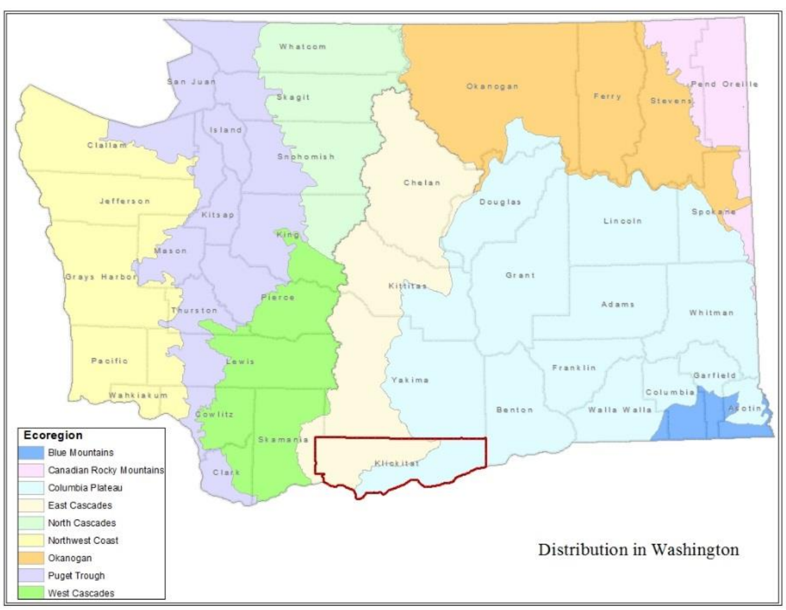
Description Author: Joe Rocchio, Rex Crawford, James Morefield, and Gwen Kittel.

MODOC BASALT FLOW VERNAL POOL

Concept: Shallow ephemeral water bodies found in very small depressions along the flanks of the Columbia River Gorge along the Oregon-Washington border. In Washington, it is limited to very small depressions and swales in Klickitat County and are especially abundant within and near Horsethief State Park or at slightly higher elevations within the ponderosa pine zone.

Conservation Status: Imperiled (S2). This is a very geographically limited system in Washington. Most pools have likely been impacted by past and/or current livestock grazing. Logging may impact pools in the lower forest zone. Roads may impact some pools.

Distribution: This ecological system consist of shallow ephemeral water bodies found in very small depressions (typically no larger than 50 square meters) along the flanks of the Columbia River Gorge along the Oregon-Washington border. In Washington, it is limited to very small depressions and swales in Klickitat County and are especially abundant within and near Horsethief State Park or at slightly higher elevations within the ponderosa pine zone.



Environment: This system is found on top of massive basalt flows where soils are very thin over solid bedrock. These pools typically occur in very small depressions. Often perched above the surrounding landscape, vernal pools are generally not subject to runoff from major stream systems. Climatically, the system is defined by wet winters (November through January) and severe summer drought (July-September), although May or June can be wet.

Vegetation: Characteristic plants species of this system are predominantly annual forbs.

Diversity can be high, especially over the course of a growing season as periodic inundation and drying leads to development of concentric zones of different plants as the pools dry (Crowe et al. 1994). Floristically this system is akin to the California vernal pool flora (approximately one-third of species are shared); however, many of the most abundant species are not reported in Californian pools (Bjork and Dunwiddie 2004). Characteristic species include *Epilobium densiflorum (= Boisduvalia densiflora)*, *Callitriche marginata*, *Cicendia quadrangularis*, *Eryngium vaseyi*, *Psilocarphus brevissimus*, and *Sedella pumila (= Parvisedum pumilum)*. *Deschampsia danthonioides* was found to be dominant in some of the pools within the ponderosa pine zone in Klickitat County.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Groups and Associations that are associated with this ecological system. The plant associations listed below are those identified for the Columbia Plateau Vernal Pool system. Additional inventory is needed to confirm which of these plant associations occur in the Modoc Basal Flow Vernal Pools systems and whether additional plant association might be present.

G529 North Pacific Vernal Pool Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Danthonia unispicata - Poa secunda Herbaceous Vegetation	G3/SNA	CEGL001783
Deschampsia danthonioides - Grindelia squarrosa Herbaceous Vegetation [Provisional]	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Deschampsia danthonioides - Juncus bufonius Grassland [Provisional]	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Deschampsia danthonioides Grassland [Provisional]	G2/S1	CWWA000178
Eleocharis macrostachya - (Eleocharis acicularis, Carex douglasii) Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Eleocharis palustris Vernal Pool Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Navarretia leucocephala - Plagiobothrys leptocladus - (Downingia spp.) Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Polygonum polygaloides Verna Pool Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
G796 Northern Rocky Mountain Lowland & Foothill Riparian Forest Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Pinus ponderosa / Camassia quamash Woodland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Pinus ponderosa / Lomatium nudicaule Woodland	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)

Ecological Processes: Pool inundation primarily results from direct precipitation and varies yearly and seasonally. The size of the associated small upland watershed and surface runoff from adjacent pools or wetlands affects the duration and depth of inundation (Environmental Science Associates 2007). Inundation is highly irregular, sometimes not occurring for several years. Depressions usually (but not always) fill with water during winter and spring and generally dry well by early to mid-summer. In exceptional times they can remain inundated for two consecutive years.

Threats: Historical and contemporary land use practices have impacted hydrologic, geomorphic, and biotic structure and function of vernal pools in the Columbia Basin. Direct alteration of hydrology (i.e., channeling, draining, impounding) or indirect alteration (i.e., roads or removing vegetation on adjacent slopes) results in changes in amount and pattern of herbaceous wetland habitat. In general, excessive livestock use leads to a shift in plant species composition. Several exotic species can invade this habitat with grazing or other soil disturbance. Native species, such as *Juncus bufonius* and *Polygonum aviculare* increase with excessive livestock use and *Eleocharis* spp. decrease (Brown 2001). Vernal pool invasibility

depends on multiple biotic and physical factors including hydrologic regime, soil nutrient properties, the native plant community, site disturbance history and climatic variability (Environmental Science Associates 2007). Southern Oregon vernal pools showed a pattern noted in California vernal pools of non-native plant species occurring in higher abundance in the outer edge or "flank" zone of pools (Environmental Science Associates 2007). Invasion likely occurs as an indirect result of the prevalence of non-native upland plants in the surrounding uplands (Environmental Science Associates 2007). Zedler (1987) stated that "moderate cattle or horse grazing does not seem to pose much of a threat to the persistence of vernal pool plants despite the disruptive effect of trampling". However, Brown (2001) following a 2-year study in eastern Washington found a significantly greater cover of "weedy species" in grazed vernal pools.

Non-native plants or animals, which can have wide-ranging impacts, tend to increase with stressors. Several exotic species invade vernal pools particularly upper zones: *Centaurea spp., Cirsium arvense, Descurainia sophia, Elytrigia repens, Phalaris arundinacea, Poa compressa, Poa pratensis,* and *Sisymbrium altissimum* (Bjork and Dunwiddie 2004). *Ventenata dubia* has also been observed in these vernal pools. Although most wetlands receive regulatory protection at the national, state, and county level, many wetlands have been and continued to be filled, drained, grazed, and farmed extensively. Wetland animals, such as waterbirds, amphibians, or invertebrates can be affected by changes in hydrology.

Classification Comments: Biogeographic distinctions separate this system from the Columbia Plateau Vernal Pool and the North Pacific Hardpan Vernal Pool. Annual plant dominance and lack of surface salt deposits distinguish the Columbia Plateau Vernal Pool from the Inter-Mountain Basins Alkaline Closed Depression and Inter-Mountain Basins Playa systems.

Related Concepts: This ecological system is not explicitly in any of the habitat types as identified in Johnson and O'Neil (2001); however, it may fit into the Herbaceous Wetland habitat type. The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize the Modoc Basalt Flow Vernal Pool as a unique mapping unit and did not aggregate it into another mapping unit.

References

Bjork, C. R. 1997. Vernal pools of the Columbia Plateau of eastern Washington. Report to the Washington Field Office of The Nature Conservancy. 29 pp. plus 7 appendices.

Bjork. C.R. And P. W. Dunwiddie. 2004. Floristics and Distribution of Vernal Pools on the Columbia Plateau of eastern Washington. RHODORA 106 (928): 327–347.

Brown, W. L. 2001. Eastern Washington vernal pools: Ecology and conservation, pp. 144–150. In: S. H. Reichard, P. Dunwiddie, J. Gamon, A. Kruckeberg, and D. Salstrom, eds., Conservation of Washington's Rare Plants and Ecosystems. Washington Native Plant Society, Seattle, WA.

Crowe, E. A., A. J. Busacca, J. P. Reganold, and B. A. Zamora. 1994. Vegetation zones and soil characteristics in vernal pools in the Channeled Scabland of eastern Washington. Great Basin Naturalist 54: 234–247.

Environmental Science Associates. 2007. *Agate Desert Vernal Pool Functional Assessment Methodology*. Environmental Science Associates, Sacramento, CA.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Rocchio, F.J. and R.C. Crawford. *In Progress*. Ecological Classification of Native Wetland & Riparian Vegetation of Washington State. Natural Heritage Report 20XX-XX. Washington Dept. of Natural Resources, Natural Heritage Program. Olympia, WA.

Description Author: Joe Rocchio, Rex Crawford, Pat Comer and Todd Keeler-Wolf.

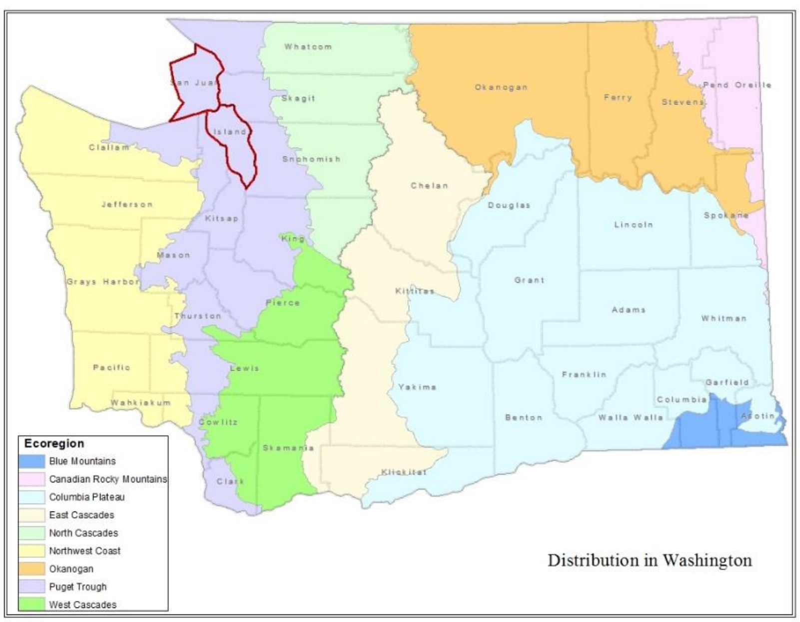
NORTH PACIFIC HARDPAN VERNAL POOL

Concept: Shallow ephemeral water bodies found in depressions in bedrock among grasslands and open woodlands in the San Juan Islands. May also include small vernal pools embedded within wet prairies.

Conservation Status: Imperiled (S2S3). This system has very limited distribution. Most occurrences are very small. Very little is known about this system.

Distribution: This small patch system consists of shallow ephemeral water bodies found in very small depressions occurs throughout intermountain valleys of California, Oregon and the Gulf and San Juan islands of Washington and British Columbia.

Environment: These hardpan vernal pools include an indurated clay or cemented (Si or Fe) hardpan that retains water inputs throughout some portion of the spring, but typically the depression dries down entirely into early summer months. In the San Juan and Gulf islands, they are found in small depressions in bedrock**.** They are generally not subject to runoff from major stream systems. Climatically, the system is defined by wet winters (November through January) and summer drought (July-September).



Vegetation: Characteristic plant species including *Downingia elegans*, *Isoetes orcuttiana*, *Pilularia americana*, *Camassia quamash*, *Triteleia hyacinthina*, *Eleocharis* spp., *Eryngium petiolatum*, *Plantago elongata* (=*P. bigelovii*), *Plagiobothrys figuratus*, *Plagiobothrys scouleri*, *Grindelia nana*, *Veronica peregrina*, *Deschampsia danthonioides*, and *Callitriche* spp. Very little information specific to the Washington pools is known.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification

Group and Association that is associated with this ecological system. Additional inventory is needed to determine whether additional plant associations are associated with this system.

G529 North Pacific Vernal Pool Group	Global/ State Rank	NatureServe/ WNHP Code
Plagiobothrys scouleri - Plantago bigelovii Herbaceous Vegetation	G2/S1?	CEGL003459

Ecological Processes: Pool inundation primarily results from direct precipitation and varies with the size of the associated small upland watershed associated. Depressions fill with water during winter and spring and generally dry by mid- to late summer. Due to draw-down hydrodynamics, vernal pools typically form concentric rings of similar vegetation.

Threats: Given the location of this system on bedrock, it is exposed to less threats that many other wetland types. Grazing is likely the primary threat, and the degree to which this is still impacting hardpan vernal pools today is unknown. In places like Young Hill (English Camp on San Juan Island), past grazing surely impacted these pools. Nonnative species are also a threat in some pools.

Classification Comments: This is a geographically limited system in Washington, occurring only in the San Juan Islands. Two other vernal pool systems, the Modoc Basalt Flow Vernal Pool and Columbia Plateau Vernal Pool, also occur in Washington but are distinct in their geographic distribution as well. Vernal seepage sites within balds and bluffs have some similarities to these vernal pools, but are found on slopes rather than in contained depressions, do not show clear zonation of vegetation, and do not have vernal pool endemic plant species (Chappell 2006). Very small patches of vernal pool vegetation also occur within the context of the Willamette Valley Wet Prairie system. These areas hold standing water then dry by summer end and typically support an abundance of annual species such as *Downingia elegans*, *Plagiobothrys* spp., and *Eryngium petiolatum* (Alverson 2009b). More study is needed to determine whether these areas are better considered part of the North Pacific Hardpan Vernal Pool system.

Related Concepts: This ecological system does not explicitly fall within any of the habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize North Pacific Hardpan Vernal Pool as a unique mapping unit and did not aggregate it into another mapping unit.

References

Chappell, C.B. 2006. Plant Associations of Balds and Bluffs of western Washington. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. Online: http://www1.dnr.wa.gov/nhp/refdesk/communities/index.html

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

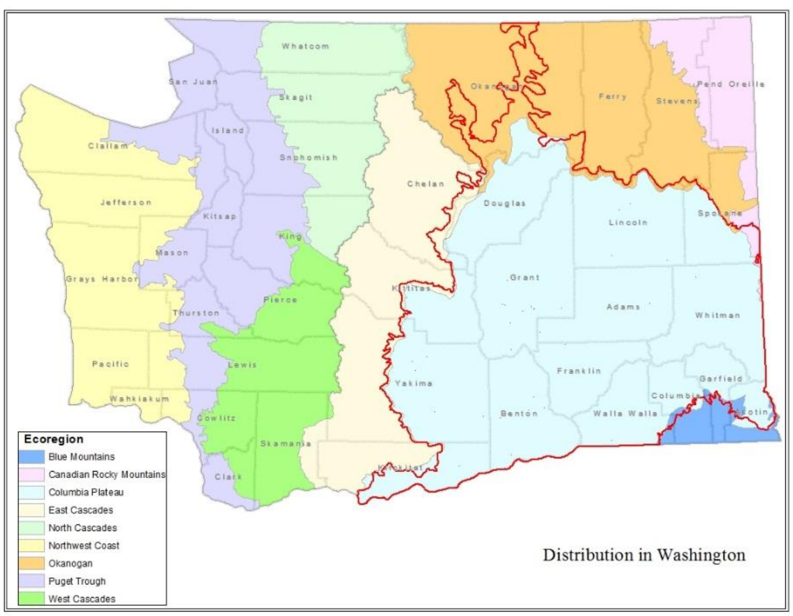
Description Author: Chris Chappell and Joe Rocchio.

INTERIOR ALKALINE WETLANDS

INTER-MOUNTAIN BASINS ALKALINE CLOSED DEPRESSION

Concept: Herbaceous-dominated, seasonally flooded alkaline depressions moderately to densely covered by salt-tolerant and halophytic species such as *Distichlis spicata*, *Carex praegracilis*, *C. douglasii*, *Argentina anserina*, *Puccinellia lemmonii*, *Poa secunda*, *Muhlenbergia* spp., *Schoenoplectus maritimus*, *Schoenoplectus americanus*, *Spartina gracilis*, and *Triglochin maritima*. There is a high density of occurrences in northern Douglas County, where past glaciation left many landforms suitable for the development of this system. It is also common in the Swanson Lakes State Wildlife Area in Lincoln County and the lower Crab Creek area in Grant County. This system is very similar and often occurs in a mosaic with the Inter-Mountain Basins Playa system.

Conservation Status: Imperiled (S2). This system is found throughout the Columbia Basin. Alterations to hydrology from dams, irrigation, and road have resulted in some direct conversion of this wetland system to other types (such as North American Arid Freshwater Emergent Marsh). Grazing is widespread in many occurrences and continues to impact ecological integrity of sites.



Distribution: This ecological system occurs throughout much of the cool arid and semi-arid regions of the Columbia Plateau and Great Basin either as a large or small patch type. They almost always appear within a shrub steppe or semi-desert landscape. In Washington, there is a high density of occurrences in northern Douglas County, where past glaciation left many landforms suitable for the development of this system. It is also common in the Swanson Lakes State Wildlife Area in Lincoln County and the lower Crab Creek area in Grant County. The distribution map depicts the extent of this system's distribution in Washington.

Environment: This system is found in seasonally to semi-permanently flooded depressions that usually retain water into the growing season but typically dry in summer. They are located in basins with internal drainage and many are associated with groundwater discharge. This system can also occur along the margins of perennial lakes with extremely low-gradient shorelines. Soils are alkaline to saline clays with hardpans. Salt encrustations can occur on the soil surface but are often absent due to surface trampling from livestock. During exceptionally wet years, an increase in precipitation can dilute the salt concentration in the soils which may allow for less salt-tolerant species to establish.

Vegetation: These depressions are moderately to densely covered by salt-tolerant and halophytic species such as *Distichlis spicata*, *Carex praegracilis*, *C. douglasii*, *Argentina anserina*, *Puccinellia lemmonii*, *Poa secunda*, *Muhlenbergia* spp., *Leymus triticoides (= Elymus triticoides)*, *Schoenoplectus maritimus*, *Schoenoplectus americanus*, *Spartina gracilis*, and *Triglochin maritima*. *Schoenoplectus acutus*, typically without *Typha latifolia* due to its lower salt tolerance, can establish where flooding occurs for three or more months. *Eleocharis palustris* can occur in areas inundated for 1 to 3 months. *Distichlis spicata* and *Juncus balticus* are almost always present in seasonally saturated soils. *Amphiscirpus nevadensis* sometimes occurs. *Leymus cinereus* typically forms a band of vegetation at the transition zone with upland shrub-steppe vegetation.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system.

G538 North American Desert Alkaline-Saline Herbaceous Wetland & Playa Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Distichlis spicata - (Scirpus nevadensis) Herbaceous Vegetation	G4/SNA	CEGL001773
Distichlis spicata / Carex (praegracilis, douglasii) Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Distichlis spicata Herbaceous Vegetation	G5/S1?	CEGL001770
Eleocharis rostellata Alkaline Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Hordeum jubatum Great Basin Herbaceous Vegetation	G4/SNR	CEGL005285
Leymus cinereus - Carex praegracilis Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Leymus cinereus - Distichlis spicata Herbaceous Vegetation	G3/S1	CEGL001481
Leymus cinereus Herbaceous Vegetation	G2G3Q/S1	CEGL001479
Puccinellia nuttalliana Herbaceous Vegetation	G3?/SNR	CEGL001799
Sporobolus airoides Northern Intermountain Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)

Ecological Processes: Precipitation and runoff characteristics in contributing basins are important to hydrological function. Seasonal drying exposes mudflats which are often colonized by pioneering species, such as *Hordeum jubatum*. Salt crust may sporadically occur on the soil surface.

Threats: Historical and contemporary land use practices have impacted hydrologic, geomorphic, and biotic structure and function of these wetlands in the Columbia Basin. Reservoirs, water diversions, ditches, roads, and human land uses in the contributing watershed can also have a substantial impact on the hydrological regime. Direct alteration of hydrology (i.e., channeling, draining, damming) or indirect alteration (i.e., roads or removing vegetation on adjacent slopes) results in changes in the amount and pattern of herbaceous wetland habitat. In general, excessive livestock use leads to a shift in plant species composition. Native species, such as *Juncus balticus,* increase with excessive livestock use. Non-native plants or animals, which can have wide-ranging impacts, also tend to increase with these stressors. Several exotic species invade including *Cardaria* spp., *Chenopodium glaucum, C. rubra,* (*Salsola* spp.), *Bassia hyssopifolia*, and *Kochia scoparia*. Halogeton, a toxic exotic plant, is found most commonly in this habitat. Other nonnative species present include *Salsola kali, Sisymbrium altissimum*, and *Bromus tectorum*. Minor changes in the water table depth or duration of inundation can have profound effects on soil salinity, and consequently, wetland vegetation (Cooper and Severn 1992). Wetland animals, such as waterbirds, amphibians, or invertebrates are affected by changes in hydrology.

Classification Comments: Higher soil salinity levels that occur in this system distinguish it from other ephemeral wetlands such as vernal pools. In Washington, the Inter-Mountain Basins Playa and the Inter-Mountain Basins Alkali Closed Depression broadly overlap (Rocchio and Crawford 2009) and are difficult to distinguish. They differ by: 1) vegetation cover (playa are typically sparse to patchily vegetated, generally <10% plant cover while closed depressions are moderately to densely covered by herbaceous plants), 2) soil chemistry (playas are considered more saline than closed depressions), and 3) hydrological regime (playas are more intermittently flooded; closed depressions are more seasonally to semi-permanently flooded). This system is very similar to Western Great Plains Closed Depression Wetland but is distinguished by biogeographic patterns (NatureServe 2007).

Related Concepts: This ecological system falls within the Desert Playa and Salt Scrub Shrublands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize the Inter-Mountain Basins Alkaline Closed Depression as a unique mapping unit and did not aggregate it into another mapping unit.

References

Cooper, D.J. and C. Severn. 1992. Wetlands of the San Luis Valley, Colorado: An Ecological Study and Analysis of the Hydrologic Regime, Soil Chemistry, Vegetation and the Potential Effects of a Water Table Drawdown. Unpublished report prepared for Colorado Division of Wildlife, U.S. Fish and Wildlife Service, and the Rio Grande Water Conservation District.

Haukos, D.A. and L.M. Smith. 2003. Past and Future Impacts of Wetland Regulations on Playa Ecology in the Southern Great Plains. Wetlands 23(3):

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Rocchio, F.J. 2006. Intermountain Basins Playa Ecological System Ecological Integrity Assessment. Colorado Natural Heritage Program Colorado State University Fort Collins, CO. Online: http://www.cnhp.colostate.edu/download/documents/2005/ecological_integrity/Intermountain%20Basins%20Playa_EIA_Dec09_05.pdf

Rocchio, F.J. and R.C. Crawford. 2009**.** Assessment of the Ecological Characteristics and Ecological Integrity of Wetlands in Northern Douglas County, Washington. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. Nat. Heritage Report 2009-11. 82p.

Rocchio, F.J. and R.C. Crawford. *In Progress*. Ecological Classification of Native Wetland & Riparian Vegetation of Washington State. Natural Heritage Report 20XX-XX. Washington Dept. of Natural Resources, Natural Heritage Program. Olympia, WA.

Description Author: Joe Rocchio, Rex Crawford, Jimmy Kagan, and Pat Comer.

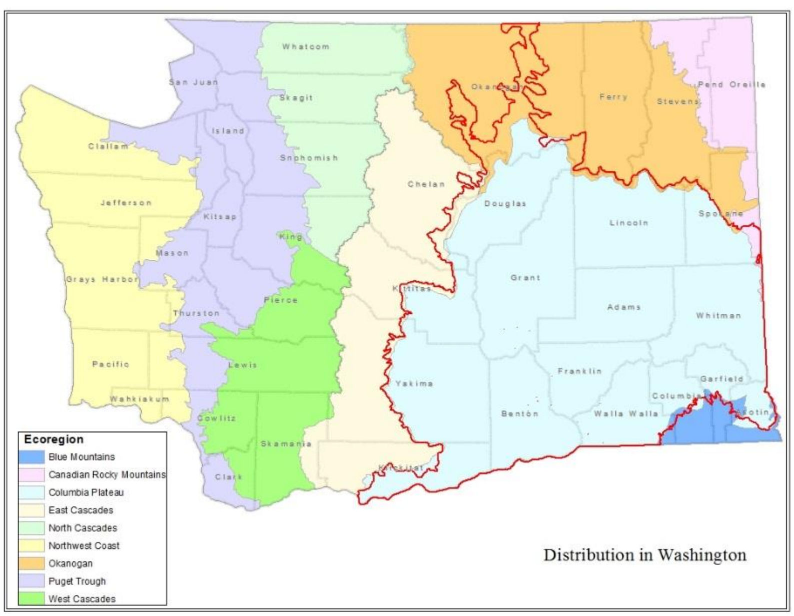
INTERIOR ALKALINE WETLANDS

INTER-MOUNTAIN BASINS GREASEWOOD FLAT

Concept: Open to moderately dense shrublands dominated or codominated by *Sarcobatus vermiculatus* and with saline soils. This system typically occurs near drainages on stream terraces and flats or may form rings around more sparsely vegetated playas. Seasonally high water tables and intermittent flooding is expected, however most sites remain dry at the soil surface through most growing seasons.

Conservation Status: Critically Imperiled (S1). This system is geographically limited and is never very abundant where it occurs. There has been more degradation in ecological integrity than there has been outright loss of area. Threats from nonnative species and continual grazing and the fact that most extant occurrences are small and fragmented suggest the S1 rank.

Distribution: This large patch system occurs sporadically throughout much of the western North American Inter-Mountain Basins and east into the western Great Plains. In Washington, it occurs in the Columbia Basin and Okanogan Valley. The distribution map depicts the extent of this system's distribution in Washington.



Environment: This system typically occurs near drainages on stream terraces and flats or may form rings around more sparsely vegetated playas or alkaline depressions. Seasonally high water tables and intermittent flooding can occur, however most sites remain dry at the soil surface through most growing seasons. Soils are typically saline and bare ground often covered with salt crusts is a common feature. The water table remains high enough to maintain vegetation, despite salt accumulations.

Vegetation: This system appears as an open to moderately dense shrubland dominated or codominated by *Sarcobatus vermiculatus*. It usually occurs as a mosaic of multiple plant associations. There may be interspersed patches of *Distichlis spicata* throughout the site. Other shrubs that may be present to co-dominant, listed in order of decreasing tolerance of a high water table or high salinity, are *Krascheninnikovia lanata*, *Grayia spinosa*, *Ericameria nauseosa*, and *Artemisia tridentata* ssp. *tridentata*. The herbaceous layer, when present, is usually dominated by graminoids, in order of decreasing tolerance of a high water table or high salinity, such as *Distichlis spicata, Puccinellia* spp., *Eleocharis palustris*, *Leymus cinereus*, and *Pascopyrum smithii.*

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system.

G537 North American Desert Alkaline-Saline Shrub Wetland Group	Global/ State Rank	NatureServe/ WNHP Code
Sarcobatus vermiculatus / Distichlis spicata Shrubland	G4/S2?	CEGL001363
Sarcobatus vermiculatus / Leymus cinereus Shrubland	G3/S1	CEGL001366

Ecological Processes: The primary ecological processes maintaining greasewood flat system is an elevated groundwater table. *Sarcobatus vermiculatus* and *Ericameria nauseosa* are intolerant of periodic inundation and waterlogged, saline soils and typically increase with water table drawdown (Cooper et al. 2006). *Sarcobatus vermiculatus* is an obligate phreatophyte and is able to tap into groundwater at great depth (>10 meters). Severe fires can kill *Sarcobatus vermiculatus* although it commonly sprouts after low- to moderate-severity fire (Anderson 2004). Fire regime for associated greasewood flat plant communities is generally less than 100 year return interval (Anderson 2004) although LANDFIRE (2007) applied fire regime V (200 + years) and assumed fire to be a minor driver within this system. Grazing and other disturbances can lead to biomass increases in the spring associated with an increase in *Bromus tectorum* and other fine fuel annuals which influence fire regime (Brown et al. 2000). *Sarcobatus vermiculatus* is noted to be important winter browse for domestic sheep, cattle, big game animals, as well, as jackrabbits (Anderson 2004). It provides quality forage throughout the growing season although it contains soluble sodium and potassium oxalates that may cause poisoning and death in domestic sheep and cattle (Anderson 2004).

Threats: Any activity resulting in hydrological alterations, sedimentation, nutrient inputs, and/or physical disturbance may negatively shift species composition and allow for non-native species establishment. Declining water tables create perennially dry soils, stop surface salt accumulation, and allow salts to leach deeper into the soil profile. These changes create a drier, less saline soil resulting in a change in vegetation composition and pattern (Cooper et al. 2006). For example, the tall perennial pepperwood (*Lepidium latifolium*), a nonnative invasive species decreases the abundance of shorter native grasses and forbs. The introduction of *Bromus tectorum* into these communities has altered fuel loads and fuel distribution. Fire drastically alters the community composition because salt-desert shrubs are not adapted to periodic fire. Livestock grazing is reported to decrease small mammal numbers in *Sarcobatus vermiculatus / Distichlis stricta* (=*Distichlis spicata)* vegetation in Nevada and adjacent California (Page and others 1978). *Distichlis spicata* is considered a grazing increaser. Grazing early in the growing season, when the upper part of the soil may be wet, can sometimes cause compaction.

Classification Comments: Saline soils and dominance by *Sarcobatus vermiculatus* distinguish this type from other ecological systems.

Related Concepts: This ecological system falls within the Desert Playa and Salt Scrub Shrublands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) recognizes the Inter-Mountain Basin Greasewood Flat as one of their standard mapping units.

References

Anderson, Michelle D. 2004. *Sarcobatus vermiculatus*. In: 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/

Brown, James K., Smith, Jane Kapler, eds. 2000. Wildland fire in ecosystems: effects of fire on flora. Gen.Tech. Rep. RMRS-GTR-42-vol. 2. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 257 p.

Cooper, D, Sanderson J, Stannard D, Groeneveld D. 2006. Effects of long-term water table drawdown on evapotranspiration and vegetation in an arid region phreatophyte community. Journal of Hydrology **325**: 21-34.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

LANDFIRE. 2007. Model for Inter-Mountain Basins greasewood Flat. BpS 0811530. Online: http://www.landfire.gov/NationalProductDescriptions24.php

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Page, J.L., Dodd, N., Osbornde, T.O. and Carson, J.A. 1978. The influence of livestock grazing on non-game wildlife. CALNEVA Wildlife. [Place of publication unknown]: The Wildlife Society, Western Section 159-173.

Description Author: Joe Rocchio, Rex Crawford, NatureServe Western Ecology Team.

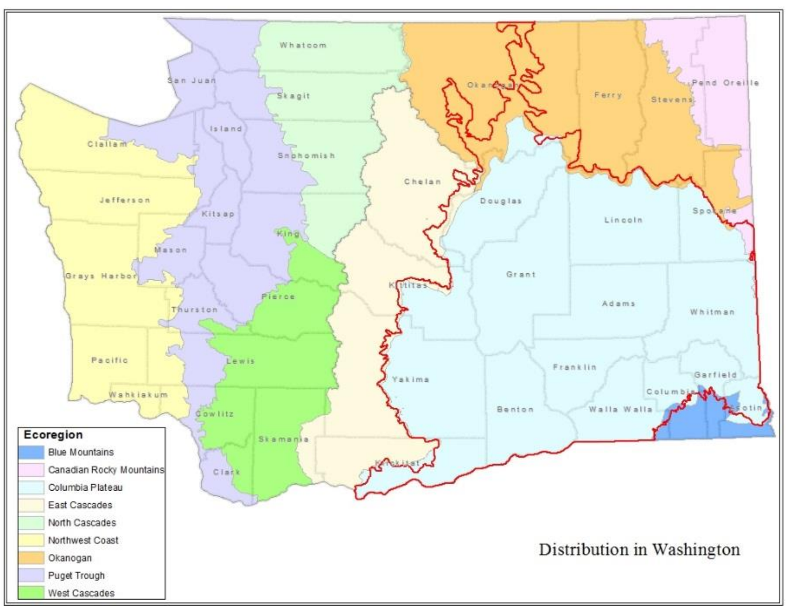
INTER-MOUNTAIN BASINS PLAYA

Concept: Intermittently flooded or groundwater supported basins with sparse to patchy vegetated plant cover (generally <10% cover) and highly saline soils which, without direct soil disturbance, have a soil crust on the surface. There is a high density of occurrences in northern Douglas County, where past glaciation left many landforms suitable for the development of this system. Playas are also common in the Swanson Lakes State Wildlife Area in Lincoln County and the lower Crab Creek area.


Photo by Rex Crawford

Conservation Status: Critically Imperiled (S1). The system is limited in Washington and most occurrences have been impacted by livestock grazing.

Distribution: The system occurs throughout much of the cool arid and semi-arid regions of the Columbia Plateau and Great Basin. In Washington, there is a high density of occurrences in northern Douglas County, where past glaciation left many landforms suitable for the development of this system. It is also common in the Swanson Lakes State Wildlife Area, Grand Coulee and the lower Crab Creek area. The distribution map depicts the extent of this system's distribution in Washington.



Environment: These wetlands are found in closed depressions or in terminal basins and are intermittently flooded with either surface and/or groundwater inputs. Soils are alkaline to saline and of a fine, clay texture with hardpans. Salt encrustations occur on the soil surface if not trampled by livestock.

Vegetation: This environment supports a flora adapted to seasonal soil saturation and highly saline conditions. Species composition varies with soil salinity and moisture and usually displays vegetation zones (Rocchio 2006). Playas are almost always unvegetated or sparsely vegetated at

their lowest elevation. Mud flats may appear with the salt flats. A few plants such as *Salicornia rubra* can appear on salt flats but they mostly lack vegetation. Salt-tolerant and halophytic species such as *Distichlis spicata*, *Suaeda occidentalis*, *Puccinellia lemmonii*, *Poa secunda*, *Spartina gracilis*, *Amphiscirpus nevadensis*, *Schoenoplectus maritimus*, *Schoenoplectus americanus*, *Triglochin maritima*, and *Salicornia rubra* are often found in vegetated areas around the outer perimeter. In Washington, the Inter-Mountain Basins Playa and the Inter-Mountain Basins Alkali Closed Depression broadly overlap (Rocchio and Crawford 2009), are difficult to distinguish. For examples, playas are almost always surrounded by moderately to densely vegetated zones that better fit the Inter-Mountain Basins Alkaline Closed Depression systems. This suggests that Inter-Mountain Basins Playa and Inter-Mountain Basins Alkaline Closed Depression could be considered a single ecological system. However, because the latter can occur without the former they have been kept separate here.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system.

G538 North American Desert Alkaline-Saline Herbaceous Wetland & Playa Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Distichlis spicata Herbaceous Vegetation	G5/S1?	CEGL001770
Puccinellia nuttalliana Herbaceous Vegetation	G3?/SNR	CEGL001799
Salicornia rubra Herbaceous Vegetation	G2G3/SNR	CEGL001999
Spartina gracilis Herbaceous Vegetation	GU/S2?	CEGL001588
Suaeda (calceoliformis, nigra, occidentalis) Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)

Ecological Processes: Playas occur on sites that are seasonally to semi-permanently flooded in winter and early spring and then usually drying by mid- to late-summer. Seasonal drying exposes salt and mud flats which are colonized by halophytic species. Although many definitions of playas describe them as closed basin systems with hydrological input limited to precipitation and surface runoff, the Inter-Mountain Basins Playa is subject to both surface and groundwater inputs. Precipitation and runoff characteristics in contributing basins are important to system function. During high precipitation years Inter-Mountain Basins Playa systems may have water for 3 to 4 months and during dry years not retain any standing water. Water usually does not percolate because of an impermeable layer. Water loss is primarily through evaporation that results in a high concentration of salts in the upper soil profile.

Threats: Direct alteration of hydrology (i.e., channeling, draining, damming) or indirect alteration (i.e., roads or removing vegetation on adjacent slopes) results in changes in the amount and pattern of herbaceous wetland habitat. In general, excessive livestock use leads to a shift in plant species composition. Native species, such as *Juncus balticus*, increase with excessive livestock use. Non-native plants or animals, which can have wide-ranging impacts, also tend to increase with these stressors. Several exotic species invade playas including *Cardaria* spp., *Chenopodium glaucum, C. rubra*, (*Salsola* spp.), *Bassia hyssopifolia*, and *Kochia scoparia*. Minor changes in the water table depth or duration of inundation can have profound effects on soil salinity, and consequently, wetland vegetation (Cooper and Severn 1992). Wetland animals, such as waterbirds, amphibians, or invertebrates are affected changes in hydrology.

Classification Comments: Higher soil salinity levels distinguish this system from other ephemeral wetlands such as vernal pools. In Washington, the Inter-Mountain Basins Playa and the Inter-Mountain Basins Alkali Closed Depression broadly overlap (Rocchio and Crawford 2009), are difficult to distinguish. They differ by: 1) vegetation cover (playa are typically sparse to patchily vegetated, generally <10% plant cover while closed depressions are moderately to densely covered by herbaceous plants), 2) soil chemistry (playas are considered more saline than closed depressions), and 3) hydrological regime (playas are more intermittently flooded; closed depressions are more seasonally to semi-permanently flooded). However, in Washington, the Inter-Mountain Basins Playa and the Inter-Mountain Basins Alkali Closed Depression broadly overlap (Rocchio and Crawford 2009) and are difficult to distinguish. For examples, playas are almost always surrounded by moderately to densely vegetated zones that better fit the Inter-Mountain Basins Alkaline Closed Depression systems. This suggests that these two systems could be considered a single type. However, because the alkaline closed depressions can occur without playa characteristics they have been kept separate here.

Related Concepts: This ecological system falls within the Desert Playa and Salt Scrub Shrublands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize the Inter-Mountain Basins Alkaline Closed Depression as a unique mapping unit and did not aggregate it into another mapping unit.

References

Cooper, D.J. and C. Severn. 1992. Wetlands of the San Luis Valley, Colorado: An Ecological Study and Analysis of the Hydrologic Regime, Soil Chemistry, Vegetation and the Potential Effects of a Water Table Drawdown. Unpublished report prepared for Colorado Division of Wildlife, U.S. Fish and Wildlife Service, and the Rio Grande Water Conservation District.

Haukos, D.A. and L.M. Smith. 2003. Past and Future Impacts of Wetland Regulations on Playa Ecology in the Southern Great Plains. Wetlands 23(3):

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Rocchio, F.J. 2006. Intermountain Basins Playa Ecological System Ecological Integrity Assessment. Colorado Natural Heritage Program Colorado State University Fort Collins, CO. Online: http://www.cnhp.colostate.edu/download/documents/2005/ecological_integrity/Intermountain%20Basins%20Playa_EIA_Dec09_05.pdf

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Rocchio, F.J. and R.C. Crawford. *In Progress*. Ecological Classification of Native Wetland & Riparian Vegetation of Washington State. Natural Heritage Report 20XX-XX. Washington Dept. of Natural Resources, Natural Heritage Program. Olympia, WA.

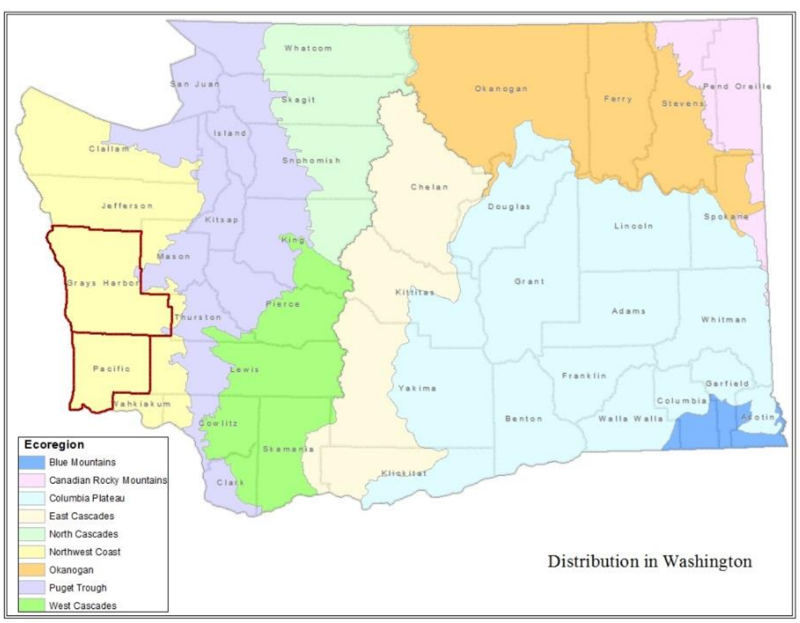
Description Author: Joe Rocchio, Rex Crawford, Jimmy Kagan, and Pat Comer.

NORTH PACIFIC COASTAL INTERDUNAL WETLAND

Concept: Herbaceous and woody-dominated wetlands with less than 40 cm organic soil layer located in small coastal interdunal depressions and extensive deflation plains behind stabilized foredunes. In Washington, these interdunal wetlands are primarily found along the southwest outer coast.

Conservation Status: Critically Imperiled (S1). Interdunal wetlands are geographically limited in extent being primarily found in southwest Washington coast from the Columbia River to just north of the Copalis River. The wetland type has experienced direct loss due to development and cranberry production. Dams on the Columbia River and nonnative, *Ammophila* spp. infestations on sand dunes have altered sand dynamics which has reduced the areas where new interdunal wetland formation can occur Internationally, interdunal wetlands are of significant conservation importance due to frequent association with many rare and endangered plant species and their associated fauna (Grootjans et al. 2004).

Distribution: This small patch system ranges from southern Oregon through the Aleutian Islands in Alaska. These wetlands are found along the southwest Washington coast, from the Columbia River to just north of the Copalis River. The distribution map depicts the counties within which the system occurs.



Environment: These wetlands typically occur behind stabilized foredunes. Foredunes are tall ridges created by sand-trapping vegetation. These wetlands occur in the swale between it and the next dune. Winter precipitation increases the water table and inundates some communities to a depth of 1 m (3 feet) with fresh or brackish water. Some wetlands are perched on an iron-cemented duripan, and groundwater pH ranges from 5.0-6.3 (6.9), with low conductivity. Soils are mineral sometimes with a thin organic layer (less than 40 cm (16 in)).

Vegetation: Depending on moisture and salinity gradients, interdunal wetlands are colonized by herbaceous species such as *Carex obnupta*, *Argentina egedii*, *Juncus lesueurii*, *Juncus falcatus* ssp. *sitchensis*, *Juncus nevadensis*, *Equisetum variegatum* and various other emergent species resembling wet meadows or marshes (Wiedemann 1984). Shrubs such as *Salix hookeriana* and *S. sitchensis* can be present particularly in older wetlands that gain characteristics of shrub swamps (Christy et al. 1998, Wiedemann 1984). Older slacks with persistent freshwater (near lakes and ponds) support conifer swamps with *Pinus contorta* var. *contorta*, *Picea sitchensis* or *Thuja plicata*.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Groups and Associations that are associated with this ecological system.

G256 North Pacific Maritime Hardwood-Conifer Swamp Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Pinus contorta var. contorta / Carex obnupta Forest	G2/S2	CEGL000142
G322 Vancouverian Wet Shrubland Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Malus fusca - (Salix hookeriana) / Carex obnupta Shrubland	G3/S2	CEGL003294
Salix hookeriana - Spiraea douglasii Shrubland	GNR/S1	CWWA000237
Salix hookeriana / Carex obnupta - (Argentina egedii ssp. egedii) Shrubland	G4/S1?	CWWA000140
Spiraea douglasii Shrubland	G5/S5	CEGL001129
G517 Vancouverian Freshwater Wet Meadow & Marsh Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Carex obnupta - Argentina egedii ssp. egedii Herbaceous Vegetation	G4/S2?	CEGL001820
Juncus falcatus - Juncus (lesueurii, nevadensis) Herbaceous Vegetation	G3/S1?	CWWA000093

Ecological Processes: Distinct landform and vegetation patterns are common to these dune systems. Most important for the formation of interdunal wetlands are the foredunes, which are tall ridges created by sand-trapping vegetation. As wind blows inland it erodes the sand behind foredunes down to the level of the water table. Depth to the water table in the swale or dune slack varies as the sand is actively eroded by wind. When sand is wet, it is more resistant to further erosion and interdunal wetlands are able to develop. A variety of moisture and salinity gradients occur due to variations in the depth of sand and distance from estuaries or ocean water. Seasonal rise in the water table also causes pools to form in forested sites on old deflation plains. In areas with many interdunal wetlands slight differences in elevation may initiate groundwater flow from one wetland to another (Grootjans et al. 2004). This primarily freshwater wetland system is 1) not tidally-influenced although maritime water can effect salinity and pH, 2) has a mineral soil sometimes with a thin organic layer and 3) is groundwater dependent with seasonal fluctuations. Under natural conditions, individual wetlands (slacks) are temporary being filled by sand or vegetation through succession to other wetland systems or isolated from the water table.

Threats: In addition to outright loss, many occurrences of this ecological system have undergone extensive degradation or change (being converted from one wetland type to another) due to stressors such as ditching, draining, nonnative species, nearby cranberry farms and development. The physical forms of dunes have been altered by invasion of European beachgrass (*Ammophila arenaria*), which has been extensively planted for stabilization purposes and has also spread widely on its own. *Ammophila arenaria* foredune stabilization decreases sand supply to backdune areas which leads to soil formation (Wiedemann and

Pickart 2004). Unstabilized sand is now a relatively rare condition primarily because of the introduction of this species and many deflation plains are much larger than their historical extent. It is not clear how this may affect vegetation patterns relative to historical conditions, however without dynamic dune systems, the diversity of structure within interdunal wetlands may homogenize, with shrubby and/or forested wetlands predominating.

Classification Comments: In Oregon and Washington interdunal wetlands had previously been included in other freshwater wetland ecosystems. However, this small patch system is only found embedded within the North Pacific Maritime Coastal Sand Dune and Strand system. As applied here, the North Pacific Interdunal wetland system includes all herbaceous, woody species-dominated wetlands with less than 40 cm organic soil layer within a coastal dune landscape. Where such wetlands develop peat over 40 cm they are included in the North Pacific Bog and Fen ecological system.

Related Concepts: This ecological system does not explicitly fall within any of the habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize North Pacific Coastal Interdunal Wetland as a unique mapping unit and did not aggregate it into another mapping unit.

References

Christy, J.A., J.S. Kagan, and A.M. Wiedemann. 1998. Plant associations of the Oregon Dunes National Recreation Area. Siuslaw National Forest, Oregon. US Department of Agriculture, Forest Service. PNW Region. Technical Paper R6-NR-ECOL-TP-09-98.

Grootjans, A.P., E.B. Adema, R.M. Bekker and E.J. Lammerts. 2004. Why Young Coastal Dune Slacks Sustain a High Biodiversity. 2004. *in* Coastal Dunes, Ecology and Conservation Ecological Studies 171. M.L.Martínez, N.P. Psuty (Eds.) Springer-Verlag.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat

Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Wiedemann A. M. 1984. The Ecology of Pacific Northwest Coastal sand dunes: a community profile. U.S. Fish Wildl. Serv. FWS/OBS-84/04.

Wiedemann, A.M. and A.J. Pickart. 2004. Coastal temperate zone climates. Ecological Studies 171: 53-65.

Description Author: Rex Crawford, Keith Boggs, Gwen Kittel, and John Christy.

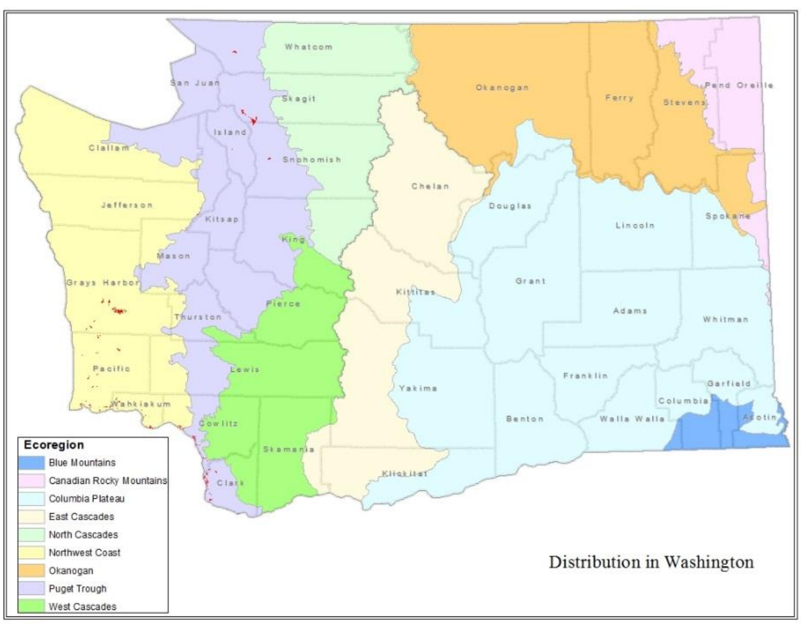
NORTH PACIFIC INTERTIDAL FRESHWATER WETLAND


Photo by Birdie Davenport

Concept: Tidally-influenced, freshwater herbaceous and woody wetlands. These wetlands occurs in narrow strips to more extensive patches along tidally-influenced portions of rivers along Washington's coastal margin, Columbia River, Chehalis River, and smaller streams exposed to tides.

Conservation Status: Critically Imperiled (S1). This system has a narrow ecological niche and has experienced significant loss and/or conversion from historical conditions due to various stressors. Although there are significant areas of this type left, most occurrences have been impacted to some degree, especially by nonnative species such as *Phalaris arundinacea*.

Distribution: This small patch ecological system is a tidally-influenced freshwater wetland occurring in small patches along the coastal margins and intertidal zones of the Pacific Northwest coast from Cook Inlet, Alaska, south to the central coast of Oregon (NatureServe 2007). In Washington, it occurs in narrow strips to more extensive patches along tidally-influenced portions of rivers along Washington's coastal margin and Columbia River, Chehalis River, and smaller streams exposed to tides.



Distribution in Washington

Environment: These wetlands are found along tidally influenced portions of rivers. This environment results when a heavier saltwater "wedge," pushes under freshwater. Freshwater then backs-up in rivers and sloughs spilling over on to adjacent floodplains. Overflow water is typically less than 0.5 parts per thousand salts (Kunze 1994).

Vegetation: Vegetation structure and composition varies and depend on substrate characteristics, elevation, and tidal flooding


Photo by Rex Crawford

regime of particular sites. The vegetation is complex and includes tree-, shrub- and herbaceous-dominated patches. The most common plant community may be the *Picea sitchensis* swamps that occur along many small and large tidally-influenced channels. *Alnus rubra* and *Populus balsamifera* ssp. *trichocarpa* dominated forests can also be found. Shrublands dominated by *Cornus sericea*, *Salix hookeriana*, *S. sitchensis*, and *Malus fusca* are also common. Herbaceous species include *Carex lyngbyei*, *Lysichiton americanus*, *Eleocharis spp.*, *Caltha palustris*, *Myriophyllum hippuroides, Typha angustifolia*, *Schoenoplectus acutus*, *S. tabernaemontani*, *Athyrium filix-femina*, and *Carex obnupta* (Callaway et al. 2012).

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Groups and Associations that are associated with this ecological system.

G254 North Pacific Lowland Riparian Forest & Woodland Group	Global/ State Rank	NatureServe/ WNHP Code
Alnus rubra / Rubus spectabilis / Carex obnupta - Lysichiton americanus Forest	G3G4/S3S4	CEGL003389
Populus balsamifera ssp. trichocarpa / Cornus sericea / Impatiens capensis Forest	G1/S1	CEGL003408
G256 North Pacific Maritime Hardwood-Conifer Swamp Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Picea sitchensis / Cornus sericea / Lysichiton americanus Forest	G2/S1	CEGL000055
Picea sitchensis / Rubus spectabilis / Carex obnupta - Lysichiton americanus Forest	G2G3/S2	CEGL000400
G322 Vancouverian Wet Shrubland Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Cornus sericea - Salix (hookeriana, sitchensis) Shrubland	G3/S1	CEGL003292
Malus fusca - (Salix hookeriana) / Carex obnupta Shrubland	G3/S2	CEGL003294
G517 Vancouverian Freshwater Wet Meadow & Marsh Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Carex obnupta Herbaceous Vegetation	G4/S4	CEGL003313
Eleocharis obtusa Herbaceous Vegetation [Provisional]	G4/SU	CEGL003326
Lilaeopsis occidentalis Herbaceous Vegetation [Provisional]	G3/S2	CEGL003329
Athyrium filix-femina Coastal Herbaceous Vegetation	G4?/S2	CWWA000048
Bidens frondosa Herbaceous Vegetation	G4/S1	CTWA003325
Caltha palustris - Lysichiton americanus Herbaceous Vegetation	G3/S2	CWWA000055
Carex interrupta Herbaceous Vegetation	G3G4/S3?	CWWA000176
Carex lyngbyei Herbaceous Vegetation	G4/S2	CEGL003369

G517 Vancouverian Freshwater Wet Meadow & Marsh Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Eleocharis ovata - Ludwigia palustris Herbaceous Vegetation	G2/S2	CWWA000217
Eleocharis palustris Pacific Coast Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Equisetum fluviatile Pacific Coast Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Schoenoplectus (acutus, tabernaemontani) Pacific Coast Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)

Ecological Processes: Daily, freshwater tidal fluctuations are a primary ecological driver. This environment results when a heavier saltwater "wedge," pushes under freshwater. Freshwater then backs-up in rivers and sloughs spilling over on to adjacent floodplains. Related topography is created by river flooding events of sediments and large woody debris deposition and daily scouring and reworking by tidal action.

Threats: Historical and contemporary land use practices have impacted hydrologic, geomorphic, and biotic structure and function of tidal areas in Washington. Hydrological alterations, especially those which alter tidal exchange, would have a negative effect on ecological processes and species composition. Natural sedimentation from the watershed changes elevation and the influence of tidally flooded areas. Reservoirs, water diversions, ditches, roads, and human land uses in the contributing watershed can also have a substantial impact on the hydrological regime. Channel flow and tidal inundation are disrupted by construction of jetties, dikes, and dams. Where hydrological alterations are long term, wetland systems may reestablish to reflect new hydrology. Timber harvesting changes stand structure, wildlife habitat, site topography. Human land uses both within the wetland as well as in adjacent upland areas have reduced connectivity between wetland patches and upland areas. Much of this system has been lost to diking and subsequent conversion to agriculture. Land uses in contributing the watershed have the potential to contribute excess nutrients into to the system which could lead to the establishment of non-native species and/or dominance of native increasing species. Invasive weeds such as *Phalaris arundinacea*, *Polygonum sachalinense*, and *Rubus armenicus* are problems in these freshwater wetlands

Classification Comments: This type is distinguished from the Temperate Pacific Salt and Brackish Marsh system by having overflow water that is typically less than 0.5 parts per thousand salts. Where small areas of mudflat occur in tidally influenced freshwater areas, they are included in this intertidal freshwater wetland and not in Temperate Pacific Freshwater Mudflat.

Related Concepts: This ecological system falls within the Westside Riparian-Wetlands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize North Pacific Coastal Interdunal Wetland as a unique mapping unit and but did aggregate it into the Pacific Coastal Marshes system.

References

Callaway, J.C., A.B. Borde, H.L. Diefenderfer, V.T. Parker, J.M. Rybczyk, and R.M Thom. 2012. Pacific Coast Tidal Wetlands. *In* Wetland Habitats of North America, Edited by D.P. Batzer and A.H. Baldwin. University of California Press. Los Angeles, CA.

Chappell, C. 2000. Intertidal Salt Marshes Appendix 11 Willamette Valley – Puget Trough – Georgia Basin Ecoregion Terrestrial Ecological System EO Specs and EO Rank Specs. *In* Floberg, J., M. Goering, G. Wilhere, C. MacDonald, C. Chappell, C. Rumsey, Z. Ferdana, A. Holt, P. Skidmore, T. Horsman, E. Alverson, C. Tanner, M. Bryer, P. Iachetti, A. Harcombe, B. McDonald, T. Cook, M. Summers, D. Rolph. 2004. Willamette Valley-Puget Trough-Georgia Basin Ecoregional Assessment, Volume One: Report. Prepared by The Nature Conservancy with support from the Nature Conservancy of Canada, Washington Department of Fish and Wildlife, Washington Department of Natural Resources (Natural Heritage and Nearshore Habitat programs), Oregon State Natural Heritage Information Center and the British Columbia Conservation Data Centre.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Kunze, L.M. 1994. Preliminary classification of native, low elevation, wetland vegetation in western Washington. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 120 pp.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Rocchio, F.J. and R.C. Crawford. *In Progress*. Ecological Classification of Native Wetland & Riparian Vegetation of Washington State. Natural Heritage Report 20XX-XX. Washington Dept. of Natural Resources, Natural Heritage Program. Olympia, WA.

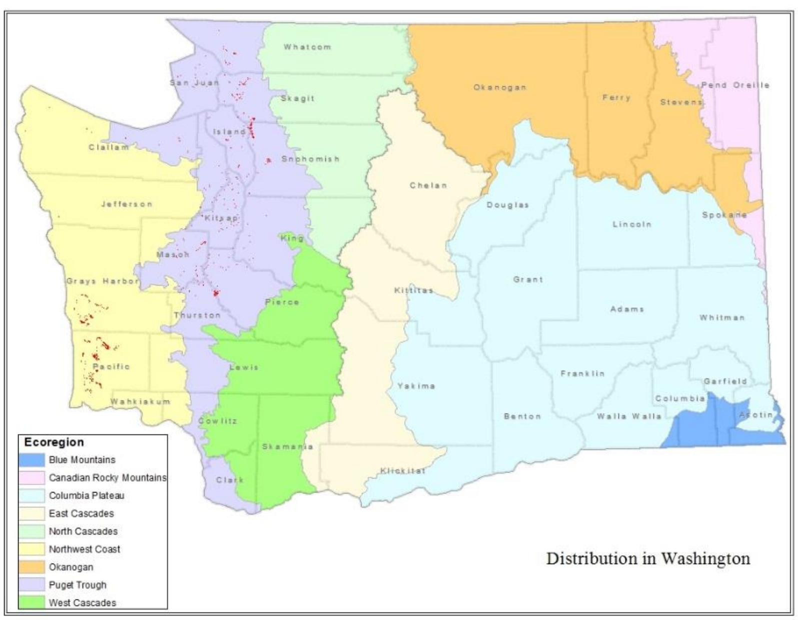
Description Author: Rex Crawford, Chris Chappell and Gwen Kittel.

TEMPERATE PACIFIC TIDAL SALT AND BRACKISH MARSH

Concept: Coastal salt and brackish marshes found in large bays on the outer coast and around the waters of Puget Sound. Occurrences are confined primarily to inter-tidal portions of estuaries, coastal lagoons and bays, and behind sand spits or other locations protected from wave action. Vegetation composition varies according to tidal fluctuations and varying degree of salinity (saline to brackish).

Conservation Status: Imperiled (S2). Significant amounts of this ecological system has been lost due to development, agriculture and conversion to other wetland types. Degradation has occurred across much of its range and in most occurrences.

Distribution: This is a small patch system found along the Pacific Coast, from south-central Alaska to the central California coast. In Washington, it occurs in large bays on the outer coast and around the waters of Puget Sound.



Environment: Occurrences are confined primarily to inter-tidal portions of estuaries, coastal lagoons and bays, and behind sand spits or other locations protected from wave action. Their associated specific environments are defined by ranges of salinity, tidal inundation regime, and soil texture. Vegetation usually occurs as a zonal mosaics of multiple communities due to variation in daily and seasonal dynamics of freshwater input balanced against evaporation and tidal flooding of saltwater. Summer-dry periods result in decreased freshwater inputs and thus higher salinity levels.

TIDAL/COASTAL WETLANDS

Vegetation: Low marshes are located in areas that tidally flood every day and are dominated by a variety of low-growing forbs and low to medium-height graminoids, especially *Salicornia virginica, Suaeda calceoliformis*, *Jaumea carnosa*, *Distichlis spicata*, *Schoenoplectus maritimus (= Scirpus maritimus)*, *Schoenoplectus americanus (= Scirpus americanus)*, *Carex lyngbyei*, and *Triglochin maritima*. High marshes are located in areas that flood infrequently and are dominated by medium-tall graminoids and low forbs, especially *Deschampsia caespitosa*, *Argentina egedii (=Potentilla pacifica)*, *Juncus balticus*, and *Symphyotrichum subspicatum (= Aster subspicatus)*. Transition zone (slightly brackish) marshes are often dominated by *Typha* spp. or *Schoenoplectus acutus (= Scirpus acutus)*, *Atriplex prostrata (= Atriplex triangularis)* and *Phragmites* spp.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system.

G499 Temperate Pacific Tidal Salt & Brackish Marsh Group	Global/ State Rank	NatureServe/ WNHP Code
Argentina egedii - Juncus balticus Herbaceous Vegetation	G3G4/S2	CEGL003382
Argentina egedii - Symphyotrichum subspicatum Herbaceous Vegetation	G3G4/S1	CEGL003288
Calamagrostis nutkaensis - Argentina egedii - Juncus balticus Herbaceous Vegetation	G1/S1	CEGL003421
Carex lyngbyei - (Distichlis spicata, Triglochin maritima) Herbaceous Vegetation	G4/S2	CEGL003285
Carex lyngbyei - Argentina egedii Herbaceous Vegetation	G4/S1?	CEGL003289
Deschampsia caespitosa - (Carex lyngbyei, Distichlis spicata) Herbaceous Vegetation	G3G4/S2	CEGL003357
Deschampsia caespitosa - Argentina egedii Herbaceous Vegetation	G3G4/S2	CEGL003383
Deschampsia caespitosa - Sidalcea hendersonii Herbaceous Vegetation	G2/SNA	CEGL003384
Distichlis spicata - (Salicornia virginica) Herbaceous Vegetation	G4/S2	CEGL003356
Festuca rubra - (Argentina egedii) Herbaceous Vegetation	G1/S1	CEGL003424
Festuca rubra - Juncus lesueurii Herbaceous Vegetation	G3/S1	CWWA000180
Glaux maritima Herbaceous Vegetation	G3/S1?	CEGL003286
Ruppia maritima Estuarine Herbaceous Vegetation	G5/SU	CWWA000187
Salicornia (bigelovii, virginica) Tidal Herbaceous Vegetation	GNRQ/SNA	CEGL003123
Salicornia virginica - Distichlis spicata - Triglochin maritima - (Jaumea carnosa) Herbaceous Vegetation	G3/S2	CEGL003366
Schoenoplectus (acutus, tabernaemontani) Brackish Coastal Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Schoenoplectus (americanus, pungens) Tidal Herbaceous Vegetation	G3/S2	CEGL003367
Schoenoplectus maritimus Tidal Herbaceous Vegetation	G3/S1	CEGL003287
Triglochin maritima - (Salicornia virginica) Herbaceous Vegetation	G4/S2	CEGL003381

Ecological Processes: This system is characterized as being dominated by emergent vegetation whose composition is influenced by tidal fluctuations and varying degrees of salinity (saline to brackish). Marine salt water circulation through a marsh is the most important factor in plant species distribution. Vegetation patches usually occur as zonal mosaics of multiple communities. Zones vary in location and abundance

with daily and seasonal dynamics of freshwater input balanced against evaporation and tidal flooding of saltwater. Summer-dry periods result in decreased freshwater inputs and thus higher salinity levels. Hyper-saline environments within salt marshes occur in "salt pans" where tidal water collects and evaporates.

Threats: Natural sedimentation from the watershed changes elevation and the influence of marine water in a salt marsh. Channel flow, tidal inundation, and fresh water discharges are disrupted by construction of seawalls, jetties, dikes, and dams. Plant species composition in the salt marsh varies along the salinity gradient of the estuary so that altered tidal or freshwater sources change expected species distributions based on their tolerance of saline conditions. If the alteration is long term, wetland systems may reestablish to reflect new hydrology. Human land uses both within the marshes as well as in adjacent upland areas have reduced connectivity between wetland patches and upland areas. Land uses in contributing the watershed have the potential to contribute excess nutrients into to the system which could lead to the establishment of non-native species and/or dominance of native increasing species. Invasive weeds, such as *Spartina* spp. are problems in many of these marshes. In general, excessive livestock or native ungulate use leads to a shift in plant species composition. Non-native plants or animals, which can have wide-ranging impacts, also tend to increase with these stressors.

Classification Comments: This system is characterized as being dominated by emergent vegetation whose composition is influence by tidal fluctuations and varying degree of salinity (saline to brackish). This system is distinguished from the North Pacific Intertidal Freshwater Wetland system by having water salinities above 0.5 parts per thousand salts.

Related Concepts: This ecological system falls within the Bays and Estuaries habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize Temperate Pacific Tidal Salt and Brackish Marsh as a unique mapping unit and but did aggregate it into the Pacific Coastal Marsh Systems unit.

References

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Rocchio, F.J. and R.C. Crawford. *In Progress*. Ecological Classification of Native Wetland & Riparian Vegetation of Washington State. Natural Heritage Report 20XX-XX. Washington Dept. of Natural Resources, Natural Heritage Program. Olympia, WA.

Description Author: Rex Crawford, Keith Boggs, Chris Chappell, Gwen Kittel, Todd Keeler-Wolf, and Marion Reid.

NORTH PACIFIC MARITIME EELGRASS BED

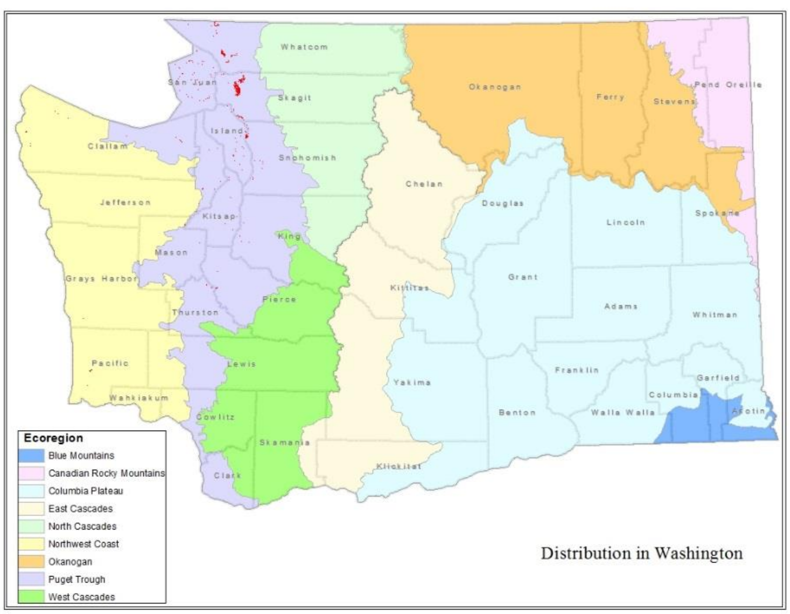
Concept: Periodically or permanently submerged marine shorelines capable of supporting eelgrass and or other seagrasses. Eelgrass beds are found in Grays Harbor, Willapa Bay, and portions of the Puget Sound. *Zostera marina* is the dominant species.

Conservation Status: Vulnerable (S3). There is some uncertainty about current ecological integrity, severity of threats, and long-term trends.


Photo by DNR-Nearshore Program

Distribution: Eelgrass beds are found throughout the coastal areas of the North Pacific Coast, from southern Oregon (Coos Bay) north into the Gulf of Alaska, Cook Inlet, and Bristol Bay coasts. In Washington, it is found in Grays Harbor, Willapa Bay, and portions of the Puget Sound.

Environment: *Zostera marina* requires sandy to muddy substrates and adequate light to allow for photosynthesis and is found in a variety of geographic and geomorphic settings. It tends to be found along relatively protected shorelines and within shallow embayments where water movement is sufficient to keep concentrations of nutrients in the water column relatively low but where wave action is such that movement and erosion of substrates and dislodging of shoots is minimal and sediment nutrient concentrations are moderate (DNR 2005). Light must generally exceed 11% of surface radiation and though *Z. marina* can tolerate water temperatures from 0°C to 40.5°C, and salinity from 0 – 35 ppt, optimum ranges for maximum photosynthesis/respiration rates and seed germination are narrower and vary locally. The combined physical requirements of *Zostera marina* usually result in eelgrass meadows being distributed



Distribution in Washington

between approximately 0 m MLLW and -15 m MLLW where water clarity is high (DNR 2005). Lower depth limits are controlled by light and upper limits by desiccation, thermal stress, and disturbance (including wave action, erosion of or burial by sediments, ice scour). Exact depth ranges vary depending on local natural and anthropogenic drivers. At upper depth limits, other seagrass species may be present.

Vegetation: This system is dominated by *Zostera marina*. Macrophytic algae may be present. In the Pacific Northwest, *Z. japonica* and occasionally *Ruppia maritima* may be found. Because *Z. japonica* is not native to this region and may displace *Z. marina* in shallower areas, its presence should be noted.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Association that are associated with this ecological system.

G373 Temperate Pacific Seagrass Group [Proposed]	**Global/ State Rank**	**NatureServe/ WNHP Code**
Zostera marina Pacific Coast Herbaceous Vegetation	G5/S4	CWWA000164

Ecological Processes: At broader geographic scales, processes that set the range of important determining factors include climate (precipitation, insolation, air and water temperatures, currents/upwelling/littoral cells), weather (timing of thermal stress and tides, timing and severity of storms, ice), tidal range (affects light and flushing), types and magnitudes of freshwater inputs (affects mean and variance in salinity), and marine and freshwater sources of sediments, suspended particulates, and dissolved nutrients (DNR 2005). Latitudinal and regional clines in these factors create related gradients in morphology, genetic diversity, rates of sexual reproduction, and associated epiphytic and benthic biota. Local geomorphic attributes and processes determining environmental factors include substrate, aspect, beach slope, fetch, tidal range or prism, sources of sediments, suspended particulates, and dissolved nutrients, and frequency of disturbances and mechanical damage caused by freezing, desiccation, ice, burial, and erosion (DNR 2005). Local processes also affect biological factors such as herbivory, disease, epiphytism, and competition for light (with seaweeds and phytoplankton).

Threats: There are an abundance of threats and stressors affecting this system. Shoreline modifications are assumed to have a direct impact on eelgrass but changes due to nutrient enrichment is less certain. In other parts of the world where eelgrass is found, there is a pretty strong relationship between coastal watershed development and eelgrass integrity. However, because of the upwelling of nutrient rich oceanic water in the Puget Sound and the high tidal range, the natural levels of nutrients in this area is higher than the current influx from adjacent, developed lands. Thus, eelgrass in the Puget Sound has evolved in a nutrient rich environment making correlations between eelgrass trends and human stressor difficult. There is little baseline data from which to base estimates of loss (Mumford 2007). However, Thom and Hallum (1991) estimated there was a 30% and 15% loss of area of eelgrass in Bellingham Bay and the Snohomish River delta, respectively. They also noted that eelgrass cover may have increased five-fold in Padilla Bay and that there is anecdotal evidence that suggest eelgrass may have decreased in distribution in selected areas of the south Puget Sound. Aquaculture can displace or degrade eelgrass beds. *Zostera japonica*, a nonnative species, can grow in shellfish beds. *Z. japonica* is one of the few eelgrass species in world that is spreading; but it doesn't grow at the same depth as *Z. marina*. In Willapa Bay, the shellfish industry is spraying *Z. japonica*, which may have a secondary effect on *Z. marina* populations but it is difficult to know how the applied herbicide are dispersing. Dredging of harbors can directly removal eelgrass and cause a temporary suspension of sediment which can shade out eelgrass. Dams on rivers could have an impact (positive or negative) on eelgrass by changing sedimentation dynamics. Eelgrass doesn't do well when buried but requires fine-sediment to thrive. Thus, a particular sediment regime allows the species to thrive. *Labyrinthula* (a natural occurring slime mold) is a vector for eelgrass wasting disease which causes decline in photosynthetic capabilities of eelgrass.

TIDAL/COASTAL WETLANDS

Classification Comments: This system is characterized as occurring in open marine water with rooted vascular plants (*Zostera marina*).

Related Concepts: This ecological system falls within the Bays and Estuaries habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize North Pacific Maritime Eelgrass Bed as a unique mapping unit and but did aggregate it into the Pacific Coastal Marshes system.

References

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Mumford, T.F. 2007. Kelp and Eelgrass in Puget Sound. Prepared in support of the Puget Sound Nearshore Partnership. Technical Report 2007-05.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Thom, R.M. and L. Hallum. 1991. Long-term Changes in the Areal Extent of Tidal Marshes, Eelgrass Meadows and Kelp Forests of Puget Sound. University of Washington, School of Fisheries, Fisheries Research Institute, Wetland Ecosystem Team. Prepared for U.S. Environmental Protection Agency, Office of Puget Sound, Region 10. Seattle, WA

Washington Department of Natural Resources (DNR). 2005. Temperate, Northern Pacific Zostera marina Meadow. DRAFT Element Occurrence Specification. Washington Department of Natural Resources Aquatics Division. Olympia, WA Washington Department of Natural Resources (DNR). 2015. Puget Sound Submerged Vegetation Monitoring Program: 2010-1013 Report. Washington Department of Natural Resources, Aquatic Resources Division, Nearshore Habitat Program. Olympia, WA

Description Author: Bart Christiaen and Joe Rocchio

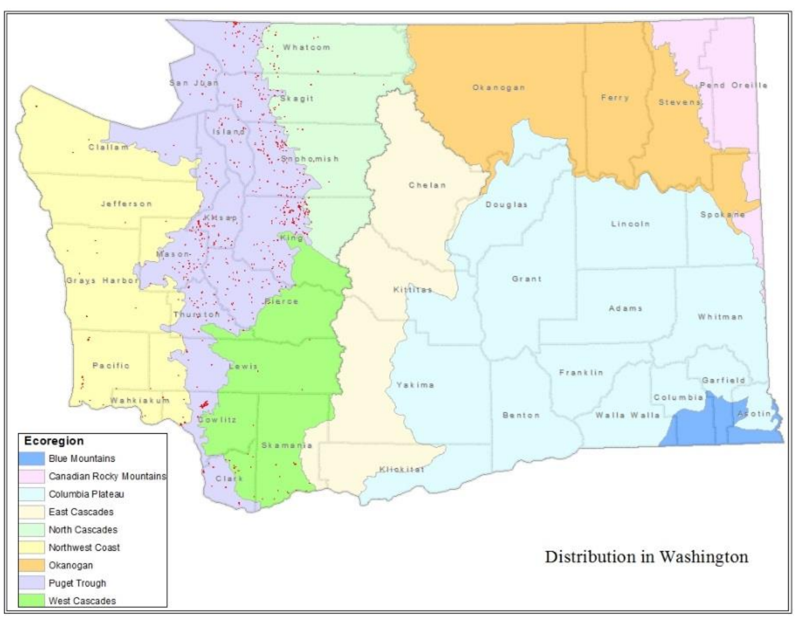
TEMPERATE PACIFIC FRESHWATER AQUATIC BED

Concept: Rooted or floating aquatic plants confined to lakes, ponds, and slow-moving portions of rivers and streams. These aquatic beds are found throughout western Washington, from the lowlands to the subalpine. The system is found in water too deep for emergent vegetation.

Conservation Status: Vulnerable (S3). This system remains relatively abundant on the landscape and may have even increased in some urban areas due to increased runoff creating more open water wetlands. However, many occurrences are degraded due to development, agriculture, and logging.

Distribution: This small patch system is found throughout the humid temperate regions of the Pacific Coast of North America. In Washington, this system this system is found throughout western Washington, from the lowlands to the subalpine.

Environment: This system is confined to lakes, ponds, oxbows, and slow-moving portions of rivers and streams. In large bodies of water, they are usually restricted to the littoral region where penetration of light is the limiting factor for growth. The system is found in water too deep for emergent vegetation.



Vegetation: Vegetation occurs as two general types of communities: floating (planmergent) and submerged communities. A third but less common type are peatland pools which are found in bogs and fens. Species found in floating (planmergent) communities include: *Azolla* spp., *Brasenia schreberi*, *Menyanthes trifoliata*, *Lemna* spp., *Nuphar lutea* ssp. *polysepala*, *Polygonum amphibium*, *Potamogeton* spp., *Ranunculus aquatilis*, *Callitriche* spp., *Schoenoplectus terminalis*, *Sparganium angustifolium*, *S. eurycarpum*, and *Wolffia* spp. *Nuphar lutea ssp. polysepala* communities are very abundant. Submerged vegetation can consist of *Myriophyllum* spp., *Ceratophyllum* spp., *Fontinalis* spp., *Elodea* spp., *Isoetes* spp., *Utricularia* spp. is often present.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system.

G544 Western North American Temperate Freshwater Aquatic Bed Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Azolla (filiculoides, mexicana) Herbaceous Vegetation	G4/S4	CEGL003017
Brasenia schreberi Western Herbaceous Vegetation	G4?/S3S4	CEGL005200
Callitriche (heterophylla, palustris) Herbaceous Vegetation	G4/S2	CEGL003301
Ceratophyllum demersum Western Herbaceous Vegetation	G5/S4S5	CEGL004017
Elodea canadensis Herbaceous Vegetation	G5/S4?	CEGL003303
Fontinalis antipyretica (var. antipyretica, var. oregonensis) Nonvascular Vegetation	G4G5/S4	CEGL003304
Hippuris vulgaris Herbaceous Vegetation	G5/S2	CEGL003315
Isoetes echinospora - (Lobelia dortmanna) Herbaceous Vegetation	GNR/SNR	TBD (Rocchio and Crawford *In Progress*)
Lemna minor Herbaceous Vegetation	G5/S5	CEGL003305
Menyanthes trifoliata Herbaceous Vegetation	G5/S4?	CEGL003410
Myriophyllum hippuroides Herbaceous Vegetation	G3/S2?	CEGL003331
Myriophyllum sibiricum Herbaceous Vegetation	GUQ/SNR	CEGL002000
Nuphar lutea ssp. *polysepala* Herbaceous Vegetation	G5/S4S5	CEGL002001
Polygonum amphibium Permanently Flooded Herbaceous Vegetation [Placeholder]	G5/S3?	CEGL002002
Potamogeton natans Herbaceous Vegetation	G5?/S5	CEGL002925
Ranunculus aquatilis Herbaceous Vegetation	G5/S4	CEGL003307
Sagittaria latifolia Herbaceous Vegetation	G2/S1	CEGL003321
Schoenoplectus subterminalis Herbaceous Vegetation	G3/S2?	CEGL003309
Sparganium angustifolium Herbaceous Vegetation	G4/S3S4	CEGL001990
Sparganium eurycarpum Herbaceous Vegetation	G4/S2S3	CEGL003323
Utricularia macrorhiza Herbaceous Vegetation	G5/S4	CEGL003310
Wolffia (borealis, columbiana) Herbaceous Vegetation	G4/S1?	CEGL003311

Ecological Processes: This system is restricted to the littoral region where penetration of light is the limiting factor for growth. The system is found in water too deep for emergent vegetation. Floating (planmergent) communities are restricted to ponds, small lakes, and sheltered bays of larger lakes as these communities are not tolerant of wave action (Pierce and Jensen 2002). Submergent community distribution is determined by water depth, water movement, and potentially substrate (Pierce and Jensen 2002).

Threats: There are no data sources that provide reliable estimates of loss. In fact, some stressors may have changed hydrology in favor of this system by increasing inundation of some depressions from increased runoff thereby increasing open water areas. Some loss may occur due to road construction, especially in the lowlands. High elevation examples have likely not been affected to any significant degree. Based on the author's observations, grazing, roads, logging, and nonnative species continue to impact many occurrences. Direct alteration of hydrology (i.e., channeling, draining, damming) or indirect alteration (i.e., roads or removing vegetation on adjacent slopes) results in changes in amount and pattern of herbaceous wetland habitat. If the alteration is long term, wetland systems may reestablish to reflect new hydrology, e.g., cattail is an aggressive. Excess nutrient inputs could lead to the establishment of non-native species and/or dominance of native increasing species. A keystone species, the beaver, has been trapped to near extirpation in parts of the Pacific Northwest and its population has been regulated in others. This may have led to a decrease in herbaceous wetlands (including aquatic bed habitat) in some portions of the landscape.

Classification Comments: This system is distinguished from the Temperate Pacific Freshwater Emergent Marsh by having a permanently flooded hydrological regime, deeper water, and dominance by floating (planmergent) or submergent vegetation. Aquatic bed communities in eastern Washington are included in the North American Arid Freshwater Emergent Marsh system.

Related Concepts: This ecological system falls within the Herbaceous Wetlands habitat type as identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize Temperate Pacific Freshwater Aquatic Bed as a unique mapping unit and did not aggregate it into another system.

References

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Pierce, J.R. and M.E. Jensen. A Classification of Aquatic Plant Communities within the Northern Rocky Mountains. Western North American Naturalist 62(3), pp. 257-265.

Rocchio, F.J. and R.C. Crawford. *In Progress*. Ecological Classification of Native Wetland & Riparian Vegetation of Washington State. Natural Heritage Report 20XX-XX. Washington Dept. of Natural Resources, Natural Heritage Program. Olympia, WA.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Description Author: Joe Rocchio, Gwen Kittel, Pat Comer, Chris Chappell, and Keith Boggs.

TEMPERATE PACIFIC FRESHWATER MUDFLAT

Concept: Freshwater, sparsely vegetated mud to extensive sods of herbaceous vegetation, which occur primarily in seasonally flooded shallow mudflats on floodplains. These mudflats are most commonly found along the lower Columbia River.

Conservation Status: Critically Imperiled (S1). The extent of this system has most likely been reduced and extant occurrences exist under a highly modified hydrological regime due to dams on the Columbia River. Nonnative species can be problematic in some sites.

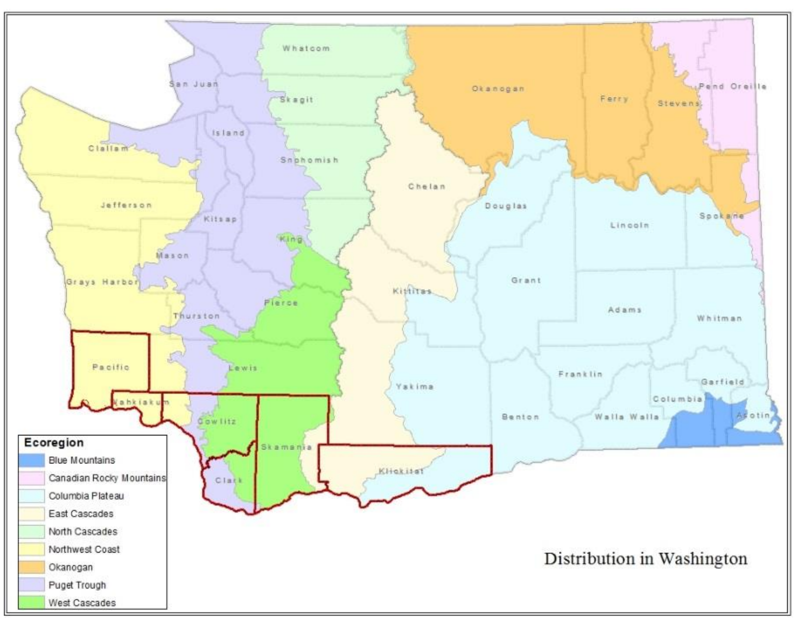
Distribution: This small patch system is scattered throughout the temperate regions of the Pacific Coast of North America. In Washington, it is most commonly found along the lower Columbia River.

Environment: This system is found on seasonally flooded, exposed mudflats on floodplains.

Vegetation: These mudflats are dominated primarily by low-stature annual plants. They range in physiognomy from sparsely vegetated mud to extensive sods of herbaceous vegetation. The predominant species include *Eleocharis obtusa*, *Lilaeopsis occidentalis*, *Crassula aquatica*, *Limosella aquatica*, *Gnaphalium palustre*, *Eragrostis hypnoides*, and *Ludwigia palustris*.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification Group and Associations that are associated with this ecological system.

G525 Temperate Pacific Freshwater Wet Mudflat Group	Global/ State Rank	NatureServe/ WNHP Code
Eleocharis obtusa Herbaceous Vegetation	G4/SU	CEGL003326
Eleocharis ovata - Ludwigia palustris Herbaceous Vegetation	G2/S2	CWWA000217
Eragrostis hypnoides - Gnaphalium palustre Herbaceous Vegetation [Provisional]	G2/SU	CEGL003327
Lilaeopsis occidentalis Herbaceous Vegetation	G3/S2	CEGL003329



Ecological Processes: During any one year, mudflats may be absent because of year-to-year variation in river water levels. Mudflats must be exposed before the vegetation develops from the seedbank.

Threats: Direct alteration of hydrology (i.e., channeling, draining, damming) or indirect alteration (i.e., roads or removing vegetation on adjacent slopes) results in changes in amount and pattern of herbaceous wetland habitat. Excess nutrient inputs could lead to the establishment of non-native species and/or dominance of native increasing species. Dams, irrigation withdrawals, and hydroelectric production was initiated on the Columbia River in the early 1930s. These activities, specifically the dams, have flattened the annual hydrological variability by decreasing high flows and increasing low flows and also decreasing velocity of water flows (NRC 2004). One effect of those changes is assumed to be less extent of mudflats since these areas would have been maintained by seasonal flooding, which would keep some areas free of perennial or woody vegetation, followed by subsequent low flows which would expose areas of primarily bare sediment. Thus, the dams on the Columbia River are assumed to have decreased extent and degraded quality of remaining sites. No data was found to provide specific information about how the current hydrological patterns have maintained mudflats.

Classification Comments: These mudflats are distinguished from Temperate Pacific Freshwater Aquatic Bed and Temperate Pacific Freshwater Emergent Marsh systems by being sparsely vegetated mud to extensive sods of herbaceous vegetation on seasonally flooded shallow mudflats on floodplains, especially along the lower Columbia River.

Related Concepts: This ecological system falls within the Herbaceous Wetlands habitat type identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize the Temperate Pacific Freshwater Mudflat as a unique mapping unit and did not aggregate it into any other mapping unit.

References

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

National Research Council (NRC). 2004. Managing the Columbia River. Instream Flows. Water Withdrawals, and Salmon Survival. National Research Council of the National Academies. The National Academies Press. Washington D.C.

Simenstad, C.A., J.L. Burke, J.E. O'Connor, and C. Cannon. 2011. Columbia River Estuary Ecosystem Classification--Concept and Application. U.S. Department of Interior, Geological Survey. Open-Filed Report 2011-1228.

Description Author: Chris Chappell and Joe Rocchio.

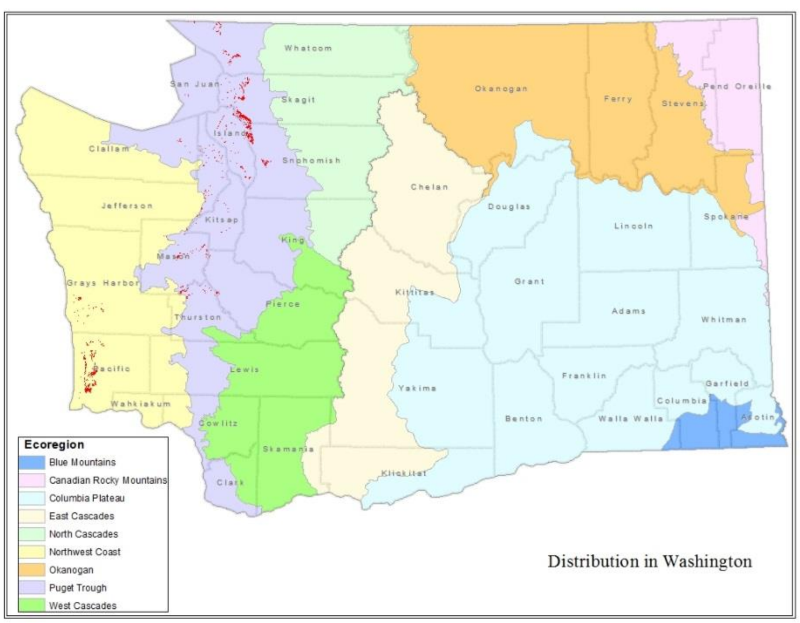
TEMPERATE PACIFIC INTERTIDAL FLAT

Concept: Sparsely vegetated flats within intertidal zones along the outer coast and along the shorelines of Puget Sound. These intertidal flats form a narrow band along oceanic inlets but are more extensive at the mouths of larger rivers. Algae are the dominant vegetation on mudflats where little vascular vegetation is present due to the daily (in some cases twice daily) tidal flooding of salt or brackish water.

Conservation Status: Vulnerable (S3S4).

Distribution: This ecological system is found along the north Pacific Coast from Kodiak Island and Cook Inlet, Alaska, south to central California. In Washington, it occurs within intertidal zones along the outer coast and along the shorelines of Puget Sound.

Environment: Bare flats form a narrow band along oceanic inlets, and are more extensive at the mouths of larger rivers.



Distribution in Washington

Vegetation: Algae are the dominant vegetation on flats where little vascular vegetation is present due to the daily (in some cases twice daily) tidal flooding of salt or brackish water. Characteristic species include *Vaucheria longicaulis* and *Enteromorpha* spp.

USNVC Associated Types: Classification of vegetation patterns in this system is needed to determine whether any repeatable plant associations occur.

Ecological Processes: Tidal prisms, channel flow, tectonic uplift or subsidence, isostatic rebound, and sediment deposition are primary drivers controlling the distribution and maintenance of this system.

Threats: The dredging and filling of marshes and tidal flats to serve various human needs remove estuarine vegetation and substrates. Channel flow, tidal inundation, and fresh water discharges are disrupted by construction of seawalls, jetties, dikes, and dams. The physical and chemical conditions of these habitats are degraded by the discharge of municipal, industrial, and agricultural effluents. Functional plant and animal communities are altered by domestic and agricultural runoff of pesticides, herbicides, and fertilizers. Invasions of exotic plants (e.g., *Spartina*) and invertebrates (e.g., green crabs) pose significant, long-term ecological and economic threats to this habitat. Large tracts of habitat have been lost and converted for coastal development. Additionally, upland activities occurring throughout the watershed, including logging, mining, and hydroelectric power development, can have destructive impacts downstream in estuarine and bay environments. Marcoe and Pilson (2011) estimated that between the years 1870-2011 there was a slight net gain of this system (increase of 2,739 acres) in the Lower Columbia River estuary. It is unclear whether this trend would hold true across the entire range of this system.

Classification Comments: This system consists of sparsely vegetated flats which occur within intertidal zones.

Related Concepts: This ecological system falls within the Bays and Estuaries habitat type identified in Johnson and O'Neil (2001). The Landscape Fire and Resource Management Planning Tools Project (i.e. LANDFIRE) does not recognize the Temperate Pacific Intertidal Mudflat as a unique mapping unit; however, they did aggregate it into the Pacific Coastal Dunes and Other Sparsely Vegetated Systems but did not map it.

References

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

Marcoe, K. and S. Pilson. 2011. Habitat Change in the Lower Columbia River and Estuary, 1870-2011. Lower Columbia River Estuary Partnership. Portland, Or. Online: http://www.estuarypartnership.org/historical-habitat-change-lower-columbia-river-1870-2010

Description Author: Joe Rocchio, Keith Boggs and Gwen Kittel.

APPENDIX A. USNVC GROUPS AND RELATED ECOLOGICAL SYSTEMS

G141 Northern Great Plains Mixedgrass Prairie Group
- Northern Rocky Mountain Montane-Foothill Deciduous Shrubland

G205 Vancouverian Dry Coastal & Lowland Beach Pine Forest & Woodland
- North Pacific Dry Douglas-fir Forest and Woodland
- North Pacific Maritime Coastal Sand Dune and Strand

G206 Cascadian Oregon White Oak - Conifer Forest & Woodland Group
- East Cascades Oak-Ponderosa Pine Forest and Woodland
- North Pacific Oak Woodland
- Northern Rocky Mountain Mesic Montane Mixed Conifer Forest
- Willamette Valley Upland Prairie and Savanna

G210 Central Rocky Mountain Douglas-fir - Pine Forest Group
- Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest
- Northern Rocky Mountain Foothill Conifer Wooded Steppe
- Northern Rocky Mountain Ponderosa Pine Woodland and Savanna

G211 Central Rocky Mountain Mesic Grand Fir - Douglas-fir Forest Group
- Northern Rocky Mountain Mesic Montane Mixed Conifer Forest
- Northern Rocky Mountain Western Larch Savanna

G212 East Cascades Mesic Grand Fir - Douglas-fir Forest Group
- East Cascades Mesic Montane Mixed-Conifer Forest and Woodland

G213 Central Rocky Mountain Ponderosa Pine Woodland & Savanna Group
- Northern Rocky Mountain Foothill Conifer Wooded Steppe
- Northern Rocky Mountain Ponderosa Pine Woodland and Savanna

G215 Middle Rocky Mountain Montane Douglas-fir Forest & Woodland Group
- Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest

G217 Central Rocky Mountain Interior Western Red-cedar - Western Hemlock Forest Group
- Northern Rocky Mountain Mesic Montane Mixed Conifer Forest

G218 Rocky Mountain Subalpine Moist Spruce - Fir Forest & Woodland Group
- Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland

G219 Rocky Mountain Subalpine Dry-Mesic Spruce - Fir Forest & Woodland Group
- Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland

G220 Rocky Mountain Lodgepole Pine Forest & Woodland Group
- Rocky Mountain Lodgepole Pine Forest

G222 Rocky Mountain Subalpine & Montane Aspen Forest & Woodland Group
- Rocky Mountain Aspen Forest and Woodland

G223 Northern Rocky Mountain Whitebark Pine - Subalpine Larch Woodland Group
- Northern Rocky Mountain Subalpine Woodland and Parkland

G237 North Pacific Red Alder - Bigleaf Maple - Douglas-fir Forest Group
- North Pacific Broadleaf Landslide Forest and Shrubland

North Pacific Maritime Mesic-Wet Douglas-Fir Western Hemlock Forest

G240 North Pacific Maritime Douglas-fir - Western Hemlock Forest Group

North Pacific Maritime Dry-Mesic Douglas-Fir Western Hemlock Forest

North Pacific Maritime Mesic-Wet Douglas-Fir Western Hemlock Forest

G241 North Pacific Maritime Silver Fir - Western Hemlock Forest Group

North Pacific Dry-Mesic Silver Fir-Western Hemlock-Douglas-fir Forest

North Pacific Mesic Western Hemlock-Silver Fir Forest

G245 North Pacific Mountain Hemlock - Silver Fir Forest & Tree Island Group

North Pacific Maritime Mesic Subalpine Parkland

North Pacific Mountain Hemlock Forest

G248 Columbia Plateau Western Juniper Woodland & Savanna Group

Columbia Plateau Western Juniper Woodland and Savanna

G254 North Pacific Lowland Riparian Forest & Woodland Group

North Pacific Intertidal Freshwater Wetland

North Pacific Lowland Riparian Forest and Shrubland

G256 North Pacific Maritime Hardwood-Conifer Swamp Group

North Pacific Coastal Interdunal Wetland

North Pacific Hardwood-Conifer Swamp

North Pacific Intertidal Freshwater Wetland

G267 Central Rocky Mountain Montane Grassland Group

Northern Rocky Mountain Subalpine-Upper Montane Grassland

G268 Southern Rocky Mountain Montane-Subalpine Grassland Group

Northern Rocky Mountain Subalpine-Upper Montane Grassland

G271 Rocky Mountain Subalpine-Montane Mesic Herbaceous Meadow Group

North Pacific Alpine and Subalpine Dry Grassland

North Pacific Maritime Mesic Subalpine Parkland

Rocky Mountain Subalpine-Montane Mesic Meadow

G272 Central Rocky Mountain Montane-Foothill Deciduous Shrubland Group

Northern Rocky Mountain Montane-Foothill Deciduous Shrubland

G273 Central Rocky Mountain Lower Montane, Foothill & Valley Grassland Group

Columbia Basin Palouse Prairie

Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland

G284 North Pacific Bog & Acidic Fen Group

North Pacific Bog and Fen

North Pacific Shrub Swamp

G285 North Pacific Neutral - Alkaline Fen Group

North Pacific Bog and Fen

G300 Intermountain Shadscale - Saltbush Scrub Group

Inter-Mountain Basins Wash

G302 Intermountain Mesic Tall Sagebrush Shrubland & Steppe Group

Inter-Mountain Basins Big Sagebrush Steppe

G304 Intermountain Mountain Big Sagebrush Shrubland & Steppe Group

Inter-Mountain Basins Montane Sagebrush Steppe

G305 Central Rocky Mountain High Montane Mesic Shrubland Group
North Pacific Montane Shrubland
G307 Columbia Plateau Scabland Shrubland Group
Columbia Plateau Scabland Shrubland
G308 Intermountain Low & Black Sagebrush Shrubland & Steppe Group
Columbia Plateau Low Sagebrush Steppe
G310 Intermountain Semi-Desert Shrubland & Steppe Group
Inter-Mountain Basins Semi-Desert Shrub-Steppe
G311 Intermountain Semi-Desert Grassland Group
Columbia Basin Foothill and Canyon Dry Grassland
G317 North Pacific Alpine-Subalpine Dwarf-Shrubland & Heath Group
North Pacific Dry and Mesic Alpine Dwarf-Shrubland, Fell-Field and Meadow
G320 North Pacific Alpine-Subalpine Turf & Herbaceous Meadow Group
North Pacific Dry and Mesic Alpine Dwarf-Shrubland, Fell-Field and Meadow
G322 Vancouverian Wet Shrubland Group
North Pacific Avalanche Chute Shrubland
North Pacific Bog and Fen
North Pacific Coastal Interdunal Wetland
North Pacific Intertidal Freshwater Wetland
North Pacific Lowland Riparian Forest and Shrubland
North Pacific Montane Riparian Woodland and Shrubland
North Pacific Shrub Swamp
Rocky Mountain Subalpine-Montane Fen
Rocky Mountain Subalpine-Montane Riparian Shrubland
Temperate Pacific Freshwater Aquatic Bed
G336 Great Plains Wet Prairie, Wet Meadow & Seepage Fen Group
North American Arid West Emergent Marsh
G373 Temperate Pacific Seagrass Group [Proposed]
North Pacific Maritime Eelgrass Bed
G488 Southern Vancouverian Shrub & Herbaceous Bald, Bluff & Prairie Group
North Pacific Herbaceous Bald and Bluff
North Pacific Hypermaritime Shrub and Herbaceous Headland
Willamette Valley Upland Prairie and Savanna
G498 North Pacific Maritime Coastal Scrub & Herb Beach & Dune Group
North Pacific Maritime Coastal Sand Dune and Strand
Willamette Valley Upland Prairie and Savanna
G499 Temperate Pacific Tidal Salt & Brackish Marsh Group
Temperate Pacific Tidal Salt and Brackish Marsh
G505 Rocky Mountain & Great Basin Swamp Forest Group
Northern Rocky Mountain Conifer Swamp
Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland
Rocky Mountain Subalpine-Montane Fen
Rocky Mountain Subalpine-Montane Riparian Woodland

G506 Rocky Mountain & Great Basin Montane Riparian Forest Group
Northern Rocky Mountain Conifer Swamp
Rocky Mountain Subalpine-Montane Fen
G507 North Pacific Montane Riparian Woodland Group
North Pacific Montane Riparian Woodland and Shrubland
Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland
G510 Inland West Ruderal Riparian Forest & Scrub Group
Ruderal Woody Wetlands
G515 Rocky Mountain Acidic Fen Group
Rocky Mountain Subalpine-Montane Fen
G516 Rocky Mountain Neutral - Alkaline Fen Group
Rocky Mountain Subalpine-Montane Fen
G517 Vancouverian Freshwater Wet Meadow & Marsh Group
North Pacific Coastal Interdunal Wetland
North Pacific Intertidal Freshwater Wetland
Temperate Pacific Freshwater Emergent Marsh
Willamette Valley Wet Prairie
G520 Vancouverian & Rocky Mountain Subalpine Snowbed, Wet Meadow & Dwarf-Shrubland Group
Rocky Mountain Alpine-Montane Wet Meadow
Temperate Pacific Subalpine-Montane Wet Meadow
G521 Vancouverian & Rocky Mountain Montane Wet Meadow Group
Columbia Plateau Vernal Pool & Modoc Basalt Vernal Pool
North American Arid West Emergent Marsh
Rocky Mountain Alpine-Montane Wet Meadow
Temperate Pacific Subalpine-Montane Wet Meadow
G524 Western North American Semi-natural Wet Shrubland, Meadow & Marsh Group
Ruderal Herbaceous Wetlands
G525 Temperate Pacific Freshwater Wet Mudflat Group
Temperate Pacific Freshwater Mudflat
G526 Rocky Mountain & Great Basin Lowland & Foothill Riparian Shrubland Group
Columbia Basin Foothill Riparian Woodland and Shrubland
G527 Western Montane-Subalpine Riparian & Seep Shrubland Group
Rocky Mountain Subalpine-Montane Fen
Rocky Mountain Subalpine-Montane Riparian Shrubland
G529 North Pacific Vernal Pool Group
Columbia Plateau Vernal Pool & Modoc Basalt Vernal Pool
North Pacific Hardpan Vernal Pool
G531 Arid West Interior Emergent Marsh Group
North American Arid West Emergent Marsh
G537 North American Desert Alkaline-Saline Shrub Wetland Group
Inter-Mountain Basins Greasewood Flat
G538 North American Desert Alkaline-Saline Herbaceous Wetland & Playa Group

Inter-Mountain Basins Alkaline Closed Depression
Inter-Mountain Basins Playa

G544 Western North American Temperate Freshwater Aquatic Bed Group
Temperate Pacific Freshwater Aquatic Bed

G565 Rocky Mountain Cliff, Scree & Rock Vegetation Group
Inter-Mountain Basins Cliff and Canyon; Rocky Mountain Cliff, Canyon, and Massive Bedrock

G573 Southern Vancouverian Cliff, Scree & Rock Vegetation Group
North Pacific Montane Massive Bedrock, Cliff and Talus

G610 North Pacific Maritime Poor Fen & Bog Forest & Woodland Group
North Pacific Bog and Fen

G647 North Pacific Maritime Coastal Sand Dune Semi-natural Scrub & Herb Vegetation Group
Ruderal Herbaceous Uplands
Ruderal Woody Uplands

G751 North Pacific Western Hemlock - Sitka Spruce - Western Red-cedar Seasonal Rainforest Group [Proposed]
North Pacific Hypermaritime Sitka Spruce Forest
North Pacific Hypermaritime Western Red-cedar-Western Hemlock Forest

G796 Northern Rocky Mountain Lowland & Foothill Riparian Forest Group
Columbia Basin Foothill Riparian Woodland and Shrubland
Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland
Columbia Plateau Vernal Pool & Modoc Basalt Vernal Pool

G800 Southern Vancouverian Dry Douglas-fir - Madrone Woodland Group
North Pacific Dry Douglas-fir Forest and Woodland

APPENDIX B – MISREPORTED AND EXTIRPATED ECOLOGICAL SYSTEMS

BOREAL DEPRESSIONAL BOG

This system has been incorrectly mapped as occurring in eastern Washington (Sayre et al. 2009). Climatic conditions do not appear to be conducive for the formation of true bogs in eastern Washington. No peatlands in eastern Washington have the diagnostic characteristics of this system which includes: (1) ombrotrophic substrates, in which the bog surface is raised above the surface/ground water table and (2) low ericaceous shrubs, and (3) occasional presence of *Picea glauca* and *Larix laricina*. Acidic, *Sphagnum*-dominated peatlands of eastern Washington better fit the Rocky Mountain Subalpine-Montane Fen ecological system.

Chadde et al. (1998) and Bursik and Moseley (1995) note small microsites of "ombrotrophic bog" in some Northern Rocky Mountain peatlands. Bursik and Moseley (1995) list *Sphagnum fuscum*, *S. magellanicum*, *S. centrale*, *S. angustifolium*, and *Polytrichum commune* as dominating these microsites. However, other than *S. fuscum*, none of those species are strong indicators of ombrotrophic habitats as they can all occur in acidic, slightly minerotrophic fens and *S. centrale* is typically found in circumneutral or even rich fens (Andrus 2004). Upon field visits to peatlands in northeastern Washington noted by Chadde et al. (1998) and Bursik and Moseley (1995), no hummocks or microsites were observed that supported true bog vegetation. Tall hummocks supporting oligotrophic *Sphagnum fuscum* and *S. capillifolium* were observed but in all cases minerotrophic vascular plants were rooted in these hummocks suggesting that minerotrophic groundwater was near the surface. Although characteristic bog species such *Kalmia microphylla*, *Drosera* spp., and *Vaccinium oxycoccos* are found in a few poor fens in eastern Washington, the predominant vegetation of these sites consists of various *Carex* species, *Salix* spp. and forbs that are typically considered minerotrophic indicators. Additionally, oligotrophic *Sphagnum* species such as *S. fuscum, S. capillifolium, S. magellanicum,* and *S. rubellum* never form a continuous cover in these sites. If present, they are limited to the tops of tall, sporadic hummocks or occasionally small lawns or carpets, suggesting minerotrophic water is at the peat surface and limiting their ability to thrive over large areas. When large patches of Sphagnum are present they are typically minerotrophic species such as *Sphagnum teres*, *S. warnstorfii*, *S. squarrosum*, etc.

References

Andrus, R. E. 2004. Sphagnaceae. *In* Bryophyte Flora of North America, Volume 1. Introduction, Acrocarpous Mosses, Part 1. Online: http://www.efloras.org/flora_page.aspx?flora_id=50

Bursik, R.J. and R.K. Moseley. 1995. Ecosystem Conservation Strategy for Idaho Panhandle Peatlands. Idaho Department of Fish and Game, Boise, Idaho.

Chadde, S.W., J.S. Shelly, R.J. Bursik, R.K. Moseley, A.G. Evenden, M. Mantas, F. Rabe, and B. Heidel. 1998. Peatlands on National Forests of the Northern Rocky Mountains: Ecology and Conservation. United States Dept. of Agriculture, Forest Service. Rocky Mountain Research Station. General Technical Report RMRS-GTR-11.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

COLUMBIA PLATEAU ASH AND TUFF BADLAND

This system had been previously reported as occurring in Washington (Sayre et al. 2009) but field observations suggest this was in error. Areas in Washington with similar floristics occur on glacial lake deposits as opposed to ash and tuff. The latter area is included in the Inter-Mountain Basins Semi-Desert Shrub Steppe system (p. 165). Thus, unless the definition of this system was expanded to include a broader range of substrates, it is not thought to occur in Washington.

References

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

COLUMBIA PLATEAU SILVER SAGEBRUSH SEASONALLY FLOODED SHRUB-STEPPE

There is uncertainty as to whether this type historically occurred but has since been extirpated from Washington or if it never occurred in the state. Areas mapped as this system are likely the Columbia Basin Foothill Riparian Woodland and Shrubland, Inter-Mountain Basins Big Sagebrush Steppe or Inter-Mountain Basins Semi-desert Shrub-Steppe systems.

INTER-MOUNTAIN BASIN BIG SAGEBRUSH SHRUBLAND

This system was previously thought to occur in Washington (Sayre et al. 2009). However, after much review of the system concepts and numerous field visits, DNR-Natural Heritage Program ecologists are of the opinion that areas matching the description of this system in Washington are actually degraded areas or simply areas of dense cover of sagebrush within the Inter-Mountain Basins Big Sagebrush Steppe and Inter-Mountain Basins Semi-Desert Shrub-Steppe. Bunchgrass cover in Washington's portion of the Columbia Basin is too high to match the definition of this system.

References

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

INTER-MOUNTAIN BASINS INTERDUNAL SWALE WETLAND

This system is not mapped as occurring in the State (Sayre et al. 2009) nor has it been found during field inventories. However, it may have historically been found in the sand dune areas near Moses Lake prior to irrigation development (Harris 1954).

References

Harris, S.W. 1954. Ecological study of the waterfowl of the potholes area, Grant County, Washington. Am. Midland Nat. 52(2):403-432.

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

INTER-MOUNTAIN BASINS MIXED SALT DESERT SCRUB

This system is not believed to occur in Washington. What is currently mapped (Sayre et al. 2009) as this system better fits the Inter-Mountain Basins Semi-Desert Shrub-Steppe system. Areas with *Grayia spinosa*, *Krascheninnikovia lanata*, on Ringold formation in Hanford area and on glacial lake flood deposits and old sand dune deposits might better fit into the Inter-Mountain Basins Semi-Desert Shrub Steppe system (p. 165) or Inter-Mountain Basins Active and Stabilized Dune Ecological System (p. 228).

References

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

INTER-MOUNTAIN BASINS SEMI-DESERT GRASSLAND

This system has not observed in Washington. However, if it does occur, it would not be distributed as currently depicted on the Ecological Systems map (Sayre et al. 20009).

References

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

NORTH PACIFIC LOWLAND MIXED HARDWOOD-CONIFER FOREST

DNR-Natural Heritage Program ecologists are of the opinion that this system, as mapped in Washington (Sayre et al. 2009), reflects early seral stands or recently disturbed areas associated with the North Pacific Maritime Dry-Mesic and North Pacific Mesic-Wet Douglas-fir-Western Hemlock Forest systems or occurrences of the North Pacific Broadleaf Landslide Forest and Shrubland. In western Washington, hardwoods such as *Alnus rubra* and *Acer macrophyllum* are primarily found in disturbed areas (whether natural or anthropogenic in nature). Since anthropogenically-induced mixed hardwood-conifer stands are likely to persist in the long-term, an argument could be made to acknowledge the system. However, given that these stands are due to human-induced disturbances it seems more accurate to either include them as ruderal vegetation or disturbed areas of the previously mentioned forest systems.

References

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

NORTHERN ROCKY MOUNTAIN WOODED VERNAL POOL

This system is not currently mapped as occurring in Washington (Sayre et al. 2009). Vernal pools near Spokane (e.g., Turnbull National Wildlife Refuge) may fit this Ecological System. The pools in these areas aren't treed but do occur in a forested or woodland landscape. Additional inventory and assessment of these pools are needed. Until such research is conducted those vernal pools are included as part of the Columbia Basin Vernal Pool system.

References

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

ROCKY MOUNTAIN POOR-SITE LODGEPOLE PINE FOREST

As described by NatureServe, DNR-Natural Heritage Program ecologists are of the opinion that this system does not occur in Washington. Areas mapped as this type (Sayre et al. 2009) are likely the Rocky Mountain Lodgepole Pine Forest system.

References

Sayre, R., P. Comer, H. Warner, and J. Cress. 2009. A New Map of Standardized Terrestrial Ecosystems of the Conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p.

APPENDIX C - RUDERAL AND CULTURAL VEGETATION

Ruderal vegetation includes those areas found on human-disturbed sites such as abandoned farmland, quarries, roadsides, CRP lands, or areas dominated by invasive species where those areas no longer support diagnostic species of a given Ecological System (Faber-Langendoen et al. 2014). Ruderal types may include components of the larger regional species pool but otherwise have a distinctive composition that differ from the Ecological Systems described in this document.

Although specific Ecological Systems were not defined for ruderal types, the U.S. National Vegetation Classification includes semi-natural or ruderal vegetation types. Below are a list of ruderal types that have been documented in Washington. This is not an exhaustive list. Ruderal vegetation types have not been thoroughly inventoried or classified and new ruderal types are continuously being recognized.

G510 Inland West Ruderal Riparian Forest & Scrub Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Elaeagnus angustifolia Ruderal Woodland	n/a	CEGL005269
Tamarix spp. Temporarily Flooded Ruderal Shrubland	n/a	CEGL003114
G524 Western North American Semi-natural Wet Shrubland, Meadow & Marsh Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Agrostis (gigantea, stolonifera) Ruderal Herbaceous Vegetation	n/a	CEGL001558
Phalaris arundinacea Western Herbaceous Vegetation	n/a	CEGL001474
Phragmites australis Western North America Temperate Ruderal Herbaceous Vegetation	n/a	CEGL001475
Poa pratensis Semi-natural Seasonally Flooded Herbaceous Vegetation	n/a	CEGL003081
G647 North Pacific Maritime Coastal Sand Dune Semi-natural Scrub & Herb Vegetation Group	**Global/ State Rank**	**NatureServe/ WNHP Code**
Ammophila arenaria Semi-natural Herbaceous Vegetation	n/a	CEGL003006
Cytisus scoparius Semi-natural Shrubland [Placeholder]	n/a	CEGL003045
GNEW North Pacific Ruderal Riparian and Swamp Forest	**Global/ State Rank**	**NatureServe/ WNHP Code**
TBD	n/a	n/a

References

Faber-Langendoen, D., T. Keeler-Wolfe, D. Meidinger, D. Tart, B. Hoagland, C. Josse, G. Navarro, S. Ponomarenko, J.P. Saucier, A. Weakley, and P. Comer. 2014. EcoVeg: a new approach to vegetation description and classification. Ecological Monographs 84 (4) pp. 533-561.